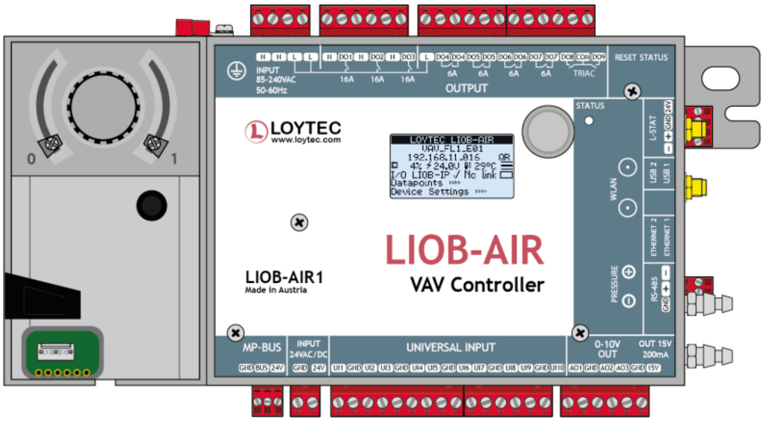
LIOB-AIR

LIOB-AIR™ VAV Controller

User Manual

LOYTEC electronics GmbH



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Contents

Abbreviations

100Base-T .... 100 Mbps Ethernet network with RJ-45 plug
Aggregation......................... Collection of several CEA-709 packets into a single CEA-852 packet
AST .... Alarming, Scheduling, Trending
BACnet .... Building Automation and Control Network
BBMD................................. BACnet Broadcast Management Device
BDT .... Broadcast Distribution Table
BOOTP .... Bootstrap Protocol, RFC 1497
CA .... Certification Authority
CEA-709 .... Protocol standard for LONWORKS networks
CEA-852 .... Protocol standard for tunneling CEA-709 packets over IP channels
CN .... Control Network
COV .... change-of-value
CR .... Channel Routing
CS.. Configuration Server that manages CEA-852 IP devices
DA....................................... Data Access (Web service)
DHCP.................................. Dynamic Host Configuration Protocol, RFC 2131, RFC 2132
DIF, DIFE .... Data Information Field, Data Information Field Extension
DL .... Data Logger (Web service)
DNS .... Domain Name Server, RFC 1034
DST.................................... Daylight Saving Time
EEP .... EnOcean Equipment Profile
GMT................................... Greenwich Mean Time
IP .... Internet Protocol
IP-852................................. logical IP channel that tunnels CEA-709 packets according CEA-852
LAN .... Local Area Network
LSD Tool .... LOYTEC System Diagnostics Tool
MAC .... Media Access Control
MD5 .... Message Digest 5, a secure hash function, see Internet RFC 1321
M-Bus .... Meter-Bus (Standards EN 13757-2, EN 13757-3)
MIB .... Management Information Base
MS/TP .... Master/Slave Token Passing (this is a BACnet data link layer)
NAT .... Network Address Translation, see Internet RFC 1631
NV...................................... Network Variable
OPC.................................... Open Process Control
OPC UA .... OPC Unified Architecture
PEM .... Privacy Enhanced Mail
PLC .... Programmable Logic Controller
RNI..................................... Remote Network Interface
RSTP .... Rapid Spanning Tree Protocol (Standard IEEE 802.1D-2004)
RTT.................................... Round-Trip Time

RTU .... Remote Terminal Unit
SCPT .... Standard Configuration Property Type
SSH..................................... Secure Shell
SL .... Send List
SMTP .... Simple Mail Transfer Protocol
SNMP .... Simple Network Management Protocol
SNTP .... Simple Network Time Protocol
SSL .... Secure Socket Layer
STP .... Spanning Tree Protocol (Standard IEEE 802.1D)
TLS..................................... Transport Layer Security
UCPT.................................. User-defined Configuration Property Type
UI.. User Interface
UNVT................................. User-defined Network Variable Type
UTC.................................... Universal Time Coordinated
VIF, VIFE........................... Value Information Field, Value Information Field Extension
WLAN .... Wireless LAN
XML .... eXtensible Markup Language

1 Introduction

1.1 Overview

LIOB-AIR is a fully IP based variable air volume controller (VAV controller) with a predefined, flexible, reprogrammable application program and sophisticated management functions for a building ventilation system

The L-STUDIO AIR designer supports fast and flexible project design meeting any VAV system requirements. Each VAV controller has a BACnet, a CEA 709 and an OPC network interface and integrates seamlessly into every BMS. The graphic pages for operation, supervision, and device configuration are hosted on the LIOB-AIR eliminating the need for a Tridium or whatsoever middleware component. Without any additional effort, L-STUDIO AIR seamlessly integrates into the LWEB-900 building management system. Local trending and alarming provide in depth operating conditions to the BMS. Local scheduling allows reliable zone operation even if the network is down. Sophisticated DCV algorithms safe energy and 24/7 online test algorithms ensure proper system operation and detect malfunctioning devices like a blocked damper actuator, a stuck reheat valve, a dead series fan, etc.

Communication can be established via Ethernet or via the optional meshed WLAN. The dual Ethernet interface allows daisy chaining VAV controllers for simple network wiring. The optional built-in WLAN supports diversity antennas for reliable wireless communication in a self-healing meshed network topology. A dedicated port connects the L-STAT thermostat for user interaction and configuration tasks. The built-in damper actuator communicates via MP-Bus and provides detailed status information. The built-in differential pressure sensor is used to measure the air flow. A number of universal inputs and analog and digital outputs can be configured to connect additional sensors and actuators.

1.2 LIOB-AIR Models

The LIOB-AIR devices are available in 3 different hardware models:

LIOB-AIR1, LIOB-AIR2, LIOB-AIR13.

LIOB-AIR1 is the device with the maximum capabilities.

LIOB-AIR2 equal to LIOB-AIR1 but does not support WLAN, no BACnet MS/TP, no 16A relays and no 85-230 Volts power supply. (WLAN is available using the LWLAN-800 wireless LAN interface).

LIOB-AIR13 equal to LIOB-AIR2 but with built-in WLAN support, but no built- in damper actuator. External damper actuators can be connected.

Figure 1 shows the different LIOB-AIR models.

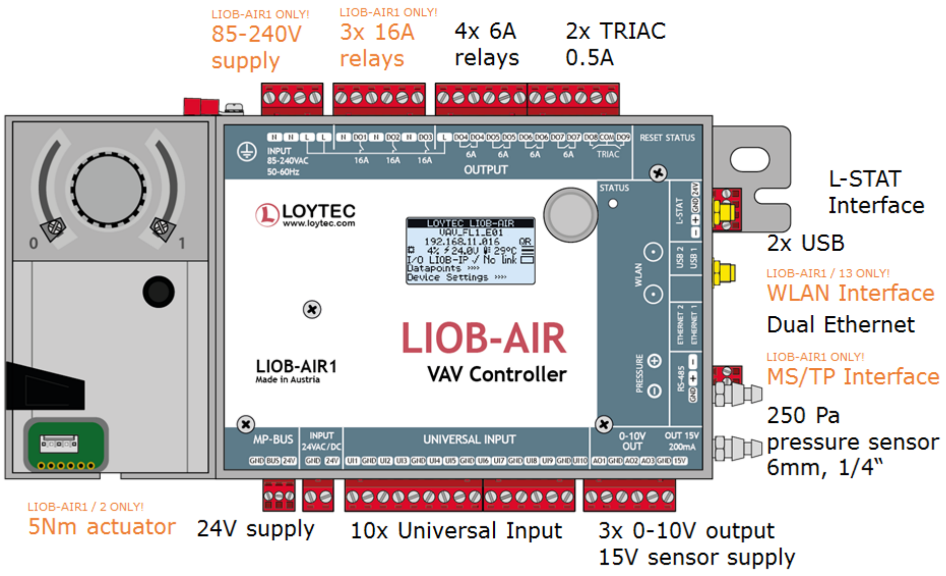

Figure 1: Different LIOB-AIR models

This Section provides an overview of the different LIOB-AIR models in Table 1. This table identifies the different features of those models. Models that possess a certain feature have a check mark (**✓**) or a value entry in the respective column. If a feature is not available in the particular model, the column is left blank.

Model / Features	LiOB-AIR1	LiOB-AIR2	LiOB-AIR13
Universal Inputs UI	10	10	10
Analog Outputs AO	3	3	3
Digital Outputs Relay 16A	3		
Digital Outputs Relay 6A	4	4	4
Digital Outputs Triac 0.5A	2	2	2
Pressure Sensor 0…250 Pa	✓	✓	✓
Built-in Damper Actuator	✓	✓	
Built-in L-STAT Interface	✓	✓	✓
CEA-709 Router			
CEA-709 RNI			
CEA-709 (FT)			
CEA-852 (IP)	✓	✓	✓
BACnet Router	✓		
BACnet MS/TP	✓		
BACnet IP	✓	✓	✓
BBMD	✓	✓	✓
Modbus RTU			
Modbus IP	✓	✓	✓
M-Bus			
SMI			
KNX TP1			
KNX IP			
EnOcean	✓[5]	✓[5]	✓[5]
OPC XML-DA	✓	✓	✓
OPC UA	✓	✓	✓
OPC Client	✓	✓	✓
SNMP	✓	✓	✓
PLC (IEC 61131)			
LIOB Connect			
LIOB FT			
LIOB IP	✓	✓	✓
LCD Display	✓	✓	✓
Serial Console			
SD Card			
USB	✓	✓	✓
Ethernet Switch/Hub	✓	✓	✓
WLAN	✓	✓[5]	✓
SSH, HTTPS, Firewall	✓	✓	✓

[5] To operate these protocols an expansion module is needed and must be ordered separately.

Table 1: Available features in different LIOB-AIR models.

1.3 Scope

This document covers LIOB-AIR devices with minimum firmware version 6.1 and describes specific functions of those device models. Basic device operations are covered in the LOYTEC Device User Manual [1] and data point configuration is covered by the L-INX Configurator User Manual [2].

2 What's New in LIOB-AIR

2.1 New in LIOB-AIR 2.1.3

This section describes the major changes and new features. For a full list of changes, refer to the Readme file.

2.1.1 Relative Humidity control

The rel. humidity sensor function with humidity control and humidity alarming was added. The humidity control calculates a humidification o dehumidification request that is aggregated to the AHU control by the manager. For details, see chapter 7.5.10.

2.1.2 Enable / Disable AHU Data Aggregation

For every device, it can be defined if the device data is aggregated or not. If there are small rooms or less important rooms or for maintenance purposes also, the data aggregation can be disabled for this device. For details, see chapter 7.6.1.

2.1.3 Weight Factor for AHU Data Aggregation

For every device, a dedicated weight factor for data aggregation can be defined. If there are large rooms or more important rooms, the data aggregation can be weighted for this device or room so it gets more impact to the aggregated data. For details, see chapter 7.6.1.

2.1.4 Effective Setpoint Aggregation

Additionally to the existing data points, the effective setpoint of the space temperature control is aggregated as minimum, maximum, summary and number of setpoints. This can be used for supply air setpoint reset in the AHU control. For details, see chapter 7.6.1.4 and chapter 7.7.1.4.

2.1.5 AHU Data Class Aggregation

Additionally to the existing method of value aggregation as minimum, maximum and summary a new method class aggregation is implemented now. That means that e.g. the damper position is classified if it is actually operating in a predefined position range 0-25%, 25-50%, 50%-75%. 75-90%, >90%. The aggregation counts all the devices that have e.g. the damper position in the dedicated classes. This class aggregation is realized for damper positions, terminal loads, humidification and dehumidification demands, occupancy states and HVAC mode requests. For details, see chapter 7.6.1 and chapter 7.7.

2.1.6 Optimum Start

Additionally to occupancy scheduler an Optimum Start function is operating in the “Master” device of a VAV Group. It calculates the optimum time to start WARMUP or PRE_COOL to ensure that the space temperature has reached the next scheduled setpoint at the scheduled time. It requests the HVAC Modes WARMUP or PRE_COOL to the AHU. For details, see chapter 7.5.12.4.

2.1.7 Night reset of Setpoint Offset

The external setpoint offset is reset to 0°C or 0°F every night to save energy. This function can be enabled or disabled. For details, see chapter 7.5.6.3.

2.1.8 Energy Demand Limiting

To save energy during the summertime the energy demand of the zones can be reduced by raising the cooling setpoint. The AHU control sends a request of Energy Demand Limiting (EDL Request) this raises the cooling setpoints in the zones by individually adjustable offsets. For details, see chapter 7.5.6.2.

2.1.9 Fans with ECM motors

ECM motors are highly energy efficient and allow a variable speed operation even if the fan is always running on constant speed. It is selectable during the runtime if the fan is operating variable or constant speed. It is also selectable if the variable speed fan performs a direct start or a smooth start. For details, see chapter 7.5.14.

2.1.10 Anti-backward rotation start of fans

To prevent the series (and parallel) fans starting with backward rotation, the primary air damper is closed for an adjustable duration before energizing the fan. The anti-backward rotation start function can be enabled or disabled individually. For details, see chapter 7.5.14.

2.1.11 Series Fan switches off if room is Unoccupied

The series fan has a new logic and it usually switches off if the room is unoccupied. However, in dedicated HVAC modes or on heating or cooling requests the series fan is switched on even if the room is unoccupied. For details, see chapter 7.5.14.1.

2.1.12 Damper Release

There are some defined cases when the damper is closed independent of the flow control output. These cases to lock the damper are:

1. Close the damper in Unoccupied mode (can be enabled/disabled).

2. Close the damper if series or parallel fan is on in HVAC_OFF mode.

3. Close the damper if the fan requests an anti-backward rotation start.

For details, see chapter 7.5.13.1.

2.1.13 Discharge Air Control with Stratification Limitation

The calculation of the discharge air temperature setpoint is limited by an adjustable maximum difference value to the current space temperature to prevent stratification effects of warm air in the room and to ensure ventilation efficiency. For details, see chapter 7.5.8.2. Additionally an alarm function monitors the discharge over temperature above the current space temperature. In case the discharge over temperature increases above an adjustable limit, the stratification alarm is triggered. For details, see chapter 7.5.8.4.

2.1.14 Peripheral Heat Actuators

The peripheral heat units supply additional heating energy to the peripheral zones of the building. It can be realized as radiators or convectors using hot water or electrical energy. There are modulating, floating or On Off actuators available. A Winter Minimum Position function can be parameterized to prevent “cold feet” or condensation effects in peripheral zones with large glass facades in wintertime. . For details, see chapter7.5.16.

2.1.15 Individual CEA 709 data point interface

The complete CEA 709 data point interface with synchronization to all User registers and Favorites is no longer supported by the VAV application. The CEA 709 data points and the synchronization can be created individually according to the project demands. For details, see chapter 6.6.1.

3 Software Tools Installation

To build a VAV-System based on the LOYTEC LIOB-AIR VAV-Controller the following software tools are needed and have to be installed on an engineering PC.

These tools are only needed to engineer and maintain a project but they are not needed later during the operation of the VAV-System.

3.1.1 L-STUDIO AIR

This is the LOYTEC engineering tool to configure the various VAV-Types in a project, create the LIOB-AIR Device-Types and combine different devices to Area Types and Floor Types. The VAV-System of the whole building can be created in a very fast and efficient workflow. With a powerful, deploy function the VAV software is downloaded in multiple devices simultaneously. Please download the L-STUDIO AIR engineering tool from www.loytec.com Support > Download > products > LIOB-AIR1 and install it on your engineering PC.

3.1.1.1 L-STUDIO AIR License

L-STUDIO needs a proper license to be executed on your PC. This license will be generated by LOYTEC depending on the hardware information of the PC.

After you have installed L-STUDIO, please start the License Manager from the Windows Start Menu as shown in Figure 2.

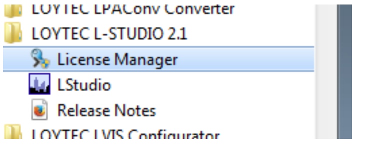

Figure 2: Start the License Manager

Please select the „Node locked“ option and enter your Name, Company, Email and Country. Then press the “Get HW Info” button to generate the hardware information as shown in Figure 3.

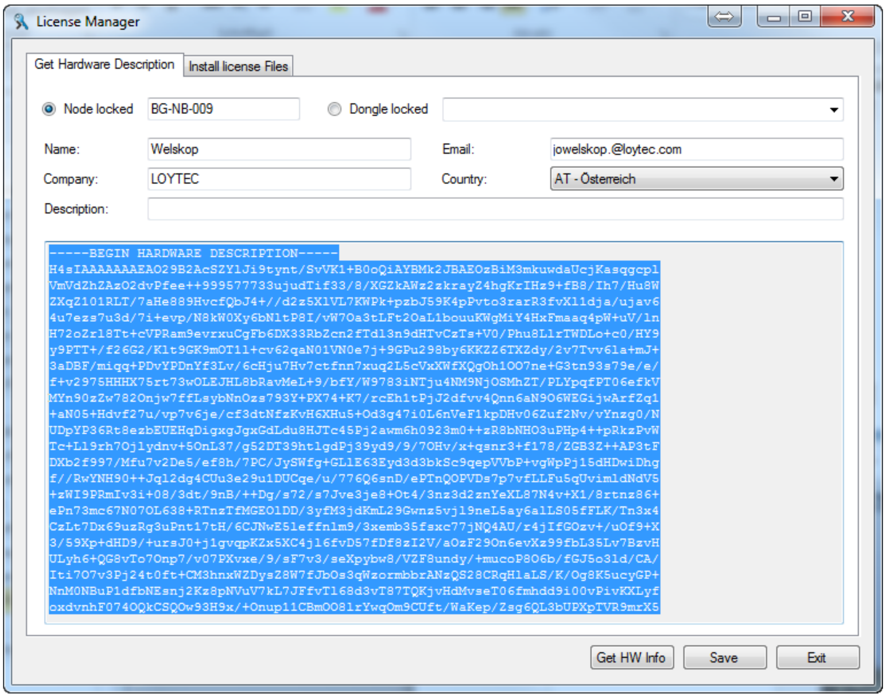

Figure 3: License Manager

The next step is to press the “Save” button which saves the hardware information file “*.zhwdb64”. Please send this file to sales@loytec.com and request an L-STUDIO license.

After receiving your license file start the License Manager again, go to the “Install License Files” tab and press the “Install license files…” button.

3.1.1.2 L-STUDIO VAV Library

This is a 70019102-LIOB_AIR_Library-pck-xxxx.exe file, which contains all the needed libraries to build and run a VAV system. A “VAV Start” sample solution is included as well. Please download the L-STUDIO AIR library from www.loytec.com Support > Download > Libraries/Templates, select “LIOB-AIR Library xxxx” and install it on your engineering PC.

3.1.2 L-INX Configurator

This is the LOYTEC configurator to setup devices and data points of LIOB-AIR VAV-Controllers, L-INX Automation Severs, L-IOB Modules and Controllers, L-DALI Controllers and L-GATE devices. Please download the L-INX configurator tool from www.loytec.com Support > Download > products > LIOB-AIR1 and install it on your engineering PC.

3.1.3 L-VIS Configurator

This is the LOYTEC configurator to build graphical LWEB-802/803 pages for the L-WEB system on PC or mobile devices. In addition, the L-VIS Touch Panel can be configured with the L-VIS Configurator. Please download the L-VIS configurator tool from www.loytec.com Support > Download > products > LIOB-AIR1 and install it on your engineering PC.

3.1.4 LWEB-802 Visualization Software

It is also possible to run the visualization with LWEB-802. This is a platform independent graphical user interface to visualize graphical projects in a standard web browser. LWEB-802 works on Microsoft Windows, MacOS, Android or iOS and so it is able to operate also on mobile devices. This is already built into the LIOB-AIR device!

3.1.5 LWEB-900 Building Management Software

This is the advanced Engineering and Building Management Software for LOYTEC devices.

During the engineering process, it can be used as a tool to setup multiple parameters of VAV-Systems very efficiently in a short time. It also provides a very efficient firmware upgrade function, backup and restore functions as well as alarm functions.

During the lifetime of the VAV-System, LWEB900 can also be used as a powerful building management system.

If LWEB-900 is used as a tool to increase efficiency during the engineering process and is not used as a building management system, a Competence Partner License is needed only!

To get the LWEB-900 software and license please contact sales@loytec.com

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4 Hardware Installation

4.1 Enclosure

The enclosure of the product and its terminal layout are shown on the installation sheet found in the product’s box.

4.2 Product Label

The product label on the LIOB-AIR contains the following information (for an example see Figure 4):

- LIOB-AIR order number with bar-code (e.g. LIOB-AIR1),
- Serial number with bar code (Ser#).

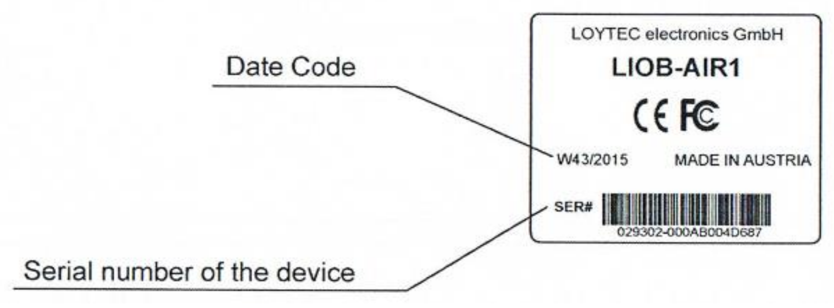


Figure 4: Example product label.

Unless stated otherwise, all bar codes are encoded using “Code 128”. An additional label is also supplied with the device for documentation purposes. The specific contents of the product label are shown on the installation sheet found in the product’s box.

4.3 Mounting

The device comes prepared for mounting in VAV-Boxes. The device can be mounted in any position. However, an installation place with proper airflow must be selected to ensure that the device’s temperature does not exceed the specified range (see Chapter 11).

4.4 LED signals

The LIOB-AIR device is equipped with a three-color status LED, which indicates the current state of the device resp. of it's I/Os as listed in Table 2.

Behavior	Description	Comment
OFF	No Power	The device is not powered or still booting.
GREEN	Normal Operation	The device is powered and has finished booting.
ORANGE	Manual Mode	At least one I/O is in manual mode.
RED	Error	An error has occurred (e.g. a sensor is disconnected or signals an error).

Table 2: Status LED Patterns of LIOB-AIR

4.5 Status Button

The LIOB-AIR device is equipped with a status button (see product installation sheet). When pressing the status button shortly during normal operation of the device, a service pin message (CEA-852) and I-Am message (BACnet) is sent out.

The status button can also be used to switch the device back to factory default state. Press the button and power-cycle the device. Keep the button pressed until the Status LED illuminates orange permanently. Release the button within five seconds from that time on to reset the device to factory defaults.

4.6 Wiring

The wiring information of the product and its terminal layout are shown on the installation sheet found in the product's box.

5 Getting Started

5.1 Introduction

This chapter describes how to engineer a simple one device VAV-System based on the LOYTEC LIOB-AIR VAV-Controller. It will show the workflow using L-STUDIO AIR in a step-by-step description. Please note that the whole process only includes configuration steps and that no programming skills are needed.

Please note that this is only the first information to get started. To get more details please refer to the chapters following the "Getting Started" chapter. The complete workflow is described in chapter 7.2.

LOYTEC also provides a ready to use standard VAV application as a standalone VAV controller. This can be restored into the LIOB-AIR device using the WebUI. It runs directly on the device without being configured and deployed by the L-STUDIO-AIR engineering tool. The procedure using the standard VAV application is described in chapter 7.4.

5.2 First VAV Project

5.2.1 Example VAV scheme

The VAV Box scheme in our Example looks like Figure 5. We will create the LIOB-AIR1 VAV application to control this type of VAV Box.

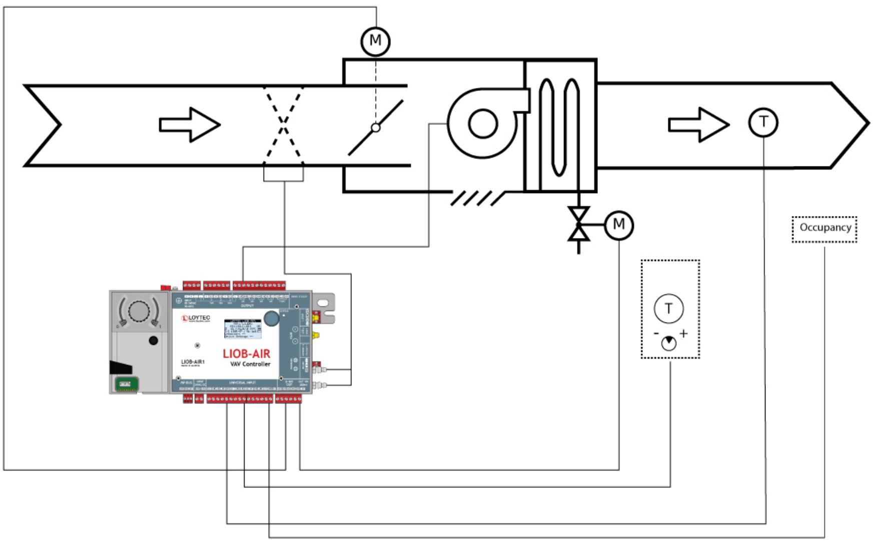


Figure 5: Example VAV Box scheme

5.2.2 Hardware Installation and IP Address Setup

The LIOB-AIR controller is connected to the network using one of the Ethernet/IP ports or WLAN. The device must be powered either with 24 VAC/DC or with 85-240 VAC (check the front label of the LIOB-AIR device). After the device has booted, the initial IP address must be configured on the LCD UI. This is done by selecting the IP address ("192.168.1.254") in the LCD UI using the jog dial, see Figure 6. After that, select "Ethernet 1" and setup the IP address, mask, and gateway or, alternatively, enable DHCP. Finally, select "Save and reboot". All other settings can further be performed with the WebUI of the LIOB-AIR controller.

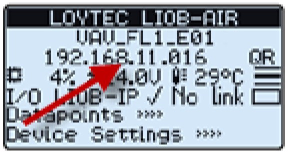


Figure 6: Select IP address in LIOB-AIR display

5.2.3 Workflow

To create and engineer a VAV system LOYTEC provides the engineering system L-STUDIO AIR and a VAV library for LIOB-AIR controllers. Since the LIOB-AIR controllers have been created, configured and deployed using L-STUDIO AIR they have to be parameterized using the built in LWEB-802/803 visualization projects or using LWEB900 parameter views.

L-STUDIO AIR is operating with types and instances. Once a type is created, it can be instantiated multiple times in other types or in the application. Any modification of a type is automatically applied to all instances of this type. With the strict use of the type concept a VAV solution can be set up, operated, and maintained very efficiently.

5.2.3.1 Basic Workflow Overview

To build the example VAV system the following steps have to be proceeded:

1. **Create a new VAV solution:** This is based on the "VAV Start Solution" that provides ready to use VAV_Types with functions, data points and visualizations, VAV_Device_Types with a Standard I/O configuration and instantiated VAV_Types, and Manager_Types.

2. **Define the VAV_Types:** The VAV functions are defined by selecting the needed sensors and actuators as e.g. Space Temperature Control, IAQ Control, MP-Bus Damper, Reheat Hot Water Modulating, etc. This is done based on existing VAV_Types of the VAV library with a maximum functionality, deleting the functions not needed.

3. **Define the VAV_Device_Types:** The VAV_ Types have to be instantiated in a concrete Hardware type like LIOB-AIR1, or LIOB-AIR2, or LIOB-AIR13. The local I/O has to be configured and the Favorites have to be connected. In addition, a Multi Manager or Area- Floor or Building-Managers can be instantiated in the VAV_Device_Types. This is done by copying and modifying of existing VAV_Device_Types of the VAV library.

4. **Build the VAV Application:** The VAV_Device_Types have to be instantiated on the "System" page to build the entire building.

5. **Create the VAV Device(s)**: Since the VAV application now includes the device(s), the LIOB_AIR VAV controller(s) now can be created automatically in a dedicated device list.

6. **Set the IP-Address(es) in the device list**: Because L-STUDIO has to know where to deploy the configured device(s) the IP-Address(es) have to be set in the device list.

7. **Build and Deploy the solution**: After these steps are finished, L-STUDIO can build and compile the solution and deploy the software to multiple devices simultaneously with a powerful deploy function.

8. **Parameter Settings in VAV-Box**: The VAV controller is operating the VAV application. Now all important parameters have to be set. This is e.g. the air flow data. This can be done using the built in LWEB-802/803 visualization project or using LWEB-900 parameter views.

5.2.3.2 Start with the “VAV Start” solution

Everything needed for a VAV-Project is already included in the “VAV Start” sample project. It was already installed on the PC with the library installation described in chapter 3.1.1.2. These are the function libraries as well as samples of VAV_Types and VAV_Device_Types, which are to be found in a folder structure.

The basic procedure is to take this “VAV Start Solution” as the basic solution and enhance it to the final project solution by copying and modifying the included sample types.

Start the L-STUDIO AIR tool, open “File” menu and select the “New” and “Solution” function as shown in Figure 7. This will open the “New Solution” dialog as shown in Figure 8.

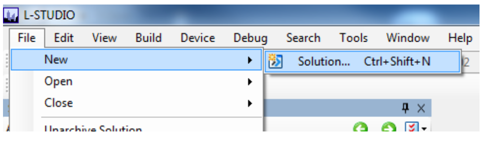


Figure 7: Create New Solution

Select the “VAV Start Solution”, enter the project name e.g. “MyVAVproject” select the file location and press the “Create” button.

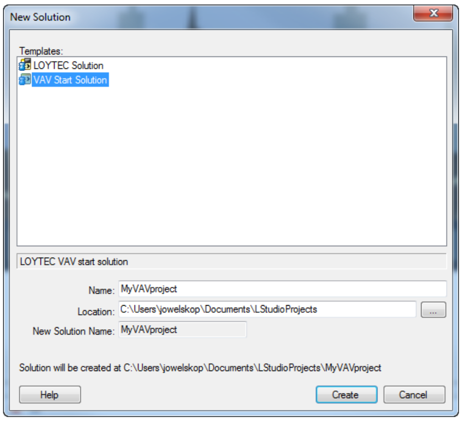


Figure 8: New Solution

The new VAV solution “MyVAVproject” will be created.

For more details, please refer to chapter 7.2.3.

5.2.3.3 Define the VAV_Type(s)

The first step in a project is to identify the different types of VAV Boxes, which have to operate different functions e.g. some with Discharge Temperature Control and some without.

The Folder “VAV_Types” already includes 2 VAV types as shown in Figure 9:

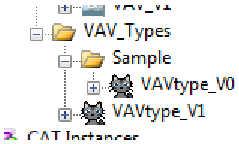


Figure 9: included VAV_Types

The “VAVtype_V0” in the “Sample” folder is the basic type, which can be used as a template. It is a maximum type and it contains all the Sensors and actuators with all functions a VAV controller can operate. It can be copied when needed but it should not be modified to ensure to have always a “clean” template to create new VAV types.

The “VAVtype_V1” is a copy of the “VAVtype_V0” and it shall be the first type the user can modify and adapt to his requirements.

The components we use in L-STUDIO AIR have some funny cat symbols. These are CAT items. CAT means composite automation type. A CAT includes the function, the data points and the visualization.

The basic idea is to modify the first type “VAVtype_V1” and if further types are needed to copy the “VAVtype_V0” and paste it to e.g. “VAVtype_V2” to the VAV_Types folder. This new-copied type also can be modified to get another type that is needed in the project. For all variations of VAV Boxes in the project, a dedicated VAV type has to be defined.

Now the “VAVtype_V1” shall be modified. A double click on to the “VAVtype_V1” will open a new tab in the editor window. There the sub tab “Composite” has to be selected.

There the 3 function areas of a VAV-Controller are displayed, the Sensor Area, the VAV core Area and the Actuator Area as shown in Figure 10.

In the Sensor Area all the sensor functions a VAV controller can have are included. Here the sensor functions that are not needed in this VAV type have to be deleted.

In the VAV Core Area, the core functions of every VAV controller are included. This “Core” block must not be deleted! It has many connectors where the dedicated sensor and actuator functions can be connected. All the available sensor and actuator functions must be connected to the core.

In the Actuator Area, all possible actuator functions of a VAV controller are included. Here Actuators that are not needed in this VAV type can be deleted.

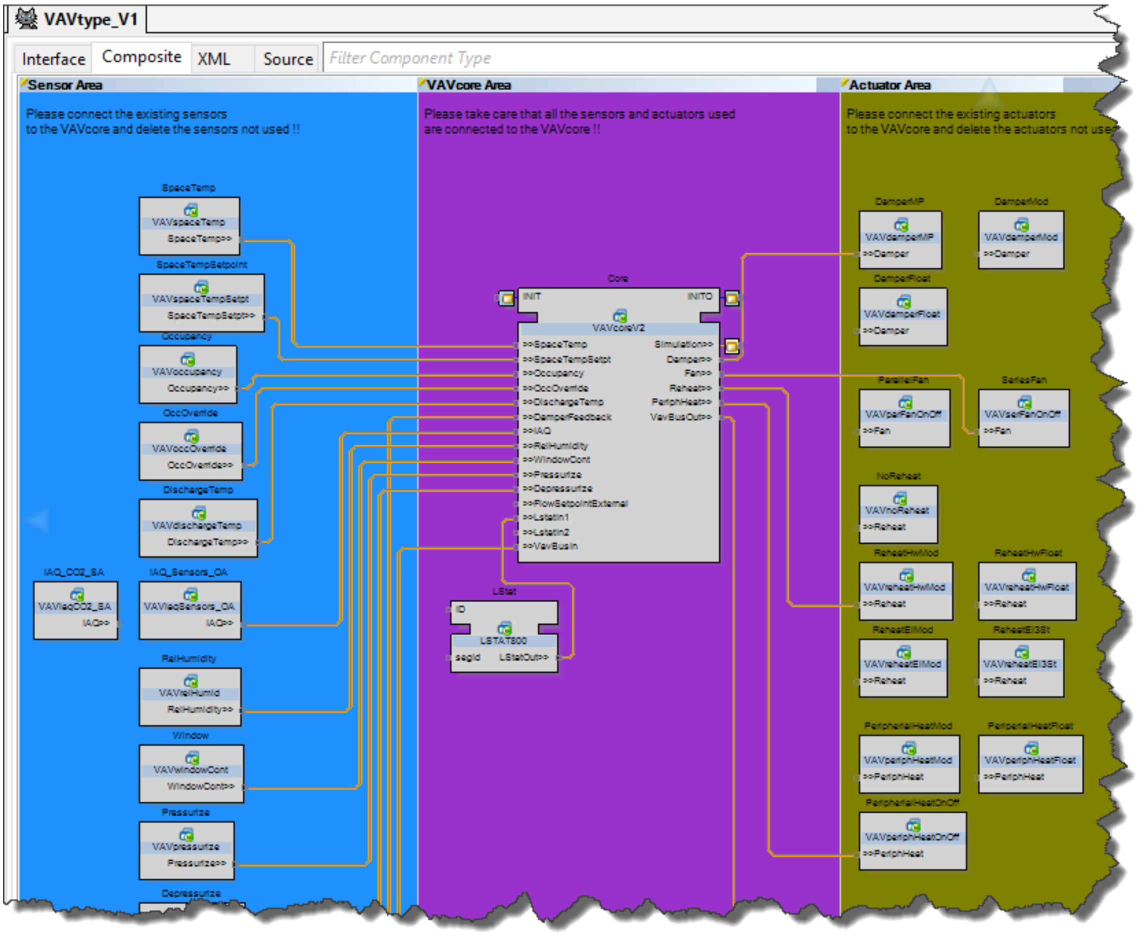


Figure 10: Original VAVtype_V1

The "VAVtype_V1" shall be modified for the first project. It shall have the following sensor and actuator functions:

- Space Temperature sensor with Space Temperature Control,
- Discharge Temperature sensor with Discharge Temperature Control,
- External Space Temperature Setpoint sensor to modify the Space Temperature Setpoint,
- Occupancy sensor with occupancy function
- Occupancy Override sensor with "Bypass"- button function
- MP-Bus Damper actuator to control the air flow
- Series Fan actuator to support the air flow
- Reheat Hot Water Modulating actuator to reheat the discharge air

The unused sensor and actuator functions have to be deleted whereas the remaining sensor and actuator functions have to be connected to the core using the dedicated connectors.

To delete a function, it has to be selected and with the right click context menu, it can be deleted. The CAT has to be saved.

Please note that only in the colored sensor and actuator areas the functions have to be deleted. The Core and the blocks outside from the colored areas must not be deleted.

It is important to know that all the instance names of the CATs instantiated in the VAV_Type e.g. Core or SpaceTemp must not be changed! This is because the instance names of the CATs are part of the data point paths.

The “VAVtype_V1” now should look like shown in Figure 11:

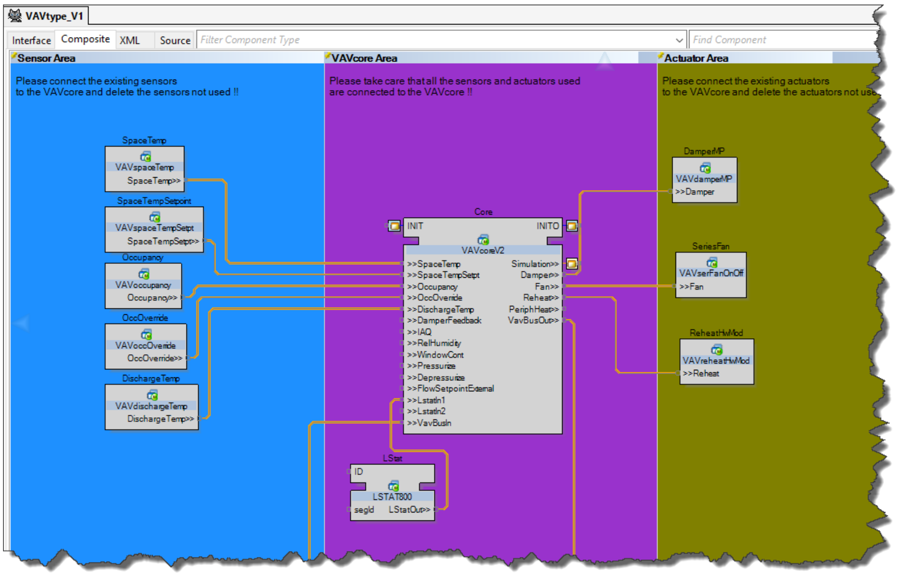


Figure 11: modified VAVtype_V1

For more details, refer to chapter 7.2.4.

5.2.3.4 Define the VAV_Device_Type(s)

Since the VAV_Type has been defined, the next step is to define the VAV_Device_Type. VAV_Device_Types refer to a dedicated hardware device type e.g. a LIOB-AIR1 and the local I/Os are configured. In a VAV_Device_Type, a VAV_Type is instantiated and the sensors and actuators from the VAV_Type using the Favorite data points are connected to the local I/Os of the VAV_Device_Type.

The Folder “VAV_Device_Types” already includes 5 ready-to-use VAV_Device_Types as shown in

Figure 12:

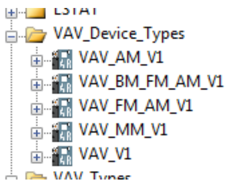


Figure 12: included VAV_Device_Types

The VAV_V1 is a VAV_Device_Type that has the VAV_Type VAVtype_V1 already instantiated. This VAV_Device_Type we will use in our example.

The other predefined VAV_Device_Types have Manager_Types included and are not used in this first example.

The device in our example shall be a LIOB-AIR1. To check or to modify the hardware controller type assigned to a VAV_Device_Type, the right click context menu of the VAV_Device_Type has to be opened and the "Properties" menu has to be selected. This opens the "CAT Properties" dialog and the "Device Identification" can be checked or modified, as shown in Figure 13. Here we will leave it as it is on LIOB-AIR1.

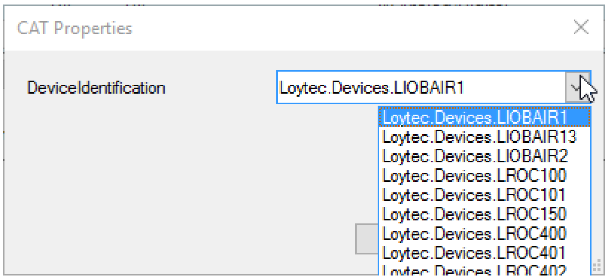


Figure 13: Check or change the Device Identification

A double click on VAV_V1 opens the VAV device type and on the Composite tab the instance of the VAV_Type "VAVtype_V1" is shown, see Figure 14. The instantiated VAV_Type VAVtype_V1 is displayed there. No changes are needed here for our first example.

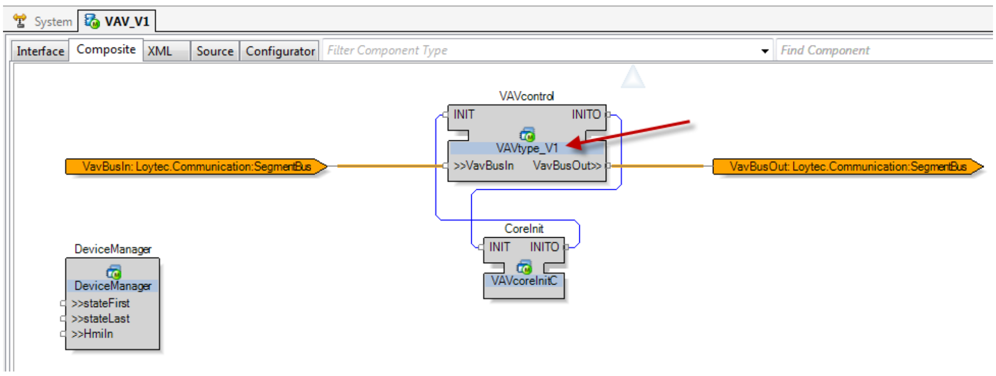


Figure 14: Device type VAV_V1

It is important to know that the instance names of the CATs instantiated in the VAV_Device_Type e.g. VAVcontrol must not be changed! This is because the instance names of the CATs are part of the data point paths.

The local I/Os are predefined and connected to the data points of the VAV type with Favorites. They can be modified if needed.

On the Configurator tab of the VAV device type the configuration can be checked and modified.

In the VAV_Device_Types, a standard I/O configuration is already set. This configuration can be used “as it is” or it can be modified by the user if changes are needed. In the predefined VAV_Device_Types, the local I/Os are already linked with Favorites to the control functions of the instantiated VAV_Type. If a not required sensor or actuator function was deleted by the user in the VAV_Type, the associated Favorites do not exist. So the according I/Os are not connected to a control function and will have no operational function. The standard I/O configuration is shown in Table 3.

UI = Universal Input analog or binary

AO = Analog Output

DO = Digital output, Relays 16A, Relays 6A, Triacs

I/O	Description	Type
UI1	Space Temperature	NTC10k
UI2	External Space Temperature Setpoint Offset	0 - 10k, -10°K…+10°K
UI3	Occupancy Sensor	binary
UI4	Occupancy Override (Bypass Button)	binary
UI5	Discharge Temperature	NTC10k
UI6	CO2 Concentration	0 – 10VDC, 0 – 2000ppm
UI7	Damper Feedback	0 – 10VDC, 0 – 100%
UI8	Window Contact	binary
UI9	rel. Humidity	0 – 10VDC, 0 – 100%rH
UI10	not used	binary
AO1	Reheat modulating	0 – 10VDC, 0 – 100%
AO2	Damper modulating	0 – 10VDC, 0 – 100%
AO3	Fan Speed	0 – 10VDC, 0 – 100%
DO1 (16A)	Reheat Stage 1	binary
DO2 (16A)	Reheat Stage 2	binary
DO3 (16A)	Reheat Stage 3	binary
DO4 (6A)	Fan	binary
DO5 (6A)	Reheat floating (Close)	binary
DO6 (6A)	Reheat floating (Open)	binary
DO7 (6A)	not used	binary
DO8 (Triac)	Peripheral Heat (On Off)	binary
DO9 (Triac)	Reheat modulating (PWM)	PWM

Table 3: Standard I/O Configuration of a LIOB-AIR1 device type

The local inputs and outputs of the LIOB-AIR device can be edited on the L-IOB tab of the configurator if some changes are needed. In the Inputs/Outputs window the I/O can be selected and the details of the selected I/O e.g. the signal type and interpretation of the Space Temperature input can be edited in the Object Parameters window as shown in Figure 15.

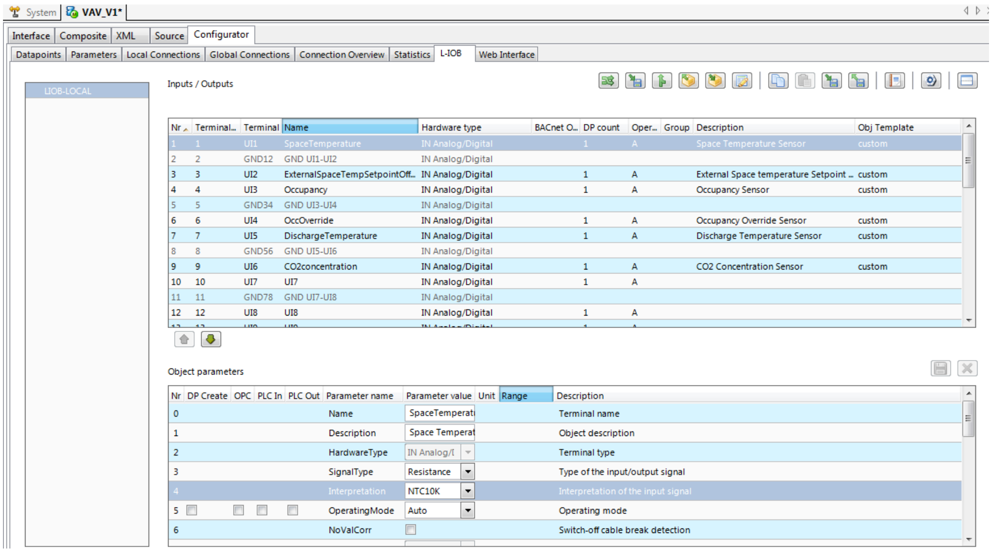


Figure 15: Configurator L_IOB tab

We will use the I/O configuration without changes in our example.

The VAV device type “VAV_V1” is ready to use.

The configuration has to be saved in L-STUDIO !

For more details, refer to chapter 7.2.5.

5.2.3.5 Build the System

The next step is to build the VAV application. There one or multiple VAV_Device_Types can be instantiated. All instances in the VAV application will be compiled and deployed to the device(s) by L-STUDIO AIR later.

The VAV application has to be built in the “System” Folder in the “VAVsystem” application. A double click on the “VAVsystem” item in the “System“ folder opens the application in the editor area as shown in Figure 16.

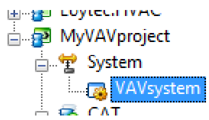


Figure 16: Open the System folder

In this editor the defined VAV_Device_Types can be put together with drag and drop from the VAV_Device_Types folder.

Our VAV_Device_Type VAV_V1 has to be dragged and dropped to the VAVsystem and has to be named to e.g. “VAV01”.

The system has to be saved.

The finished VAV system should look like shown in Figure 17.

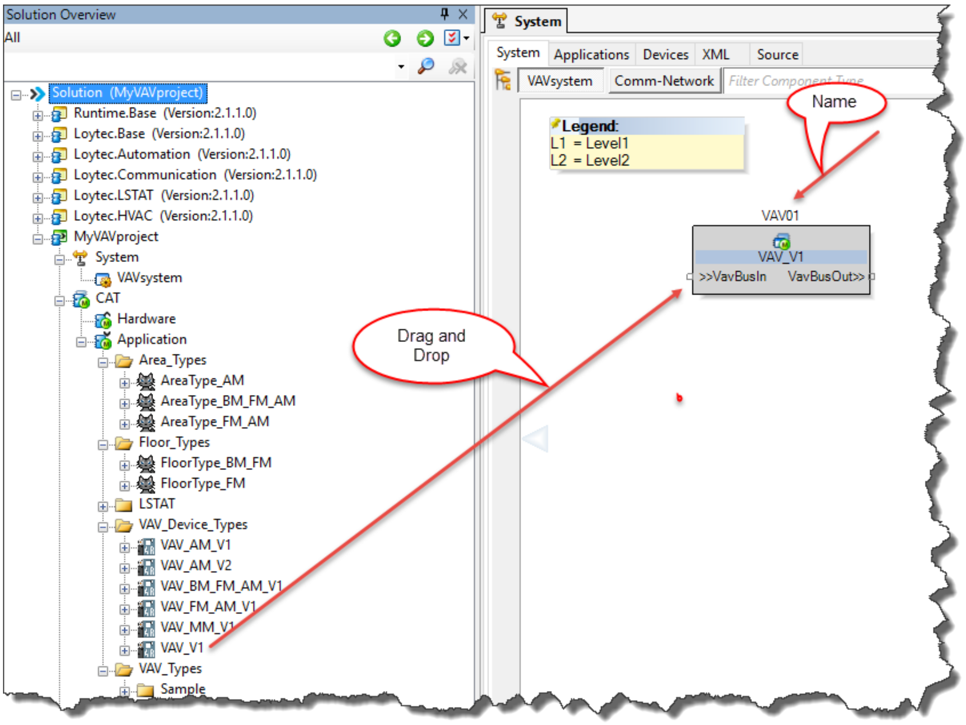


Figure 17: Finished VAV system

For more details refer to chapter 7.2.6.

5.2.3.6 Create the Devices

Since the VAVsystem is fully defined with the instance of the VAV_Device_Type, the next step is to create the device.

The devices are created in the “System” folder in the “VAVsystem” application, which was already opened, in the last chapter. On the “Devices” tab the menu “Device” has to be opened and the function “DeviceCATs…” has to be selected as shown in Figure 18.

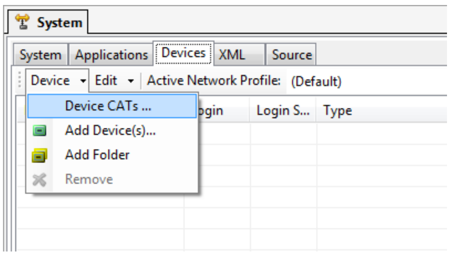


Figure 18: Open the Device CATs

This opens a “Devices” list where all the instantiated devices are included as shown in Figure 19. The devices are named using the instance name of the device and the system name.

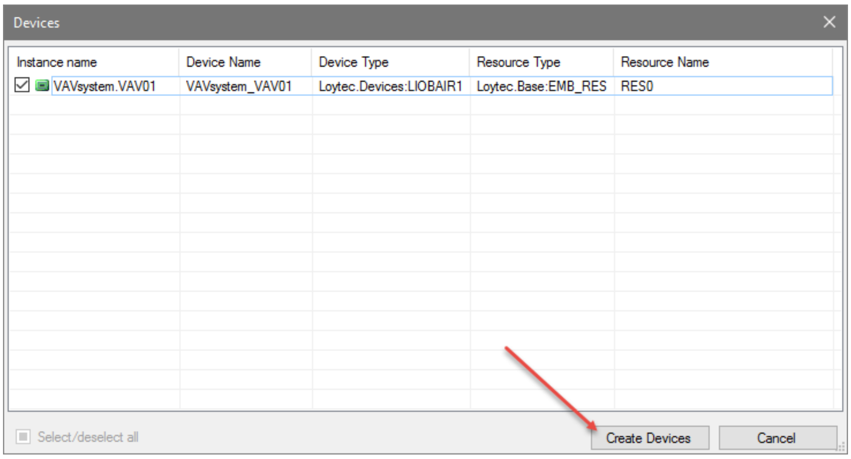


Figure 19: Devices list

A click on the “Create Devices” button starts the device creation. All devices that are created now appear in the list on the “Devices” tab. After the system is saved the created devices also appear in the “System” folder in the Solution Overview (this takes a little time) and is shown in Figure 20.

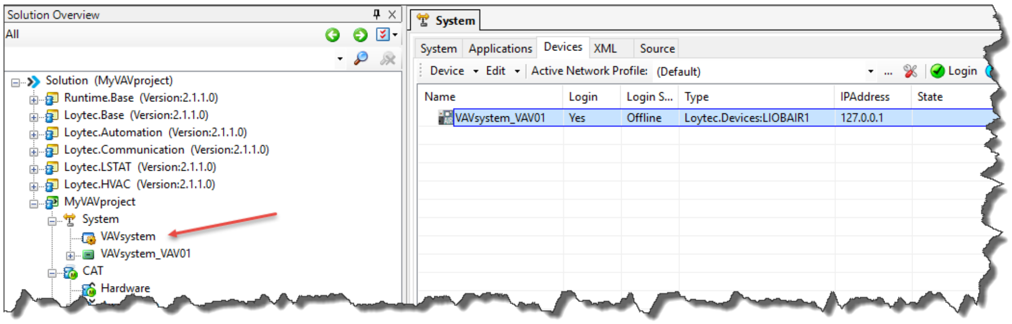


Figure 20: Created Device(s)

For more details refer to chapter 7.2.8.

5.2.3.7 Set IP Addresses in the Devices List

Actually, the created LIOB-AIR device has the standard IP Address 127.0.0.1 in the “Devices” list. The next step is to set the individual IP-Addresses for the LIOB-AIR device so that L-STUDIO is able to address the device to deploy the configuration and to communicate.

The IP-Address of the device has to be set in the device list on the “Devices” tab. The BACnet ID should be set also in this list. See for a proper addressed device. Please note that in larger systems this can be a lot of work. However, L-STUDIO helps with an efficient IP Address function, see chapter 7.2.9.

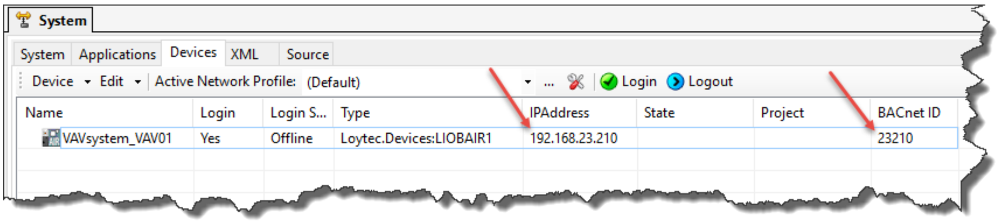


Figure 21: Set IP-Address and BACnet ID

The system has to be saved when finished.

5.2.3.8 Build the Solution and Deploy

The VAV system is configured now and has to be compiled and deployed to the device by L-STUDIO as the next step.

On the “Devices”  icon in the L-STUDIO icon bar the function “Deploy advanced …” has to be selected. Then L-STUDIO starts compiling the whole solution immediately. In the output area, some messages show the progress of building the project. This can take a few minutes.

After the compilation has finished the “Advanced Deploy” dialog opens and shows the list devices. Here the devices that shall be downloaded have to be selected as shown in Figure 22. In our example, there is only one device to be selected.

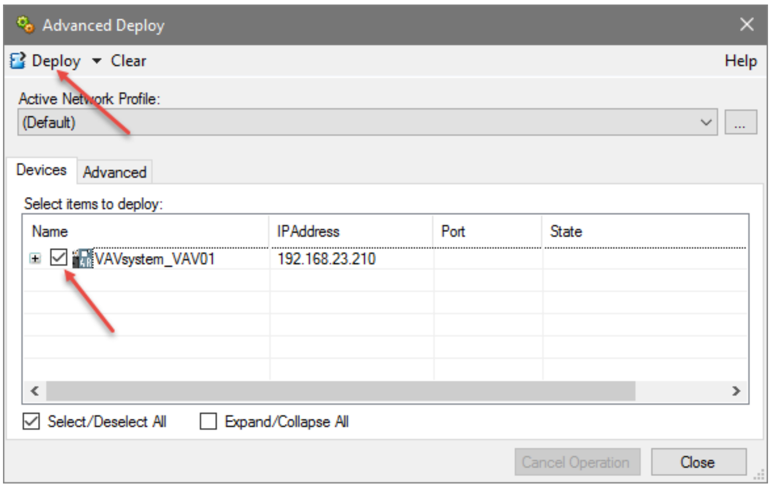


Figure 22: Advanced Deploy dialog

To start the Deploy process, “Deploy” has to be selected in the menu of the “Advanced Deploy” dialog. L-STUDIO now deploys the configuration and software to all selected devices, while using a powerful parallel deploy mechanism.

After all selected devices are deployed, the “Advanced Deploy” dialog has to be closed by pressing the “Close” button.

Now all LIOB-AIR devices are configured and are operating the VAV control algorithms.

5.2.3.9 Parameter Settings in VAV-Box

Since the LIOB-AIR device is deployed with L-STUDIO, it is operating with the configured VAV control program. The next step is to enter all important parameter values that are needed to provide a proper operation of the VAV. This is e e.g. the air flow data. The parameter values are entered at runtime of the system. That means that if some changes are needed later, they can also be applied during runtime.

Every LIOB-AIR device hosts multiple graphical projects to configure, operate and maintain the VAV controller. The visualization software LWEB-802 which is a platform independent, browser based graphical user interface is needed to run the graphical projects. This LWEB-802 visualization software is already built into the LIOB-AIR device. The graphical project that is needed to enter all the VAV control parameters is the “VAVstatus.lweb2” project.

<u>Open the WebUI of the LIOB-AIR controller</u>

The browser (recommended Google Chrome) has to be started on the PC or a mobile device. In the browser address line, the IP Address of the LIOB-AIR-Controller has to be entered.

The browser displays the WebUI (user interface) of the device which shows the device information and a navigation menu on the left page, see Figure 23.

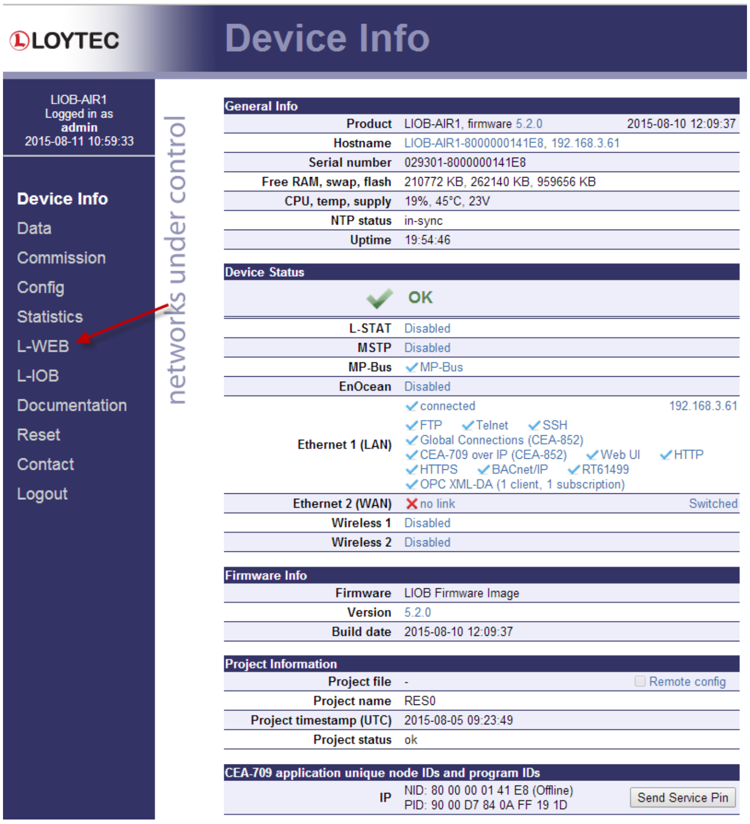


Figure 23: WebUI of the LIOB-AIR device

In the left menu the “L-Web“ has to be selected which opens the “LWEB Project List”.

There are two user accounts available:

Admin , default password: **loytec4u**

Operator, default password: **operator** (this is ok to run LWEB visualization)

Set the LWEB-802 URL (optional):

If the PC or mobile device is connected to the Internet, the LWEB-802 visualization is loaded from the LOYTEC website and the "VAVstatus.lweb2" graphical project can be started directly. If the PC has no Internet connection, the use of the pre-installed LWEB-802 has to be activated. This is done on the "LWEB-802 Config" submenu selecting the "Pre-installed" option as shown in Figure 24. The default setting is "LOYTEC Website" that can be used if the PC has an Internet connection.

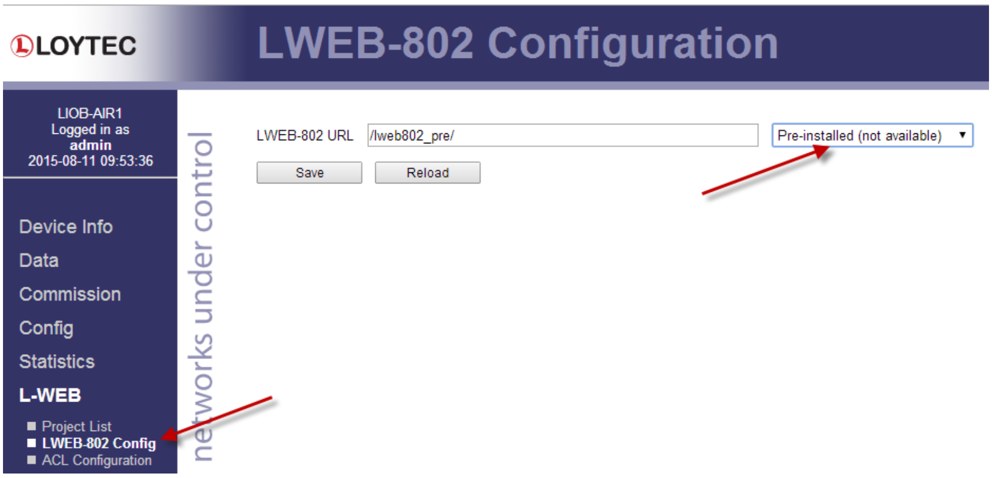


Figure 24: Select the Pre-installed LWEB-802

Start the VAVstatus.lweb2 visualization project

To open the visualization of the graphical project "VAVstatus.lweb2", the LWEB-802 icon of this project has to be clicked in the L-WEB Project List as shown in Figure 25.

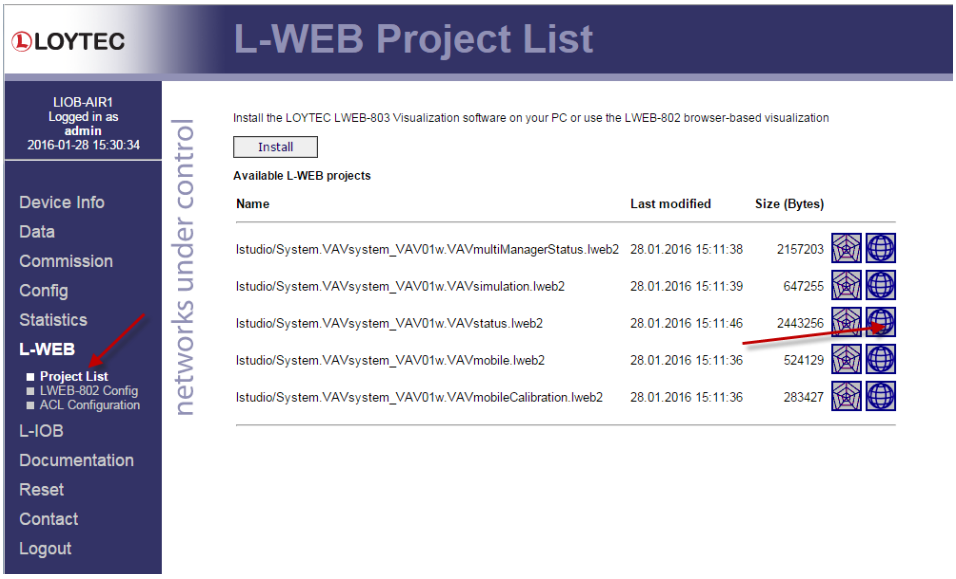


Figure 25: Open the graphical project VAVstatus.lweb2

The VAVstatus visualization starts with the “Status Overview” page and without having entered the parameters it looks like Figure 26:

Figure 26: Status Overview

The “Status Overview” page shows top level data and provides a basic information of operation to the user. The whole project is using a tile design where every tile displays information regarding a dedicated function. A click on a tile leads to pages with more information about this function. On the top area of every page there is a title area (head line) which displays the name of the page, the location of the device, the actual PIN code level and other information. On the bottom area of every page there is a navigation area with individual navigation tiles which open additional pages. The Home tile always opens the “Status Overview” page.

The tiles are displayed in different colors which shows if the function is a sensor (blue), a controller (purple), an actuator (ocher) or a device (green).

The values are displayed in different colors, too, which indicates if the value is only displayed (green) or can be changed by the user (orange).

To enter the Flow Configuration Data, the purple Air Flow tile has to be clicked. The PIN Code to enter the Flow Data is “1212”.

The LIOB-AIR VAV controller is now operating the VAV application. Of course it needs to be parameterized using the VAVstatus LWEB-802 visualization program or the LWEB-900 software. Please refer to chapter 7.2.12 to get more information how to set the parameters.

The “Getting Started” capter ist finished now!

6 Concepts

6.1 LIOB-AIR VAV Control

This chapter describes the concepts of the LIOB-AIR and the VAV application as the basic ideas of the system. The details will be described in the chapters later on.

6.1.1 The LIOB-AIR System

LIOB-AIR is a fully IP-based variable air volume controller. It provides a predefined and flexible application program and sophisticated management functions to build a complete building ventilation system.

It comes as an I/O controller with physical inputs and outputs, an integrated differential pressure sensor and, depending on the model, with an on board MP-Bus damper actuator.

There are Universal Inputs (binary, Voltage, Current, Resistance), Analog Outputs (0 to 10V) and Digital Outputs (Relays, TRIACs) available to connect the sensors and actuators.

A graphical display and a jog dial allow local operation and device configuration.

The fully IP-based communication uses Ethernet or the optional meshed WLAN. The built-in dual Ethernet interface allows daisy chaining multiple LIOB-AIR devices and simple network wiring as well as a redundant IP network. The optional WLAN supports a reliable wireless communication in a self-healing meshed network.

The LOYTEC L-STAT network thermostat with internal sensors for temperature, humidity, occupancy and CO_2 and with a display and buttons as room control unit is fully supported by the LIOB-AIR controller.

The VAV engineering system L-STUDIO-AIR allows configuration of the predefined flexible VAV application program by the user very easy without a deep knowledge of a programming tool. L-STUDIO-AIR also supports a fast and flexible design of VAV projects of any size.

Ready to use integrated web based graphic visualizations provide full access to the VAV control functions to the system integrator and allow the operation, parameterization and commissioning of a VAV-box. In addition, a comfortable calibration is provided. The platform independent user interface LWEB802 allows running these graphical visualizations in a standard web browser on PC´s and mobile devices.

Integrated management functions are aggregating process values and provide data to the air handing units for an optimal demand based control. Also powerful balancer functions are realized for an easy setup of the complete ductwork. These aggregation, communication and balancing functions are established automatically without any user programming.

These integrated visualizations and management functions are hosted on the LIOB-AIR devices and eliminate the need for a Tridium or whatever middleware component.

Multiple VAV Boxes in one room operating with supply or exhaust air are grouped automatically to provide an optimal and consistent operation of the room air balance and the temperature control.

Air handling unit controllers of any brand can be connected to the manager of the LIOB-AIR system using standard communication as BACnet or OPC or using hard-wired connections.

Optionally using the standard VAV applications provided by LOYTEC, the LIOB-AIR controllers can operate as standalone controllers without using the VAV engineering system L-STUDIO-AIR.

The supported standard protocol interfaces of the LIOB-AIR devices (BACnet, OPC XML-DA, OPC UA, CEA709, MP-Bus, Modbus, and EnOcean) allow the integration into every Building Management System.

The LOTEC AST functions (Alarming, Scheduling, and Trending) are fully integrated in the LIOB-AIR devices. E-Mail notifications are also supported by the devices.

The integrated Webserver provides access to the LIOB-AIR device for device configuration, operation and monitoring of the available data points, access to the local I/Os, display of device statistics, access to the time schedulers and alarm lists.

The LWEB-900 Building Management System provides a total integration of the LIOB-AIR system, which accompanies the user from installation and configuration of LIOB-AIR devices all the way to daily operation of the VAV system.

6.1.2 VAV-Functions

The LIOB-AIR system actually supports pressure independent single duct systems. The following chapter describes the multiple VAV-Box equipment systems that can be controlled by the LIOB-AIR system. The VAV functions are described in detail in chapter 7.5.

6.1.2.1 Supported VAV-Box Systems

1. Standard (VAV only)

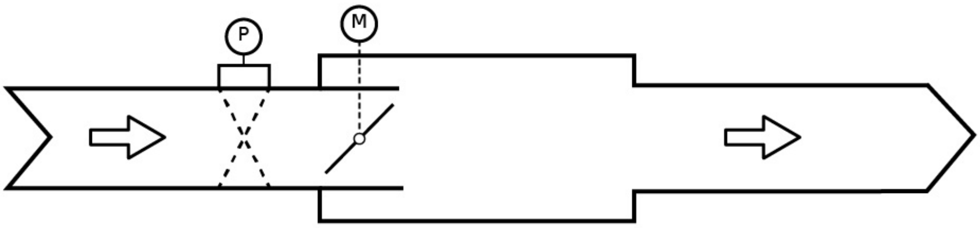


Figure 27: Standard VAV-Box (VAV only)

The VAV-Box type as displayed in Figure 27 is only equipped with a pressure sensor and a damper actuator.

The LIOB-AIR device operates the following functions in standard:

- Flow Control,
- Damper control
- HVAC Mode control
- Effective Occupancy Control
- AHU communication
- VAV Group communication

Depending on the configured sensors, the LIOB-AIR device can also operate the following functions:

- Space Temperature control cooling and heating
- Occupancy sensor function
- Occupancy Override sensor function
- Energy Hold Off
- IAQ control
- Space humidity control
- External flow setpoint control (alternatively)

2. VAV with electric reheat

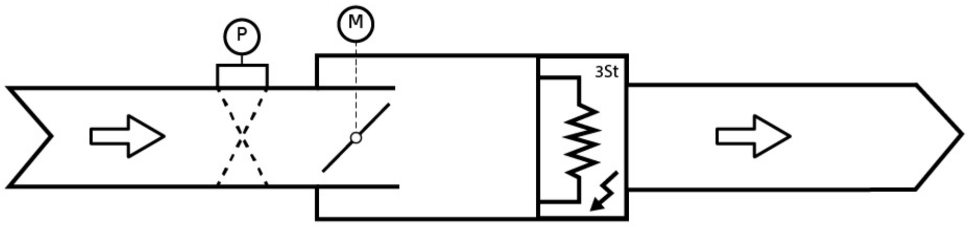


Figure 28: VAV-Box with electric reheat

The VAV-Box type as displayed in Figure 28 is equipped as the standard VAV-Box (1.) with an additional electric modulating or staged reheat actuator. The LIOB-AIR device operates the following functions in standard:

- Flow Control,
- Damper control
- Electric reheat control
- HVAC Mode control
- Effective Occupancy Control
- AHU communication
- VAV Group communication

Depending on the configured sensors, the LIOB-AIR device can also operate the following functions:

- Space Temperature control cooling and heating
- Discharge Temperature control
- Occupancy sensor function
- Occupancy Override sensor function
- IAQ control
- Space humidity control

3. <u>VAV with hot water reheat</u>

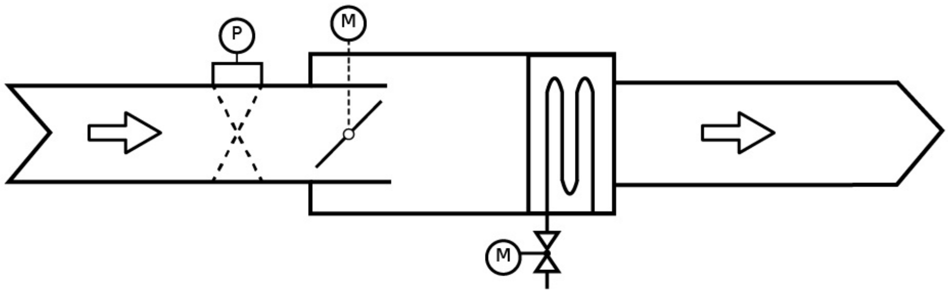


Figure 29: VAV-Box with hot water reheat

The VAV-Box type as displayed in Figure 29 is equipped as the standard VAV-Box (1.) with an additional hot water modulating or floating reheat actuator. The LIOB-AIR device operates the following functions in standard:

- Flow Control,
- Damper control
- Hot water reheat control
- HVAC Mode control
- Effective Occupancy Control
- AHU communication
- VAV Group communication

Depending on the configured sensors, the LIOB-AIR device can also operate the following functions:

- Space Temperature control cooling and heating
- Discharge Temperature control
- Occupancy sensor function
- Occupancy Override sensor function
- IAQ control
- Space humidity control

4. VAV with series fan

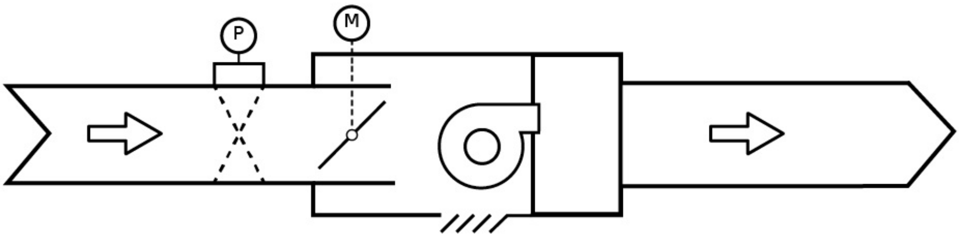


Figure 30: VAV-Box with series fan

The VAV-Box type as displayed in Figure 30 is equipped as the standard VAV-Box (1.) with an additional series fan actuator. The LIOB-AIR device operates the following functions in standard:

- Flow Control,
- Damper control
- Series fan control
- HVAC Mode control
- Effective Occupancy Control
- AHU communication
- VAV Group communication

Depending on the configured sensors, the LIOB-AIR device can also operate the following functions:

- Space Temperature control cooling and heating
- Occupancy sensor function
- Occupancy Override sensor function
- IAQ control
- Space humidity control

5. VAV with series fan and electric reheat

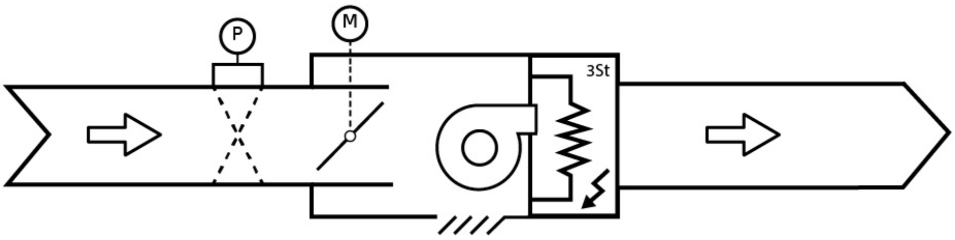


Figure 31: VAV-Box with series fan and electric reheat

The VAV-Box type as displayed in Figure 31 is equipped as the standard VAV-Box (1.) with an additional series fan and an electric modulating or staged reheat actuator. The LIOB-AIR device operates the following functions in standard:

- Flow Control,
- Damper control
- Series fan control
- Electric reheat control
- HVAC Mode control
- Effective Occupancy Control
- AHU communication
- VAV Group communication

Depending on the configured sensors, the LIOB-AIR device can also operate the following functions:

- Space Temperature control cooling and heating
- Discharge Temperature control
- Occupancy sensor function
- Occupancy Override sensor function
- IAQ control
- Space humidity control

6. VAV with series fan and hot water reheat

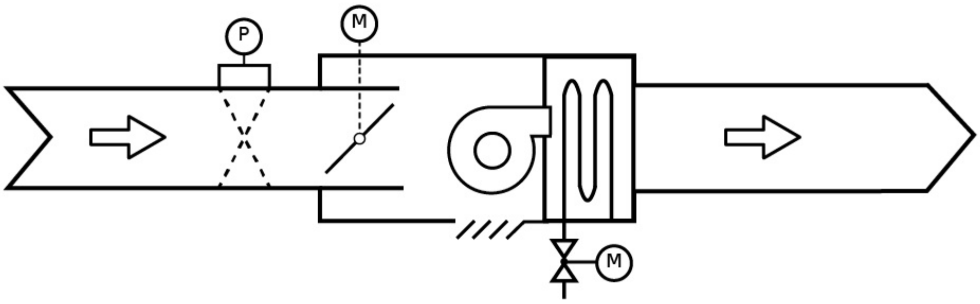


Figure 32: VAV-Box with series fan and hot water reheat

The VAV-Box type as displayed in Figure 32 is equipped as the standard VAV-Box (1.) with an additional series fan and a hot water modulating or floating reheat actuator. The LIOB-AIR device operates the following functions in standard:

- Flow Control,
- Damper control
- Series fan control
- Hot water Reheat control
- HVAC Mode control
- Effective Occupancy control
- AHU communication
- VAV Group communication

Depending on the configured sensors, the LIOB-AIR device can also operate the following functions:

- Space Temperature control cooling and heating
- Discharge Temperature control
- Occupancy sensor function
- Occupancy Override sensor function
- IAQ control
- Space humidity control

7. VAV with parallel fan and electric reheat

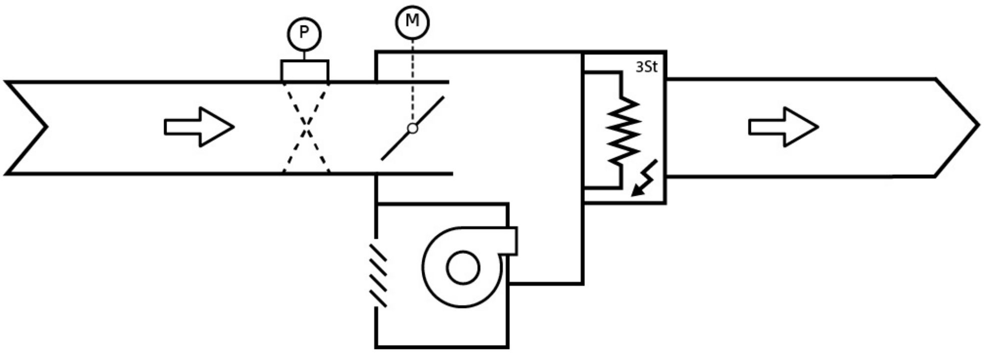


Figure 33: VAV-Box with parallel fan and electric reheat

The VAV-Box type as displayed in Figure 33 is equipped as the standard VAV-Box (1.) with an additional parallel fan and an electric modulating or staged reheat actuator. The LIOB-AIR device operates the following functions in standard:

- Flow Control,
- Damper control
- Parallel fan control
- Electric reheat control
- HVAC Mode control
- Effective Occupancy Control
- AHU communication
- VAV Group communication

Depending on the configured sensors, the LIOB-AIR device can also operate the following functions:

- Space Temperature control cooling and heating
- Discharge Temperature control
- Occupancy sensor function
- Occupancy Override sensor function
- IAQ control
- Space humidity control

8. VAV with parallel fan and hot water reheat

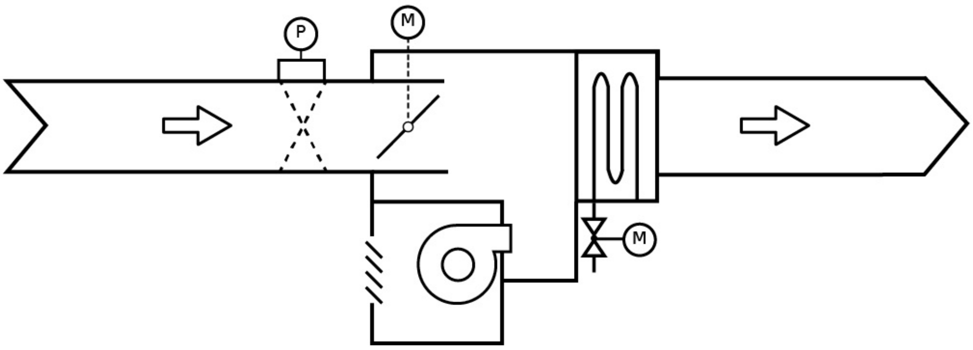


Figure 34: VAV-Box with parallel fan and hot water reheat

The VAV-Box type as displayed in Figure 34 is equipped as the standard VAV-Box (1.) with an additional parallel fan and a hot water modulating or floating reheat actuator. The LIOB-AIR device operates the following functions in standard:

- Flow Control,
- Damper control
- Parallel fan control
- Hot water Reheat control
- HVAC Mode control
- Effective Occupancy control
- AHU communication
- VAV Group communication

Depending on the configured sensors, the LIOB-AIR device can also operate the following functions:

- Space Temperature control cooling and heating
- Discharge Temperature control
- Occupancy sensor function
- Occupancy Override sensor function
- IAQ control
- Space humidity control

6.1.2.2 Supported Sensors and Actuators

LIOB-AIR provides local I/O for a hardwired connection of the sensors and actuators. However, the sensor and actuator values can also be connected using the standard communication supported by The LIOB-AIR.

Sensors:

Sensors can be connected hard-wired to the local universal inputs (UI). These can be analog sensors for e.g. temperature, setpoints, humidity, CO2, VOC, or binary sensors for e.g. Occupancy or Window contacts.

The sensor signal types can be Resistance, Voltage, or Current.

The LIOB-AIR VAV application provides a Standard I/O configuration, which can be modified and adjusted by the user.

If the LOYTEC L-STAT network thermostat is configured and connected to the dedicated port of the LIOB-Air the integrated sensors for Temperature, rel. Humidity, CO2, and Occupancy are used by the VAV application automatically.

It is also possible to use third party network thermostats sensors that are communicating via Modbus, BACnet MS/TP, or EnOcean.

Actuators:

The LIOB-AIR supports the following Actuators connected with bus or local I/O as digital outputs (DO) and analog outputs (AO) and pulse wide modulated outputs (DO-PWM):

Damper actuators:	MP-Bus,
	or modulating (AO: 0…10VDC),
	or floating (2x DO).
Reheat hot water:	modulating (AO: 0…10VDC, or DO-PWM),
	or floating (2x DO).
Reheat electric:	modulating (AO: 0…10VDC),
	or up to 3 stages (3x DO + 3xAO).
Peripheral heat:	modulating (AO: 0…10VDC, or DO-PWM),
	or floating (2x DO),
	or On Off (1xDO).

6.1.2.3 Standard I/O Configuration

The LIOB-AIR VAV application provides a standard I/O configuration. If the sensors and actuators are connected hard-wired to these standard inputs and outputs relating to this configuration, the system will work without any additional work.

Of course, the standard I/O configuration can be modified and adapted to the project demands. However, it always saves engineering work starting with the Standard I/O configuration.

The standard I/O configuration is shown in Table 4.

IO	Description	Type
UI1	Space Temperature	NTC10k
UI2	External Space Temperature Setpoint Offset	0 - 10k, -10°K…+10°K
UI3	Occupancy Sensor	binary
UI4	Occupancy Override (Bypass Button)	binary
UI5	Discharge Temperature	NTC10k
UI6	CO2 Concentration	0 – 10VDC, 0 – 2000ppm
UI7	Damper Feedback	0 – 10VDC, 0 – 100%
UI8	Window Contact	binary
UI9	rel. Humidity	0 – 10VDC, 0 – 100%rH
UI10	not used	binary
AO1	Reheat modulating	0 – 10VDC, 0 – 100%
AO2	Damper modulating	0 – 10VDC, 0 – 100%
AO3	Fan Speed	0 – 10VDC, 0 – 100%
DO1 (16A)	Reheat Stage 1	binary
DO2 (16A)	Reheat Stage 2	binary
DO3 (16A)	Reheat Stage 3	binary
DO4 (6A)	Fan	binary
DO5 (6A)	Reheat floating (Close)	binary
DO6 (6A)	Reheat floating (Open)	binary
DO7 (6A)	not used	binary
DO8 (Triac)	Peripheral Heat (OnOff)	binary
DO9 (Triac)	Reheat modulating (PWM)	PWM

Table 4: Standard I/O configuration

6.1.2.4 VAV-Control

A typical VAV scheme with sensors and actuators and controller instrumentation is shown as an example in Figure 35. The space temperature sensor, the setpoint, the occupancy sensor, and CO_2 sensor can be connected hardwired to the local I/O of the LIOB-AIR, or an L-STAT network thermostat can be used connected to the dedicated port of the LIOB-AIR. For more details, see chapter7.5.1.

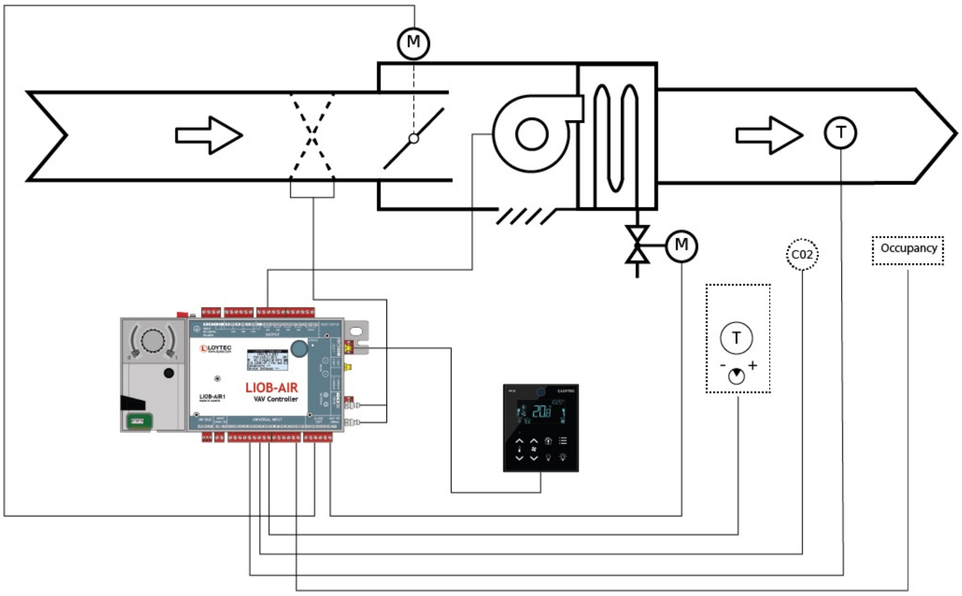


Figure 35: VAV scheme with instrumentation

The general control functions of the VAV application are shown for example in the control scheme displayed in Figure 36. The control cricuits and the functuinal dependencies can be seen here for a basic understanding.

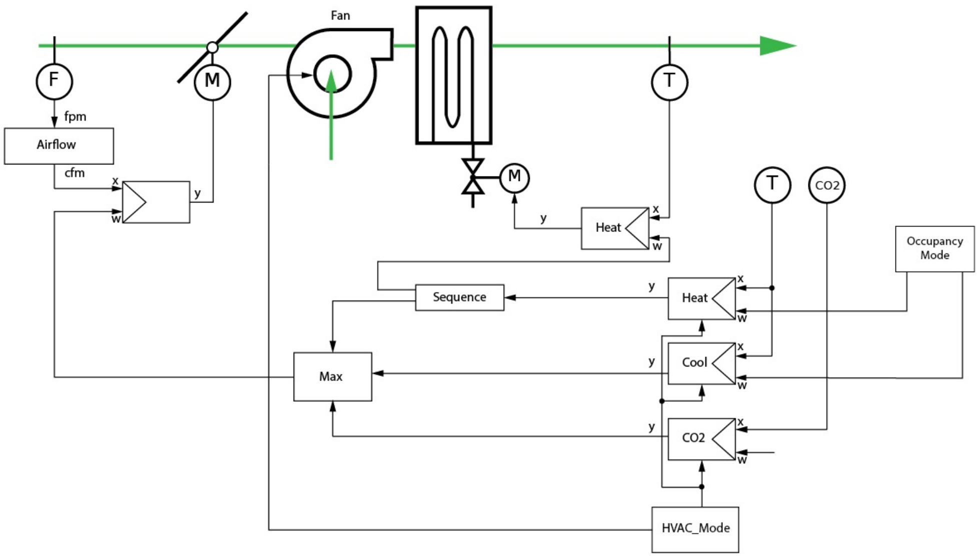


Figure 36: VAV control scheme

The space temperatire setpoints for the cooling and heating controllers are selected by the effective occupancy mode of the room. There is always a dead zone between the cooling and heating setpoints that supports the occupants comfort and saves energy. The setpoints and the controller outputs are shown in principle inFigure 37.

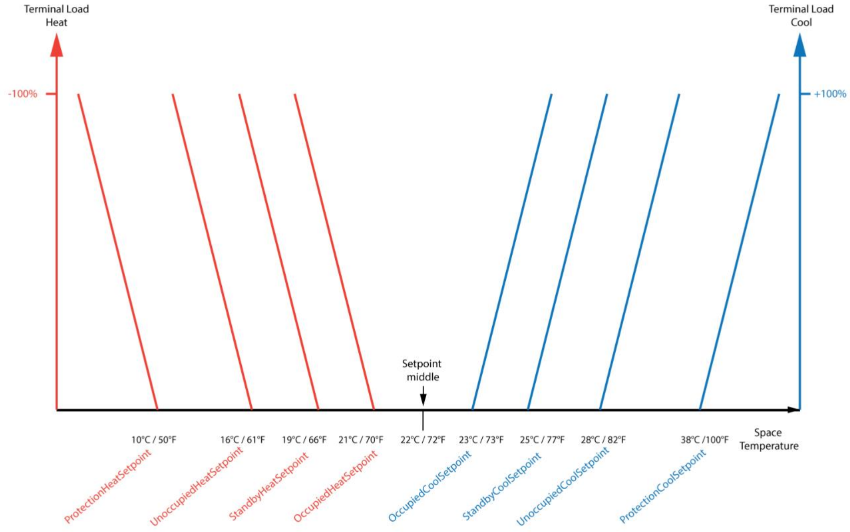


Figure 37: Space temperature setpoints, cooling and heating control outputs

The control outputs of the space temperture cooling and heating controllers are used in a sequence to calculate the cooling and heating air flow setpoints, to calculate the discharge aír temperature setpoint and to calculate the output to the peripheral heat valve. This sequence is displayed for example in Figure 38.

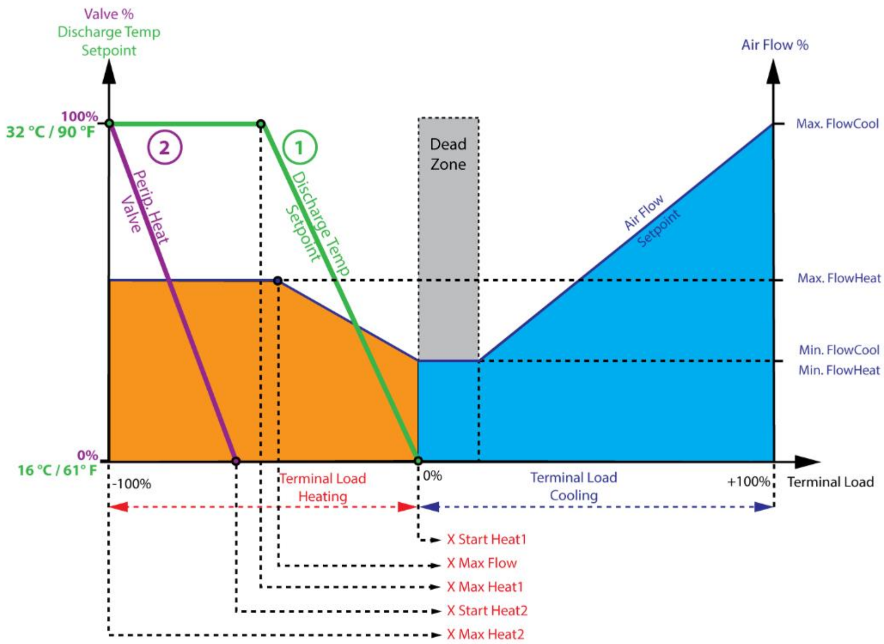


Figure 38: Sequence scheme of cooling and heating controller

The control output of the IAQ controller in this example calculates the supply air flow demand that will be maximum selected and maintained by the air flow controller. This is displayed in Figure 39.

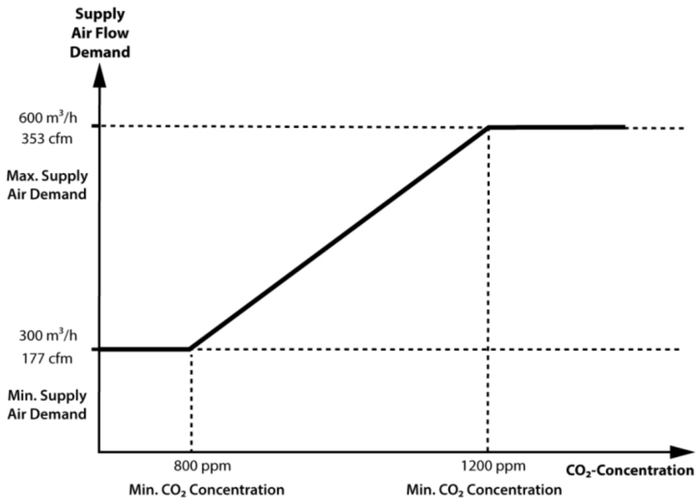


Figure 39: IAQ Control, Supply Air Flow Demand Curve

6.1.2.5 AHU Communication

To gain a proper and energy saving operation of the air handling unit (AHU) the VAV controllers will have to send operational data to the AHU controller. In the reverse direction, the VAV controllers need to receive operational information from the AHU.

For that reason, the VAV controllers are aggregating data as e.g. damper positions or terminal loads and provide this data as “Values to AHU” to a Multi Manager. This is an internal serial communication and it is established by the LIOB-Air System automatically.

The Multi Manager also receives data as HVAC Mode or outdoor air fraction from the AHU control. This data is also communicated to the VAV controllers as a broadcast using the internal serial communication that is established by the LIOB-Air System automatically.

The communication between the Multi Manager and the AHU controller has to be set up by the system integrator using BACnet or OPC or hard-wired connections.

See chapter 7.5.2 for further information.

6.1.2.6 VAV Groups

If bigger rooms are equipped with multiple VAV-Boxes, they have to collaborate in a VAV Group. One VAV controller is set as “Master” and all the others are set as “Slaves”. The Master is performing the room control functions and calculates and sends out setpoints to the slaves for their local control functions. If there are additional exhaust boxes in the room, the “Master” also cares for the room pressure balance.

The VAV Groups communication is also using the internal serial communication that is established automatically. See chapter 7.5.3 for further information.

6.2 Standard VAV Application

LOYTEC provides a VAV standard application. This is a VAV controller with fixed functions that can be parameterized by the user. This standard VAV application is operating stand-alone and is not able to establish the internal serial communication to other VAV controllers. However, it is able to communicate with BACnet, CEA709, and OPC and so it can be integrated in every BMS.

The standard VAV application is loaded into the LIOB-AIR device using the restore function of the WebUI. There is no need to use the L-STUDIO AIR engineering tool. The standard VAV application is useful for simple VAV systems that do not need any AHU communication or VAV Groups. If some communication is needed it has to be established by the system integrator using BACnet or OPC.

LOYTEC will provide multiple variations of the VAV standard application in future releases. See chapter 7.4 for more details.

6.3 L-STUDIO AIR

L-STUDIO AIR is the engineering tool to configure and commission LIOB-AIR VAV systems. A complete VAV function library provided by LOYTEC offers many VAV functions. A strong type based concept allows efficient configuration of VAV-Box functions and device configurations. The customer VAV project is built based on a project template that includes ready to use VAV-Box functions and device configurations. The templates provide a maximum functional range that can be reduced by deleting the not needed functions.

Additional to the VAV functions the data points and the graphical visualization are configured automatically.

The VAV system with all containing devices can be engineered and deployed to the LIOB-AIR device network in a very short time.

The engineering of a VAV system using L-STUDIO AIR does not require a deeper knowledge of a PLC programming language.

Please note that the VAV function library is the only source to configure the VAV-Box functions. A free programming of functions is not supported for LIOB-AIR VAV systems. If there are special functions are needed in a VAV project, please contact sales@loytec.com.

6.4 LWEB-802/803

Since the LIOB-AIR controllers are configured and deployed by L-STUDIO AIR, the next step is to enter all important parameter values that are needed to provide a proper operation of the VAV controllers. These are e.g. the air flow data, the grouping of multiple boxes in a room (VAV Groups) and e.g. the definition of the Air Supply Zone (AHU). The parameter values are entered at runtime of the system. That means that if some changes are needed later, they can also be applied during runtime.

This parameterization can be done using the built in graphical visualization projects.

The LIOB-AIR VAV system provides a built in graphical visualization based on the LOYTEC LWEB802 and LWEB 803 graphical user interfaces.

LWEB802 is a browser based platform independent visualization that utilizes HTML5 and Java Script and Web services. Dynamic graphic pages can be displayed and operated using a standard web browser on PCs tablets or smart phones. There is no need to install any additional software or browser plug-ins.

LWEB-803 is a visualization software for Microsoft Windows PCs.

Every LIOB-AIR device hosts multiple ready to use graphical projects to configure, operate, calibrate and maintain the VAV controller. These graphical projects for all VAV controllers are built automatically based on the L-STUDIO AIR device configurations.

6.5 LWEB-900

The parameter settings by using the LWEB visualization projects are useful for smaller projects with a few VAV controllers. If the building management system LWEB-900 is used it will increase the efficiency of the workflow. Even if LWEB-900 is not used as a building management system in the project, it can be used as a tool to increase the efficiency of the commissioning work. In this case, LWEB-900 will not remain onsite during the runtime of the VAV system. To use LWEB-900 as a tool a Competence Partner license is needed only.

During the engineering process The LWEB-900 parameter view, it can be used as a tool to setup multiple parameters of multiple VAV controllers very efficiently in a short time. It also provides a very efficient firmware upgrade function, backup and restore functions as well as alarm functions.

6.6 Data Points

In this chapter, the most important concepts of data points are described.

Please refer to the LOYTEC Device User Manual [1] and to the LINX Configurator User Manual [2] to get deeper information regarding data points, User Registers, Favorites, local I/O, BACnet server objects, CEA709 network variables, local connections, alarms and trends.

6.6.1 Data Point Communication

The function control logic of the VAV application is operating with User Registers directly to display values and states and to get setpoints. All these User Registers are OPC exposed and are can be read and written by other devices as OPC tags using OPC communication. The LWEB-802/803 visualization and the LWEB-900 building management system are operating these OPC data points.

LIOB-AIR devices communicate all data points as BACnet server objects also. The User Registers and the BACnet server objects are synchronized automatically. This is part of the VAV application is using Local Connections. On data points that are read- and writeable the synchronization is operating bidirectionally. Therefore, every time a data point value has changed on a User Register or on a BACnet server object the opposite data point is synchronized automatically. For that reason, LIOB-AIR devices can be integrated in BACnet systems with the complete functionality of operation and parameterization.

LIOB-AIR devices also support communication using CEA709 network variables. But these CEA 709 data points have to be created individually according to the project demands. The CEA 709 data points can be linked to the User Registers using local connections. The CEA 709 data points are synchronized with the User Registers automatically. The creation of CEA 709 data points and the local connection to the User Registers can be done easily in the VAV_Device_Type using the “Smart Auto-Connect” function of the LINX configurator. Please refer to the LINX Configurator User Manual [2] for more details.

The principle of the User Registers synchronization is shown in Figure 40

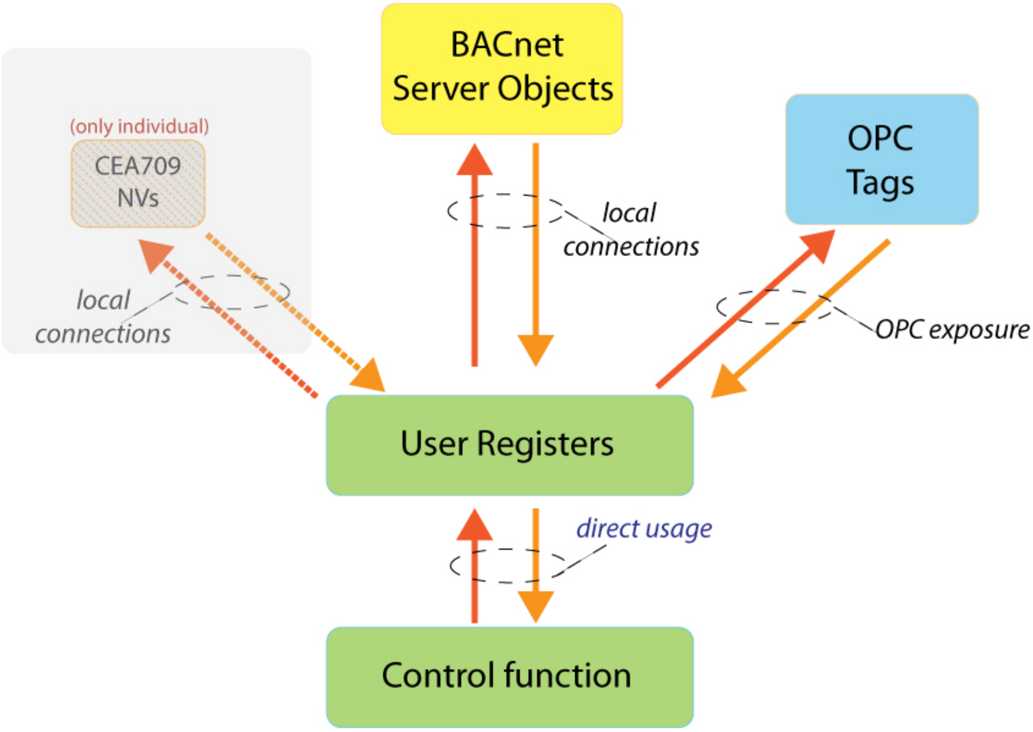


Figure 40: User Registers synchronization

The function control logic of the VAV application is operating with Favorites directly. The Favorites are used to be linked to the local I/Os of the LIOB-AIR device. This is very flexible and allows modifying the link to the local I/O (or to other communication data points) without changing the function control logic. All these Favorites are OPC exposed and are can be read and written by other devices as OPC tags using OPC communication. The LWEB-802/803 visualization and the LWEB-900 building management system are operating these OPC data points.

LIOB-AIR devices are able communicate all local I/Os as BACnet input or output server objects also. This has to be configured in the VAV_Device_Type by the system integrator using the Configurator in L-STUDIO AIR. The local I/O inputs and outputs that shall be available as BACnet input or output server objects have to be set as BACnet Object. The local I/O and the BACnet server objects are synchronized automatically according to the BACnet standard. For that reason, LIOB-AIR devices can be integrated in BACnet systems with the complete functionality of inputs and outputs.

LIOB-AIR devices also support communication using CEA709 network variables. But these CEA 709 data points have to be created individually according to the project demands. The CEA 709 data points can be linked to the Favorites using local connections. The CEA 709 data points are synchronized with the Favorites automatically. The creation of CEA 709 data points and the local connection to the Favorites can be done easily in the VAV_Device_Type using the "Smart Auto-Connect" function of the LINX configurator. Please refer to the LINX Configurator User Manual [2] for more details.

The principle of the Favorites synchronization is shown in Figure 41.

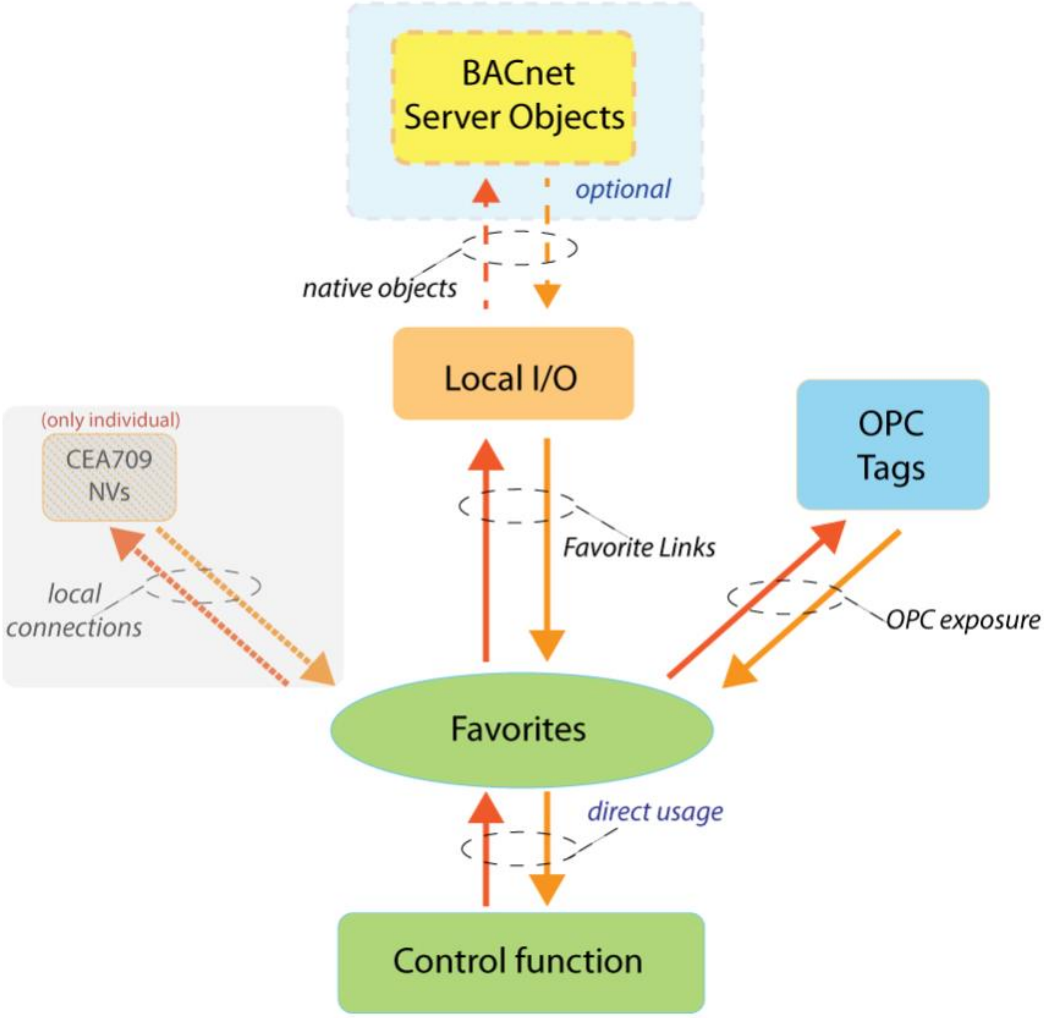


Figure 41: Favorites synchronization

6.6.2 Alarms

There are two generic alarm serves available in the VAV application “alarm” and “manual”. If there is a fault detected by the VAV application a dedicated alarm is triggered in the alarm server “alarm”. If e.g. an actuator function, (e.g. Damper) is set from Auto to Manual mode a dedicated alarm is triggered in the alarm server “manual”. The alarm lists “alarm” and “manual” can be operated in the LWEB802/803 VAVstatus.lweb2 visualization.

Both generic alarm servers are reporting their alarms to the dedicated BACnet alarm servers “auto” and “manual”. So all alarms are available, if the LIOB-AIR devices are integrated in BACnet networks.

6.6.3 Trends

The important data point values are trended by the generic trend function in the LIOB-AIR devices. These Trends are OPC exposed and are available using OPC communication. The trend data is displayed in the LWEB802/803 VAVstatus.lweb2 visualization.

If additional trend data is needed in BACnet networks or CEA709 networks, these trends have to be configured in the VAV_Device_Type by the system integrator using the Configurator in L-STUDIO AIR.

7 LIOB-AIR VAV System

7.1 System Architecture

7.1.1 Introduction

To gain a proper operation of a complete VAV system the VAV controllers have to communicate to each other and to an air handling unit. Therefore, in the most cases VAV systems are consisting of multiple controllers in a communication network. The LOYTEC engineering tool L-STUDIO was developed with the main purpose to program or configure complete controller networks with controller function and a seamless integrated network communication. In case of L-STUDIO AIR, VAV applications for LIOB-AIR controllers can be configured and the controller network communication is established automatically.

LOYTEC provides a VAV library for L-STUDIO AIR that allows configuring the needed VAV functions. Please note that the functions of the VAV library can be configured, but a free programming of VAV controllers is not supported.

L-STUDIO AIR is based on a strong type and instance concept. Every function is defined as a type and can be instantiated multiple times in other types. If a type has been modified the changes are applied to all instances of this type automatically. In case of LIOB-AIR, the important types are VAV_Types, Manager_Types and VAV_Device_Types.

The VAV functions are defined in VAV_Types.

The data aggregation is operated by manager functions, which are defined by Manager_ Types.

VAV_Types and Manager_Types can be instantiated in dedicated hardware device types, which are the resulting VAV_Device_Types.

There are two possible system design strategies supported by L-STUDIO AIR, the Adhoc Design and the Structured Design.

The multiple VAV_Device_Types can be instantiated in the VAV system using the Adhoc Design or the Structured Design.

<u>Adhoc Design:</u> The system has a flat structure without any hierarchy. It is easy to set up and it is the solution for the usual cases.

<u>Structured Design:</u> The system has a very strong structure. It can be used if there are identical shapes and instrumentation of the zones on a floor and the floors replicate on multiple levels. In Structured Design, areas have to be built as Area_Types and floors have to be built as Floor_Types to be instantiated multiple times.

7.1.2 Adhoc Design

The Adhoc Design can be used in most cases of building a VAV system. This could be a scheme e.g. consisting of an Area West and an Area East, which shall reach above multiple floors. However, in case of the Adhoc Design the areas are a very soft definition in the LIOB-AIR system. It can be an area on a floor but it also can be a part of a building consisting of multiple floors. The instrumentation of the areas in the building is not identical usually. The same or different VAV_Device_Types can be instantiated multiple times in the areas of the VAV system.

For data aggregation and AHU communication, the Multi Manager is used in the Adhoc Design. This manager function can be instantiated in one of the VAV controller devices additional to the VAV function. The Multi Manager supports the communication to one air handling unit. The Multi Manager consists of 5 areas and up to 20 VAV controllers can be connected to every area.

The principle of the Adhoc Design using the Multi Manager is shown in Figure 42. There the manager function is shown with the 5 areas. The VAV controllers are connected to a chain to one of the areas of the Multi Manager. (This principle is displayed without the mandatory ”loops”).

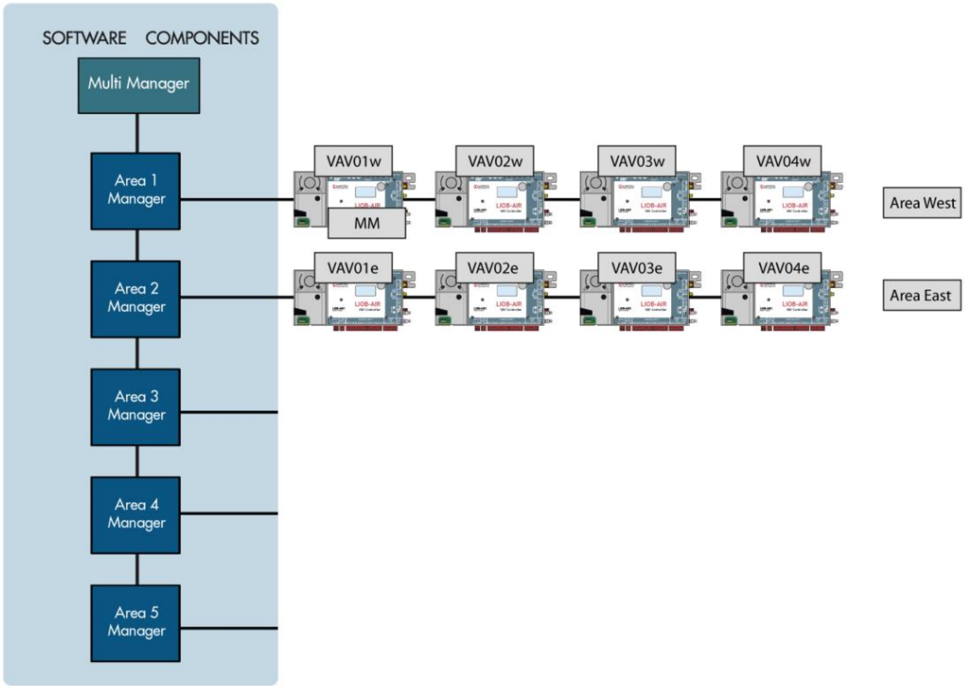


Figure 42: Principle of Adhoc Design

The real L-STUDIO AIR solution of the principle above is shown in Figure 43. There the Multi Manager is shown in the device instance “VAV01w”. This is a VAV controller with an additional Multi Manager function. The VAV controllers are chained in two areas and are connected to two of the Multi Manager ports.

The chaining of the VAV controllers and of the manager establishes the internal serial communication system of the LIOB-AIR controllers. It is important to build the chain as a loop. So the first and the last VAV controller are connected to the area port with the same index (1…5) of the Multi Manager. This ensures a stable internal serial communication even if a VAV controller in the chain is not communicating caused e.g. by a power failure.

Please note that the beginning and the end of the chain must be connected to the ports with the same index (e.g.: VavBusIn1, VavBusOut1). The Multi Manager connectors FloorBusIn and FloorBusOut <u>must not</u> be connected.

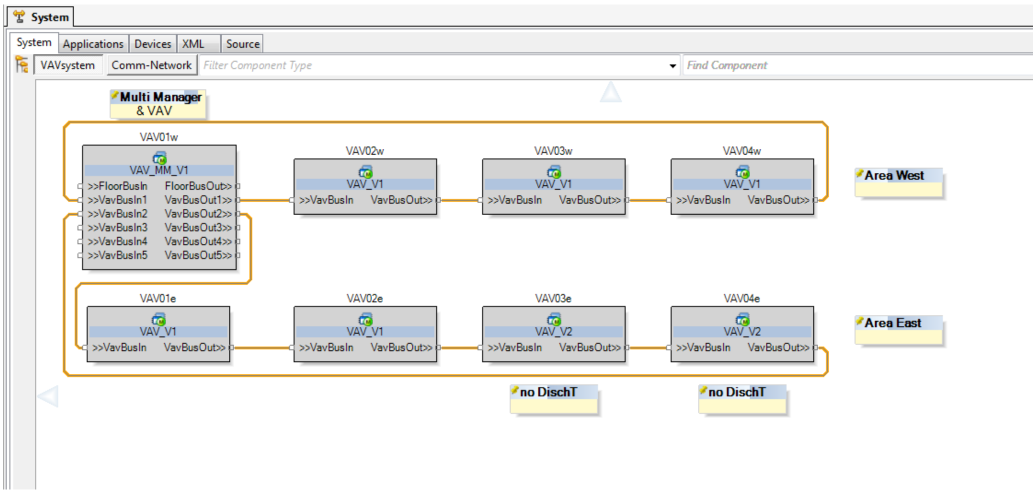


Figure 43: Adhoc Design in L-STUDIO

7.1.3 Structured Design

The Structured Design can be used in special cases of building a VAV system. If a building consists of areas that are repeating on each floor and the instrumentation of these building areas with VAV controllers is identical the Structured Design can be recommended. Hence, it is useful to build Area- Types for the different areas. In case of the Structured Design, there is a hard definition of an area that is always only a part of a floor of a building. There can be multiple areas on a floor. The combination of areas on a floor is often identical on every floor. Hence, it is useful to build Floor- Types for the different floors.

For instance, there can be the west area, which has always 4 VAV controllers of the same type installed. Further, there can be the east area, which has always 3 VAV controllers of a different type installed. The floor can consist of the west area and the east area. This floor replicates on every level of the building in the same way. These replicating zones can be built in L-Studio as Area_Types containing the VAV controllers and these Area_Types can be combined to a Floor_Type. This Floor_Type can be put together one time for each level and so the building structure is set up in short time. The building structure with areas and floors is shown in Figure 44.

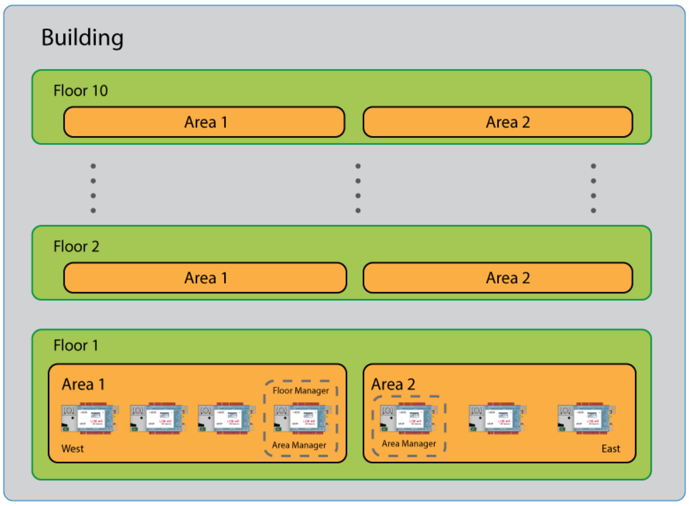


Figure 44: Areas, Floors, Building (Structured Design)

For data aggregation and AHU communication, dedicated Area Managers are used for every area. These Area Managers aggregate and communicate data to the dedicated floor manager of every floor. The Floor Managers aggregate and communicate data to the Building Manager. This manager function can be instantiated in the VAV controller devices additional to the VAV function. It is possible to instantiate one Area Manager and one Floor Manager and one Building manager additional to the VAV function into a LIOB-AIR device. The managers support the communication to 4 air handling units. Every VAV controller has to be assigned to one of the air handling units during the runtime.

The principle of the Structured Design using the Area- Floor- and Building- Managers is shown in Figure 45. (This principle is displayed without the mandatory ”loops”). This is for instance a building with 5 floors. The Floors contain the area west and the area east. The area west contains 4 VAV controllers of one dedicated type and this area is identical on every floor. The area east contains 3 VAV controllers of one different dedicated type and this area is identical on every floor. The Area Manager function is instantiated additionally in the VAV01 devices of both areas. The Floor Manager Function is instantiated additionally in the VAV01 devices of the area west. The Building Manager Function is instantiated additionally in the VAV01 device of the area west on the second floor. The VAV controllers are connected to chains to one of the Area Managers.

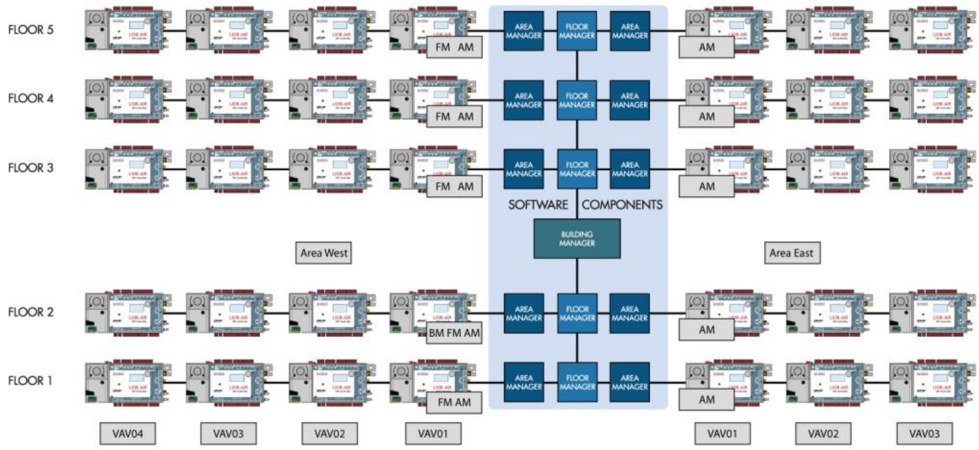


Figure 45: Principle of Structured Design

The real L-STUDIO AIR solution of the principle above is shown in the following figures. Please note that the beginning and the end of the chain must be connected to the ports of the manager.

The Area_Type_AM which contains the VAV controllers type V2 and the one device with the additional Area Manager that is valid for Area East on Floor1,2,3,4,5 is shown in Figure 47.

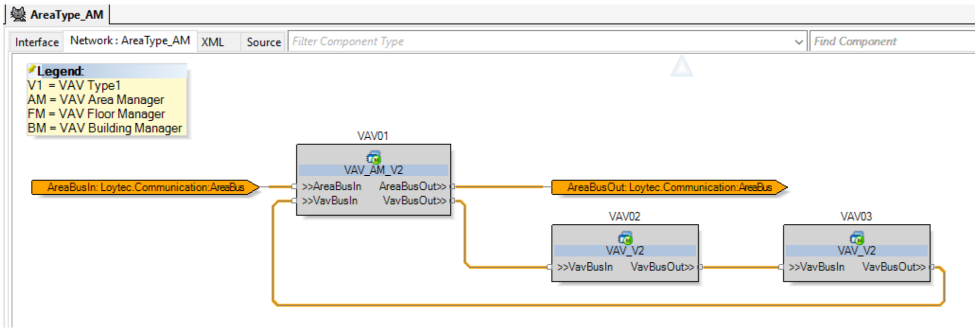


Figure 46: Area_Type_AM in Structured Design

The Area_Type_FM_AM that contains the VAV controllers Type V1 and the one device with the additional Area Manager and Floor Manager that is valid for Area West on Floor 1,3,4,5 is shown in Figure 47.

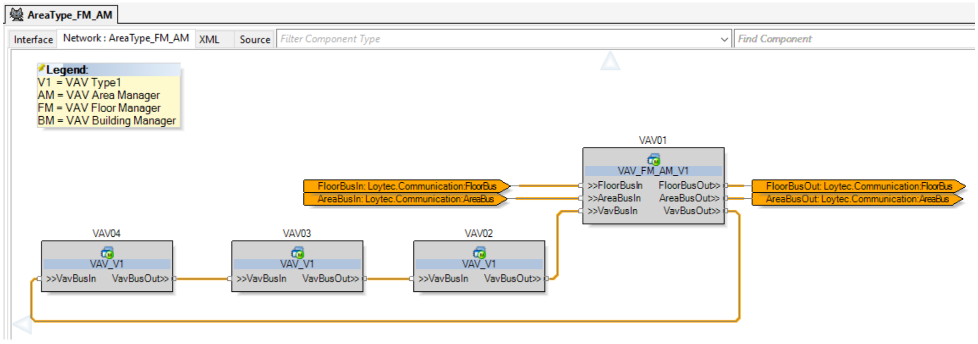


Figure 47: Area_Type_FM_AM in Structured Design

The both Area_Types are put together in the Floor_Type_FM that is valid for the Floor 1,3,4,5 is shown in Figure 48.

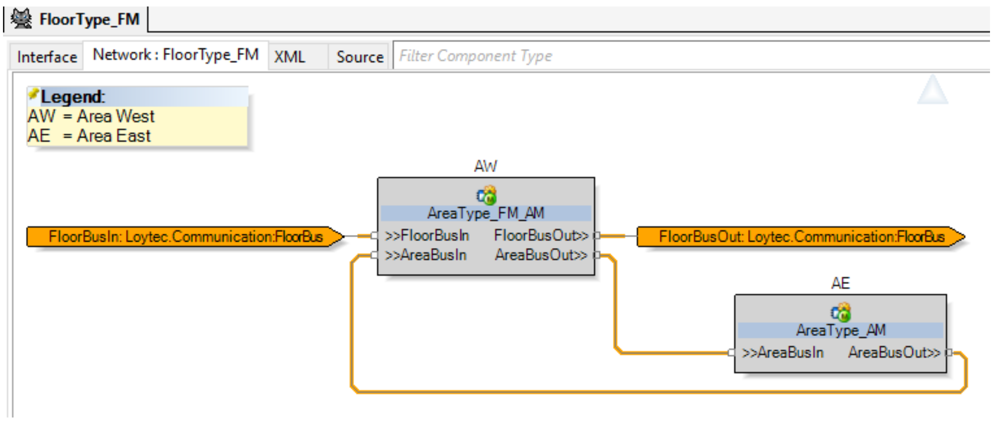


Figure 48: Floor_Type_FM in Structured Design

The Floor_Types of the building are put together as dedicated instances for every level L1; L2,L3,L4,L5 to the complete system as shown in Figure 49. Please note that the Floor_Type_BM_FM_AM was not shown before.

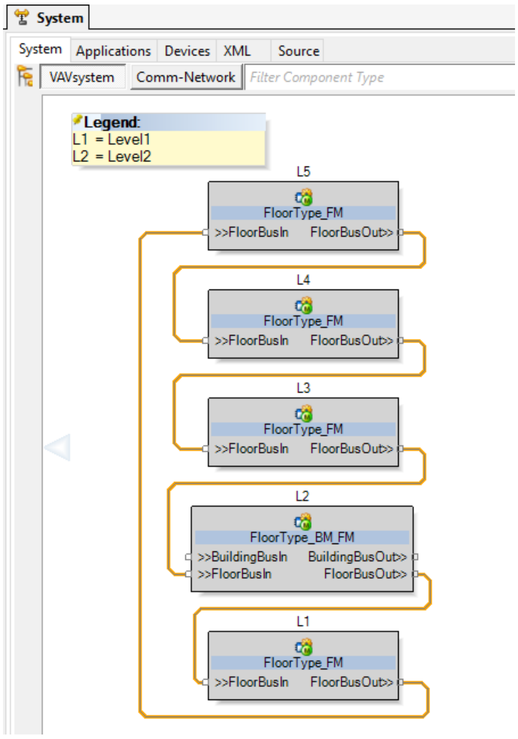


Figure 49: Complete system in Structured Design

The chaining of the VAV controllers and of the manager establishes the internal serial communication system of the LIOB-AIR controllers. It is important to build the chains as loops. This ensures a stable internal serial communication even if a VAV controller in the chain is not communicating caused e.g. by a power failure.

7.1.4 VAV_Types

A VAV controller operates many control functions. There are core functions, which are operated in every type of VAV controller e.g. the flow control, the HVAC Mode control or the Effective Occupancy control etc. Further there are special functions that vary between different VAV controllers e.g. Space Temperature control, Discharge Temperature control, IAQ control, Reheat control, etc. In a VAV system, there are often different types of VAV controllers to be found.

All the functions a VAV controller shall operate are defined in VAV_Types. There is a core function that is available in every VAV_Type. Additional Functions are activated if the relating sensor or actuator function is present and connected to the core in the VAV_Type. A VAV_Type can be configured easily by deleting the not requested sensors and actuators from a predefined maximum VAV_Type. The core function and the sensor and actuator functions of a VAV_Type in L-STUDIO AIR are shown in Figure 50.

There is also the LSTAT800 block connected to the core that enables the configuration and communication to a connected L-STAT network thermostat.

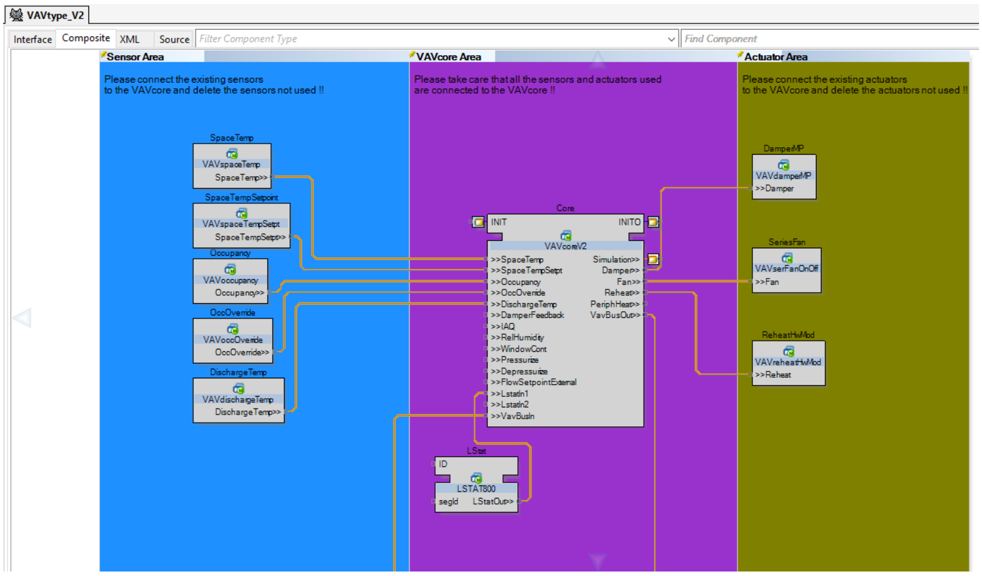


Figure 50: Example VAV_Type in L-STUDIO AIR

In the VAV_Type all functions, data points and visualizations are included. However, note that a VAV_Type is always independent of any hardware! The functions do not refer to fixed hardware inputs or outputs of a device but they use “Favorite” data points. These Favorites can be used later to connect the functions to hardware inputs and outputs. (This is done in the VAV_Device_Types.)

During the setup of a VAV system, the user has to build as many different VAV_Types as required in the project.

The principle scheme of a VAV_Type is shown in Figure 51.

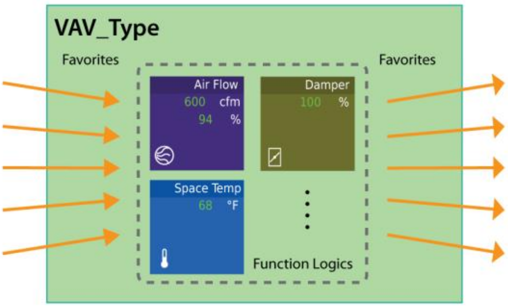


Figure 51: Principle scheme of a VAV_Type

7.1.5 Manager_Types

To aggregate values from the zones (e.g. max. damper position, etc.) and communicate to the AHUs as well as report operational data from the AHUs (e.g. HVAC-mode, etc.) to the VAV Boxes the predefined Manager_Types are available in the VAV library of L-STUDIO AIR. There are Manager_Types existing for Multi Managers, Area Managers, Floor Managers and Building Managers. These Manager_Types are also independent of any hardware. They can be instantiated additionally to a VAV_Type in a VAV_Device_Type.

Area, Floor, and Building Managers are only to be used in the optional “Structured Design”. Area Managers aggregate values from the VAV controllers in their own Area and send these data to the Floor Manager, which aggregates the data of all areas of this floor. The Building Manager aggregates values of all Floor Managers and this can be used by the connected AHUs for multiple operation and optimization functions.

Area, Floor, and Building Managers support up to 4 air supply zones (AHUs). Therefore, the VAV system can have up to 4 AHUs and every VAV controller can be assigned to one these AHUs. It is no problem if some of the air supply zones are not used.

The Multi Manager is the only manager to be used in the “Adhoc Design”. It allows creating a flat system structure. It includes 5 Area Managers to with each up to 20 VAV controllers can be connected. These areas are no real areas in a floor but only free groups of VAV controllers in the building. An Area Manager aggregates values from the connected up to 20 VAV controllers. The Multi Manager aggregates values from the 5 internal Area Managers and this can be used by the connected AHUs for multiple operation and optimization functions.

The Multi Manager only supports 1 air supply zone (AHU). Therefore, the VAV system can have only one AHU and all VAV controllers are assigned to that.

Typical aggregated values from the VAV controllers to the AHUs are: Minimum and maximum Terminal Load, Maximum Damper Position, Minimum Maximum and Average Space Temperature and relative Humidity, summary of air flow, summary of outdoor air demand or summary of supply air demand.

Typical values from the AHUs sent to the VAV controllers are: HVAC mode, outdoor air fraction, CO2 outdoor air, CO2 supply air.

7.1.6 VAV_Device_Types

A VAV_Device_Type defines a concrete hardware device type like LIOB-AIR1 or LIOB-AIR2 or LIOB-AIR13. All physical inputs and outputs can be configured in the VAV_Device_Type. The VAV_Types and Manager_Types are independent of any hardware and can be instantiated in multiple VAV_Device_Types. With the instance of a VAV_Type, all the VAV functions are built into a VAV_Device_Type. The connection of the physical IOs of the VAV_Device_Type to the functions of the instantiated VAV_Type is done using the Favorite data points that are provided by the VAV_Type. An example how a VAV_Device_Type looks inside (with an instantiated VAV_Type) in L-STUDIO AIR is shown in Figure 52.

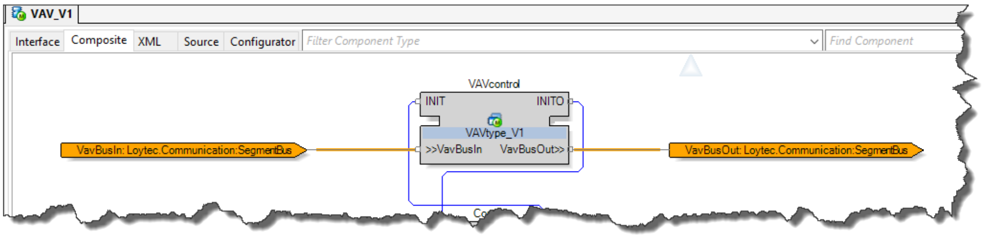


Figure 52: Example VAV_Device_Type in L-STUDIO AIR

In the VAV_Device_Type, the local I/O configuration and the connection of the Favorite data points of the instantiated VAV_Type can be set up with the configurator in L-STUDIO AIR as shown in Figure 53.

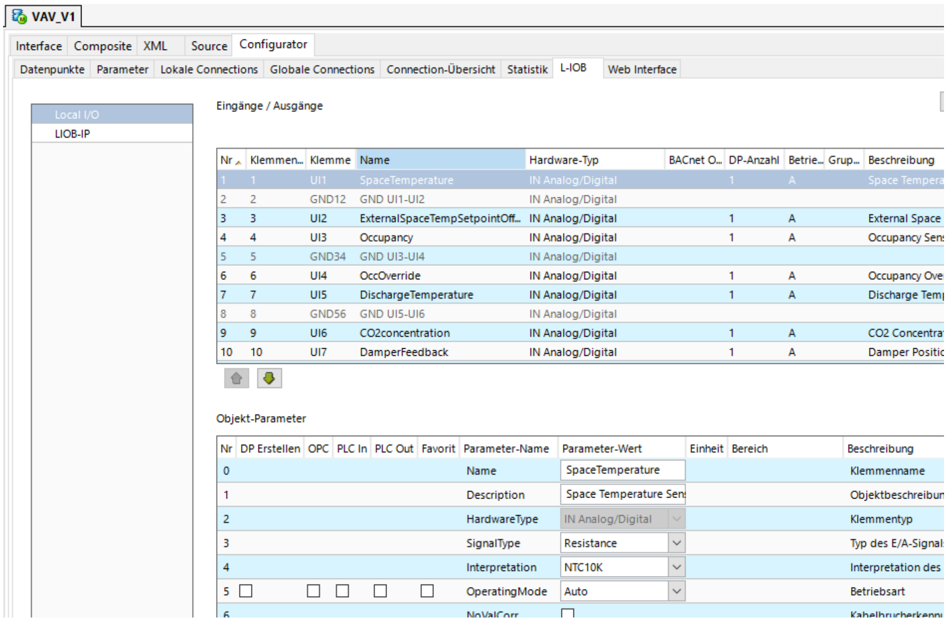


Figure 53: Configuration of a VAV_Device_Type in L-STUDIO AIR

The principle scheme of a VAV_Device_Type is shown in Figure 54.

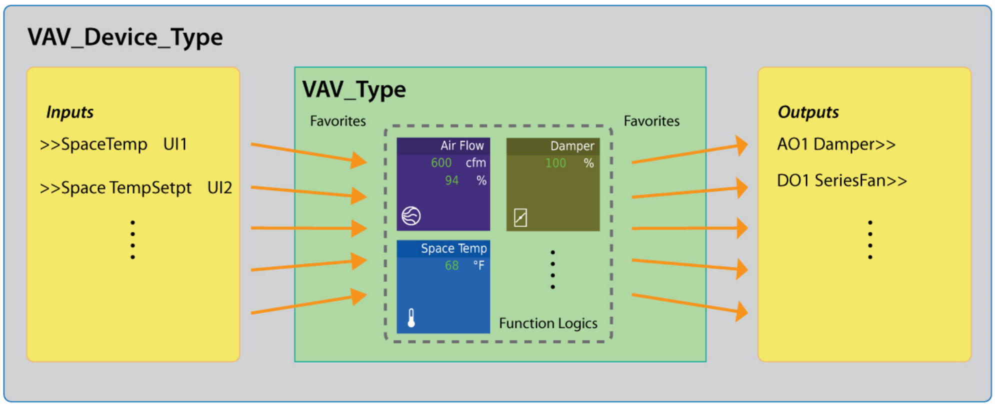


Figure 54: Principle scheme of a VAV_Device_Type

Optionally one or more manager types can be instantiated in a VAV_Device_Type additionally in the Structured Design. One Multi Manager type can be instantiated in a VAV_Device_Type additionally in the Adhoc Design, as shown in Figure 55. (Here the communication connection of the VAV_Type has to be connected to the first area port of the Multi Manager.)

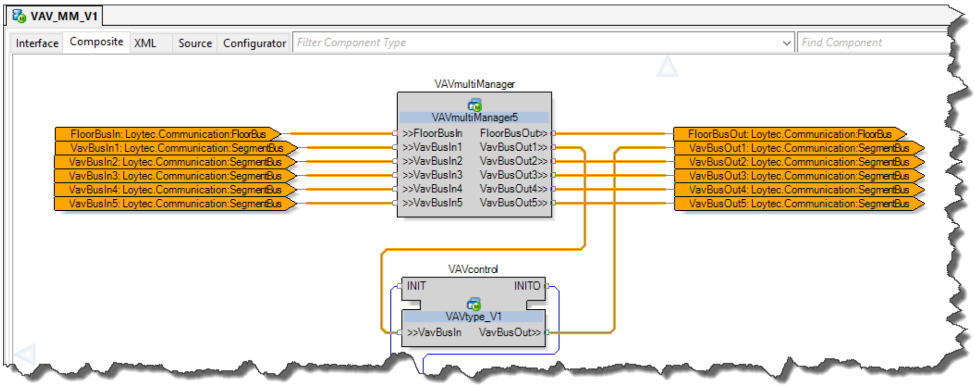


Figure 55: Example VAV_Device_Type with Multi Manager in L-STUDIO AIR

The principle scheme of a VAV_Device_Type with an additional instantiated Manager_Type Multi Manager is shown in Figure 56.

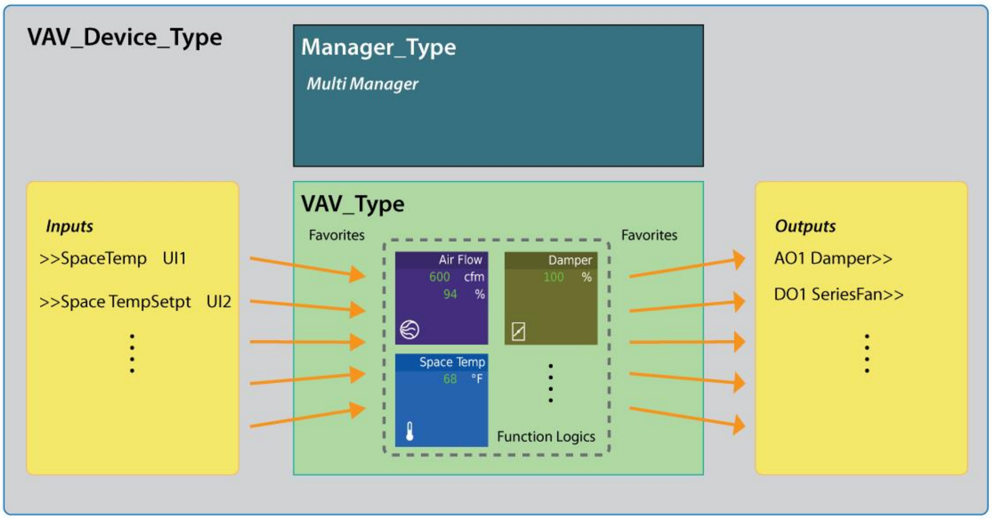


Figure 56: Principle scheme of a VAV_Device_Type with Multi Manager

During the setup of a VAV system, the user has to build as many different VAV_Device_Types as required in the project. This can be the same or different hardware devices in combination with different VAV_Types and perhaps additional Manager_Types.

7.2 Workflow

To create and engineer a VAV system LOYTEC provides the engineering system L-STUDIO AIR and a VAV library for LIOB-AIR controllers. Since the LIOB-AIR controllers have been created, configured and deployed using L-STUDIO AIR they have to be parameterized using the built in LWEB-802/803 visualization projects or using LWEB900 parameter views.

This workflow is described in the following chapters.

7.2.1 Hardware Installation and IP Address Setup

The LIOB-AIR controller is connected to the network using one of the Ethernet/IP ports or WLAN. The device must be powered with either 24 VAC/DC or 85-240 VAC (check the front label of the LIOB-AIR device). After the device has booted, the initial IP address must be configured on the LCD UI. This is done by selecting the IP address (“192.168.1.254”) in the LCD UI using the jog dial, see Figure 6. After that, select “Ethernet 1” and setup the IP address, mask, and gateway or, alternatively, enable DHCP. Finally, select “Save and reboot”. All other settings can further be performed with the WebUI of the LIOB-AIR controller.

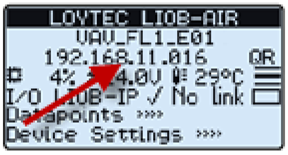


Figure 57: Select IP address in LIOB-AIR display

7.2.2 Basic Workflow Overview

To build a VAV system the following steps have to be proceeded:

1. **Create a new VAV solution:** This is based on the “VAV Start Solution” that provides ready to use VAV_Types with functions, data points and visualizations, VAV_Device_Types with a Standard I/O configuration and instantiated VAV_Types, and Manager_Types.

2. **Define the VAV_Types:** The VAV functions are defined by selecting the needed sensors and actuators as e.g. Space Temperature Control, IAQ Control, MP-Bus Damper, Reheat Hot Water Modulating, etc. This is done based on existing VAV_Types of the VAV library with a maximum functionality, deleting the functions not needed.

3. **Define the VAV_Device_Types:** The VAV_ Types have to be instantiated in a concrete Hardware type like LIOB-AIR1, or LIOB-AIR2, or LIOB-AIR13. The local I/O has to be configured and the Favorites have to be connected. In addition, a Multi Manager or Area- Floor or Building-Managers can be instantiated in the VAV_Device_Types. This is done by copying and modifying of existing VAV_Device_Types of the VAV library.

4. **Define the Area_Types (only in Structured Design):** The VAV controller instrumentation of the multiple Area_Types using the defined VAV_Device_Types has to be configured. This is done copying and modifying of existing Area_Types of the VAV library.

5. **Define the Floor_Types (only in Structured Design):** The Area_Types have to be instantiated in one or multiple Floor_Types. This is done copying and modifying of existing Floor_Types of the VAV library.

6. **Build the VAV Application**: In Adhoc Design the VAV_Device_Types have to be instantiated on the “System” page to build the entire building. In Structured Design, the Floor_Types have to be instantiated on the “System” page to build the entire building.

7. **Create all the VAV Devices**: Since the VAV system now includes all floors, areas and devices, all the LIOB_AIR VAV controllers now can be created automatically in a dedicated device list.

8. **Set the IP-Addresses in the device list**: Because L-STUDIO AIR needs to know where to deploy the configured devices, the IP-Addresses have to be set in the device list.

9. **Build and Deploy the solution**: After these steps are finished, L-STUDIO can build and compile the solution and deploy the software to multiple devices simultaneously with a powerful deploy function.

10. **Parameter settings in VAV-Boxes**: The VAV controllers are operating the VAV application. Now all important parameters have to be set. These are e.g. the air flow data, the grouping of multiple boxes in a VAV Group and e.g. the definition of the Air Supply Zone (AHU). This can be done using the built in LWEB-802/803 visualization project or using LWEB-900 parameter views.

11. **Parameter settings in Managers**: The manager functions are executed by dedicated VAV controllers. Now all important parameters have to be set. This is e.g. the Air Supply Zone (AHU). This can be done using the built in LWEB-802/803 visualization project or using LWEB-900 parameter views.

12. **Backup the Devices**: It is highly recommended to back up all the devices with data point configuration, parameter values, logical functions, communication functions, device settings and visualizations. This can be done using the device backup functions of the dedicated WebUIs or using LWEB-900.

7.2.3 Create a new VAV solution

Everything needed for a VAV-Project is included in the “VAV Start Solution” sample project. It was already installed on the PC with the VAV library installation described in chapter 3.1.1. These are the function libraries as well as samples of VAV_Types, VAV_Device_Types, Area_Types and Floor_Types that are to be found in a folder structure. The basic procedure is to take this “VAV Start Solution” as the basic solution and enhance it to the final project solution by copying and modifying the included sample types.

Start L-STUDIO AIR, open “File” menu and select the “New” and “Solution” function as shown in Figure 58. This will open the “New Solution” dialog as shown in Figure 59.

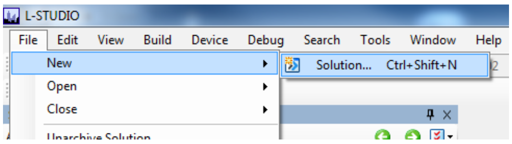


Figure 58: Create New Solution

Select the “VAV Start Solution” template, enter the project name e.g. “MyVAVproject” select the file location and press the “Create” button.

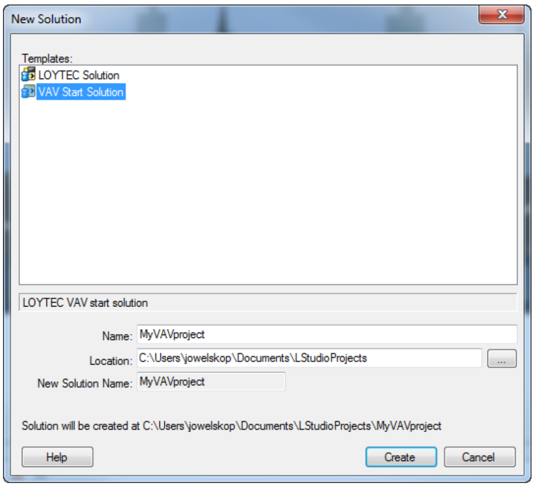


Figure 59: New Solution template

The new VAV solution "MyVAVproject" will be created.

7.2.3.1 L-STUDIO Screen Areas

The L-STUDIO screen consists of 3 screen areas as shown in Figure 60:

The **Solution Overview** displays the opened solution in a tree view and allows a structured navigation in the application and in the libraries.

In the **Editor Area,** you can display, watch and modify the components you have selected in a view with multiple tabs.

In the **Output Area** detailed information, errors, warnings and messages can be shown. E.g. there are messages shown from the compiler or the deploy process.

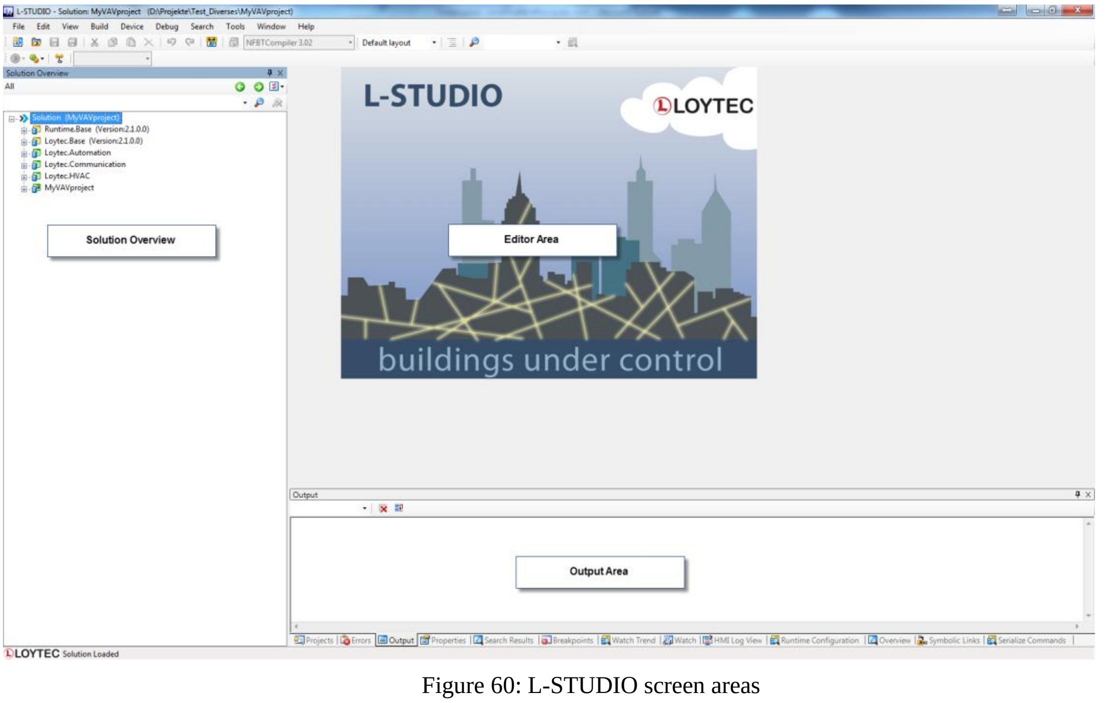


Figure 60: L-STUDIO screen areas

For more details, please refer to the L-STUDIO help system.

7.2.3.2 Structure of the sample project

In the Solution Overview, please expand the folders as shown in Figure 61.

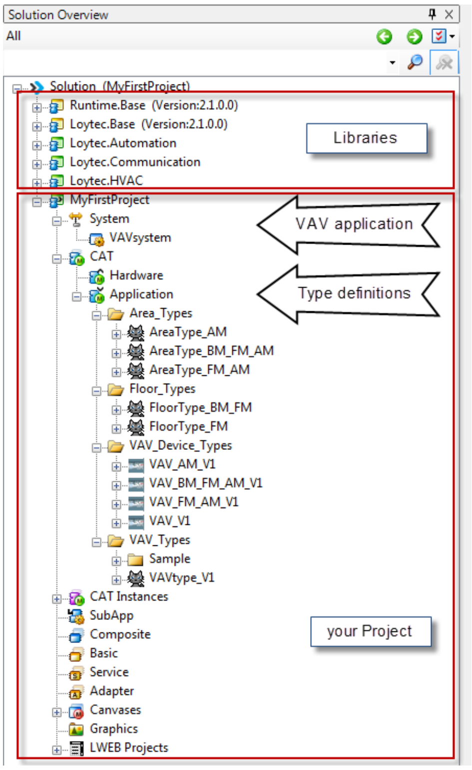


Figure 61: Sample project folder layout

The upper part of the tree includes all “Libraries” that are needed to generate a VAV application. In the libraries, all the automation and communication functions of the logic and control are defined. You will not have to modify these libraries in most projects but they must be present in the solution.

In the lower part, you see the structure and components of your project “MyVAVproject”. In the “System” folder, you will see all your LIOB-AIR devices that have been created

In the CAT\Application folder, there are other folders (VAV_Types, VAV_Device_Types, Area_Types, Floor_Types, and LSTAT) which contain basic type definitions. These basic type definitions must be copied and modified by the user building a VAV project.

In L-STUDIO, types with a “CAT” icon are defined as “Composite Automation Types” which means that there are functions, data points and visualizations included in this type.

The Device_Types are shown with a “Device” icon. In L-STUDIO, these types are defined as “Device CATs” which means that there are CATs and also device configurations included in this type.

7.2.4 Define VAV_Type(s)

As described in chapter 7.1.4 the VAV_Types are defining the VAV functions independent of any controller hardware type.

The first step in a project is to identify the different types of VAV Boxes, which have to operate different functions e.g. some with Discharge Temperature Control and some without.

The Folder “VAV_Types” already includes 2 VAV type CATs as shown in Figure 62:

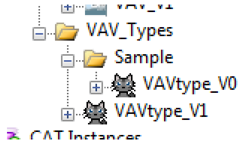


Figure 62: included VAV_Types

The “VAVtype_V0” CAT in the “Sample” folder is the basic type which can be used as a template. It is a maximum type and it contains all the sensor and actuators with all functions a VAV controller can operate. It can be copied when needed <u>but it should not be modified</u> to ensure to have always a “clean” template to create new VAV types.

The “VAVtype_V1” is a copy of the “VAVtype_V0” and it shall be the first type the user can modify and adapt to his requirements.

If there are multiple VAV_Types needed the VAVtype_0 can be copied, pasted and modified multiple times as VAVtype_V2, VAVtype_V3, VAVtype_V4, VAVtype_V5…. The copies should be placed into the VAV_Types folder. The naming of the VAV_Types can be done to the user demands.

The copy and paste process is always done by using the right click context menu of the VAVtype_V0 CAT.

Please note that the principle is to copy the VAVtype_0 as the maximum function type and delete the sensor and actuator functions that are not needed in the copied VAV_Type. In case if a sensor or actuator was deleted accidentally it is highly recommended to delete the copied VAV_Type, create a new copy of the VAVtype_V0 and modify it again correctly. This only a little work but it ensures the proper operation of creating the data points and the graphical visualization automatically.

A double click to the “VAVtype_V1” will open a new tab in the editor window. There the sub tab “Composite” has to be selected.

There the 3 function areas of a VAV controller are displayed, the Sensor Area, the VAV core Area and the Actuator Area as shown in Figure 63.

In the Sensor Area, all the sensor functions a VAV controller can have are included. Here the sensor functions that are not needed in this VAV_Type have to be deleted.

In the VAV Core Area, the core functions of every VAV controller are included. This “Core” block <u>must not</u> be deleted! It has many connectors where the dedicated sensor and actuator functions can be connected. All the available sensors and actuators must be connected to the core. In addition, the LSTAT800 CAT of the VAV library is included in the VAV Core Area and is connected to the dedicated port of the Core. It contains the automatic configuration and communication of the LOYTEC L-STAT network thermostat and should not be deleted.

In the Actuator Area, all possible actuator functions of a VAV controller are included. Here Actuators that are not needed in this VAV_Type can be deleted.

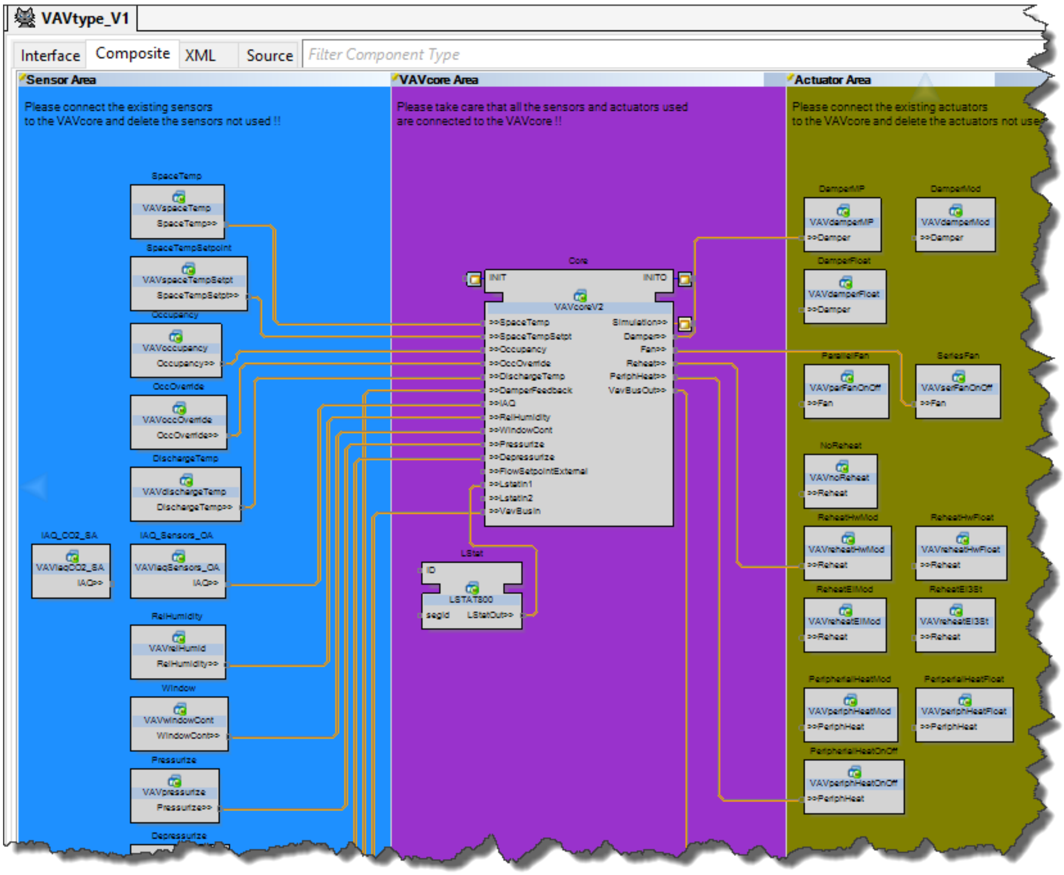


Figure 63: VAVtype_V1 without changes

7.2.4.1 First VAV_Type:

The "VAVtype_V1" shall be modified for example. It shall have the following sensors and actuators:

- Space Temperature sensor with Space Temperature Control,
- Discharge Temperature sensor with Discharge Temperature Control,
- External Space Temperature Setpoint sensor to modify the Space Temperature Setpoint,
- Occupancy sensor with occupancy function
- Occupancy Override sensor with "Bypass"- button function
- MP-Bus Damper actuator to control the air flow
- Series Fan actuator to support the air flow
- Reheat Hot Water Modulating actuator to reheat the discharge air

The unused sensor and actuator functions have to be deleted whereas the remaining sensor and actuator functions have to be connected to the core via the dedicated connectors.

To delete a function, it has to be selected and with the right click context menu, it can be deleted.

The CAT has to be saved.

Please note that only in the colored sensor and actuator areas the functions have to be deleted. The Core and the blocks outside from the colored areas <u>must not</u> be deleted.

It is important to know that all the instance names of the CATs instantiated in the VAV_Type e.g. Core or SpaceTemp <u>must not</u> be changed! This is because the instance names of the CATs are part of the data point paths.

The modified VAVtype_V1 is displayed in Figure 64.

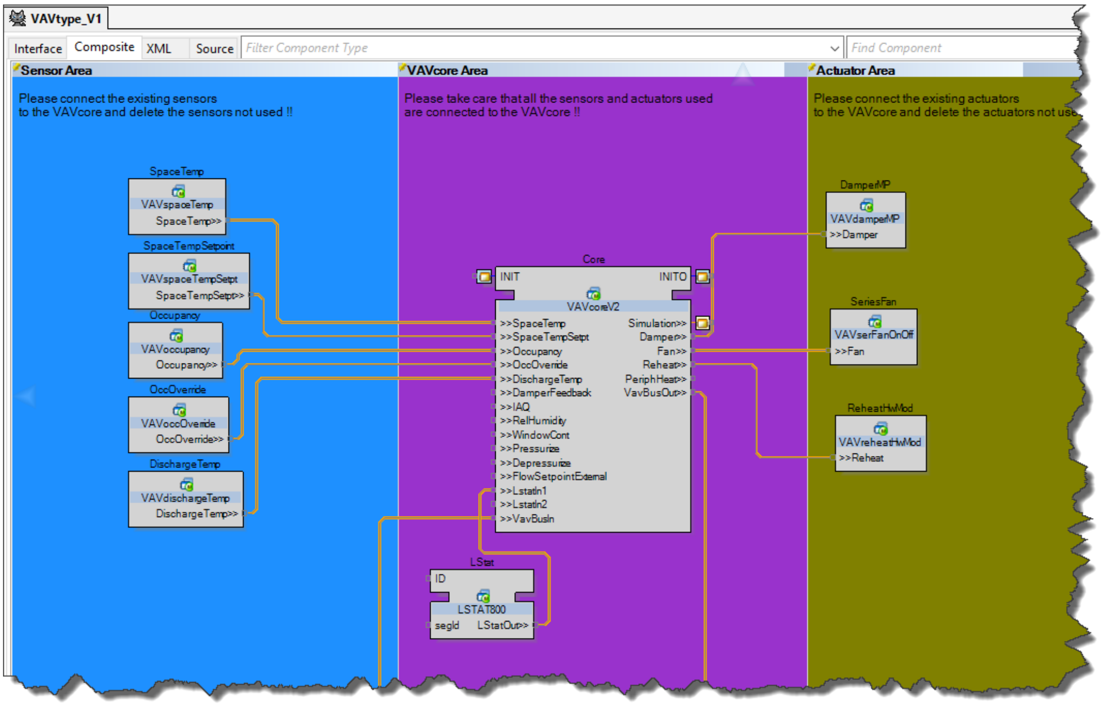


Figure 64: VAVtype_V1 modified

7.2.4.2 Second VAV_Type:

A second VAV_Type shall be created for example. It is similar to the first VAV_Type VAVtype_V1 but it has no Discharge Temperature sensor and no Discharge Temperature Control function. So the reheat will be controlled by the Space Temperature controller directly.

Copy VAVtype_V0, and paste it to VAVtype_V2 in the VAV_Types folder as shown in Figure 65.

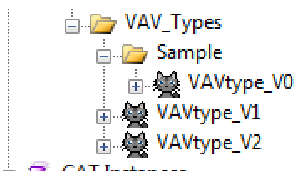


Figure 65: VAVtype_V2 copied

Now the VAVtype_V2 CAT can be opened and modified as described above. When the modifications are done and saved, it looks like Figure 66.

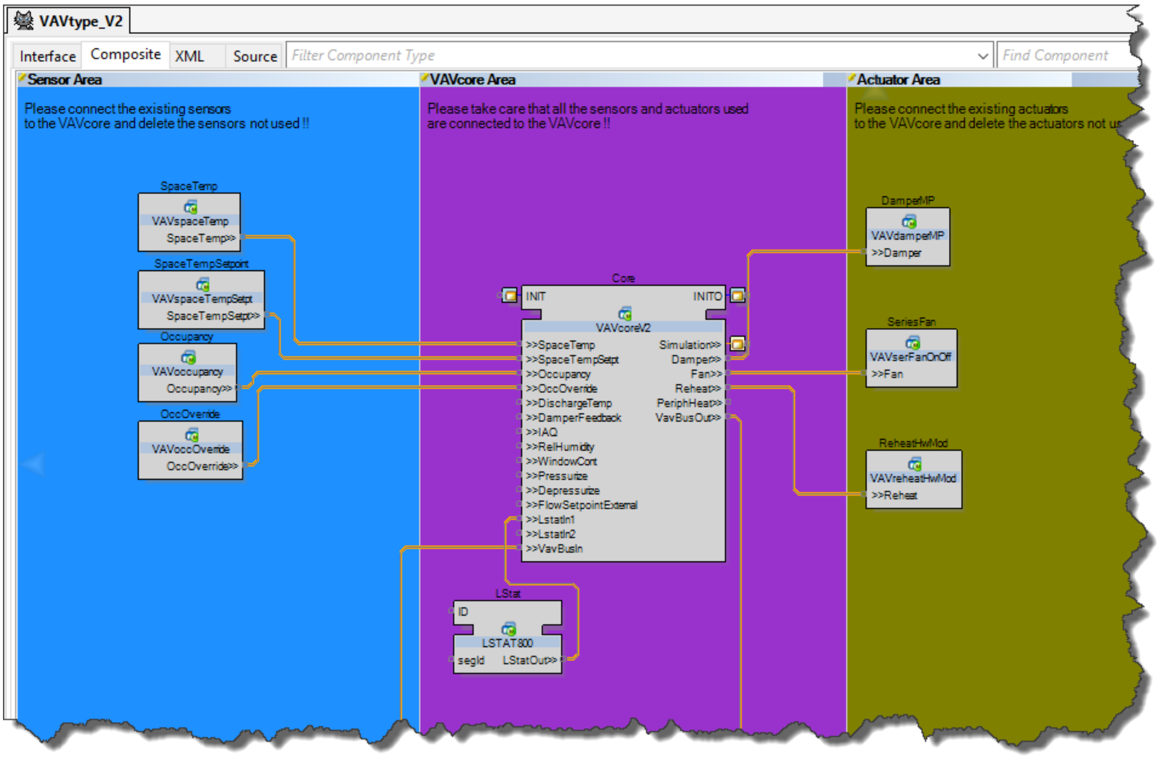


Figure 66: VAVtype_V2 modified

7.2.5 Define VAV_Device_Type(s)

Since the VAV_Types have been defined, the next step is to define the VAV_Device_Types. As described in chapter 7.1.6 VAV_Device_Types refer to a dedicated controller hardware device type e.g. a LIOB-AIR1 and the local I/Os are configured. In a VAV_Device_Type, a VAV_Type is instantiated and the sensors and actuators from the VAV_Type using the Favorite data points are connected to the local I/Os of the VAV_Device_Type. In addition, Manager_Types can be instantiated in VAV_Device_Types additionally.

The Folder “VAV_Device_Types” already includes 5 ready-to-use VAV_Device_Types as shown in Figure 62.

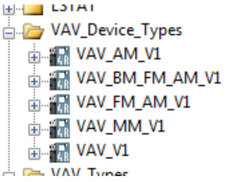


Figure 67: included VAV_Device_Types

The VAV_V1 is a VAV_Device_Type with the VAV_Type VAVtype_V1 already included.

The VAV_MM_V1 is a VAV_Device_Type equal to VAV_V1 but with a Multi Manager included additionally.

The VAV_AM_V1 is a device type equal to VAV_V1 but with an Area Manager included additionally.

The VAV_FM_AM_V1 is a device type equal to VAV_V1 but with an Area Manager and a Floor Manager included additionally.

The VAV_BM_FM_AM_V1 is a device type equal to VAV_V1 but with an Area Manager, a Floor Manager and a Building Manager included additionally.

These included VAV_Device_Types can be used directly in the VAV application, or they can be copied, pasted and modified.

7.2.5.1 First VAV_Device_Type:

Our first VAV_Device_Type shall use for example a LIOB-AIR1 device and the functionality of the VAV_Type VAVtype_V1 as defined in chapter 7.2.4.1.

To check or to modify the hardware controller type assigned to a VAV_Device_Type, the right click context menu of the VAV_Device_Type has to be opened and the “Properties” menu has to be selected. This opens the “CAT Properties” dialog and the “Device Identification” can be checked or modified, as shown in Figure 68.

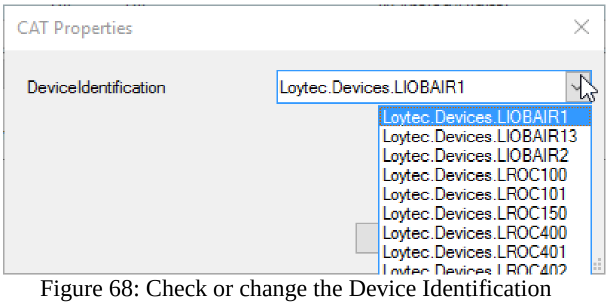


Figure 68: Check or change the Device Identification

A double click on VAV_V1 opens the VAV_Device_Type and on the Composite tab the instance of the VAV_Type "VAVtype_V1" is shown, see Figure 69. Because this is the first VAV_Device_Type we can use it "as it is" and there is no modification needed in the Composite tab.

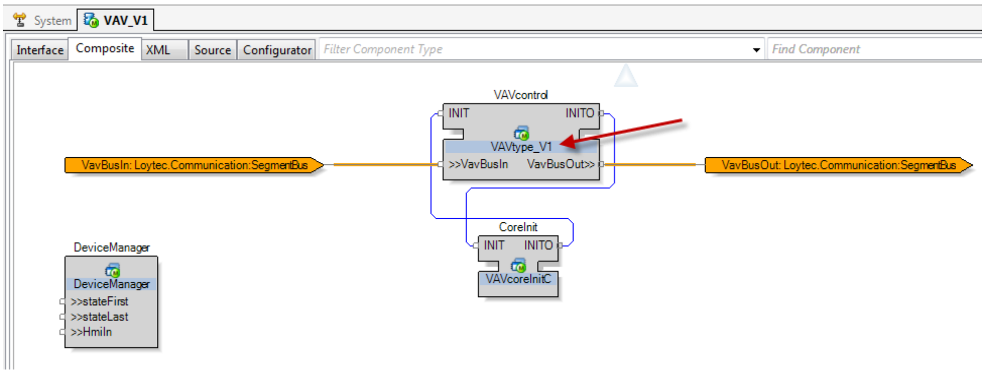


Figure 69: VAV_Device_Type: VAV_V1

It is important to know that the instance names of the CATs instantiated in the VAV_Device_Type e.g. VAVcontrol <u>must not</u> be changed! This is because the instance names of the CATs are part of the data point paths.

The local IOs are predefined and connected to the data points of the VAV_Type with Favorites. This can be modified if needed.

On the Configurator tab of the VAV_Device_Type, the device configuration can be checked and modified.

It is very important that only the Favorite links and the local I/O are allowed to modify in the VAV_Device_Type configuration. All the other items in the configuration as folder names, data point names and data point properties must not be modified, because these are built automatically in the VAV_Types.

Please refer to the LOYTEC Device User Manual [1] for detailed information using the configurator functions, data points, Favorites, local I/O, etc.

The engineering unit system the VAV_Device_Type is operating should be checked and modified first. SI units are set as default. The unit system can be changed in the Project Settings of the Configurator. The Project Settings have to be selected in the LIOB-AIR1 menu as shown in Figure 70 to open the Project Settings dialog.

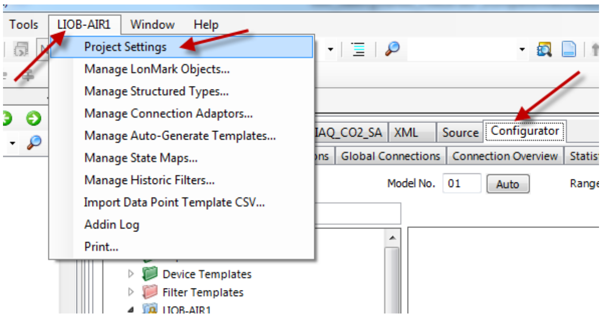


Figure 70: Select Project Settings of the Configurator

On the General tab in the section "Unit settings", the Data point units can be changed to e.g. "U.S.". To make the change take effect in the devices on download the check box has to be checked also as shown in Figure 71.

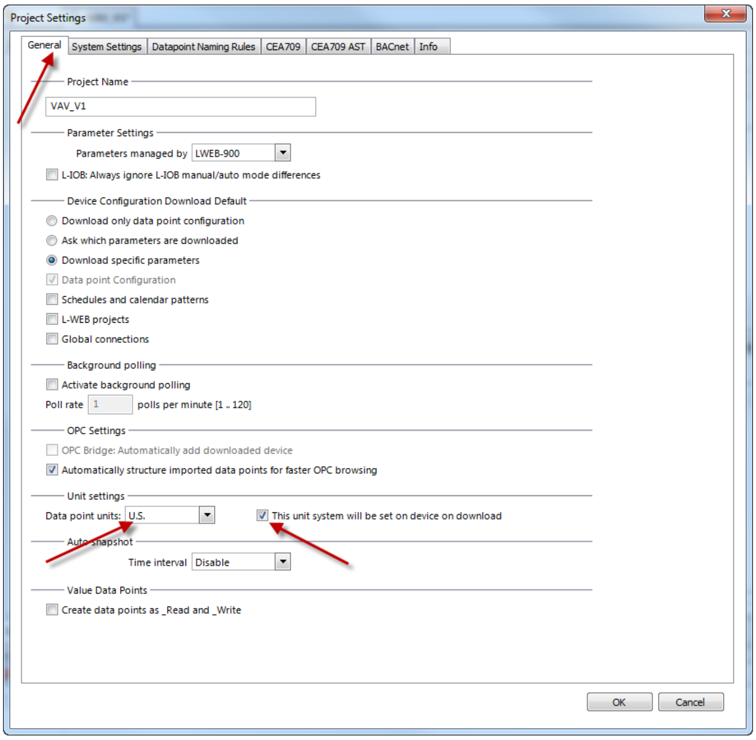


Figure 71: Change Unit settings

The System Settings in the VAV_Device_Types included in the "VAV Start Solution" have a useful setup. These settings can be modified on the "System Settings" tab to fit the customer demands. Please note that this is most efficient to be done before creating the devices (chapter 7.2.8). If the System Settings have to be changed after creating the devices, they have to be changed in every dedicated device (resources).

In the VAV_Device_Types, a standard I/O configuration is already set. This configuration can be used "as it is" or it can be modified by the user if changes are needed. In the predefined VAV_Device_Types, the local I/Os are already linked with Favorites to the control functions of the instantiated VAV_Type. If a not required sensor or actuator function was deleted by the user in the VAV_Type, the associated Favorites do not exist. So the according I/Os are not connected to a control function and will have no operational function. The standard I/O configuration is shown in Table 5.

Please note that in case of a manual instantiation of a VAV_Type into a VAV_Device_Type the local I/O also must be connected to the Favorites manually. This is one of the benefits using the predefined VAV_Device_Types.

UI = Universal Input analog or binary

AO = Analog Output

DO = Digital output, Relay 16A, Relay 6A, Triac

IO	Description	Type
UI1	Space Temperature	NTC10k
UI2	External Space Temperature Setpoint Offset	0 - 10k, -10°K…+10°K
UI3	Occupancy Sensor	binary
UI4	Occupancy Override (Bypass Button)	binary
UI5	Discharge Temperature	NTC10k
UI6	CO2 Concentration	0 – 10VDC, 0 – 2000ppm
UI7	Damper Feedback	0 – 10VDC, 0 – 100%
UI8	Window Contact	binary
UI9	rel. Humidity	0 – 10VDC, 0 – 100%rH
UI10	not used	binary
AO1	Reheat modulating	0 – 10VDC, 0 – 100%
AO2	Damper modulating	0 – 10VDC, 0 – 100%
AO3	Fan Speed	0 – 10VDC, 0 – 100%
DO1 (16A)	Reheat Stage 1	binary
DO2 (16A)	Reheat Stage 2	binary
DO3 (16A)	Reheat Stage 3	binary
DO4 (6A)	Fan	binary
DO5 (6A)	Reheat floating (Close)	binary
DO6 (6A)	Reheat floating (Open)	binary
DO7 (6A)	not used	binary
DO8 (Triac)	Peripheral Heat (On Off)	binary
DO9 (Triac)	Reheat modulating (PWM)	PWM

Table 5: Standard I/O Configuration of a LIOB-AIR1 device type

The local inputs and outputs of the LIOB-AIR device can be edited on the L-IOB tab of the configurator if some changes are needed. This is shown in this chapter.

In the Inputs/Outputs window the IO can be selected and the details of the selected I/O e.g. the signal type and interpretation of the Space Temperature input can be edited in the Object Parameters window as shown in Figure 72. See the LINX Configurator User Manual [2] for more details.

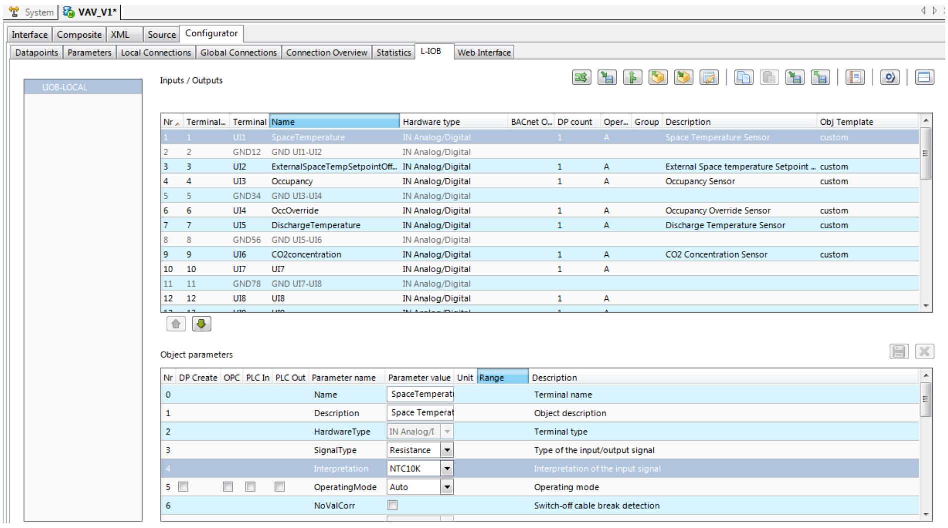


Figure 72: Configurator L_IOB tab

The physical Space Temperature input of the VAV_Device_Type is linked with a Favorite to the Space Temperature control function of the VAV_Type. To edit the Favorite link of e.g. the Space Temperature if needed, the Datapoints tab of the configurator has to be selected. In the folder *LIOB-AIR1\Favorites\VAVcontrol\SpaceTemp*, the *inSpaceTemp* Favorite is displayed with the Link Target Path to the local input of the Space Temperature as shown in Figure 73. See the LINX Configurator User Manual [2] for more details.

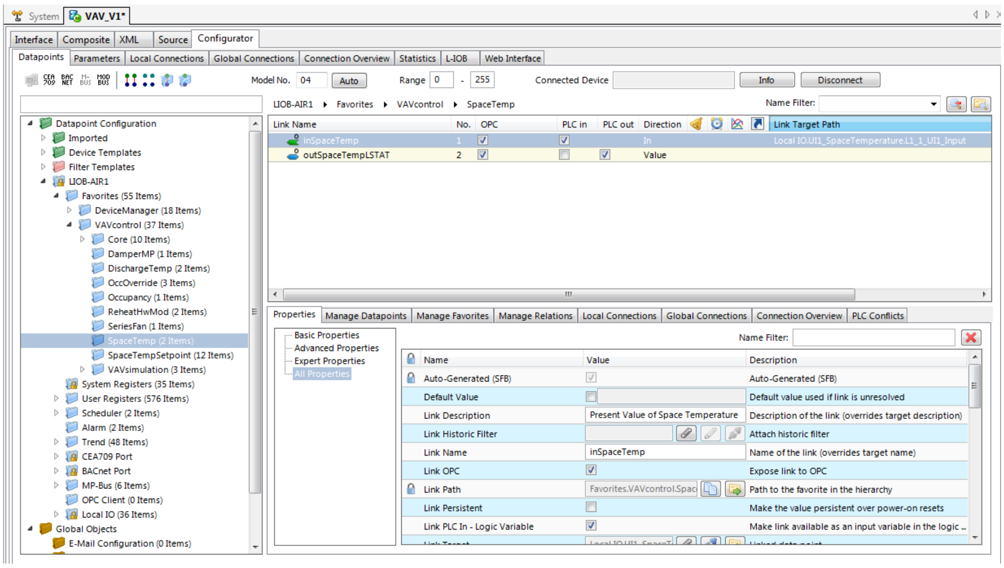


Figure 73: Favorite: Space Temperature

The link can be edited by right clicking on the *inSpaceTemp* Favorite and select “Link Favorite(s) to…”. The “Select Datapoints” dialog opens and the hardware input of the *UI1_Space Temperature* can be selected in the Folder *LIOB-AIR1\Local IO* if the user needs to change to a different hardware input as shown in Figure 74.

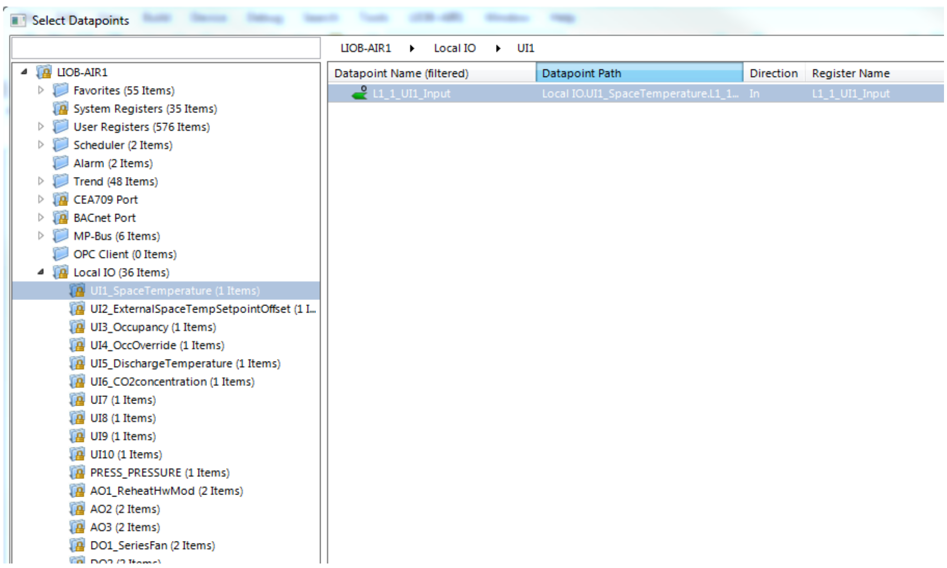


Figure 74: Selection of UI1_Space Temperature hardware input

If the entire local I/Os are set up correctly and are linked to the Favorites the VAV_Device_Type “VAV_V1” is ready to use.

The configuration has to be saved in L-STUDIO !

7.2.5.2 Second VAV_Device_Type:

The second VAV_Device_Type shall use for example a LIOB-AIR1 device and the functionality of the VAV_Type VAVtype_V2 (without discharge temperature control) as defined in chapter 7.2.4.2.

To create the second VAV_Device_Type the following procedure must be executed.

Because this second VAV_Device_Type does not have any Manager_Type instantiated, the VAV_V1 can be copied and pasted to VAV_V2 in the VAV_Device_Types folder.

<u>Please do not create VAV_Device_Types manually from scratch</u>! Additional VAV_Device_Types always have to be created by copy and paste form a predefined VAV_Device_Type of the VAV_Device_Types folder.

So the VAV_V1 has to be copied and pasted as VAV_V2 to the "VAV_Device_Types" folder as shown in Figure 75.

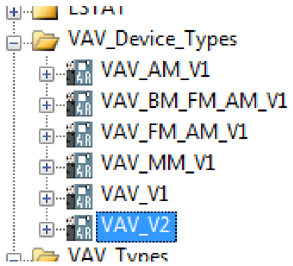


Figure 75: Copied VAV_V2 in folder structure

Now the VAV_V2 can be modified. Double clicking on to the VAV_V2 will open a new tab in the editor window. There the Composite sub tab has to be selected.

The instance type of the *VAVcontrol* must be changed from VAVtype_V1 to VAVtype_V2 to refer to the second VAV_Type (without the discharge temperature control). This is done by a click onto the instance type and change it from "Main:VAVtype_V1" to "Main:VAVtype_V2" as shown in Figure 76.

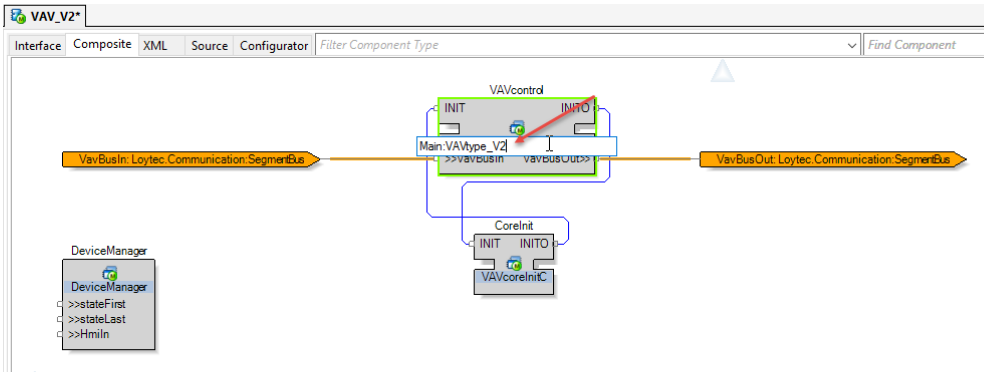


Figure 76: Change instance type to VAVtype_V2

When the instance type is changed from "Main:VAVtype_V1" to "Main:VAVtype_V2" the new VAV_Type is instantiated and all the Favorites of the new VAV_Type are linked to the local I/O of the VAV_Device_Type automatically. The visualization projects are adapted also automatically. Please note that the instance of the VAV_Type must never be deleted in the VAV_Device_Type, because the Favorite links and the visualization would get lost and must be rebuilt manually. In this case, it is the better way to copy and paste an existing VAV_Device_Type and do a new modification.

Because there is no discharge Sensor on this VAV device type, the local IO of this sensor input can be “neutralized” in the configurator. This can be done optionally! On the local IO UI5 enter “UI5” in the Name field and the content of the Description field can be deleted as shown in Figure 77.

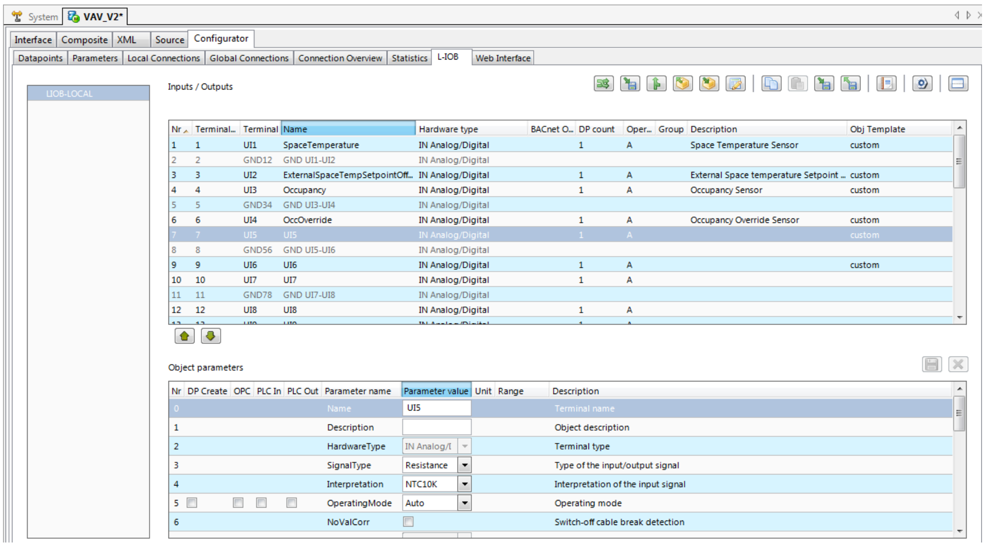


Figure 77: Delete the Discharge Temperature on UI5

Because the discharge temperature sensor was deleted in the “VAVtype_V2”, there is no Favorite existing to which the local sensor input can be connected. Therefore, there is nothing further to do.

This is only an example. The local I/O can be configured completely regarding the project demands using the configurator. See LINX Configurator User Manual [2] for more details.

The configuration has to be saved in L-STUDIO !

7.2.5.3 VAV_Device_Types with Managers

Adhoc Design

If you are using Adhoc Design (most cases) with the easy and flat structure, you have to use one Manager_Type Multi Manager in the VAV system.

The Multi Manager is described in chapter 7.1.

The Multi Manager does not need to have dedicated devices. It can be instantiated additionally to a VAV controller in a LIOB-AIR.

VAV_Device_Type with Multi Manager

The VAV_Device_Type with a Multi Manager is already defined in the “VAV_Start” solution as the VAV_MM_V1 in the VAV_Device_Type folder. Here a Multi Manager is included additionally to the VAV_Type VAVtype_V1. In our example, we will use this type as it is.

We will have a look into this VAV_Device_Type but actually, there is no need to change anything. Double clicking on to the VAV_MM_V1 will open a new tab in the editor window. There the Composite sub tab has to be selected as shown in Figure 78.

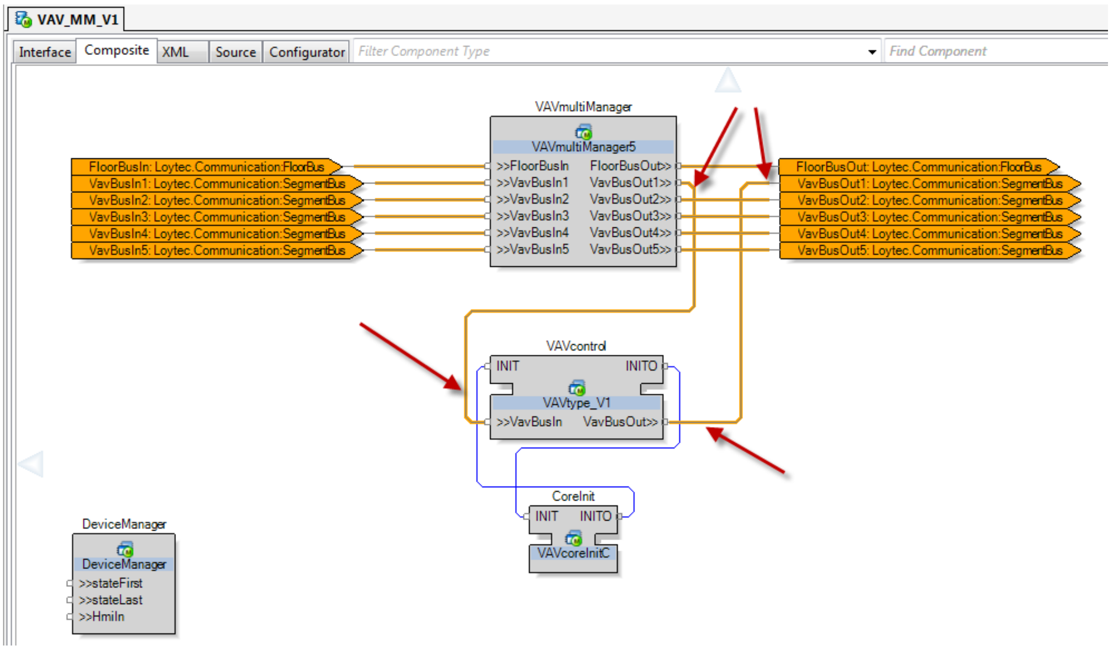


Figure 78: VAV_Device_Type: VAV_MM_V1

In this VAV_Device_Type, there is also a VAV_ Type VAVtype_V1 instantiated. The local I/O as well as the Favorites would have to be edited if there are changes to the sample type as described in the last chapters.

It would also be possible to change the instance of the VAVcontrol from VAVtype_V1 to VAVtype_V2 if this would be needed as described in the last chapter. However, in this example we do not change anything.

The Multi Manager has 5 communication bus connectors of the 5 containing Area Managers. In addition, it is important to note that the also included VAV_ Type VAVtype_V1 is connected to the communication bus of the Area 1 Manager.

If you are not using Structured Design, you can skip the rest of this chapter.

Structured Design

If you are using Structured Design (rare cases) to structure, your building in floors and areas you will have to use dedicated Manager_Types as Building-, Floor-, and Area Managers in the VAV system.

The Building-, Floor-, and Area Managers are described in chapter 7.1.

The Area- Floor- or Building managers do not need to have dedicated devices. They can be instantiated additionally to a VAV controller in a LIOB-AIR. It is also possible to instantiate multiple Manager_Types in a LIOB-AIR like a VAV controller plus 1 Area-Manager plus 1 Floor-Manager plus 1 Building-Manager as a maximum.

Because these devices with additional managers are needed in the Structured Design of a VAV system multiple times, multiple VAV_Device_Types with multiple combinations of Manager_Type additional to the VAV_Type VAVtype_V1 already defined in the "VAV_Start" solution in the VAV_Device_Type folder. These are VAV_AM_V1, VAV_FM_AM_V1, and VAV_BM_FM_AM_V1.

VAV_Device_Type(s) with Area Manager

The first VAV_Device_Type with an Area Manager is already defined in the "VAV_Start" solution as the VAV_AM_V1 in the VAV_Device_Type folder. Here an Area Manager with 4 air supply zones is included.

We will have a look into this VAV_Device_Type but actually, there is no need to change anything. Double clicking on to the "VAV_AM_V1" will open a new tab in the editor window. There the Composite sub tab has to be selected as shown in Figure 79.

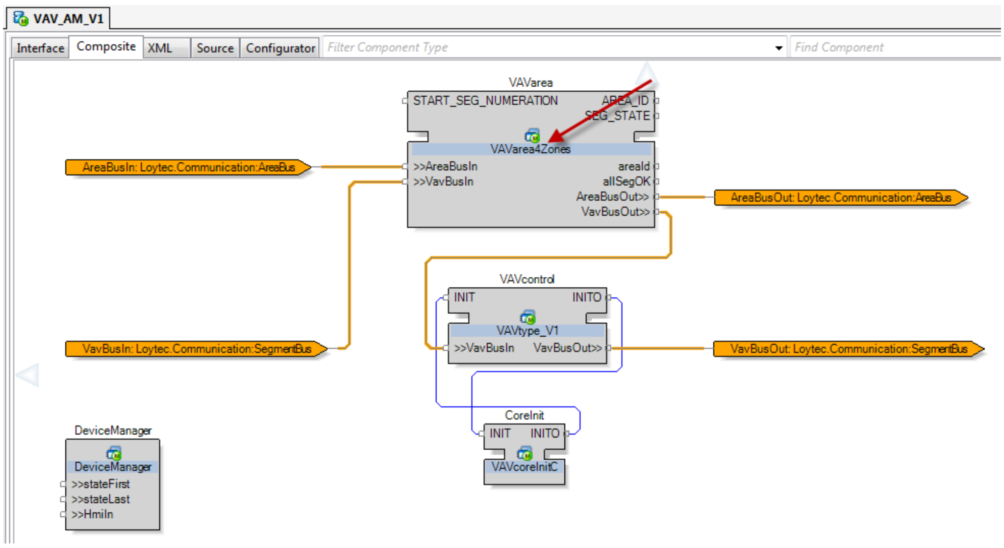


Figure 79: VAV_Device_Type: VAV_AM_V1

In this VAV_Device_Type, there is also a VAV_Type VAVtype_V1 instantiated. The local I/O as well as the Favorites have to be edited only if there are changes to the sample type as described in the last chapters.

It would also be possible to change the instance type of the VAV_Type from VAVtype_V1 to VAVtype_V2 if this would be needed as described in the last chapters. However, in this example we do not change anything.

VAV_Device_Type with Area and Floor Manager

It is also useful to have a device with an Area Manager and a Floor Manager. This device type is to be used one time in every floor. It manages its own area and the Floor Manager manages all areas on the floor.

The first VAV_Device_Type with an Area Manager and a Floor Manager is already defined in the “VAV_Start” solution as the VAV_FM_AM_V1 in the VAV_Device_Type folder. Here an Area Manager and a Floor Manager with 4 air supply zones are included and can be modified only if needed.

In this VAV_Device_Type, there is also a VAVtype_V1 instantiated. The local I/O as well as the Favorites have to be edited only if there are changes to the sample type as described in the last chapters.

It would also be possible to change the instance of the VAV_Type from VAVtype_V1 to VAVtype_V2 if this would be needed as described in the last chapters. However, in this example we do not change anything.

VAV_Device_Type with Area, Floor and Building- Manager

One VAV device in the building must have a Building- Manager included. To this Building-Manager the 4 AHUs are communicating, get aggregated data from and send AHU data to the VAV system. Because we do not need a dedicated device for the Building- Manager, it has to be instantiated in one of the VAV devices.

The first VAV_Device_Type with an Area Manager and a Floor Manager and a Building Manager is already defined in the “VAV_Start” solution as the VAV_BM_FM_AM_V1 in the VAV_Device_Type folder. Here an Area Manager and a Floor Manager and a Building Manager with 4 air supply zones are included and can be modified only if needed.

This device type will be used in the project only one time.

In this VAV_Device_Type, there is also a VAVtype_V1 instantiated. The local I/O as well as the Favorites have to be edited only if there are changes to the sample type as described in the last chapters.

It would also be possible to change the instance of the VAV_Type from VAVtype_V1 to VAVtype_V2 if this would be needed as described in the last chapters. However, in this example we do not change anything.

7.2.6 Build the system in Adhoc Design

Since all the needed VAV_Device_Types have been defined the VAV application can be built in L-STUDIO.

In this chapter, the VAV application is built using the Adhoc Design.

This example is a scheme e.g. consisting of an Area West and an Area East, which perhaps shall reach above multiple floors. In the Area West there are e.g. 4 VAV Boxes LIOB-AIR1 with Discharge Temperature Control. In the Area East there are e.g. 2 VAV Boxes LIOB-AIR1 with Discharge Temperature control and 2 VAV Boxes LIOB_AIR1 (VAV03e & 04e) without Discharge Temperature control. In the Area West, the "VAV01w" device shall operate the Multi Manager. This is shown in Figure 80.

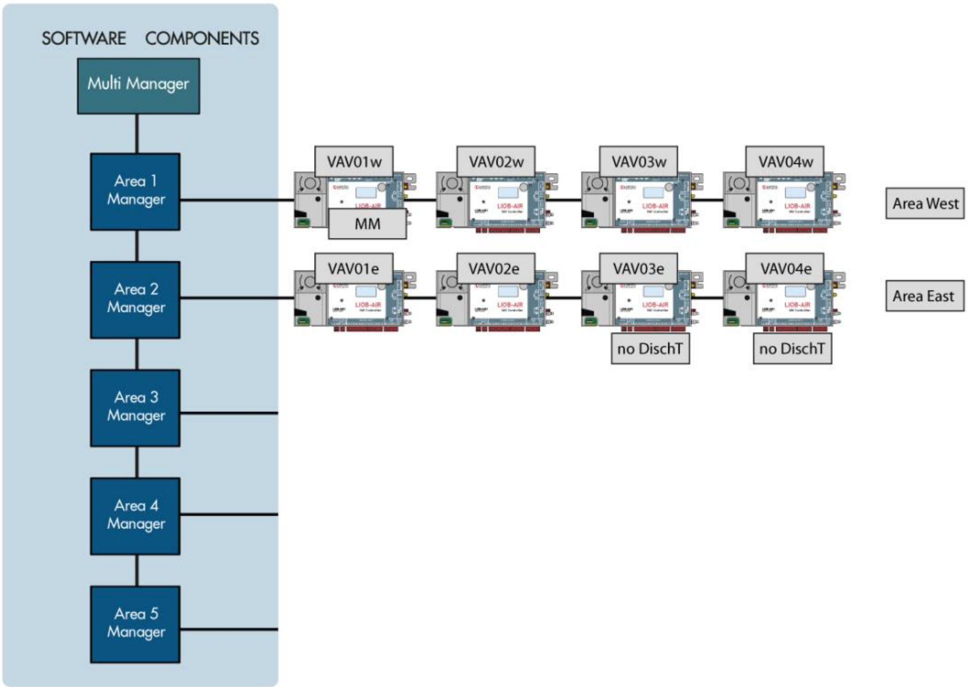


Figure 80: Example scheme of the Adhoc Design

The VAV application has to be built in the L-STUDIO "System" folder in the "VAVsystem" application. A double click on the "VAVsystem" item in the "System" folder opens the application in the editor area as shown in Figure 81.

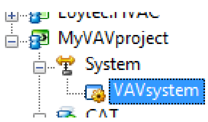


Figure 81: Open the System folder

In this editor, the defined VAV_Device_Types can be put together with drag and drop from the VAV_Device_Types folder and have to be connected in loop chains.

The process of dragging and dropping VAV_Device_Types in the VAV system is creating the instances of the VAV_Device_Types. The names that are given to the dropped devices are the instance names.

Please note that the instance names of the VAV_Device_Type instances have to be unique in the VAV system.

The “VAV01w” in the Area West is the device with Discharge Temperature Control and Multi Manager. Therefore, the VAV_Device_Type VAV_MM_V1 has to be dragged and dropped to the VAVsystem and has to be named to e.g. “VAV01w”.

The “VAV02w, VAV03w, VAV04w” in the Area West are the devices with Discharge Temperature Control without any managers. Therefore, the VAV_Device_Type VAV_V1 has to be dragged and dropped to the VAVsystem and has to be named to “VAV02w”. This type can be copied and pasted 2 times in the VAVsystem and the copies have to be renamed to “VAV03w” and “VAV04w”.

The “VAV01e, VAV02e” in the Area East are the devices with Discharge Temperature Control and without any managers. Therefore, the VAV_Device_Type “VAV_V1” has to be dragged and dropped to the VAVsystem and has to be named to “VAV01e”. This type can be copied in the VAVsystem and the copy has to be renamed to “VAV02e”.

The “VAV03e, VAV04e” in the Area East are the devices without Discharge Temperature Control and without any managers. Therefore, the VAV_Device_Type “VAV_V2” has to be dragged and dropped to the VAVsystem and has to be named to “VAV03e”. This type can be copied in the VAVsystem and the copy has to be renamed to “VAV04e”.

Because the VAV controllers and the Multi Manager have to communicate, the devices have to be connected to a chain with the VAVbusIn and VAVbusOut connectors. The devices of the Area West shall be connected to the VAVbusOut1 and VAVbusIn1and the devices of Area East shall be connected to the VAVbusOut2 and VAVbusIn2 ports of the Multi Manager. These connections must at last build a loop. Building these chain loops will establish the internal seral communication between the devices.

The unused VAVbus connectors of the Multi Manager can be left open. The Floor Bus connectors of the Multi Manager must not be connected.

The finished VAV system should look like shown in Figure 82.

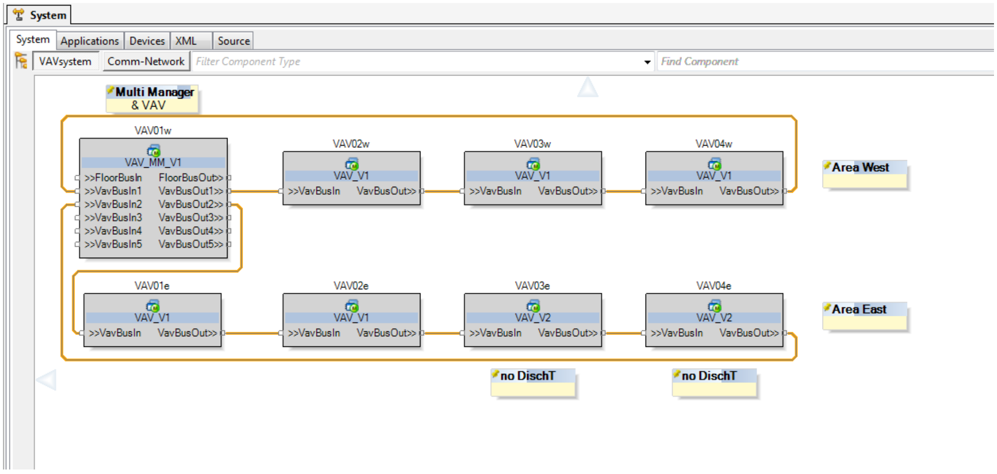


Figure 82: Finished VAV system in Adhoc Design.

7.2.7 Build the system in Structured Design

If you are not using Structured Design, you can skip this chapter.

In this chapter, the VAV application is built using the Structured Design.

This example is a scheme e.g. with 5 floors consisting of an Area West and an Area East as shown in Figure 83. It shall be the same area and floor instrumentation as in the example before. In the Area West, there are e.g. 4 VAV Boxes with Discharge Temperature Control. In the Area East, there are e.g. 2 VAV Boxes with Discharge Temperature control and 2 VAV Boxes (VAV03e & 04e) without Discharge Temperature control.

In the Area West on every floor, the “VAV01” device shall operate the Area Manager West and the Floor- Manager. In the Area East on every floor, the “VAV01” device shall operate the Area- Manager East. In the second floor, the Building Manager shall be operated in the “VAV01” additionally.

Because the instrumentation in area west and area east replicates on every floor, it is useful to build the system in Structured Design.

The example scheme of Structured Design is shown in Figure 83.

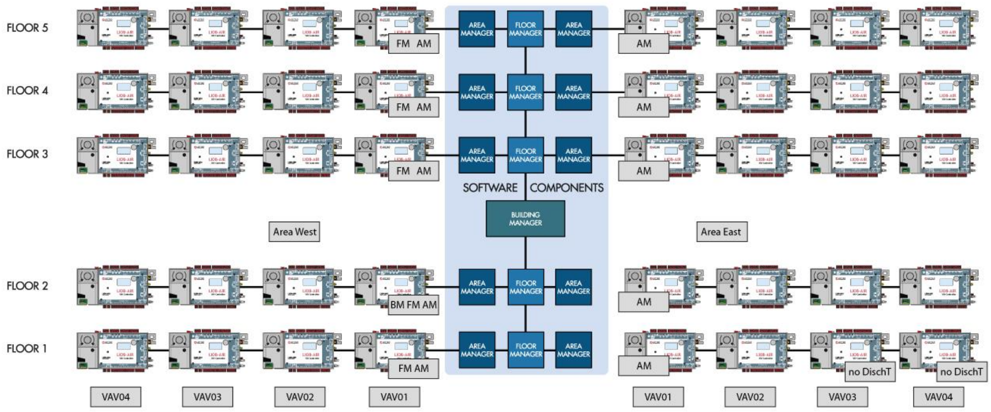


Figure 83: Example scheme of the Structured Design

We do not need to separate the instance names of the devices with “w” and “e” in this example as we did in the Adhoc Design, because we will use Area_Types and Floor_Types here, which separate the devices. The instance names only have to be unique on the same level.

7.2.7.1 Create Area_Types

The first step is to identify the identical areas in the building. In the example project, there are 3 different types of areas.

<u>Area_Type 1:</u> Area (West) with 4 LIOB-AIR devices with a VAV controller of the type VAV_V1 and one of them with an additional Floor- Manager and an Area-Manager. This area type will be named as e.g. AreaType_FM_AM.

<u>Area_Type 2:</u> Area (East) with 2 LIOB-AIR devices with a VAV controller of the type VAV_V1 and one of them with an additional Floor- Manager and an Area-Manager. Further, there are 2 LIOB-AIR devices with a VAV controller of the type VAV_V2. This area type will be named as e.g. AreaType_ AM.

Area_Type 3: Area (West) with 4 LIOB-AIR devices with a VAV controller of the type VAV_V1 and one of them with an additional Building- Manager, Floor- Manager and an Area-Manager. This Area_Type will be named as e.g. AreaType_BM_FM_AM.

In the “VAV_Start” solution there are 3 basic Area_Types already predefined. The names of the types show what is included there (BM…FM…AM…). These predefined types already contain instances of the predefined VAV_Device_Types.

The predefined Area_Types can be used as templates. They can be modified directly or can be copied and pasted and modified multiple times.

Create Area_Type 1

A double click on the “AreaType_FM_AM” CAT in the “Area_Types” folder opens the predefined Area_Type in the editor area as shown in Figure 84.

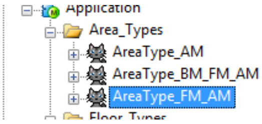


Figure 84: Open Area Type

In this editor on the Network tab the defined VAV_Device_Types can be put together with drag and drop from the “VAV_Device_Types” folder or the instance types can be changed manually and have to be connected. The predefined AreaType_FM_AM is shown in Figure 85.

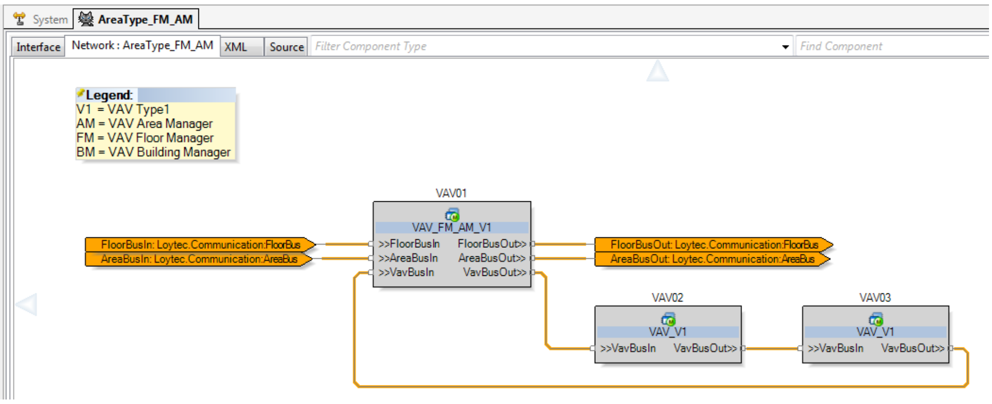


Figure 85: Predefined AreaType_FM_AM

The AreaType_FM_AM already contains an instance of our device type VAV_ FM_AM_V1 and two instances of our device type VAV_V1.

The few things to do here are to copy and paste one of the VAV_V1 types and connect the copied device instance into the VAVbus loop. Building this chain loop will establish the internal seral communication between the devices. For a better recognition, the device instances could be placed in the order of the scheme. Therefore, the finished modified AreaType_FM_AM looks like Figure 86:

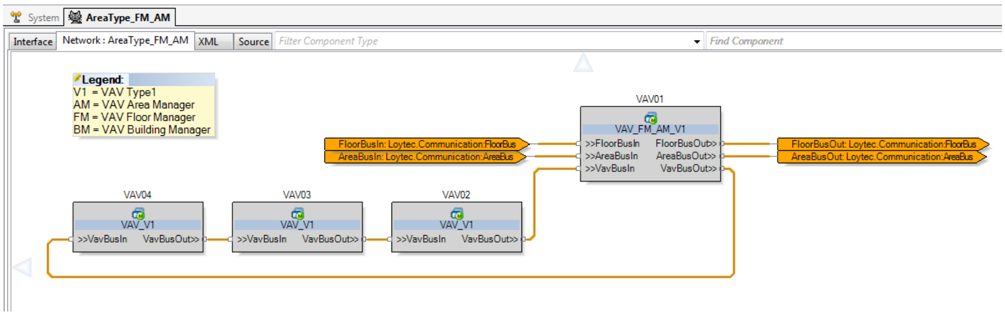


Figure 86: Modified AreaType_FM_AM

Create Area_Type 2

For the next Area_Type the predefined AreaType_AM has to be opened and modified.

The few things to do here are to delete the third instance of the VAV_V1 (VAV03) and drag and drop in the VAV_Device_Types VAV_V2 from the “VAV_Device_Types” folder two times. Both new device instances have to be renamed to VAV03 and VAV04 and have to be connected to the VAVbus loop. Building this chain loop will establish the internal seral communication between the devices. Therefore, the finished Area_Type AreaType_AM looks like Figure 87:

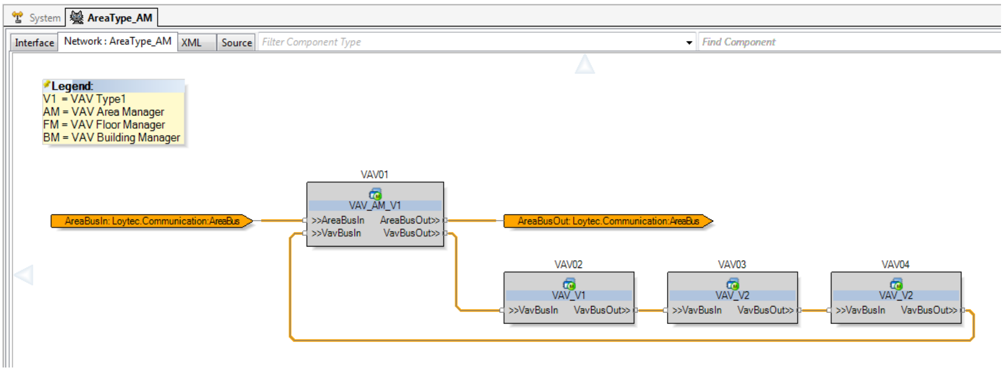


Figure 87: Modified AreaType_AM

Create Area_Type 3

For the next Area_Type type, the predefined AreaType_BM_FM_AM has to be opened and modified.

The few things to do here are to copy and paste one of the VAV_V1 types and connect the copied device instance into the VAVbus loop. Building this chain loop will establish the internal seral communication between the devices. For a better recognition, the device instances could be placed in the order of the scheme. Therefore, the finished area type AreaType_BM_FM_AM would look like Figure 88:

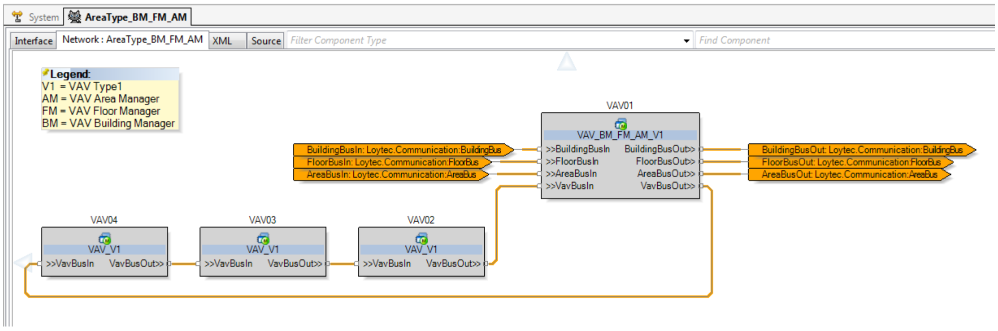


Figure 88: Modified AreaType_BM_FM_AM

7.2.7.2 Create Floor_Types

Since the Area_Types have been created, the next step is to identify the identical floors in the building. In the example project, there are 2 types of floors.

<u>Floor_Type 1:</u> Floors 1, 3, 4, 5 with Area_Type 1 (with Floor- and Area- Manager) and Area_Type 2 (with Area- Manager only). This floor type will be named as e.g. FloorType_FM.

<u>Floor_Type 2:</u> Floor 2 with Area_Type 3 (with Building-, Floor- and Area- Manager) and Area_Type 2 (with Area- Manager only). This floor type will be named as e.g. FloorType_BM_FM.

Two basic Floor_Types are already predefined in the sample project. The names of the types show what is included there (BM…FM). These predefined types already contain instances of the predefined area types.

The predefined Floor_Types can be used as templates. They can be modified directly or can be copied and pasted and modified multiple times.

A double click on the FloorType_FM CAT in the “Floor_Types” folder opens the Floor_Type in the editor area as shown in Figure 89.

Figure 89: Open Floor Type

In this editor on the “Network” tab the defined Area_Types can be put together with drag and drop from the Area_Types folder or the instance types can be changed manually and have to be connected.

Because the predefined Floor_Types match the requirements, they can be used “as they are”. Of course editing of Floor_Types as described in the previous sections is also possible.

The finished Floor_Type 1 FloorType_FM looks like Figure 90:

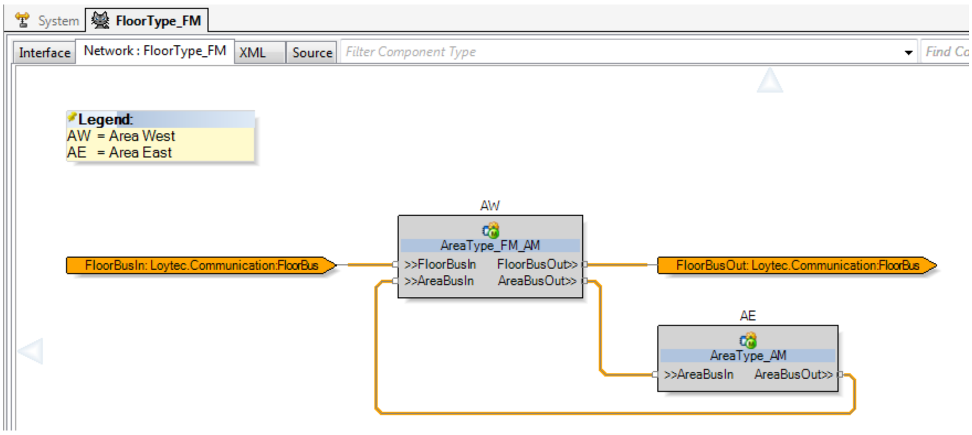


Figure 90: Modified FloorType_FM

The finished Floor_Type 2 FloorType_BM_FM looks like Figure 91:

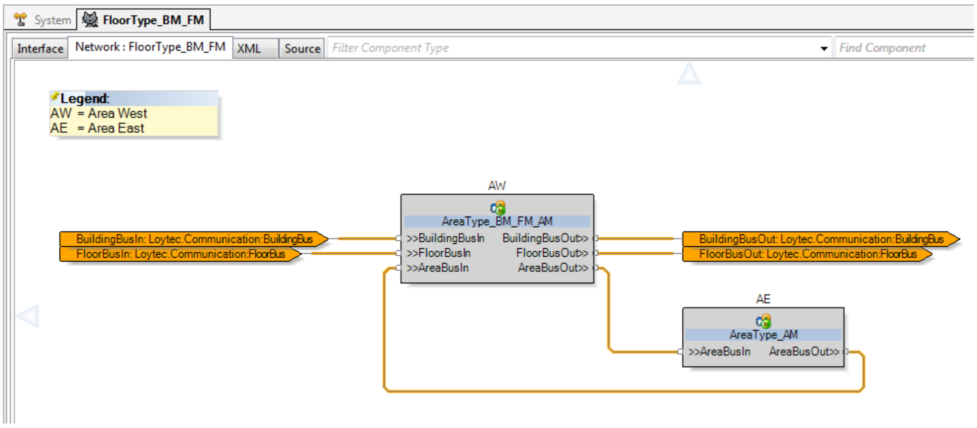


Figure 91: Modified FloorType_BM_FM

7.2.7.3 Build the System

The VAV application has to be built in the L-STUDIO System folder in the VAVsystem application. A double click on the “VAVsystem” item in the System folder opens the application in the editor area as shown in Figure 92.

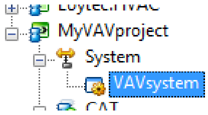


Figure 92: Open the System Folder

In this editor, the defined Floor_Types can be put together with drag and drop from the Floor_Types folder and have to be connected in loop chains.

Because the VAV_Device_Types are instantiated in the different Area_Types and the Area_Types are instantiated in different Floor_Types, now there are only the Floor_Types to be instantiated in the VAVsystem. All the LIOB_AIR devices are instantiated automatically according to the Area_Types and Floor_Types definitions.

The process of dragging and dropping Floor_Types in the VAV system is creating the instances of the Floor_Types with the included Area_Types and VAV_Device_Types. The names that are given to the dropped devices are the instance names.

Because the Floor- Managers have to communicate, the instanced of the Floor_Types have to be connected with the FloorBusIn and FloorBusOut connectors. These connections must at last build a loop. Building this chain loop will establish the internal seral communication between the devices

Because we only have one building, the Building- Manager does not need to be connected and the BuildingBusIn and BuildingBusOut connectors can be left open.

The finished VAV system should look like Figure 93.

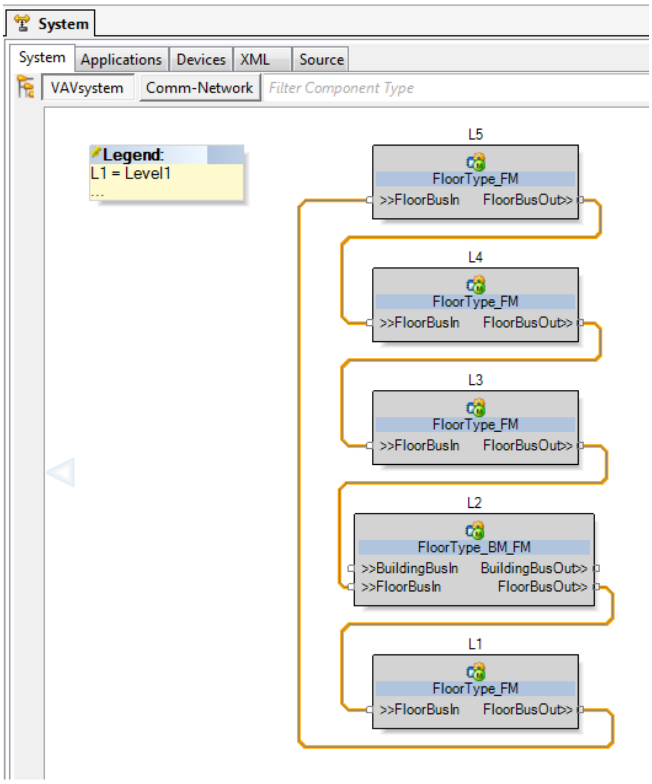


Figure 93: Finished Structured Design

This Structured Design is useful for larger system sizes with replicating instrumentation structure. By using the types and instances it is a little more work to create the Area-Types and Floor_Types but when the system is built, less work is needed. If there are modifications in the Area-Types and Floor_Types later, the change only has to be made in a type and is applied in all instances of this type automatically. This can reduce the work of configuration and commissioning dramatically in larger systems.

The following Chapters will continue with the VAV system that was built in Adhoc Design. Please note that the following workflow is identical for the Structured Design.

7.2.8 Create the Devices

Since the VAVsystem is fully defined with all instances of the VAV_Device_Types either using the Adhoc Design (without Area-Types and Floor_Types) or using the Structured Design (with Area-Types and Floor_Types), the next step is to create the devices. For every instance of a VAV_Device_Type, a device has to be created.

The devices are created in the “System” folder in the VAVsystem application, which has been already opened, in the last chapter. On the “Devices” tab the menu “Device” has to be opened and the function “DeviceCATs…” has to be selected as shown in Figure 94.

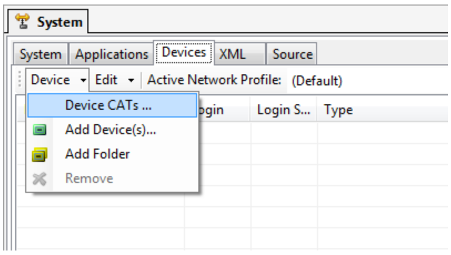


Figure 94: Open the Device CATs

This opens a “Devices” list where all the instantiated devices are included as shown in Figure 95. These devices are named using the instance name of the device, the instance name of the area and the instance name of the floor and the system name, if the Structured Design is used. In the Adhoc Design, of course the devices are named using the instance name of the device and the system name only.

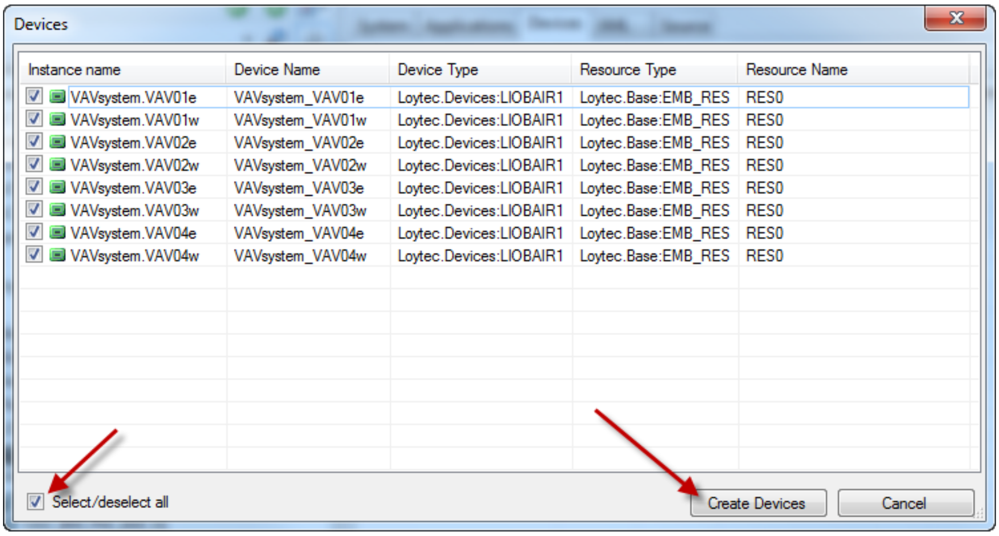


Figure 95: Devices list

It is possible to select which devices have to be created by the selection of the check box. A click on the “Create Devices” button starts the device creation. All devices that are created now appear in the list on the “Devices” tab. After the system is saved the created devices (Resources) also appear in the “System” folder in the Solution Overview (this takes a little time) and is shown in Figure 96.

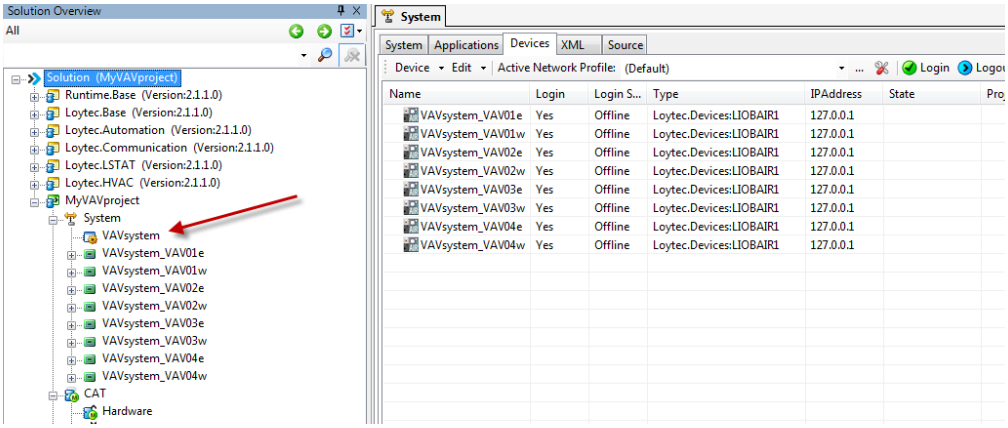


Figure 96: Created Devices

For a better overview, the devices can be organized in folders. This is useful in larger systems. It reduces the length of the devices list. If the building management system LWEB-900 is used later on, this folder structure also will be imported and puts a very good overview to the project. So for instance, for every area, a folder shall be created (West, East) and the devices shall be put into these folders.

On the “Devices” tab the menu “Device” has to be opened and the function “Add Folder” has to be selected as shown in Figure 97.

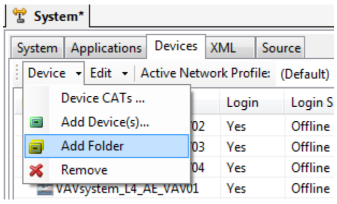


Figure 97: Select Add Folder

A “New Folder” appears in the “Devices” list and shall be renamed to “West”. This step shall be repeated for the folder “East” also.

The devices of west can be multi selected and dropped to the “West” folder. This shall be repeated for the other devices and folders also. At last, all devices are put to a folder and the list looks like Figure 98.

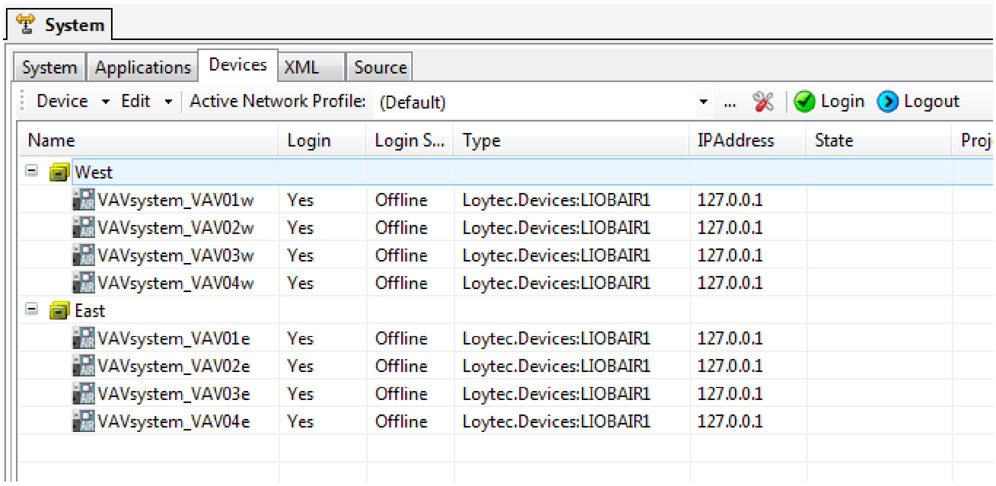


Figure 98: Devices grouped in level folders

In much larger systems it also could be useful to create subfolders for the areas to gain a better structured project. Folders and subfolders can be used in Adhoc Design ans Structured Design.

7.2.9 Set IP Addresses in Device List

The new created LIOB-AIR devices all have the same standard IP Address 127.0.0.1. The next step is to set the individual IP-Addresses for every LIOB-AIR device so that L-STUDIO is able to address the devices, to deploy the configuration and to communicate. In larger systems, this can be a lot of work. However, L-STUDIO helps with an efficient IP Address function.

All devices that shall get an IP Address have to be multi selected in the “Devices” list. On the “Devices” tab, the menu “Edit” has to be opened and the function “IP Address” has to be selected as shown in Figure 99.

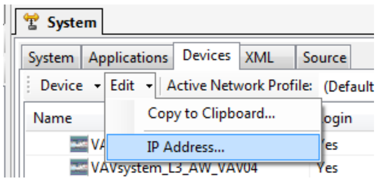


Figure 99: Select IP Address function

In the following, IP Address dialog shown in Figure 100 the start IP Address can be entered and with an increment of 1 all the following devices get the next IP address automatically.

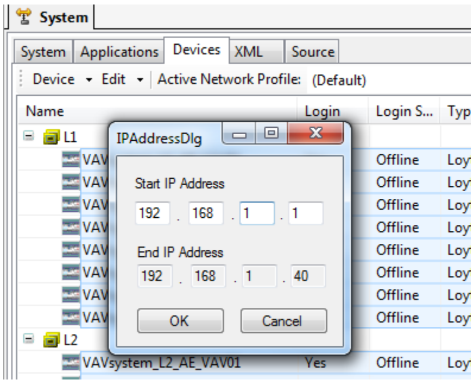


Figure 100: IP Address Dialog

Of course, it is also possible to put individual IP Addresses to the devices.

The BACnet ID should be set also at this device list.

From 4.4.6 Set the IP Addresses from Getting Started.

7.2.10 Build the Solution and Deploy

The VAV system is configured now and has to be compiled and deployed to all the devices by L-STUDIO as the next step. On the “Devices” icon in the L-STUDIO icon bar the function “Deploy advanced …” has to be selected. Then L-STUDIO starts compiling the whole solution immediately. In the output area, some messages show the progress of building the project. This can take a few minutes.

After the compilation has finished the “Advanced Deploy” dialog opens and shows the list of folders and devices. Here the devices that shall be downloaded have to be selected as shown in Figure 101.

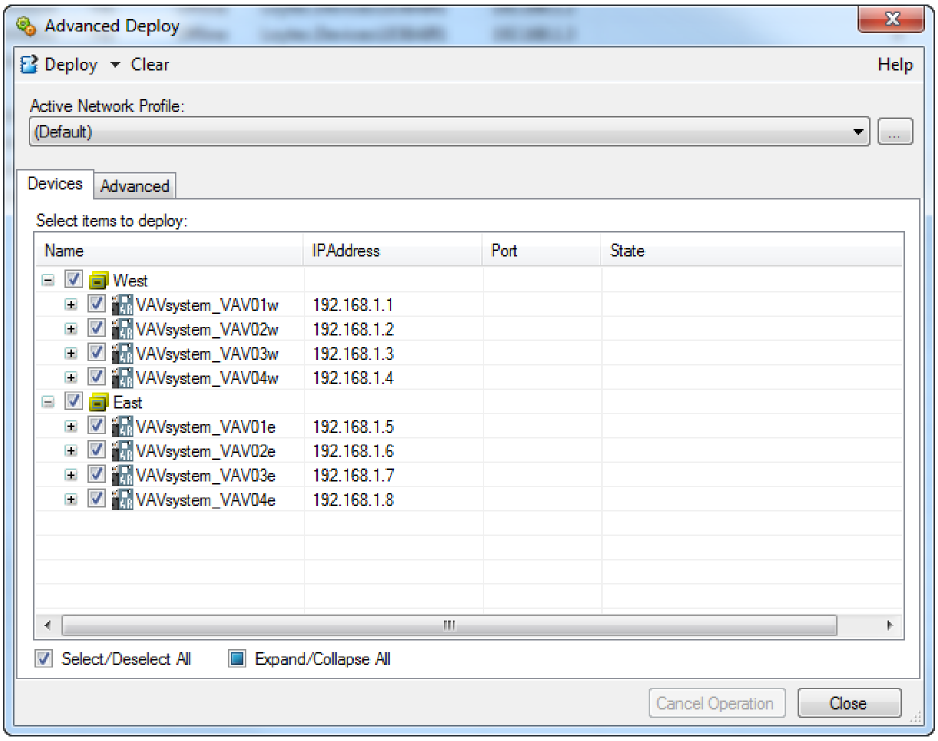


Figure 101: Advanced Deploy dialog

On the tab “Advanced” the options “Parallel deploy” and “Deploy Only Changes” should be set (are set by default).

To start the Deploy process “Deploy” has to be selected in the menu of the “Advanced Deploy” dialog. L-STUDIO now deploys the configuration and software to all selected devices while using a powerful parallel deploy mechanism.

After all selected devices are deployed, the “Advanced Deploy” dialog has to be closed by pressing the “Close” button.

Now all LIOB-AIR devices are configured and are operating the VAV control algorithm.

7.2.10.1 Upload Device System settings

The System Settings in the VAV_Device_Types included in the “VAV Start Solution” have a useful setup.

Important system settings are e.g.: Timezone offset, DST, IP Host settings, DNS servers, NTP servers, Port protocols as BSACnet/IP, etc…..

These settings can be modified on the “System Settings” tab to fit the customer demands. Please refer to the LOYTEC Device User Manual [1] and the LINX Configurator User Manual [2] for more information. Please note that this is most efficient to be done before creating the devices (chapter 7.2.8). If the System Settings have to be changed after creating the devices, they have to be changed in every dedicated device (resources).

The System settings can also be set online using the WebUI of every dedicated device. This can be helpful during the commissioning phase of the project if there are local modifications needed.

However, please note that an L-Studio deploy will overwrite the current System Settings in the local devices with the System Settings from the devices created in the L-Studio solution. So if the System Settings have been modified in the local devices they have to be uploaded and saved to the L-Studio solution devices (resources) before the next deploy is performed. This has to be done for every dedicated device that has local modified System Settings.

Step1: Open the resource configuration in L-STUDIO and connect to the device

Open the “System” folder and double click on the “Res0” resource item of the first device. Select the “Configuration” tab next. Click on the “Connect to device” button as displayed in Figure 102. The device IP-address is displayed in the “Connected Device” field, when the device is connected.

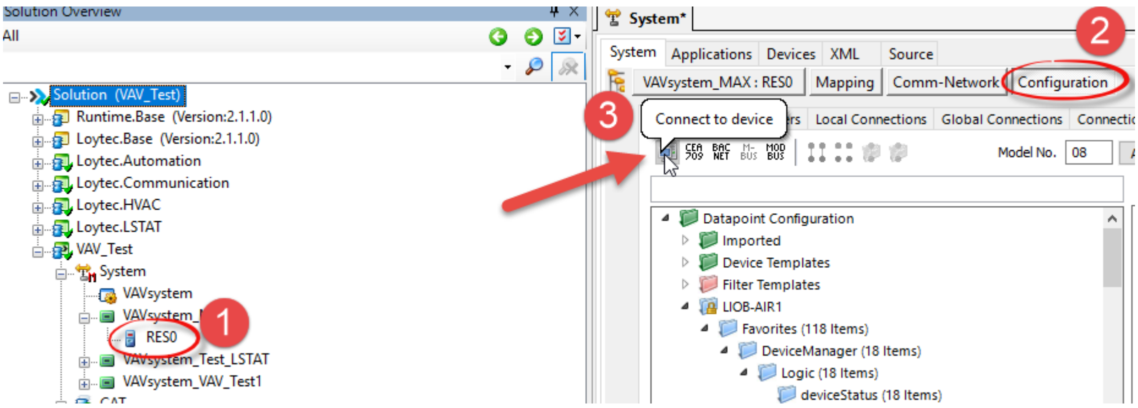


Figure 102: Connect to the device

Step2: Open the “Project Settings” of the configurator

In the L-STUDIO device menu (LIOB-AIRx or L-ROCx) open the “Project Settings”as displayed in Figure 103.

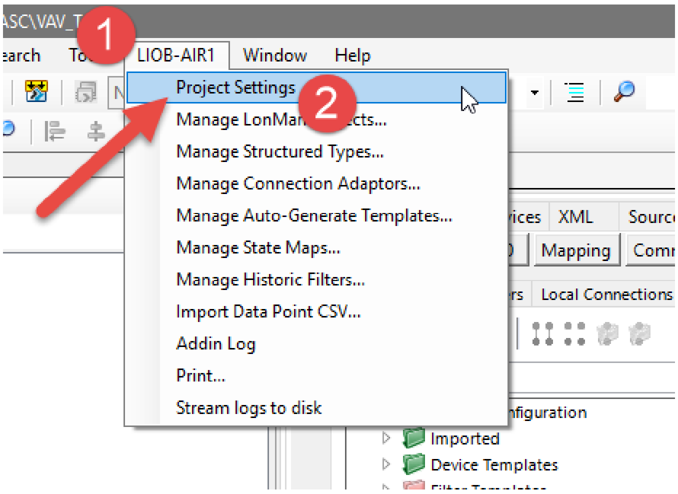


Figure 103: Open project settings

Step3: Upload the “System Settings” from the device

In the “Project Settings” window, select the “System Settings” tab. Click the “Upload” button to upload the system settings from the device into the resource configuration as displayed in Figure 104. To close the “Project Settings” click the “OK” button.

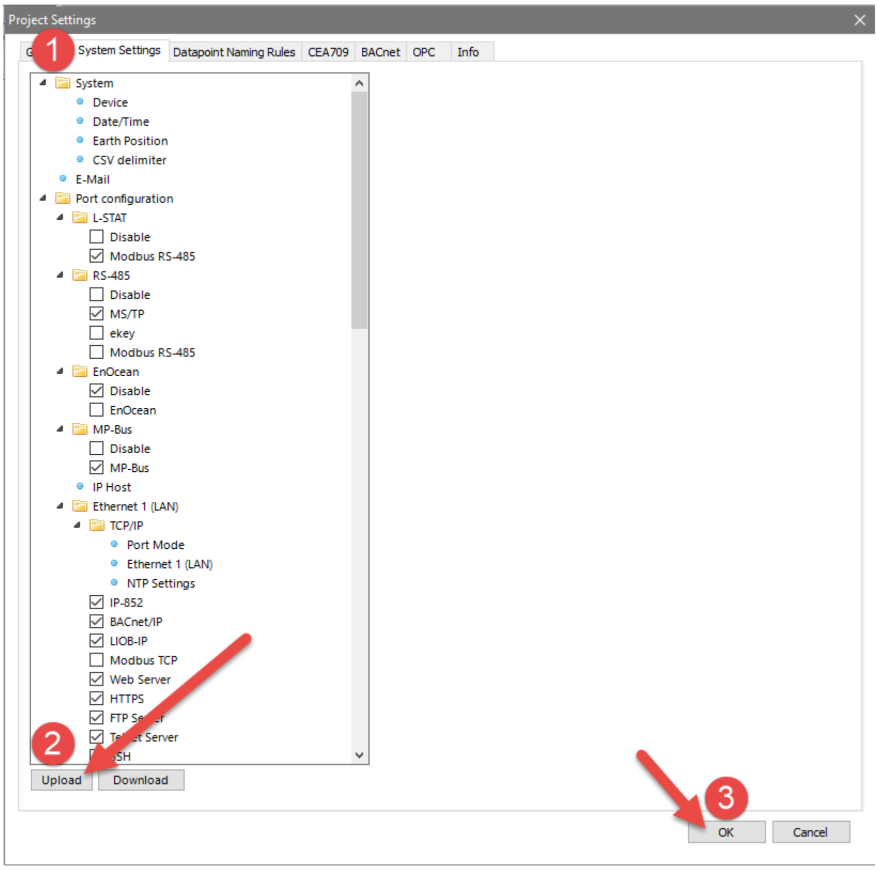


Figure 104: Upload system settings

Step3: Save the resource configuration

The “System” tab indicates the modified status with an asterisk. Press the “Save” icon to save the resource configuration as displayed in Figure 105.

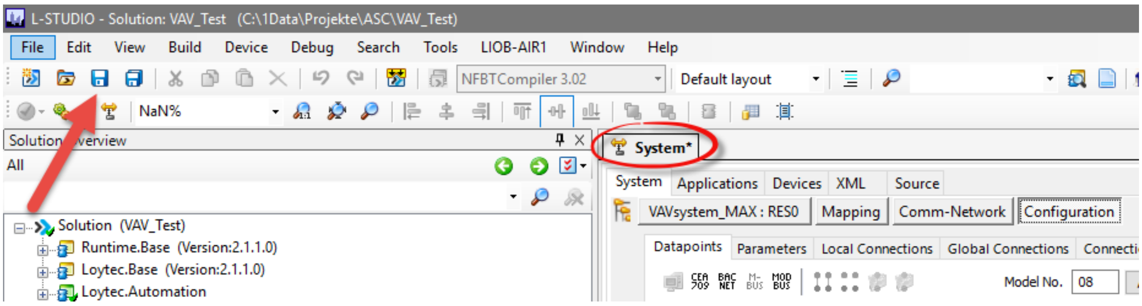


Figure 105: Save resource configuration

Step4: Disconnect from device

Press the “Disconnect” button to disconnect the configurator from the device as displayed in Figure 106.

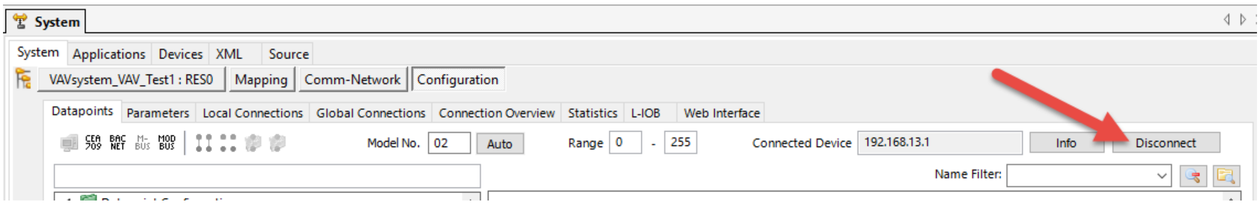


Figure 106: Disconnect from device

Repeat this 4 step procedure for every device of the system!

7.2.11 Archive the Solution

After all devices have been configured and deployed now, it is recommended to make a backup of the L-STUDIO solution. This is done using the L-STUDIO Archive function. An Archive is a compressed Zip file of the complete solution folder.

With right click on the “Solution” on the top of the tree in the Solution Overview the context menu opens and the “Archive” function has to be selected as shown in Figure 107.

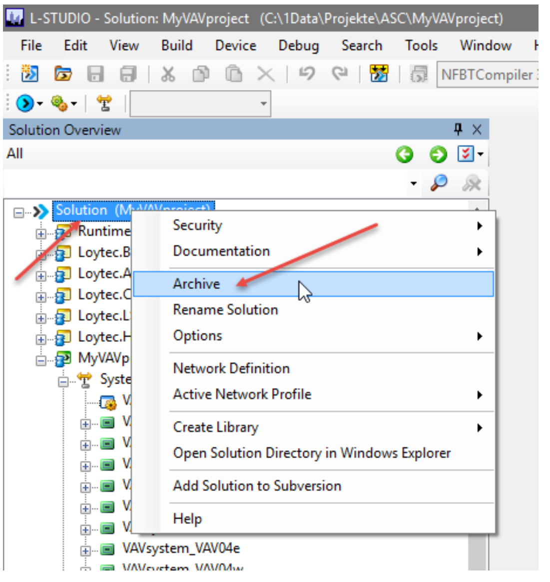


Figure 107: Archive the L-STUDIO solution

Then the archive folder and the archive name have to be selected and confirmed. The archive process can last a few minutes depending on the size of the solution. When the archive process is finished, a Message box appears as shown for example in Figure 108.

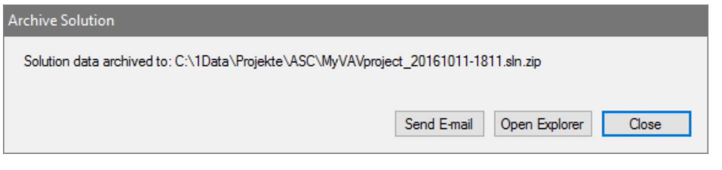


Figure 108: Archive finished

The solution archive Zip file should be saved externally.

7.2.12 Parameter Settings in VAV-Boxes

Since the LIOB-AIR devices are deployed with L-STUDIO, they are operating with the configured VAV control program and are able to communicate to each other and with the Multi Manager using the internal serial communication. The next step is to enter all important parameter values that are needed to provide a proper operation of the VAV. These are e.g. the air flow data, the grouping of multiple boxes in a room (VAV Groups) and e.g. the definition of the Air Supply Zone (AHU). The parameter values are entered during the runtime of the system. That means that if some changes are needed later, they can also be applied during runtime without using L-STUDIO

7.2.12.1 Run the VAVstatus visualization Project

Every LIOB-AIR device hosts multiple graphical projects to configure, operate and maintain the VAV controller. The visualization software LWEB-802 which is a platform independent, browser based graphical user interface is needed to run the graphical projects. This LWEB-802 visualization software is already built into the LIOB-AIR device. The graphical project that is needed to enter all the VAV control parameters is the “VAVstatus.lweb2” project.

<u>Open the WebUI of the LIOB-AIR controller:</u>

The browser (recommended Google Chrome) has to be started on the PC or a mobile device. In the browser address line, the IP Address of the LIOB-AIR-Controller has to be entered.

The browser displays the WebUI (user interface) of the device which shows the device information and a navigation menu on the left page, see Figure 109.

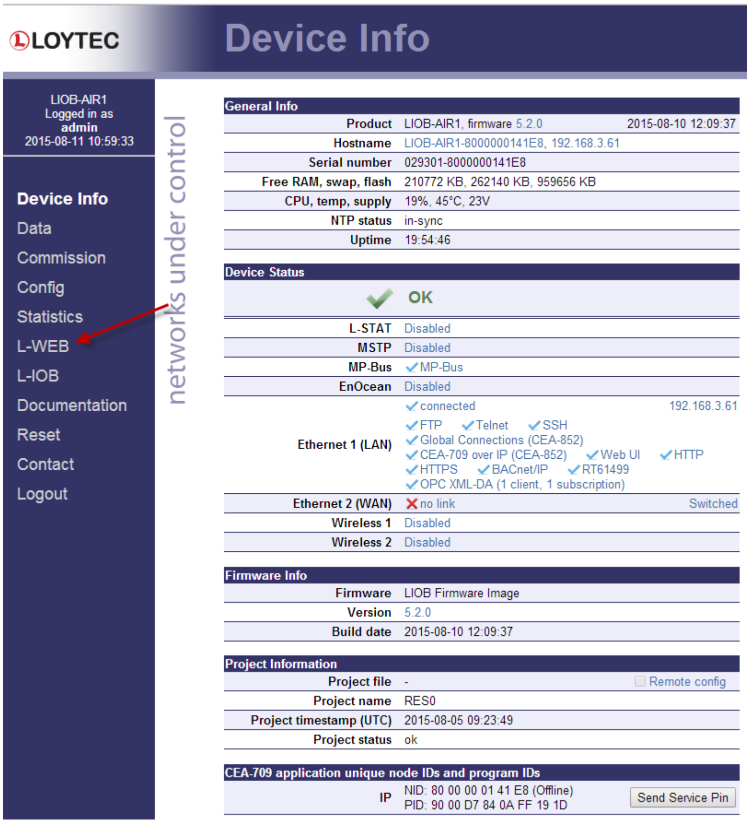


Figure 109: WebUI of the LIOB-AIR device

In the left menu the “L-Web“ has to be selected which opens the “LWEB Project List”.

There are two user accounts available:

Admin , default password: **loytec4u**

Operator, default password: **operator** (this is ok to run LWEB visualization)

If the PC or mobile device is connected to the Internet, the LWEB-802 visualization is loaded from the LOYTEC website and the “VAVstatus.lweb2” graphical project can be started directly. If the PC has no Internet connection, the use of the pre-installed LWEB-802 has to be activated. This is done on the “LWEB-802 Config” submenu selecting the “Pre-installed” option as shown in Figure 110. The default setting is “LOYTEC Website” that can be used if the PC has an Internet connection.

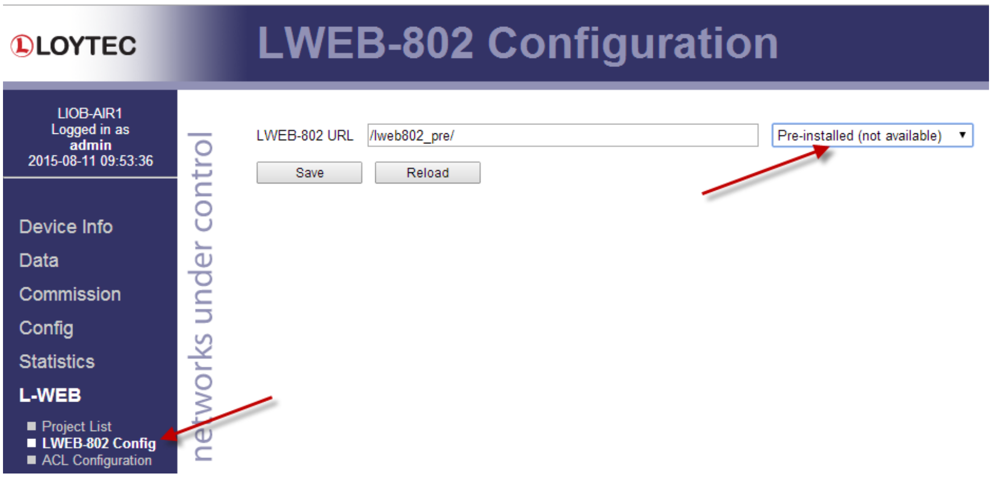


Figure 110: Select the Pre-installed LWEB-802

Start the VAVstatus.lweb2 visualization project:

To open the visualization of the graphical project “VAVstatus.lweb2” the LWEB-802 icon of this project has to be clicked in the L-WEB Project List as shown in Figure 111.

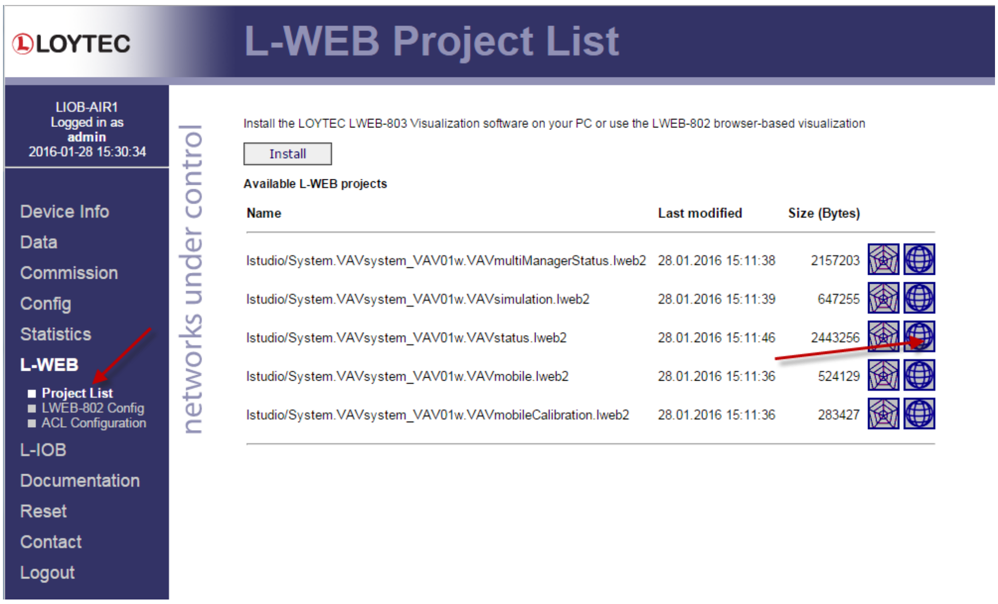


Figure 111: Open the graphical project VAVstatus.lweb2

The VAVstatus visualization starts with the “Status Overview” page and without having entered the parameters it looks like Figure 112:

Figure 112: Status Overview

During the runtime of an L-WEB project lots of pages are protected with a PIN code. Read only pages are not protected. If a protected page shall be opened the system asks for the PIN code. This code has to be entered only one time and then all the pages with this PIN code level or lower level pages are accessable. The actual PIN code level is shown on the top left title bar “Welcome:”. These are the 4 Levels of operation:

1. **Operator** (only show value pages) **no PIN** requested
2. **Calibrator** (do the calibration) **PIN: 7777**
3. **Configurator** (configure device exept the flow data) **PIN: 9999**
4. **FlowData** (as configurator and the flow data) **PIN: 1212**

The “Status Overview” page shows top level data and provides a basic information of operation to the user. The whole project is using a tile design where every tile displays information regarding a dedicated function. A click on a tile leads to pages with more information about this function. On the top area of every page there is a title area (head line) which displays the name of the page, the location of the device, the actual PIN code level and other information. On the bottom area of every page there is a navigation area with individual navigation tiles which open additional pages. The Home tile always opens the “Status Overview” page.

The tiles are displayed in different colors which shows if the function is a sensor (blue), a controller (purple), an actuator (ocher) or a device (green).

The values are displayed in different colors, too, which indicates if the value is only displayed (green) or can be changed by the user (orange).

7.2.12.2 Enter the Parameters

For a proper function of the VAV controller, the device parameters, flow parameters, AHU parameters and VAV Group parameters have to be entered. This is shown here with the direct input of parameters using the "VAVstatus" visualization project. How to use the LWEB-900 building management software to increase efficiency for multiple devices is shown later.

7.2.12.2.1 Select the Engineering Unit System

The first step to do in a project is to select the engineering unit system. The LIOB-AIR is able to operate in SI and US units alternatively. If the Engineering Unit is changed during runtime, the controller has to be reset to make the changes take effect. All the parameter values are reset to defaults during this reset, so this should only be done once and at the beginning of the project.

As a standard setting, the LIOB-AIR VAV controller is operating in SI units. Chapter 7.2.5.1 describes how to change the unit system in the VAV_Device_Type configuration. If the required unit system was set the device is already operating with the correct engineering units after deploy. If this was not done, the following procedure is needed to change to US units. To start, click on the "Device" tile as shown in Figure 113.

Figure 113: Click on the "Device" tile

The page "VAV Box System Information opens" where the „General Settings" button has to be clicked in the navigation area. This will open the "VAV Box General Settings" page as shown in Figure 114. Because this page is protected with the PIN code of "Configurator", the PIN code has to be entered before the page opens.

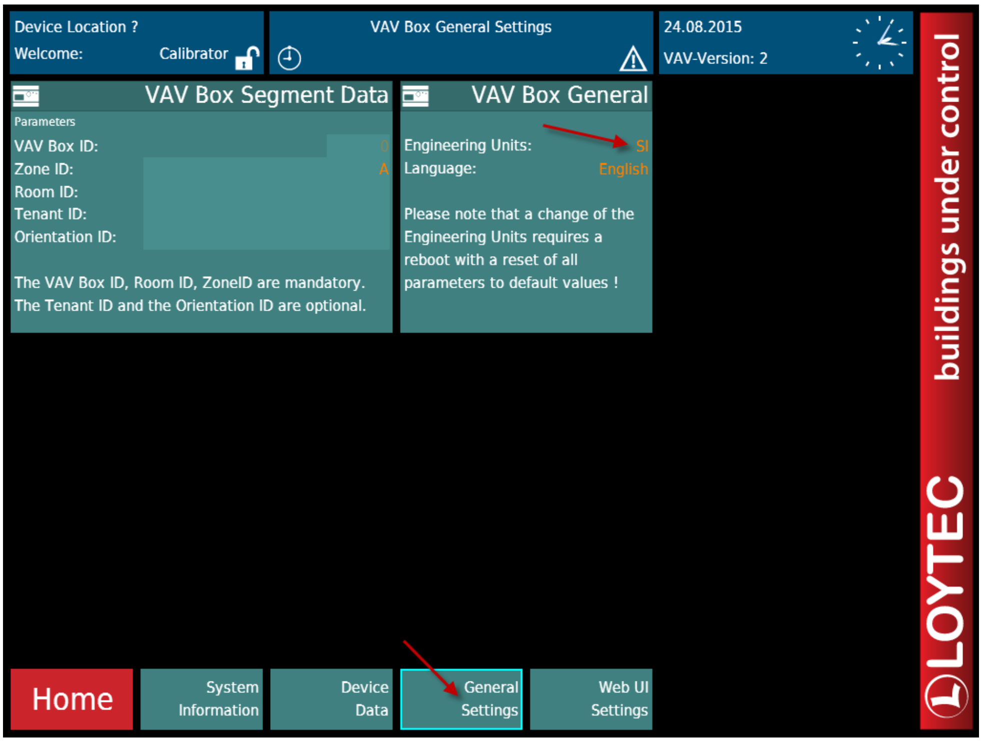


Figure 114: General Settings page

Here the SI units can be switched to US units by a drop down menu. When the US Units are selected the system displays that a reboot is requested to change the unit system and that all the parameter values are reset to the default values, see Figure 115.

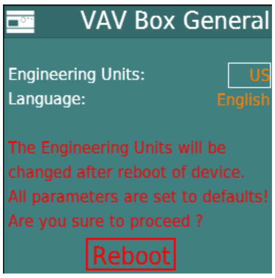


Figure 115: Switch the Engineering Units

Now the “Reboot“ button has to be pressed and the LIOB-AIR reboots, changes the unit system and sets all parameter values to useful predefined default values according to the unit system. After about 90 seconds the system is ready for operation again.

7.2.12.2.2 Device Parameters

Next, the VAV Box ID, Zone ID, Room ID have to be entered. Then the language has to be selected. In addition, the Device Type, the Project Name and the Device Location can be entered. To start click on the “Device” tile in the Status Overview and select the “General Settings” tile in the navigation area as shown in Figure 116.

On the “VAV Box Segment Data” tile the following mandatory parameters values must be entered.

VAV Box ID: this is the number of the VAV Box and it must not be empty. For VAV only systems it will work if every VAV controller gets the same segment ID e.g. **“1”**.

Zone ID: this is the name of the zone in the room, is used if the room is divided in different independent zones. This is not useful with VAV only, but it is an option in combination with the LROC control system with Lights or sunblinds. Here the default value **"A"** should be used for all VAV Boxes in the project.

Room ID: this is the name of the room, should be unique in the whole project and is set to e.g. **"Room111"**. All the VAV Boxes that have the same Room ID and the same Zone ID will communicate and colaborate in a Group automatically.

The **Tenant ID** and the **Orientation ID** are also names that can be entered optionally but these do not have any effect to the device communication.

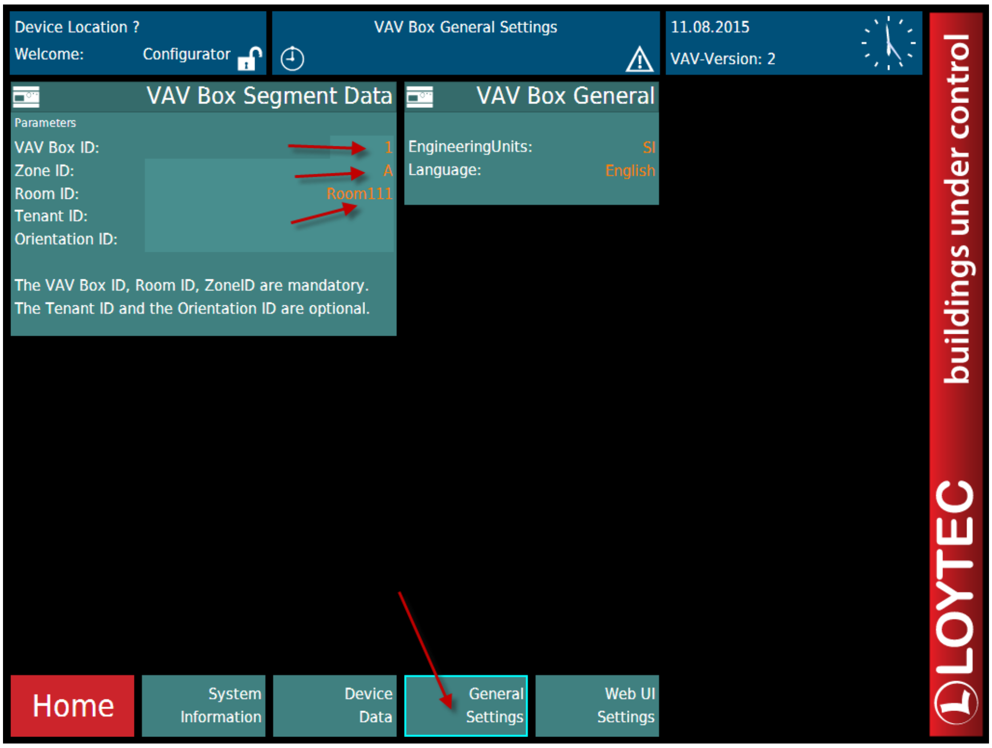


Figure 116: Enter VAV Box Segment Data

The next step is to select the **Language** (English or German).

Further device data should be entered by selecting the "Device Data" tile in the Navigation Area. This opens the page "VAV Box Device Data". On the tile "Device Data", the following parameter values can be entered as shown in Figure 117. These parameters are informational only and used to add clarity to the user and do not have to be unique.

Device Type: here the type of the VAV Box device can be entered, e.g. **"LIOB-AIR1"** or some other description needed for the project.

Project Name: the name of the project can be entered here, e.g. **"My VAV project** or some other description needed for the project. If this is empty, the name of the L-STUDIO solution is shown automatically.

Device Location: the location of the device can be entered here, e.g. "VAV 01 Supply Room 111" or some other description needed for the project. Please note that this string is displayed also in the left title area on top of all the pages as shown in Figure 117.

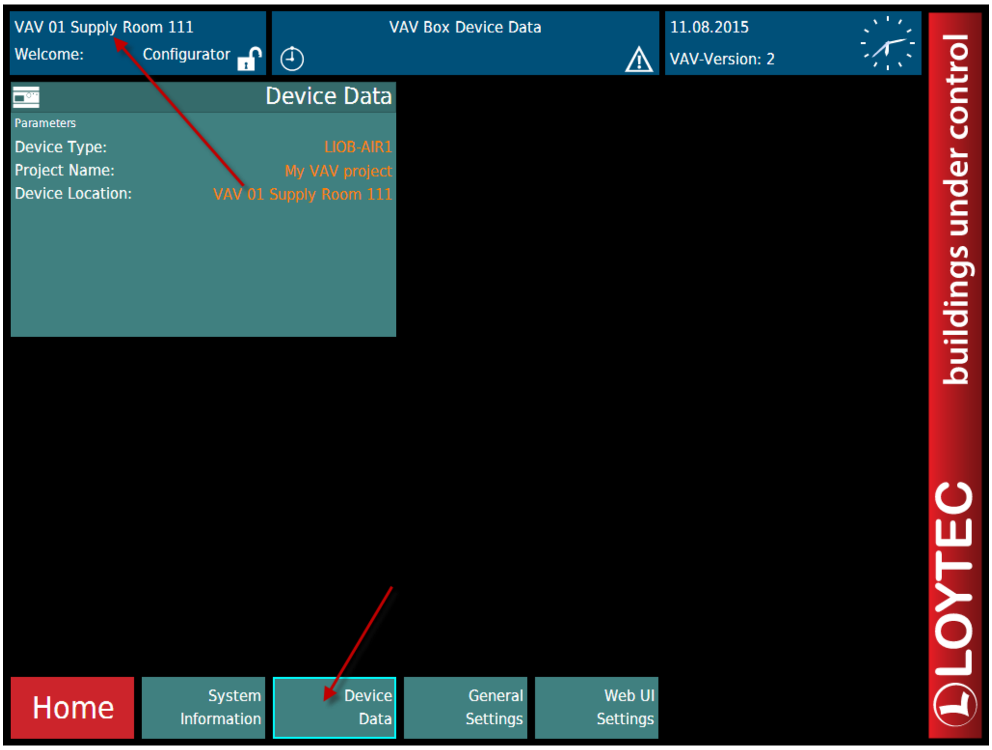


Figure 117: Device Location

7.2.12.2.3 Air Flow Parameters

To enable the VAV controller to calculate the proper air flow depending on the measured pressure and to operate in a valid air flow range, the air flow parameters must be set. To start, click on the "Air Flow" tile in the Status Overview and select the "Air Flow Configuration" tile in the navigation area. Because this page is protected with the PIN code of "FlowData" the PIN code has to be entered before the page opens.The "Air Flow Data Configuration" page is opened as shown in Figure 118.

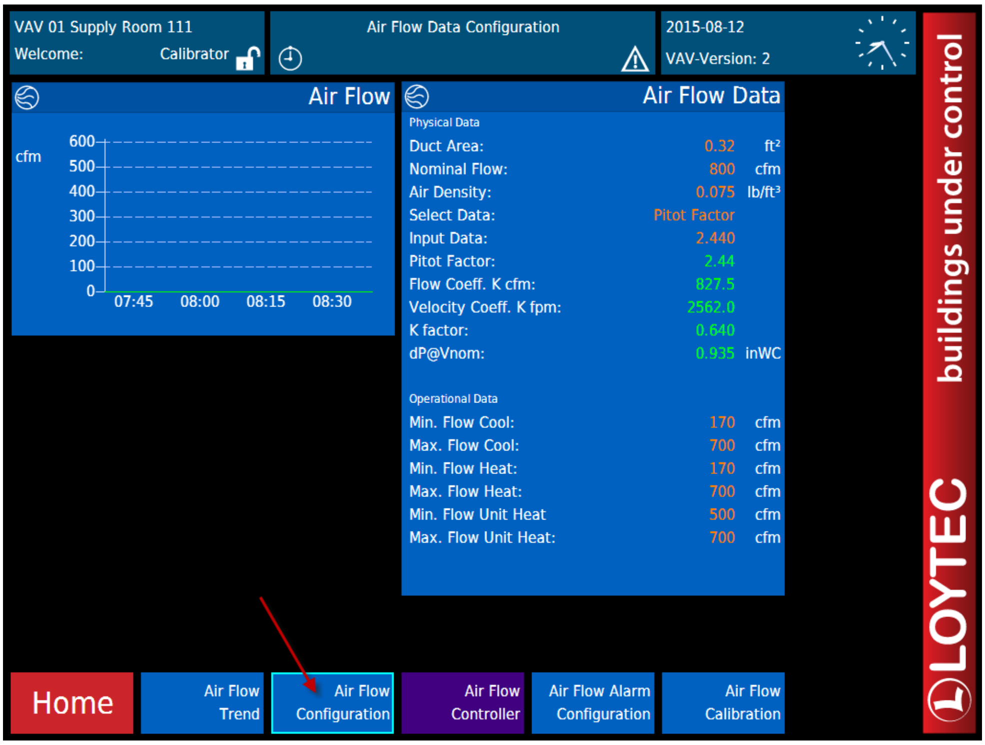


Figure 118: Air Flow Data Configuration

On the “Air Flow Data” tile, the physical data of the VAV Box must be entered.

Duct Area: set e.g. to **“0.32 ft2”**.

Nominal Flow: set e.g.to **“800 cfm”**.

Air Density: normally set to **“0.075lb/ft^3”**.

There are different types of parameters provided by the manufacturers of VAV Boxes to define the flow calculation depending on the differential pressure measurement. So it can be selected in the **“Select Data”** field, which type of parameter is entered in the **“Input Data”** field:

Pitot Factor, Flow Coefficient K_{cfm}, Velocity Coefficient K_{fpm}, K factor, dP@V_{nom}

Here the “**Pitot Factor”** can be selected in **“Select Data”** and the value e.g. **“2.44”** can be entered in **“Input Data”.** All the values of the other possible parameter types are calculated and displayed automatically.

The next step is to define the parameter values for the operational flow data. These are the limits the air flow controller must not exceed in the different operation modes.

Min. Flow Cool: this is the minimum flow setpoint the controller operates in the Cool mode this can be set to e.g. **“170 cfm”**.

Max. Flow Cool: this is the maximum flow setpoint the controller operates in the Cool mode this can be set to e.g. **“700 cfm”**. Note that this value cannot be greater than the Nominal flow.

Min. Flow Heat: this is the minimum flow setpoint the controller operates in the Heat mode this can be set to e.g. **“170 cfm”**.

Max. Flow Heat: this is the maximum flow setpoint the controller operates in the Heat mode this can be set to e.g. **“700 cfm”**. Note that this value cannot be greater than the Nominal flow.

Min. Flow Unit Heat: this is the minimum flow setpoint the controller operates in the Unit Heat mode (AHU is in Heat mode) this can be set to e.g. **“500 cfm”**.

Max. Flow Unit Heat: this is the maximum flow setpoint the controller operates in the Unit Heat mode (AHU is in Heat mode) this can be set to e.g. **“700 cfm”**. Note that this value cannot be greater than the Nominal flow.

7.2.12.2.4 Other Control Parameters

Of course, there are many other parameter values that can be set for the VAV control functions, e.g. the space temperature control setpoints for the different occupancy modes. However, these parameter values are set to useful default values and allow a “normal” operation of the VAV control. If requested all parameters on the other pages and tiles can be set by the configurator using the values in orange color.

Now the setup of the most important parameters of the VAV controller is finished. This has to be repeated in all other VAV controllers also.

A more efficient way is to use LWEB-900 to set parameter values in multiple devices, see chapter7.2.14.

7.2.12.2.5 AHU Communication Parameter

To engage communication between the VAV controller and the Multi Manager the name of the Air Supply Zone has to be set. All the VAV controllers having the identical Air Supply Zone name are aggregating values inside their area. The Multi Manager aggregates these values with its integrated 5 Area Managers. From the Multi Manager the AHU controller receives these data. The Multi Manager receives operational data from the AHU controller and sends out this data to the VAV controllers. All controllers with the same Air Supply Zone name receive and operate these data. All these processes are running automatically. The only thing needed is the identical name of the “Air Supply Zone ID” in the VAV controllers and Managers.

The “Air Supply Zone ID” set by default in the VAV controllers is AHU01.

To change the “Air Supply Zone ID” click on the “Air Supply Zone” tile in the Status Overview and select the “AHU Communication Configuration” tile in the navigation area. The “AHU Communication Configuration” page is opened as shown in Figure 119.

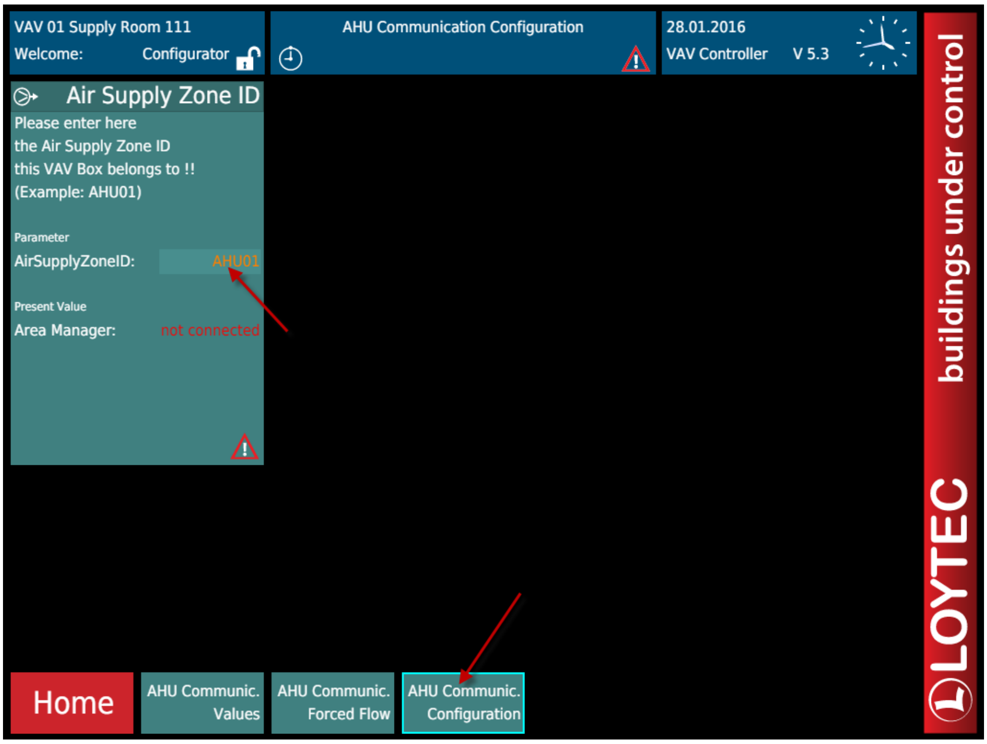


Figure 119: Air Supply Zone ID

On the Air Supply Zone ID tile, you can change the **“AirSupplyZoneID”** with e.g. **“AHU01”**. And that´s all! The VAV control is monitoring if there is a communication to an Area Manager above. This status is shown in the Present Value.

7.2.12.2.6 VAV Group Communication Parameters

If there are multiple VAV-Boxes in a room, they have to collaborate in a VAV Group. One of the VAV controllers has to be set as the master and all other controllers have to be set to slave. Therefore, the master is operating e.g. the space temperature control and calculates and communicates the air flow setpoints to the slaves. If there are VAV Boxes with supply air and exhaust air in the room, the master is e.g. calculating and communicating the air flow setpoints to the exhaust boxes depending on the actual summary air flow of the supply air boxes. Therefore, a defined air flow balance in the room is gained.

The parameters **“Room ID”** and **“Zone ID”** have been already set in the chapter “Device Parameters” see chapter 7.2.12.2.2. All VAV controllers with the same **“Room ID”** and **“Zone ID”** collaborate in a VAV Group automatically.

The most important group parameters that have to be set further are the **“Device Mode”** and the **“Air Function”** of the VAV controller.

To enter these group parameters, click on the “VAV group” tile in the Status Overview and select the “VAV Group Configuration” tile in the navigation area. The “VAV Group Configuration” page is opened as shown in Figure 120.

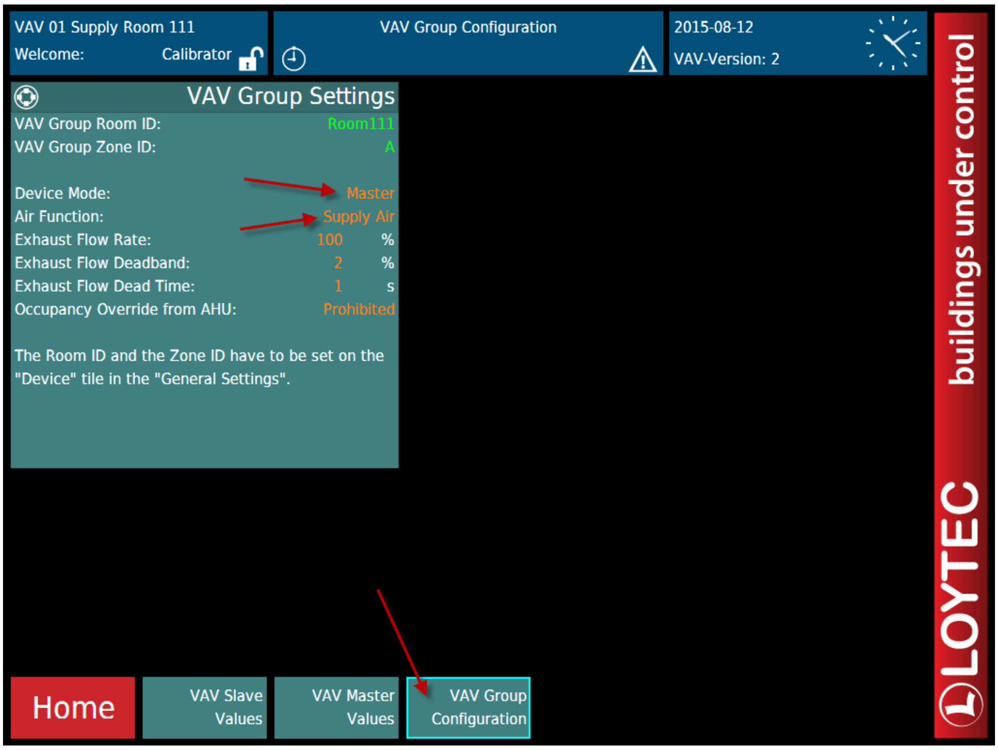


Figure 120: VAV Group Configuration

Device Mode: has to be set to e.g. **“Master”**. Please note that there must not be more than one master in a VAV Group!

Air Function: has to be set to e.g. **“Supply Air”**. Please note that a VAV controller as “Exhaust Air” will only support the damper actuator with Air Flow Control but no additional actuator functions like reheat or fan.

The other parameters on this tile can be left on their default values as displayed.

7.2.13 Parameter Settings in Managers

Depending on the L-STUDIO configuration, there are devices that operate additional Multi Manger or Area-, Floor, or Building- Manager functions (e.g. VAV_Device_Types VAV_MM_V1, VAV_BM_FM_AM_V1, VAV_FM_AM_V1, and VAV_AM_V1).

Please note that the Multi Manger is the only manager function used in the Adhoc Design. The Area-, Floor, or Building- Manager functions are only used in the Structured Design.

These managers also have to be parameterized during the runtime to gain a proper functionality.

There are also L-WEB projects hosted in the LIOB-AIR devices that visualize the data of the included managers:

Multi Manager: **VAVmultiManagerStatus.lweb2**

Area- Manager: **VAVmanagerStatusArea.lweb2**

Floor- Manager: **VAVmanagerStatusFloor.lweb2**

Building- Manager: **VAVmanagerStatusBuilding.lweb2**

These L-WEB manager projects have to be opened as described in the chapter 7.2.12.1 **“Run the VAVstatus visualization Project”** above.

The parameters for the Multi Manager and all Area Managers and all Floor Managers and the Building Manager have to be set in the same way. So only the parameterization of the Multi Manager is described here in detail. For more information, see chapter 7.7 !!

This is done in two chapters:

Chapter 7.2.13.1: This describes the parameterization of the top level Multi Manager.

Chapter 7.2.13.2: This describes the parameterization of one of the included Area Managers.

7.2.13.1 Enter the Multi Manager Parameters

The first step is to start the L-WEB project **"VAVmultiManagerStatus.lweb2"** from the WebUI of the LIOB-AIR device. At the first start, it looks like Figure 121:

Figure 121: Manager Overview

It starts with the "Manager Overview" page. There the top level tiles of the Multi Manager and of the include 5 Area managers are shown. It is the "empty" view, because no parameter values as "Air Supply Zone IDs" and "Locations" are set up to now. After proper parameterization, this screen shows how much VAVs are connected to each area and if the communication is ok or not.

7.2.13.1.1 Device Parameters

For the Multi Manager the Device Type, the project Name and the Device Location can be entered. The engineering Units and the Language do not have to be selected because this setting is already done by the VAV controller. To start click on the "Device" tile and select "Device Data" in the Navigation Area. This will open the page "Manager Device Data" as shown in Figure 122. Because this page is protected with the PIN code of "Configurator", the PIN code has to be entered before the page opens.

On the tile "Device Data", the following parameter values can be entered. These parameters are only used for user clarity and do not have to be unique.

Device Type: here the type of the VAV Box device can be entered, e.g. **"LIOB-AIR1"** or some other description needed for the project.

Project Name: the name of the project can be entered here, e.g. **"My VAV project"** or some other description needed for the project. If this is empty, the name of the L-STUDIO solution is shown automatically.

Device Location: The location of the device or some other useful description can be entered here, e.g. "**VAV Manager**". Please note that this string is displayed also in the left title area on top of all the pages.

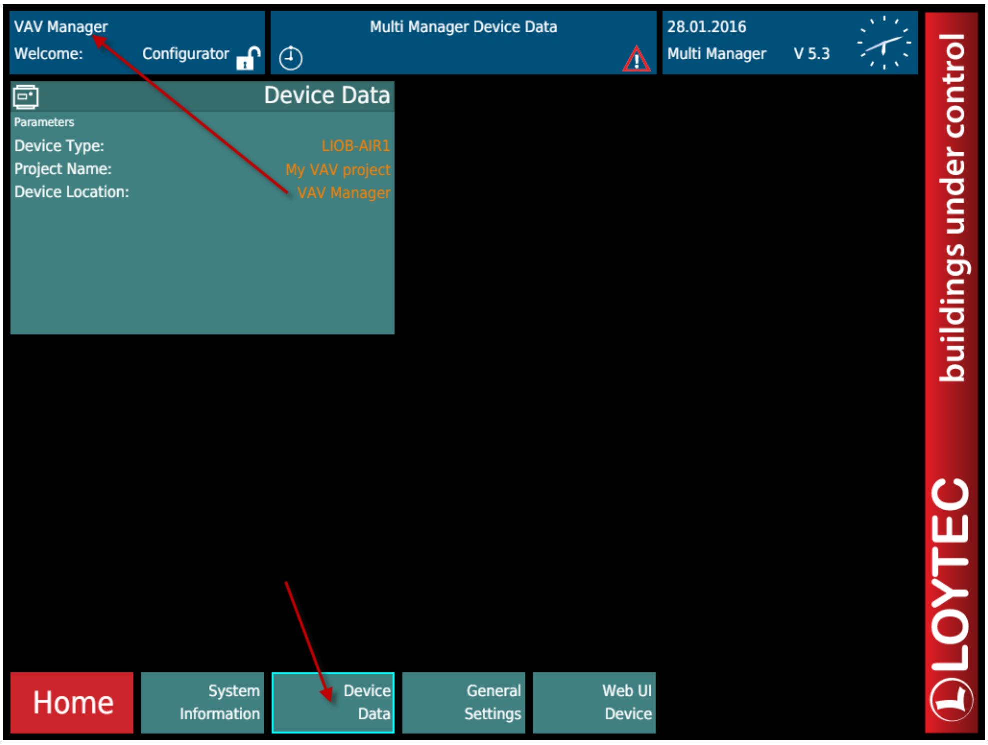


Figure 122: Manager Device Data

7.2.13.1.2 Multi Manager IDs

To enable the communication between the managers and the VAV controllers the parameter "Air Supply Zone ID" has to be set. As mentioned before the managers must have the identical Air Supply Zone ID as the VAV controllers.

To start, click on the "Multi Manager" tile. The page „Values between Manager and AHU" opens where the „ID´s Configuration" button has to be clicked in the navigation area. This will open the "ID´s Configuration" page as shown in Figure 123.

Because the Multi Manager contains multiple managers with identical pages, there is an additional display in the clock title area on top of all pages that indicates if this page shows data of the top level Multi Manager or of one of the 5 includes Area Managers.

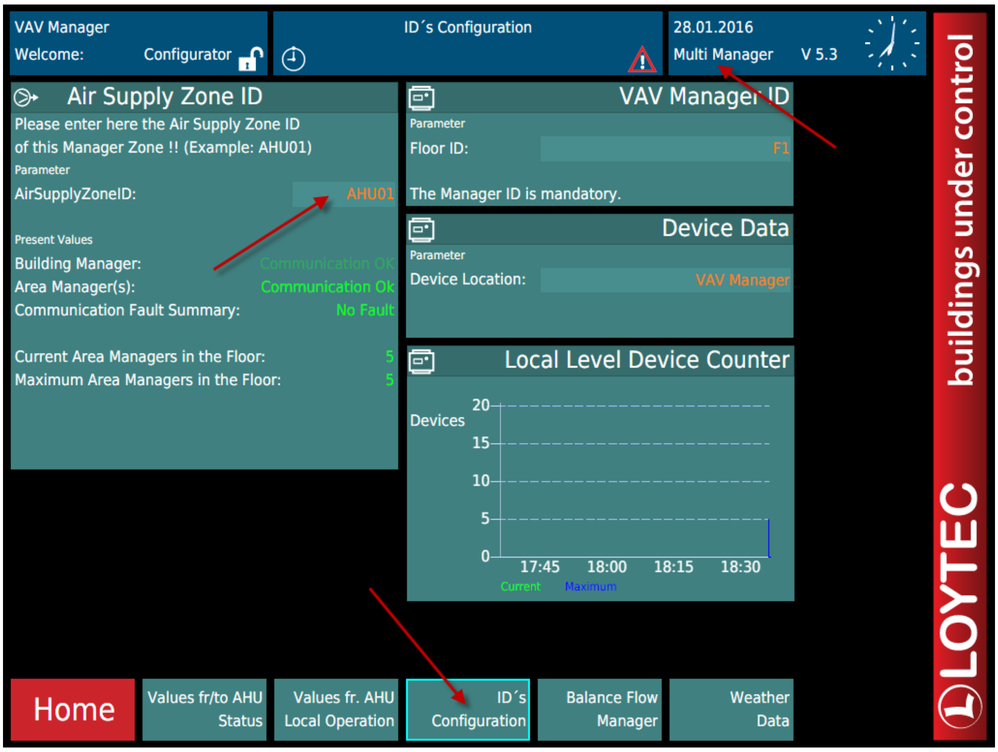


Figure 123: ID´s Configuration Multi Manager

On the “Air Supply Zone ID” tile the following mandatory parameter value must be entered.

AirSupplyZoneID: this is the name of the air supply zone and is set to e.g. **“AHU01”**. This must be identical for all Area Managers inside the Multi Manager. For that reason this parameter value is written to the AirSupplyZoneIDs of the included 5 Area Managers automatically.

On the “VAV Manager ID” tile the following mandatory parameter value can be changed.

FloorID: this is the ID of the Multi Manager. This is set by default on **“F1”** . It can be changed but there is no real need to do it. This ID must be unique inside of the Multi Manager device.

On the “Device Data” tile the following optional parameter value can be changed.

Device Location: This parameter was already set in the chapter Device Parameters. Please note that this string is displayed also in the left title area on top of all the pages.

7.2.13.2 Enter the Area- Manager Parameters in the Multi Manager

Since the top level of the Multi Manager is parameterized, now the included Area Managers need their proper parameter value inputs. Only the Area Managers where VAV controllers are connected must be parameterized. In our example, the Area1 and Area2 Managers are used.

7.2.13.2.1 Area Manager IDs

To start, click on the "Area1 Manager" tile. The page „Values between Manager and AHU" opens where the „ID´s Configuration" button has to be clicked in the navigation area. This will open the "ID´s Configuration" page as shown in Figure 124.

Please note the additional display in the clock title area on top the page that indicates that this page shows data of the Area1 Manager.

Figure 124: ID´s Configuration Area1 Manager

On the "Air Supply Zone ID" tile the following mandatory parameter value must be entered.

AirSupplyZoneID: this is the name of the air supply zone and is set to e.g. **"AHU01"**. This must be identical for all Area Managers inside the Multi Manager. For that reason this parameter value is written to the AirSupplyZoneIDs of the included 5 Area Managers automaticallywhen it is set on the Multi Manager tile.

AreaID: this is the ID of the Multi Manager. This is set by default on **"A1"** . It can be changed but there is no real need to do it. This ID must be unique inside of the Multi Manager device.

Device Location: This parameter was already set in the chapter Device Parameters. Please note that this string is displayed also in the left title area on top of all the pages.

All the included Area Managers that are used (VAV controllers are connected) have to be parameterized in the same way

Now the parameterization of the Multi Manager is finished. There is only one Multi Manager in the project. So the work is finished now.

7.2.14 Parameter Settings using LWEB-900

The parameter settings that were done in the last chapters by using the LWEB 802/803 visualization projects are useful for smaller projects with a few VAV controllers. If the building management system LWEB-900 is used it will increase the efficiency of the workflow. Even if LWEB-900 is not used as a building management system in the project, it can be used as a tool to increase the efficiency of the commissioning work. In this case, LWEB-900 will not remain onsite during the runtime of the VAV system. To use LWEB-900 as a tool a Competence Partner license is needed only.

The central component is the LWEB-900 Server, which stores all configuration data in a database and communicates with the devices of the building management system in real time. The LWEB-900 Client is the user interface of the building management system. When user starts the client, he has to log on to the server before receiving access. Client and server exchange data using web services only. Due to this system architecture, remote access is easily possible through firewalls and NAT routers.

In our case, the LWEB-900 Server and LWEB-900 Client will operate on the same PC.

7.2.14.1 Set up the LWEB-900 System

The next steps will set up the LWEB-900 Server and Client and will import the devices from the L-STUDIO project.

7.2.14.1.1 Set up the LWEB-900 Server

The LWEB-900 Server runs as a service which is started automatically when the PC boots. The user interface can be started from the Windows start menu as shown in Figure 125.

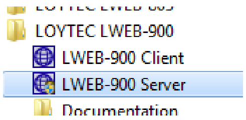


Figure 125: Start LWEB-900 Server user interface

When starting the LWEB-900 Server user interface for the first time, you will notice, that a project with the name “Default LWEB-900 Project” has already been created. You can edit the project by selecting “Edit project…” from the context menu. The project properties are displayed and can be edited as shown in Figure 126.

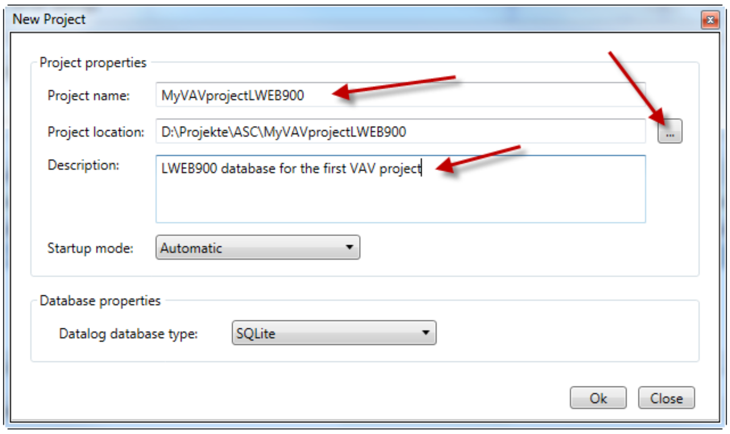


Figure 126: Project Properties

The Project name e.g. “MyVAVprojectLWEB900” has to be entered as well as the Project location and a description in the relating fields of the “Edit project” dialog.

Now the LWEB-900 Server is set up and the project is created.

7.2.14.1.2 Set up the LWEB-900 Client

The LWEB-900 Client is the primary user interface for the building management system. It can be started on the same PC as the server or on a remote PC. Multiple clients can access the server concurrently.

When the LWEB-900 Client is started, the login dialog is displayed as shown in Figure 127.

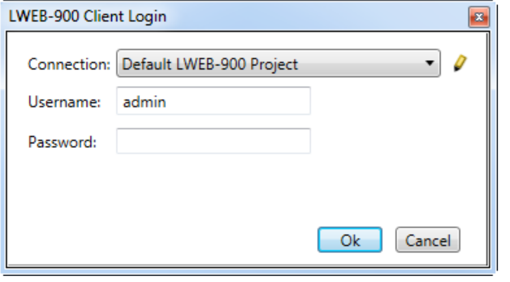


Figure 127: Client Login

The “Connection” drop-down list allows choosing between different LWEB-900 projects. To open the “Manage Project Connections” dialog, the “Edit” button has to be clicked. In the opened “Manage Project Connections” dialog, the **“**New” button has to be clicked to create a new connection from the LWEB-900 Client to the LWEB-900 Server as shown in Figure 128.

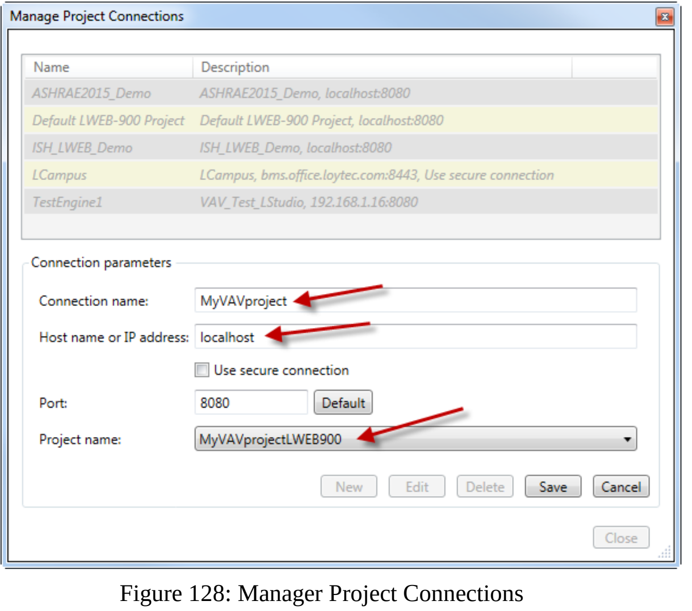


Figure 128: Manager Project Connections

The connection will be named to e.g. “MyVAVproject”. Because LWEB-900 Client and LWEB-900 Server are running on the same PC, the host name can be entered as “localhost”. The already created project on the LWEB-900 Server has to be selected as “MyVAVprojectLWEB900”. To finish the “Save” button has to be clicked.

Since the connection is created, the LWEB-900 Client Login dialog is waiting for input of a proper password. A new project has an administrator user with the following default credentials:

Username: admin

Password: loytec4u

After entering the proper password for the administrator user, the LWEB-900 Client opens the project.

7.2.14.1.3 Import the L-STUDIO Project

This step will import the L-STUDIO project with all the LIOB-AIR VAV devices into the LWEB-900 Server database.

In the Navigation View, the tree structure of the project is shown. With right click on “Devices” in the “Network” folder and selecting “New” and “New L-Studio project…” the “New L-Studio Project” is opened as shown in Figure 129and Figure 130.

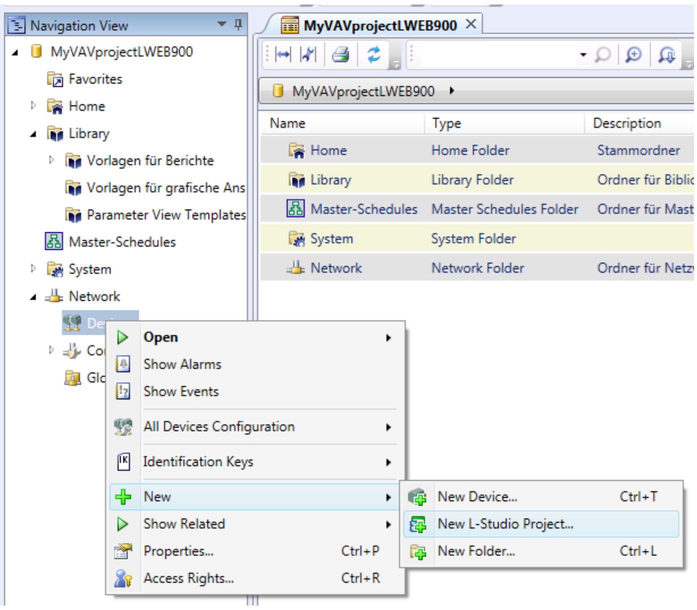


Figure 129: Start New L-Studio Project

In this dialog a Name, description and the location of the L-STUDIO solution file e.g. “MyVAVproject.sln” have to be entered. The import process starts clicking the OK button. This process can take some minutes depending on the size of the L-STUDIO project. During the “L-Studio Project Creation”, the progress of the import can be watched by a progress bar.

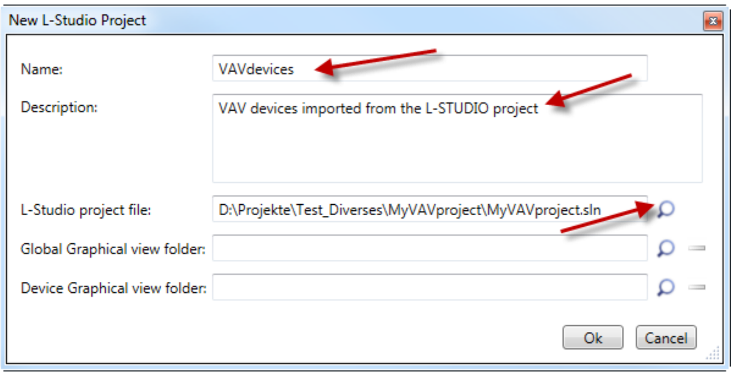


Figure 130: New L-Studio Project dialog

After the import has finished, the VAV devices are shown in the Navigation View in the "Devices" folder, using the folder structure and the device names from the L-STUDIO solution as shown in Figure 131.

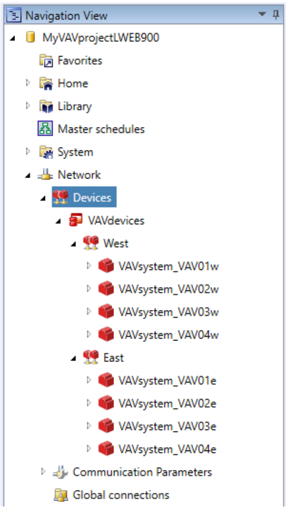


Figure 131: VAV devices in the Navigation View

Now all the VAV devices with all the data points are imported in LWEB-900. Based on this data we can generate parameter views to enter the parameters for all the devices efficiently. The device management can also be done very easily. Further, a complete building management system is available for operation.

7.2.14.2 Create Parameter Views

The parameter view allows configuring operational parameters, which are distributed to multiple devices, efficiently. For example, parameters for flow control or room temperature control can be organized in different parameter views. Each parameter view is a spreadsheet where each cell represents a parameter. Parameters can be organized freely in the matrix. In this way, it is possible to e.g. adjust the flow parameters across many rooms with a few mouse clicks and write the new values reliably into the corresponding LIOB-AIR controllers.

7.2.14.2.1 Using Parameter View Templates

For all the parameters to set up the devices, the air flow data, the AHU communication and the group communication, LOYTEC provides built-in “Parameter View Templates”. These templates can be found in the LWEB-900 Navigation View in the Library folder as displayed in Figure 132.

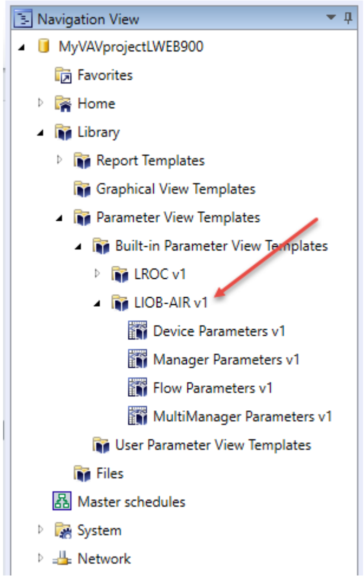


Figure 132: Parameter View Templates

There is a “Device Parameters v1” template for the device parameters like e.g. the Room ID, Device Location, Master/Slave, Supply or Exhaust air, Air Supply Zone, etc. There is also a “Flow Parameters v1” template for the flow parameters like Duct Area, Nominal Flow, Pitot Factor, Maximal and Minimal Flows, etc. For use in Structured Design, there is a “Manager Parameters v1” template for the Area-, Floor- and Building-Managers for the Manager Parameters like Manager ID, Air SupplyZone ID, etc. For use in Adhoc Design, there is a “MultiManager Parameters v1” template for the Multi Manager for the Manager Parameters like Manager ID, Air SupplyZone ID, etc. There will be additional templates available in the future releases.

7.2.14.2.2 Create the Device Parameter View

First, the Device Parameter View shall be created based on the “Device Parameters v1” template.

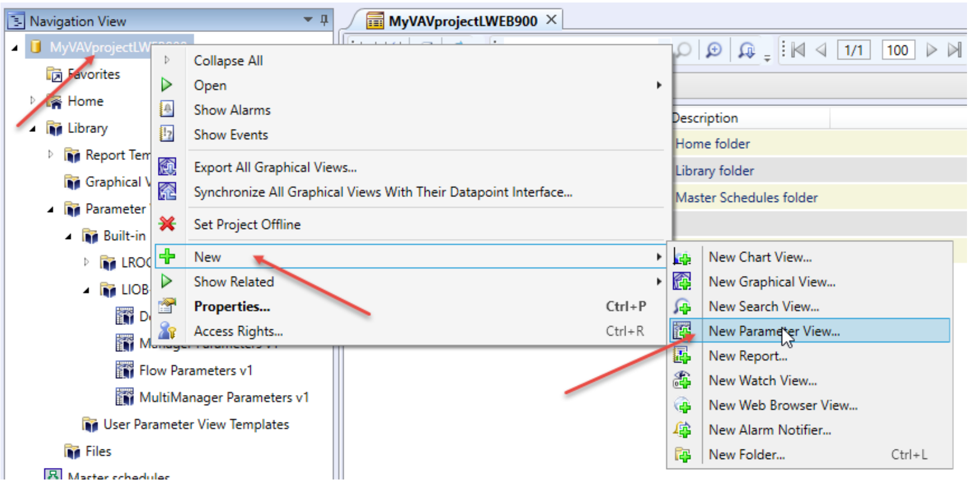


Figure 133: Create a new Parameter View

Right click on the root folder e.g. “MyVAVprojectLWEB900” select “New” and then “New Parameter View…” opens the “New Parameter View…” dialog as shown in Figure 133.

There the View name has to be entered e.g. “1_DeviceParameters”. Because the new parameter view shall be based on a built-in template, the “Initialize from template” option has to be checked and the template “Device Parameters v1” template has to be selected as shown in Figure 134. To refer the new parameter view to the devices the “Devices” have to be selected in the “Network” folder as shown in Figure 135.

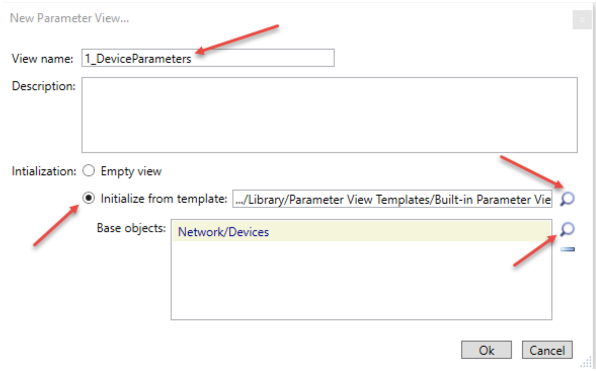


Figure 134: New Parameter View dialog

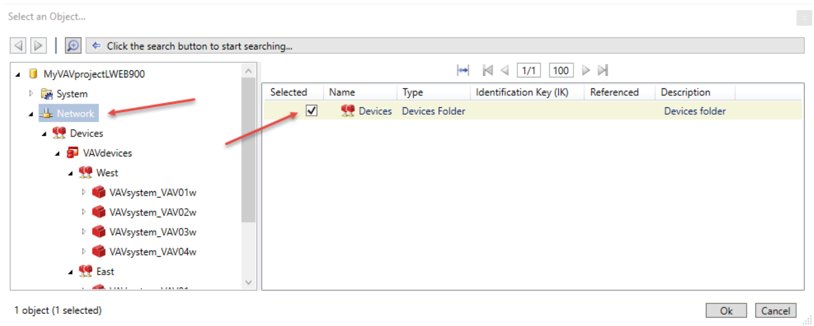


Figure 135: Select Base Objects dialog

Now the new parameter view e.g. “1_DeviceParameters” appears at the bottom of the Navigation View and it can be opened by a double click see Figure 136.

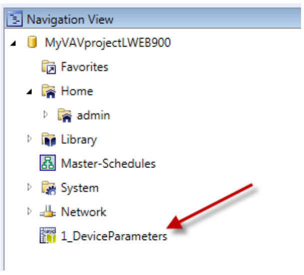


Figure 136: New Parameter View dialog

The new parameter view “1_DeviceParameters” opens and shows the pre-defined parameters for all LIOB-AIR devices in the project. Pressing the “Upload Parameters” button  (F8) will upload the current parameter values from the connected devices.as shown in Figure 137.

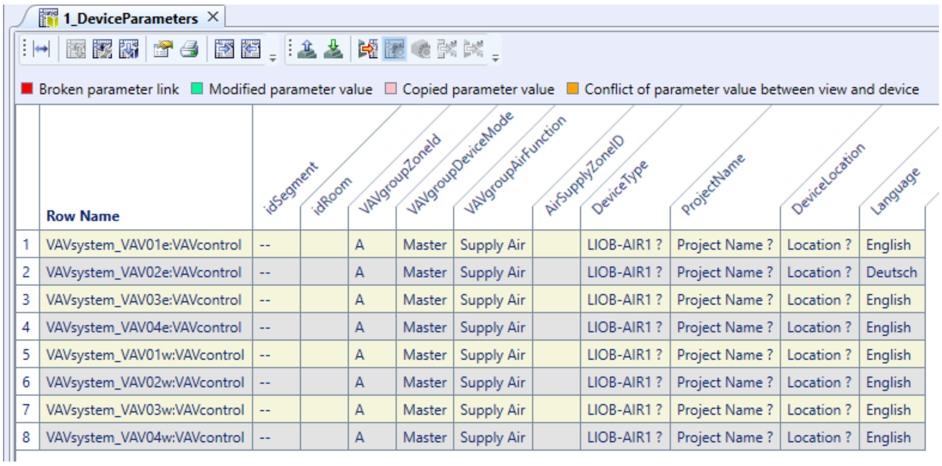


Figure 137: New Device Parameter View

In the rows, all the LIOB-AIR devices of the project are listed and in the columns, the dedicated parameters are shown.

The same Parameters we have entered in a single device in 5.2.3.9 can be entered here for all devices in the VAV system.

There are some efficient functions to be used if a parameter has to get the same value in multiple devices. Here e.g. the Project Name is the same in all devices. A right click on the column head ProjectName and selects the column. Then any right click in the selected area opens a context dialog where the option "”Edit Parameters…” has to be chosen as shown in Figure 138.

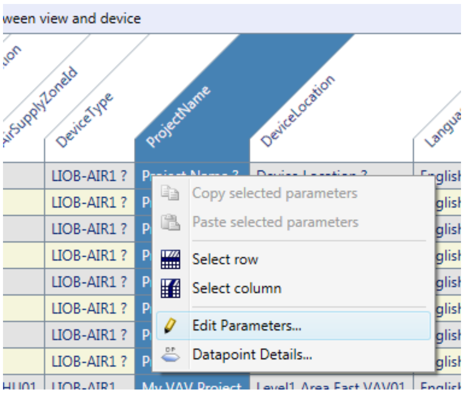


Figure 138: Edit Parameters

Now the Project name can be entered for all selected devices as shown in Figure 139.

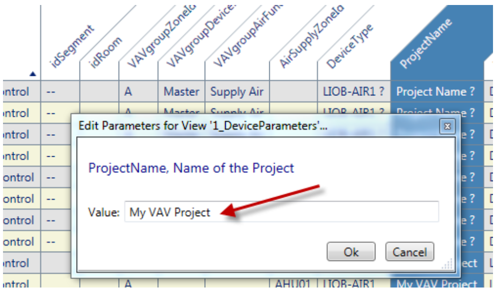


Figure 139: Enter Project Name

This value is applied to this parameter in all LIOB-Air devices in the LWEB-900 database. Because these values are not downloaded into the devices up to now, they are displayed in green color as shown in Figure 140.

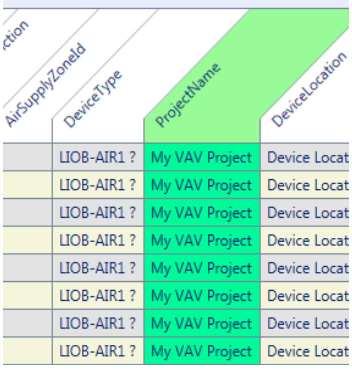


Figure 140: Modified Parameter values

The download is initiated by clicking on the “Download Parameters…” Icon as shown in Figure 141:

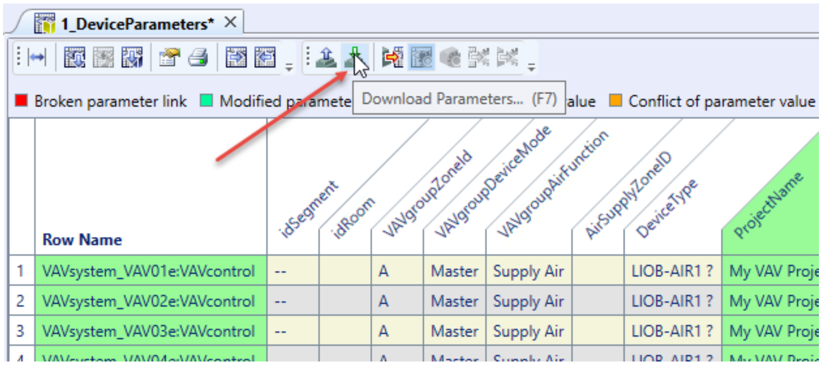
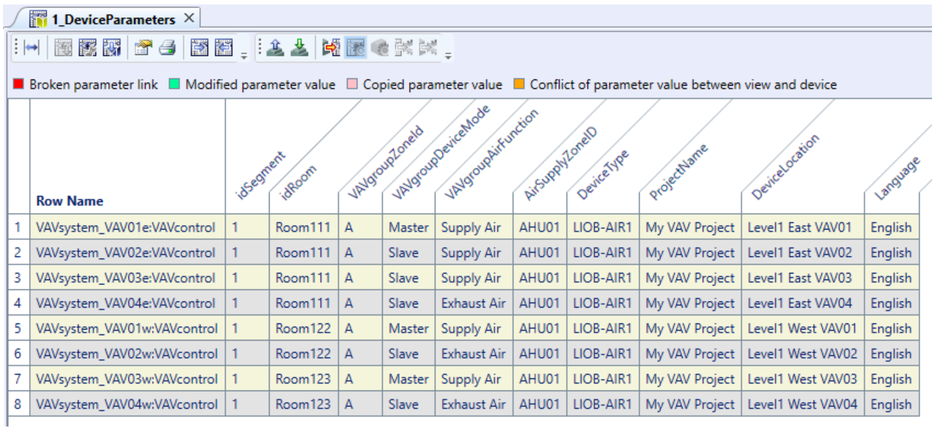


Figure 141: Download Parameters

The Parameters are downloaded to all selected devices now. The download can be done every time but usually it is done if all Parameter values of the Parameter View have been entered.

If all the Parameter values have been entered and downloaded the Parameter view can look like Figure 142.



	Row Name	idSegment	idRoom	VAVgroupZoneId	VAVgroupDeviceMode	VAVgroupAirFunction	AirSupplyZoneID	DeviceType	ProjectName	DeviceLocation	Language
1	VAVsystem_VAV01e:VAVcontrol	1	Room111	A	Master	Supply Air	AHU01	LIOB-AIR1	My VAV Project	Level1 East VAV01	English
2	VAVsystem_VAV02e:VAVcontrol	1	Room111	A	Slave	Supply Air	AHU01	LIOB-AIR1	My VAV Project	Level1 East VAV02	English
3	VAVsystem_VAV03e:VAVcontrol	1	Room111	A	Slave	Supply Air	AHU01	LIOB-AIR1	My VAV Project	Level1 East VAV03	English
4	VAVsystem_VAV04e:VAVcontrol	1	Room111	A	Slave	Exhaust Air	AHU01	LIOB-AIR1	My VAV Project	Level1 East VAV04	English
5	VAVsystem_VAV01w:VAVcontrol	1	Room122	A	Master	Supply Air	AHU01	LIOB-AIR1	My VAV Project	Level1 West VAV01	English
6	VAVsystem_VAV02w:VAVcontrol	1	Room122	A	Slave	Exhaust Air	AHU01	LIOB-AIR1	My VAV Project	Level1 West VAV02	English
7	VAVsystem_VAV03w:VAVcontrol	1	Room123	A	Master	Supply Air	AHU01	LIOB-AIR1	My VAV Project	Level1 West VAV03	English
8	VAVsystem_VAV04w:VAVcontrol	1	Room123	A	Slave	Exhaust Air	AHU01	LIOB-AIR1	My VAV Project	Level1 West VAV04	English

Figure 142: finished Device Parameter View

In this parameter view, the VAV instrumentation of the rooms can be set up easily for the whole project. Even if a room configuration has changed, only this parameter view has to be edited during runtime.

7.2.14.2.3 Build the Flow Parameters View

The next step is to set up the flow parameters for all devices in the project. So the flow measurement and the flow control will be engaged for a proper function.

The new parameter view e.g. “2_FlowParameters” has to be created using the same procedure described in the chapter before. Here the parameter view template “Flow Parameters v1” has to be selected.

If the new parameter view is opened, it looks like Figure 143:

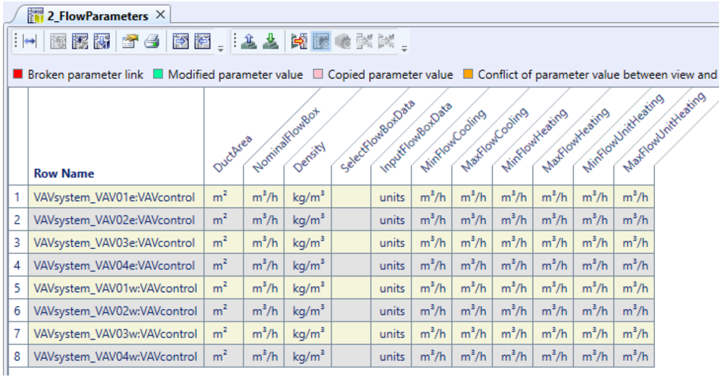


Figure 143: new Flow Parameter View

The best way to fill out this table is to enter all parameter values for one VAV Box. Then the row has to be selected and in the right click menu, the “Copy selected parameters” has to be chosen as shown in Figure 144.

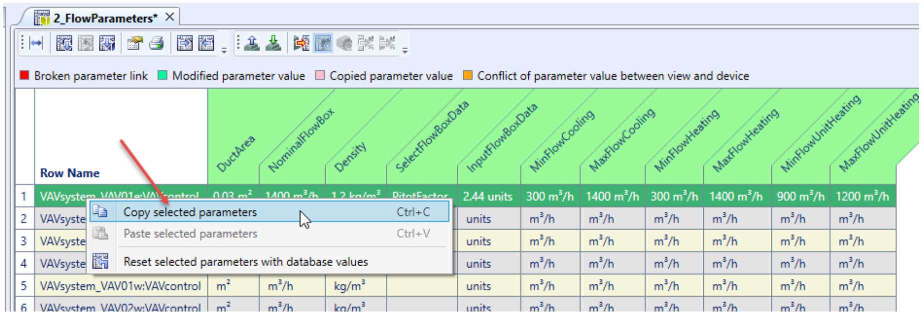


Figure 144: Copy selected parameters

Then with multi selecting different other rows the parameter values can be copied to these devices. So the VAV Boxes of the same dimensions can be parameterized in a short time. The finished Flow Parameter View can look like Figure 145

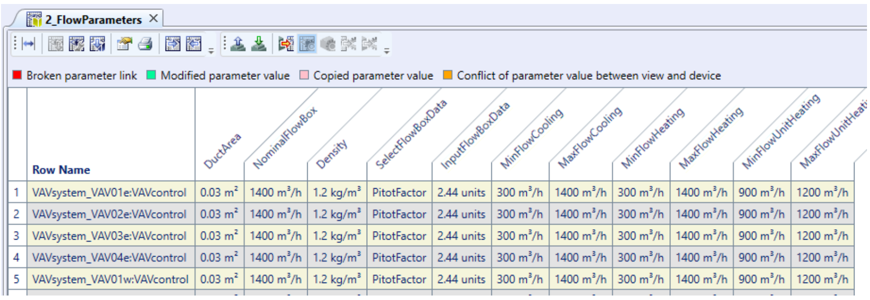


Figure 145: finished Flow Parameter View

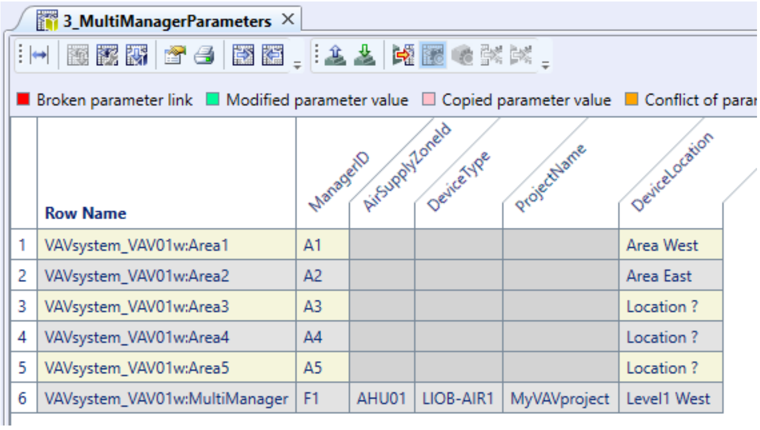
At last, the push to the “Download Parameters” Icon downloads all parameters of this list into all LIOB-AIR devices.

7.2.14.2.4 Build the Managers Parameters View

The next step is to set up the manager parameters for the Multi Manager. For a proper function, the parameters ManagerID and AirSupplyZoneID are mandatory. These address the managers and define to which air supply zone the manager belongs to. The Multi manager only supports one Air Supply Zone. The other parameters are used for a better structure and documentation of the system.

The new parameter view e.g. “3_ManagerParameters” has to be created using the same procedure described in the “Build Device Parameter View” chapter before. Here the parameter view template “Multi Manager Parameters v1” has to be selected.

The finished Flow Parameter View can look like Figure 146



	Row Name	ManagerID	AirSupplyZoneId	DeviceType	ProjectName	DeviceLocation
1	VAVsystem_VAV01w:Area1	A1				Area West
2	VAVsystem_VAV01w:Area2	A2				Area East
3	VAVsystem_VAV01w:Area3	A3				Location ?
4	VAVsystem_VAV01w:Area4	A4				Location ?
5	VAVsystem_VAV01w:Area5	A5				Location ?
6	VAVsystem_VAV01w:MultiManager	F1	AHU01	LIOB-AIR1	MyVAVproject	Level1 West

Figure 146: finished Multi Manager Parameter View

Now all the important parameters are set for the complete system. The VAV system is now able to operate. The commissioners and balancers can start their work now.

7.2.15 Backup the Devices

L-STUDIO is configuring the functions, the data points, the visualization and the communication of the devices. The parameter values in the devices are set to default values with the first deploy. During the commissioning, the parameter values are modified during the runtime.

Since all parameters have been set in the LIOB-AIR devices using the LWEB-802/803 visualization or the LWEB-900 building management system, a backup of the devices is highly recommended.

There are two possibilities to do a backup of the devices:

1. Backup function in the WebUI

2. Backup in LWEB900

7.2.15.1 Backup in the WebUI

On single devices or in very small systems a backup of a device can be executed in the WebUI.

In the Config menu, the “Backup” button has to be pressed to start the download of the backup file from the device to the local PC, as shown in Figure 147.

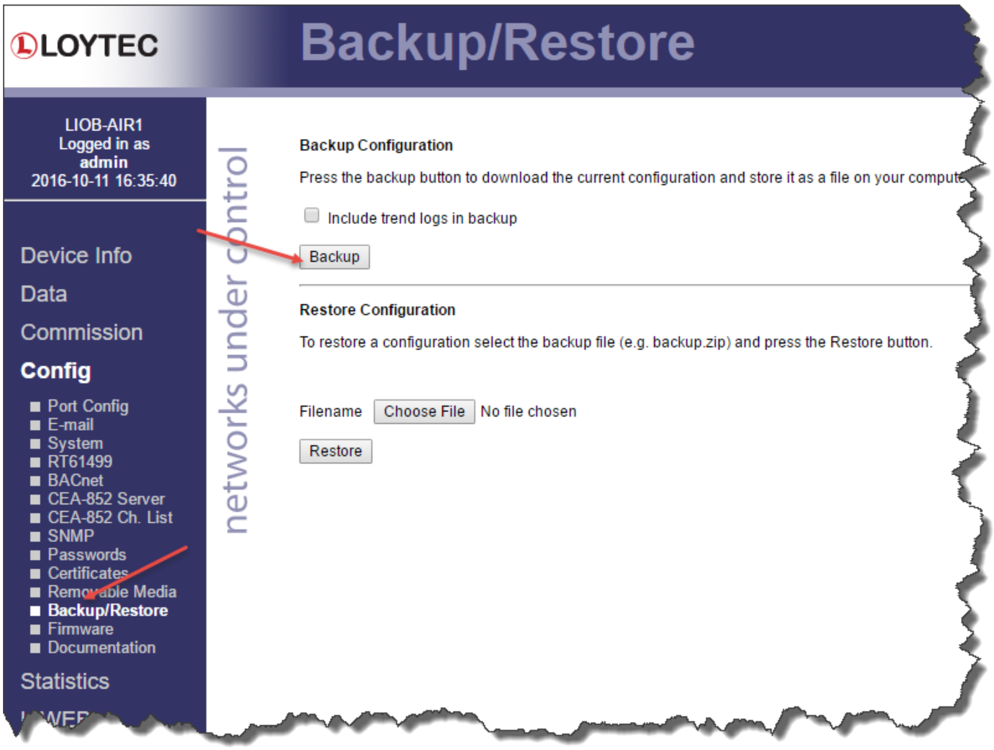


Figure 147: Backup the device in the WebUI

The downloaded backup is a Zip file that should be saved externally.

Please refer to the LOYTEC Device User Manual [1] about more information.

7.2.15.2 Backup in LWEB-900

In the usual cases, it is recommended to do the backup of the devices using LWEB-900.

As mentioned in the previous chapters, even if LWEB-900 is not used as a building management system in the project it can be used as a tool to increase the efficiency of the commissioning work. In this case, LWEB-900 will not remain onsite during the runtime of the VAV system. To use LWEB-900 as a tool a Competence Partner license is needed only.

The backup can be performed individually for every device or commonly for all devices in one step. A double click on the L-Studio project “VAVdevices” opens the device manager in LWEB-900. On the “Backup/Restore” tab, the devices can be multi selected. A click on the “Backup selected devices” button starts the backup process. This is shown in Figure 148

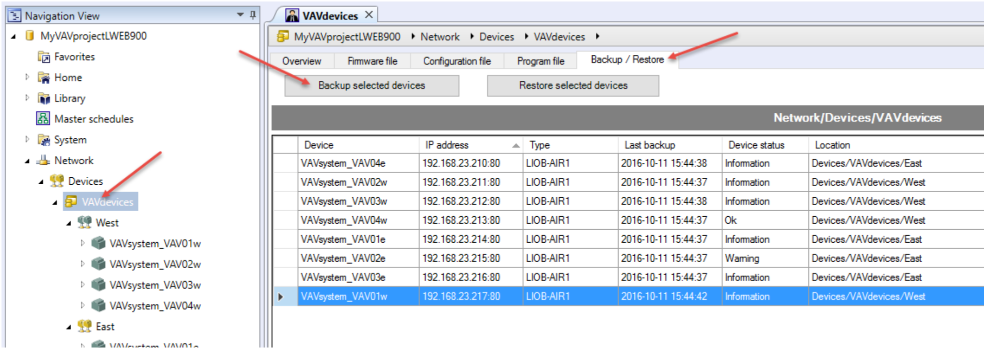


Figure 148: Backup devices in LWEB-900

Additionally to the manual backup, it is also possible to create backup schedules in LWEB-900 to perform the device backups periodically.

The device backups are saved in the LWEB-900 project database. It is also recommended to execute a backup of the LWEB-900 project database and save it externally

Please refer to the LWEB-900 User Manual [4] for more information.

7.3 VAV Application

7.3.1 Application Structure

The principle of VAV_Types and VAV_Device_Types is explained in the chapters 7.1.4and 7.1.6. How to build the system using VAV_Types and VAV_Device_Types in Adhoc Design or Structured Design is described in chapter 7.2.

This chapter describes the structure of the core functions and the additional sensor functions and actuator functions.

LOYTEC provides a VAV library that needs to be installed before starting the engineering of a VAV system.

Every VAV solution must be created in L-STUDIO AIR based on the "VAV Start Solution" template that is available after the VAV library installation.

All the functions that are available in the LIOB-AIR controller are included in the VAV library "Loytec.HVAC". Because this is an installed library, the content of the CATs cannot be modified.

If there are special functions requested in a VAV project that are not supported by the VAV library, please contact support@loytec.com. LOYTEC will check your request and will provide an individual solution.

The VAV library "Loytec.HVAC" can be found in the Solution Overview of L-STUDIO AIR as shown in Figure 149.

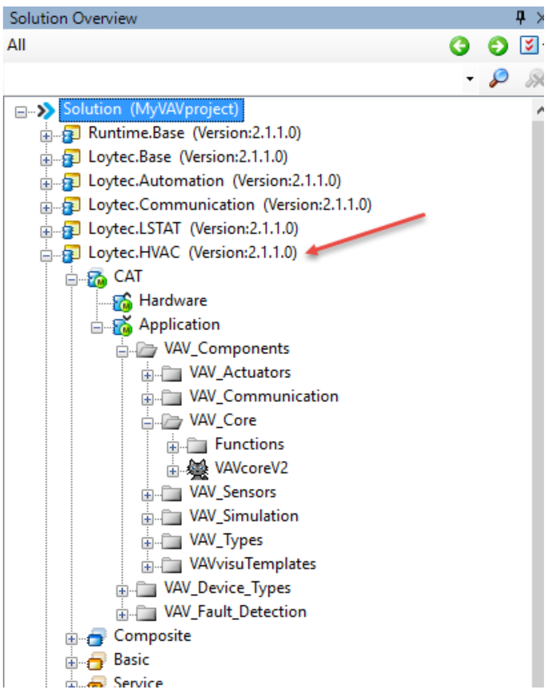


Figure 149: VAV library Loytec.HVAC

To gain an easy engineering process every new created VAV solution based on the “VAV Start Solution” template contains the predefined VAV_Types VAVtype_V0 and VAVtype_V1 that provide the maximum functionality of a VAV controller. That means that all functions of the VAV library are instantiated in the predefined VAV_Types.

Therefore, there is no need for the system integrator to operate with the VAV library during the engineering process!!

The principle of creating new VAV_Types is to copy and paste the maximum VAVtype_V0 and delete the sensor functions and actuator functions that are not needed.

In the new-crated VAV solution based on the “VAV Start Solution” template, the predefined VAV_Types can be found in the VAV_Types folder as shown in Figure 150

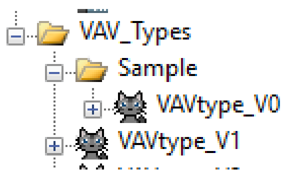


Figure 150: Predefined VAV_Types

The VAVtype_V0 is the base template. It can be copied when needed but it should not be modified to ensure to have always a “clean” template to create new VAV types.

The “VAVtype_V1” is a copy of the “VAVtype_V0” and it shall be the first type the user can modify and adapt to his requirements.

Figure 151 shows the content of the predefined maximum VAVtype_V0 on the Composite tab.

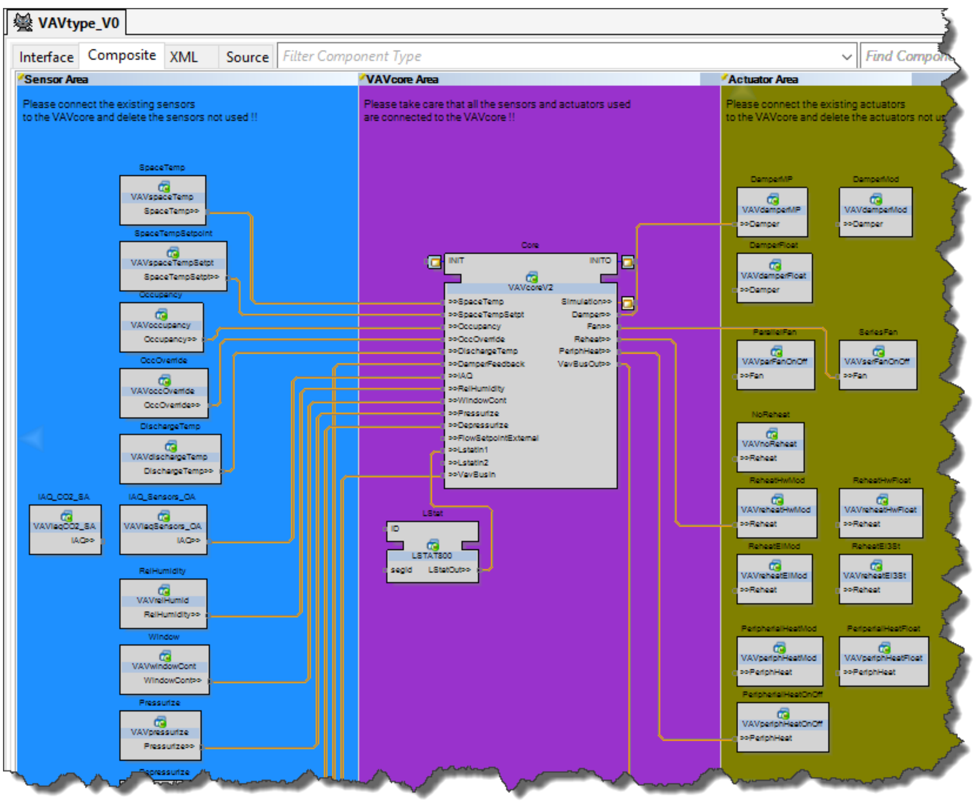


Figure 151: Predefined VAVtype_V0

There are 3 function areas displayed, the Sensor Area (blue), the VAV core Area (purple) and the Actuator Area (ocher).

In the Sensor Area, all the sensor function CATs of the VAV library are included and connected to the Core CAT.

In the VAV core Area, the Core CAT of the VAV library is included. This “Core” block must not be deleted because it contains all the core functions every VAV controller must have! It has many connectors where the dedicated sensor functions and actuator functions are connected. In addition, the LSTAT800 CAT of the VAV library is included in the VAV core Area and is connected to the dedicated port of the Core. It contains the automatic configuration and communication of the LOYTEC L-STAT network thermostat and should not be deleted.

In the Actuator Area all actuator function CATs of the VAV library are included and connected to the core.

Please note that below the colored function areas some additional CATs and connectors are included and also connected to the Core. These are internal system components that must not be deleted. If there was something deleted by accident, the best way is to delete this damaged VAV_Type and copy and paste a new VAV_Type from VAVtype_V0.

Basically, all VAV functions are included in the Core CAT. There are standard functions that are always available and active independent of which sensor functions or actuator functions are connected to the Core. If a sensor or actuator function is connected to the core the regarding function is activated.

The data points of these core functions are also included in the Core and available independent of which sensor or actuator functions are connected.

The standard functions of the Core are:

- Air Flow Control
- Effective Occupancy Control
- HVAC Mode Control
- AHU Communication
- VAV Group Communication
- Energy Control (not available in the current Version)

For a detailed description of the core functions, see chapter 7.5.

For every sensor function type and every actuator function type, the Core provides dedicated connectors. On the left side, the sensor functions can be connected and on the right side, the actuator functions can be connected. Because the connectors are coded, it is not possible to connect a sensor or actuator function to a wrong connector of the Core. Only one sensor or actuator function can be connected to the connectors of the core.

In case that there are multiple CATs existing of a sensor or actuator type (e.g. IAQ, Damper, Fan, Reheat….), only one of this type can be connected to the connectors of the core. The sensor or actuator types that are needed in the VAV_Type must be connected to the Core. The unused and not connected sensor or actuator functions can be deleted or can remain there.

If a sensor or actuator function is connected to the core the regarding function is enabled. The regarding data points are created and are initialized and updated during the runtime of the device. If a sensor or actuator function is disconnected from the core the regarding data points are created, but the will not be initialized or updated during the runtime of the device. If a sensor or actuator function is deleted from the VAV_Type, the regarding data points will also be deleted and will not be present during the runtime of the device.

To gain a data point interface of the LIOB-AIR that only contains the data points that are really in use, it is the best way to delete the unused sensor and actuator functions.

The VAVtype_V0 includes also the VAVstatus.lweb2 visualization project for operation, maintenance and parameterization of the VAV controller. This visualization contains pages for all the Core standard functions and all sensor and actuator functions. If sensor or actuator functions are disconnected from the Core the regarding parts of the visualization are disabled. If a sensor or actuator functions are deleted from the VAVtype_V0 the regarding parts of the visualization are deleted.

In case a sensor or actuator function is deleted accidentally, it is also deleted in the visualization. This process cannot be reverted. If there was something deleted by accident, the best way is to delete this damaged VAV_Type and copy and paste a new VAV_Type from VAVtype_V0. For the first step of modifying a VAV_Type, it is possible only to disconnect the sensor and actuator functions and to delete these items in a later step. In this case, the regarding parts will remain in the visualization but they are only deactivated.

For a detailed description of the sensor and actuator functions, see chapter 7.5.

7.3.2 Device Configuration

As described in the chapters 7.1.6 and 7.2.5 the VAV_Device_Types provide the functionality of the instantiated VAV_Type and are relating to a concrete hardware device type e.g. LIOB-AIR1. Therefore, the VAV_Device_Types also provide the complete device configuration on a separate Configurator tab in the device CAT.

Using the VAV_Device_Types in the VAV solution based on the “VAV Start Solution” template the device configuration is built automatically. The instantiated VAV_Type and perhaps Manager_Type(s) generate the included data points to the device configuration.

On the Configurator tab of the VAV_Device_Type CAT the LINX-Configurator allows to view and to modify the device configuration. This LINX-Configurator is operating as an Add In of L-STUDIO AIR. Please refer to the LINX Configurator User Manual [2] for more information.

The folder list of the configurator shows multiple folders as displayed in Figure 152.

In the LIOB-AIRx folder, all the data points of the device type are included in dedicated subfolders relating to the technology of the data points. The important folders are:

<u>Favorites:</u> All the Favorite data points of the instantiated VAV_Type with the Core and the sensor and actuator functions are included in the VAVcontrol subfolder. Many Favorites are already connected to the local I/O relating to the Standard I/O Configuration. The Favorite data points are described in detail in chapter 7.5.

<u>User Registers:</u> All the user register data points of the instantiated VAV_Type with the Core and the sensor and actuator functions are included in the VAVcontrol subfolder. The function logic and the visualization are operating with these user registers. All the user register data points are described in detail in chapter 7.5.

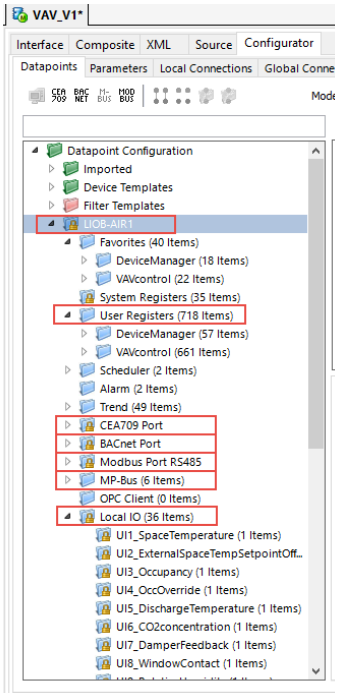


Figure 152: Folder list in configurator

Trend: All the trends of the instantiated VAV_Type with the Core and the sensor and actuator functions are included in the VAVcontrol subfolder. Important data points are trended automatically using “generic” trends. These trends are shown in the VAVstatus visualization.

CEA709 Port Datapoints: All the CEA709 data points of the instantiated VAV_Type with the Core and the sensor and actuator functions are included in the VAVcontrol subfolder. These data points have to be created individually according to the project requirements.

BACnet Port Datapoints: All the BACnet data points of the instantiated VAV_Type with the Core and the sensor and actuator functions are included in the VAVcontrol subfolder. The BACnet data points are synchronized with the relating user registers data points using local connections. These BACnet data points and the synchronization to the user registers are established automatically.

Modbus Port RS485 Datapoints: All the Modbus data points of the instantiated VAV_Type with the L-STAT functions are included in the VAVcontrol subfolder. The communication and configuration of the connected L-STAT network thermostat device is using these data points.

MP-Bus: All the MP-Bus data points of the instantiated VAV_Type with the VAVdamperMP damper actuator function are included in the VAVcontrol subfolder. The communication to the connected MP-Bus damper actuator device is using these data points.

Local IO: All the local I/O data points that are configured in the VAV_Device_Type are included in this folder. The predefined VAV_Device_Types provide a Standard I/O Configuration that can be modified to the individual project demands. Many Favorites are already connected to the local I/O relating to the Standard I/O Configuration.

The names of the data points are defined in the Core and the sensor and actuator functions. The names of the folders in the folder structure are defined by the instance names of the CATs. Therefore, the instance names in the VAV_Types and the VAV_Device_Types must not be changed to gain the proper function of the data points and the included visualization.

Please note that all the data points are generated automatically from the instantiated VAV_Type and Manager_Type(s) in the VAV_Device_Type. This is indicated individually for every data point by the “Datapoint Auto-Generated (SFB)” flag. This is shown in the properties tab of the dedicated data points as shown in Figure 153.

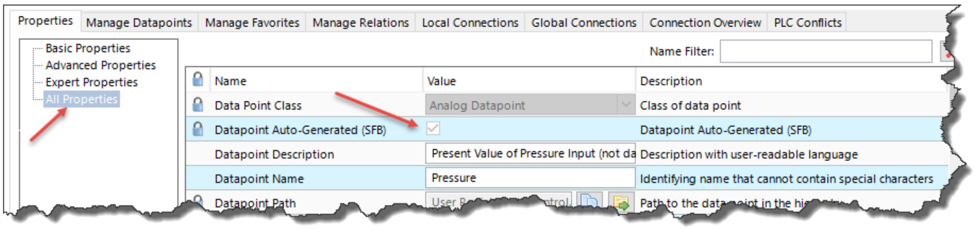


Figure 153: Datapoint Auto-Generated (SFB) flag

Please note that this flag is only shown if the “All Properties” view is selected.

All the auto generated data points should not be modified by the system integrator. The auto generation is executed every time the configurator is opened on the Configurator tab of the VAV_Device_Type. So all possible modifications would be overwritten and lost the next time!

If there are additional data points needed they <u>must not</u> be created in the folders of the auto generated data points. For these additional data points the system integrator has to create a separate folder with an own name e.g. “Special” as shown for example for user registers in Figure 154.

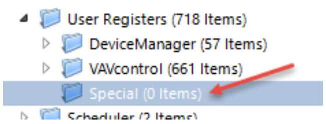


Figure 154: Separate folder for additional data points

Please note that this is the configuration of a VAV_Device_Type and this configuration is valid for all instances of this type in the VAV system.

The local I/O configuration of every predefined VAV_Device_Type is relating to the Standard I/O Configuration. The Favorite data points of the instantiated Core and sensor and actuator functions are already liked to the relating I/Os. Using the Standard I/O Configuration saves a lot of engineering work.

The local I/O configuration can be modified using the L-IOB Local I/O configuration as displayed in Figure 155.

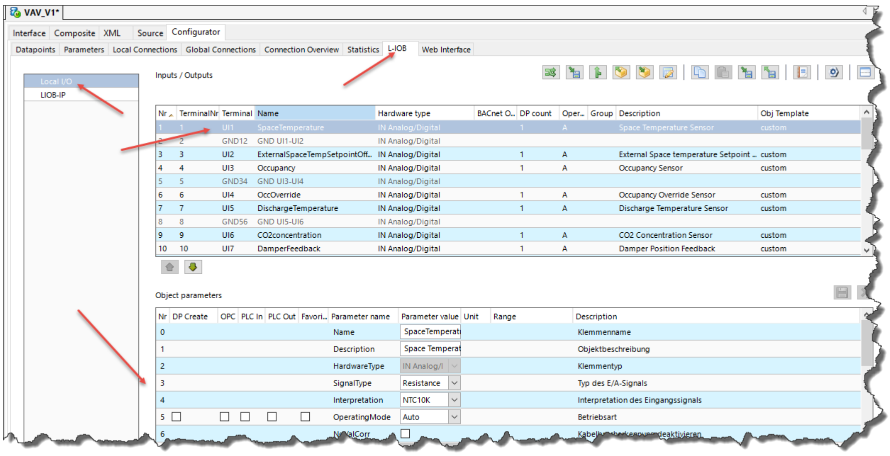


Figure 155: Local I/O configuration

The Standard I/O configuration is shown in Table 6.

IO	Description	Type
UI1	Space Temperature	NTC10k
UI2	External Space Temperature Setpoint Offset	0 - 10k, -10°K…+10°K
UI3	Occupancy Sensor	binary
UI4	Occupancy Override (Bypass Button)	binary
UI5	Discharge Temperature	NTC10k
UI6	CO2 Concentration	0 – 10VDC, 0 – 2000ppm
UI7	Damper Feedback	0 – 10VDC, 0 – 100%
UI8	Window Contact	binary
UI9	rel. Humidity	0 – 10VDC, 0 – 100%rH
UI10	not used	binary
AO1	Reheat modulating	0 – 10VDC, 0 – 100%
AO2	Damper modulating	0 – 10VDC, 0 – 100%
AO3	Fan Speed	0 – 10VDC, 0 – 100%
DO1 (16A)	Reheat Stage 1	binary
DO2 (16A)	Reheat Stage 2	binary
DO3 (16A)	Reheat Stage 3	binary
DO4 (6A)	Fan	binary
DO5 (6A)	Reheat floating (Close)	binary
DO6 (6A)	Reheat floating (Open)	binary
DO7 (6A)	not used	binary
DO8 (Triac)	Peripheral Heat (On Off)	binary
DO9 (Triac)	Reheat modulating (PWM)	PWM

Table 6: Standard I/O Configuration of a LIOB-AIR1 device type

If the device type does not support some of the I/Os, e.g. LIOB-AIR2 does not support DO1, DO2, DO3, these I/Os are not present in the configuration and the relating Favorites are not linked. In this case, the Favorites have to be linked manually.

To check or modify the Favorite links to the local I/O the "Manage Favorites" tab of the configurator can be used as shown in Figure 156.

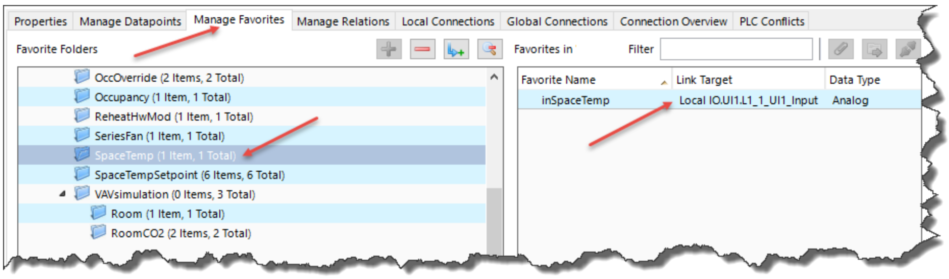


Figure 156: Manage Favorites

Please refer to the LINX Configurator User Manual [2] for more information using the configurator.

7.3.3 Visualization VAVstatus

The VAV application in the LIOB-AIR controller can be watched, operated and parameterized with an automatically built LWEB-802/803 visualization project *VAVstatus.lweb2*. As described before this visualization is modified automatically depending on the sensor and actuator functions that are connected to the Core. If a sensor or actuator function is not connected to the Core, it will not be shown in the visualization.

How to start this visualization from the WebUI of the LIOB-AIR controller is already described in chapter 7.2.12.1.

The VAVstatus visualization starts with the “Status Overview” page and it looks like Figure 157:

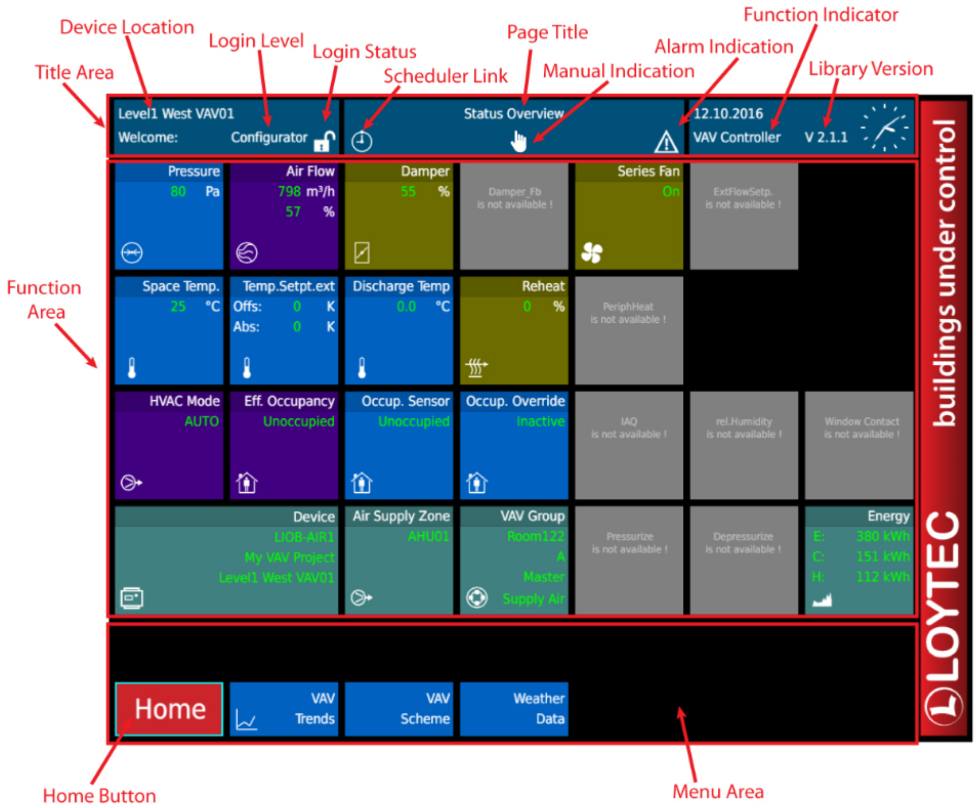


Figure 157: Status Overview of VAVstatus

The “Status Overview” page shows top level data and provides a basic information of operation to the user. The whole project is using a tile design where every tile displays information regarding a dedicated function. A click on a tile on the “Status Overview” page leads to other pages with more detailled information about the regarding function.

On the top area of every page there is a “Title Area” (head line) which displays common information:

<u>Device Location:</u> Displays the location of the device, see chapter 7.5.4.2.

<u>Login Level:</u> Displays the current Login Level that is released by a PIN code

During the runtime of an L-WEB project lots of pages are protected with a PIN code. Read only pages are not protected. If a protected page shall be opened the system asks for the PIN code on the Login tile as shown in Figure 158. This code has to be entered only one time and then all the pages with this PIN code level or lower level pages are accessable. The Login tile can also be accessed by clicking on the left Title Area tile, what is useful to logout. The actual PIN code level is shown on the top left title bar “Welcome:”. These are the 4 Levels of operation:

1. **Operator** (only show value pages) **no PIN** requested
2. **Calibrator** (do the calibration) **PIN: 7777**
3. **Configurator** (configure device exept the flow data) **PIN: 9999**
4. **FlowData** (as configurator and the flow data) **PIN: 1212**

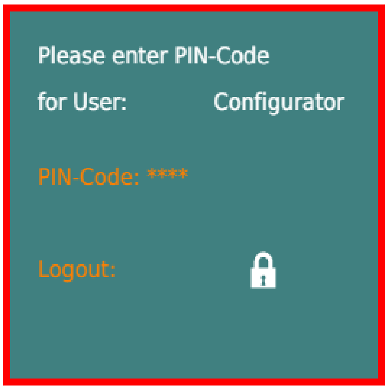


Figure 158: Login tile

The requested PIN code level to popen a protected page is shown in the Login tile, here: “Configurator”. A click on “PIN-Code: ****” opens the dialog to enter the PIN code.

When the correct PIN code was entered the Login tile disappears and the requested page is opened. If a wrong PIN code was enterd the Login tile also disappears but the requested page is not opened.

If the Login tile was opened accitentally, it can be closed clicking on the green background area. In this case the “Status Overview” page is shown.

If “Logout” or the lock symbol is clicked the current PIN code level is reduced to “Operator”, the Login tile is closed and the “Status Overview” page is shown.

If there is no user action detected longer than 1 hour the PIN code level is reduced to “Operator” automatically (auto logout).

<u>Login Status:</u> Displayes with an opened or closed lock symbol if a higher PIN code level than “Operator” is released actually.

<u>Page Title:</u> Displays the title of the current page for a better overview.

<u>Scheduler Link:</u> A click on this icon opens the “Occupancy Control Mode Schedule” page, see chapter 7.5.12.1. Please refer to the L-VIS User Manual [5] for more information about operating the scheduler visualization.

Manual Indication: This “Hand” icon is only shown if one or more functions are not in the “Auto” mode set by the visualization. A click on this icon opens the “Manual List” that is an usual alarm list regarding all functions that are not in “Auto” mode. Please refer to the L-VIS_User_Manual for more information about operating the alarm list visualization. For a better overviev the “Hand” icon is also shown on the relating top level tiles of the regarding functions on the “Status Overview” page. An example of a damper actuator that is set to manual is shown in Figure 159.

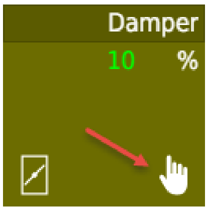


Figure 159: Manual indication

Alarm Indication: This indicates by switching to red if an alarm was triggered. A click on this icon opens the “Alarm List” that is an usual alarm list that shows the actual alarms. The alarms can be acknowledged in that list. Please refer to the L-VIS_User_Manual for more information about operating the alarm list visualization. For a better overviev the “Alarm” icon is also shown on the relating top level tiles of the regarding functions on the “Status Overview” page. An example of a flow alarm is shown in Figure 159.

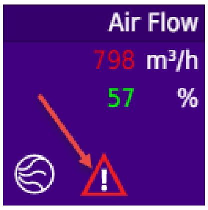


Figure 160: Alarm indication

Function Indicator: This indicates what function is visualized actually. This can be a VAV Controller, Multi Manager, Area1-5 Managers of a Multi Manager, Area Manager, Floor Manager or Building Manager. See chapter 7.7 for more details.

Library Version: This indicates the version of the VAV library the VAV system was built on. This can be useful for support purposes.

In the middle area of all pages there is the “Function Area” In this area the functional tiles are displayed that allow to watch, operate and parameterize the dedicated functions. On the “Status Overview” page there are the top level tiles that show the top level information of the dedicated functions. A click on the tiles of the “Status Overview” page leads to pages with detailed information and operation and parameterization functions.

On the bottom area of every page there is a navigation area with individual navigation tiles which open additional pages. The Home tile always opens the “Status Overview” page. Please ote that the Home tile is present on all pages but the other navigation tiles are individual on every page.

The tiles are displayed in different colors which shows if the function is a sensor (blue), a controller (purple), an actuator (ocher) or a device (green).

The values are displayed in different colors, too, which indicates if the value is only displayed (green) or can be changed by the user (orange). An example is shown for a modulating reheat actuator in Figure 161.

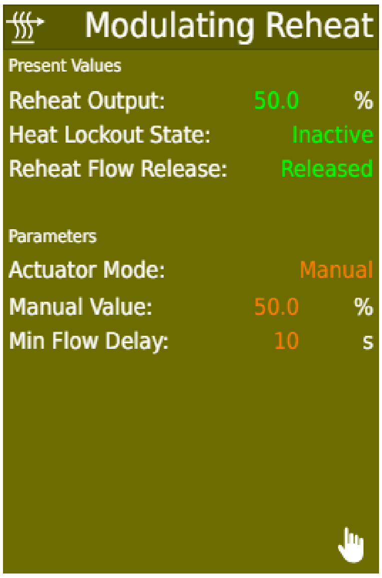


Figure 161: Different value colors

The green values can only be watched. The orange values can be changed. To change an orange value, it has to be clicked and depending of the type of value a regarding editor window opens. On binary values, the state is directly toggled on a click.

7.3.4 Visualization mobile Balancer Project

LIOB-AIR also supports a calibration of the VAV Box flow measurement. This is an easy way to determine the factor that defines the pickup probe.

Please note that if the proper factor Pitot Factor, or Velocity Coefficient K_{fpm}, or Flow Coefficient K_{cfm}, or K factor or ${}_{delta}P@V_{nom}$ is available and parameterized on the *Air Flow Data Configuration* page, the system is parameterized in the best way! <u>In this case, there is no need for a flow calibration!</u> However, if in retrofit projects there are existing VAV Boxes, but the factors that define the pickup probes are not available from the manufacturers, and then the calibration function is a good choice to determine these factors.

The calibration is supported by the *VAVstatus.lweb2* visualization project. However, if the balancer only shall have access to the calibration function and access to the other functions shall be denied to the balancer the *VAVmobileCalibration.lweb2* LWEB-802/803 visualization has to be used. This visualization is built to be used on mobile devices but it also can be operated on a PC. It is available on every LIOB-AIR device and operates the flow calibration for this dedicated device.

How to start the visualization from the WebUI of the LIOB-AIR controller is already described in chapter 7.2.12.1. However, it is also possible to put the URL of the visualization project to the *NFCString* data point of the L-STAT. If the mobile device supports NFC, it is possible to start the balancer visualization by receiving the URL via NFC.

The first step after starting the visualization is to enter the PIN code for “Calibrator”, see chapter 7.3.3. The calibration opens the main page as shown in Figure 162.

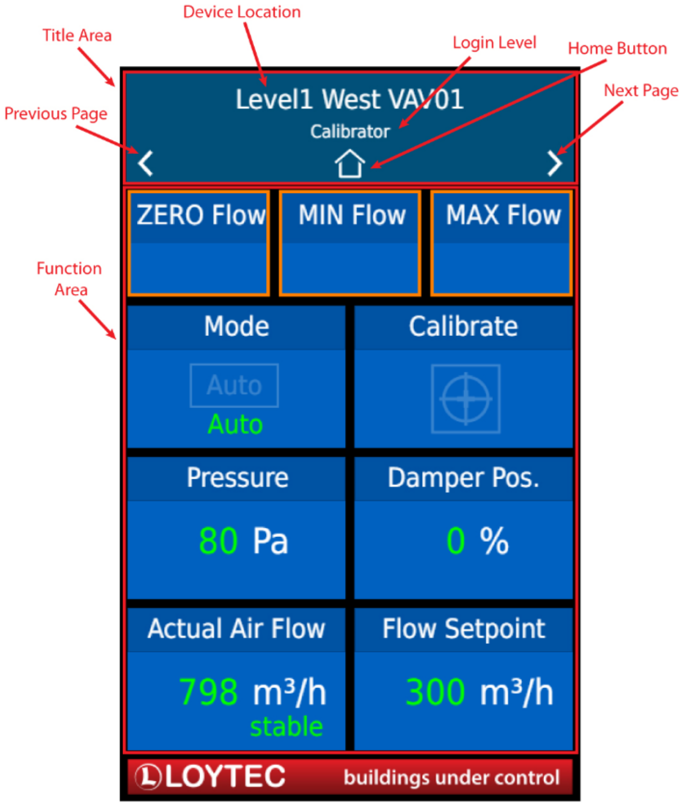


Figure 162: Main page of VAVmobileCalibration

The “Function Area” of the main page provides all the tiles that are needed for the calibation process. A click on a tile with an orange frame starts the calibration process.

On the top area of every page there is a “Title Area” (head line) which displays common information and allows the navigation to the previous page, next page or home to the main page.

Device Location: Displays the location of the device, see chapter 7.5.4.2.

Login Level: Displays the current Login Level that is released by a PIN code

The other pages that can be opened clicking on the navigation symbols are for further information and parameterization purposes and also the reset calibration page can be reached.

The complete process of the Air Flow Calibration and the usage of this visualization is described in chapter 7.5.5.5.

7.4 Standard VAV Application

LOYTEC provides a ready to use standard VAV application. This can be restored into the LIOB-AIR device using the WebUI. It runs directly on the device without being configured and deployed by the L-STUDIO-AIR engineering tool.

In the future, there will be multiple different standard VAV applications available.

It can be useful in very small systems with low functional requirements to realize a VAV control using the standard VAV application.

The standard VAV application is a standalone version which will not communicate to other VAV controllers or Managers using the internal serial communication system, see chapter 7.6. However, it can be integrated into the LWEB-900 building management system and also in BACnet or CEA 709 networks.

The application includes the most common functions of a VAV controller.

The I/O configuration can be configured using the LINX-Configurator software.

The standard VAV application does not perform the internal serial AHU communication to other VAV controllers and the Managers. However, all the data points of the AHU communication (Values to AHU / Values from AHU) are available and active in the VAV controller, see chapter 7.6.1. If some communication to an external AHU controller is needed, it has to be established by the system integrator using BACnet or OPC communication.

The internal serial weather data communication from the Manager is also not supported by the standard VAV application. However, all the data points to receive the weather data are available and active in the VAV controller, see chapter 7.6.3. If the communication of weather data from an external controller is needed it has to be established by the system integrator using BACnet or OPC communication.

The standard VAV application does not perform the internal serial VAV Group communication, see chapter 7.6.2. In case there are multiple VAV Boxes in a room that have to collaborate it is recommended to create a VAV solution using the L-STUDIO Air engineering tool.

Please contact support@loytec.com to request the Standard VAV application file.

7.4.1 Ready to use standard VAV application

The Standard VAV application supports the typical VAV Box type. The scheme is displayed in Figure 163.

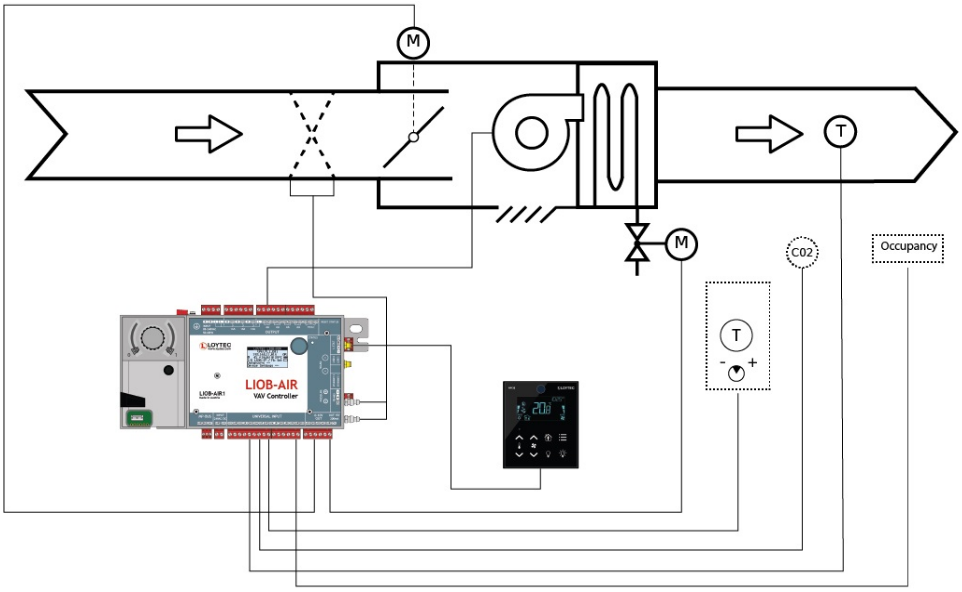


Figure 163: VAV Box scheme of standard application

The following sensor and actuator functions and control functions are executed in the Standard VAV application:

Space Temperature Control

Space Temperature Setpoint offset sensor

Occupancy Sensor

Bypass Button

Discharge Temperature Control

CO2 Control

Damper MP-bus

Reheat hot water modulating

Series Fan

Please refer to chapter 7.5.1 for more function details.

An L-STAT network thermostat is supported also. It has a standard configuration. Setpoint adjustment and occupancy override (bypass button) can be operated by the room occupant. In case of an L-STAT is connected to the LIOB-AIR the internal sensors of the L-STAT are used.

7.4.2 Hardware Installation and IP Address Setup

The LIOB-AIR controller is connected to the network using one of the Ethernet/IP ports or WLAN. The device must be powered with either 24 VAC/DC or 85-240 VAC (check the front label of the LIOB-AIR device). After the device has booted, the initial IP address must be configured on the LCD UI. This is done by selecting the IP address (“192.168.1.254”) in the LCD UI using the jog dial, see Figure 164. After that, select “Ethernet 1” and setup the IP address, mask, and gateway or, alternatively, enable DHCP. Finally, select “Save and reboot”. All other settings can further be performed with the WebUI of the LIOB-AIR controller.

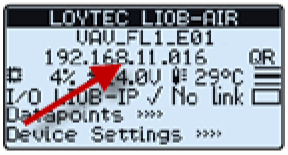


Figure 164: Select IP address in LIOB-AIR display

7.4.3 Restoring the standard VAV application

The LIOB-AIR device does not have an application if it comes out of the box. The standard VAV application is provided by LOYTEC as a backup file has to be restored to the device. This can be done using the WebUI (user interface) of the device.

7.4.3.1.1 Open the WebUI of the LIOB-AIR controller

The browser has to be started on the PC or mobile device. In the browser address line, the IP Address of the LIOB-AIR-Controller has to be entered.

The browser displays the WebUI (user interface) of the device which shows the device information and a navigation menu on the left page, see Figure 165.

In the left menu the „Config“ has to be selected. Then the Admin password has to be enterd.

There are two user accounts available:

Admin , default password: **loytec4u** (needed for restore)

Operator, default password: **operator** (this is ok to run LWEB visualization)

Next the “Port Configuration” opens and expands the Config menu on the left side. There the “Backup/Restore” has to be selected. With the “Choose File” button the backup file of the standard VAV application has to be selected. To start the restore process the “Restore” button has to be pressed, see Figure 166.

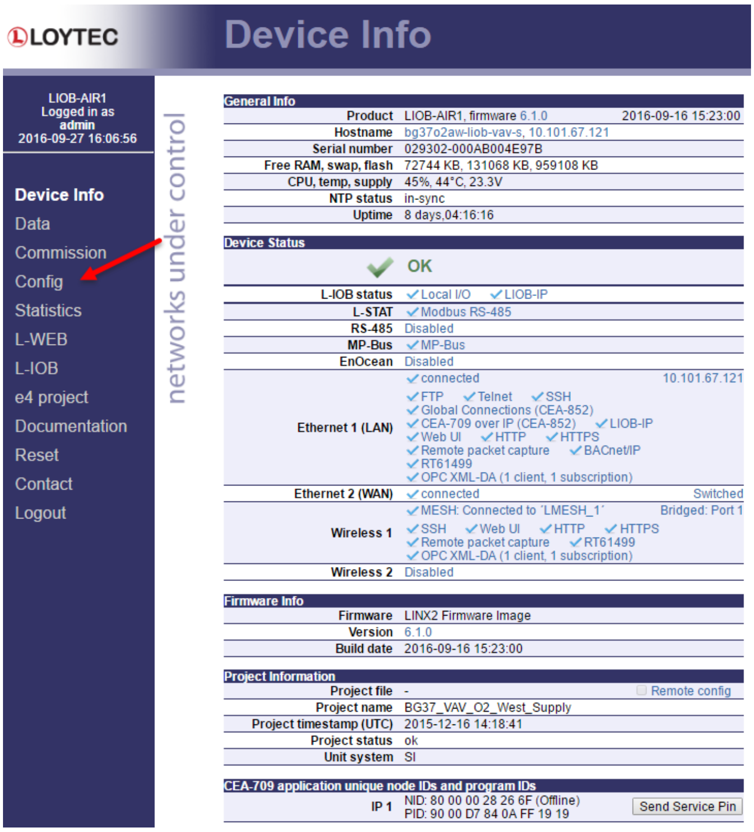


Figure 165: WebUI of the LIOB-AIR device

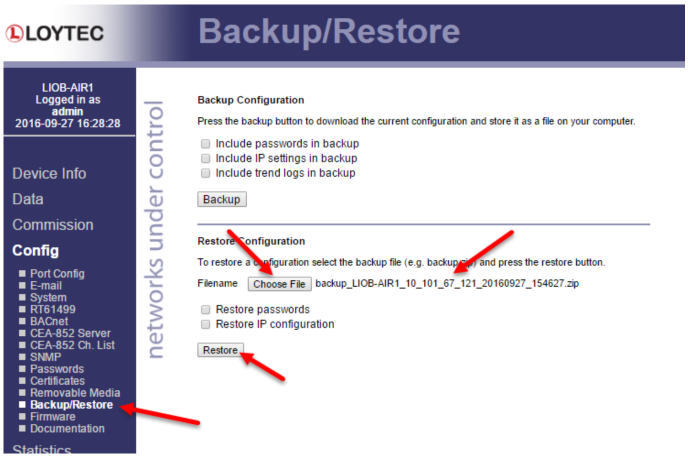


Figure 166: Start the restore process

After the restore process has finished, the LIOB-AIR device reboots automatically. Then the standard VAV application is running on the device.

7.4.4 I/O Configuration

The LIOB-AIR controller with the standard VAV application has a predefined input and output hardware configuration. This is shown in Table 7.

The user is able to do some modifications using the LOYTEC LINX-Configurator software.

UI = Universal Input analog or binary

AO = Analog Output

DO = Digital output, Relays 16A, Relays 6A, Triacs

O	Description	Type
UI1	Space Temperature	NTC10k
UI2	External Space Temperature Setpoint Offset	10k, -10°C…+10°K
UI3	Occupancy Sensor	binary
UI4	Occupancy Override (Bypass Button)	binary
UI5	Discharge Temperature	NTC10k
UI6	CO2 Concentration	0 – 10VDC, 0 – 2000ppm
AO1	Reheat modulating	0 – 10VDC, 0 – 100%
DO4	Series Fan	binary

Table 7: I/O Configuration of the standard VAV application

The user is able to do some modifications using the LOYTEC LINX-Configurator software. For the details using the LINX –Configurator, please refer to the LINX Configurator User Manual [2].

The LINX-Configurator has to be started Stand-Alone.

It has to be connected to the LIOB-AIR device Stand-Alone.

The configuration has to be uploaded from the device into the configurator.

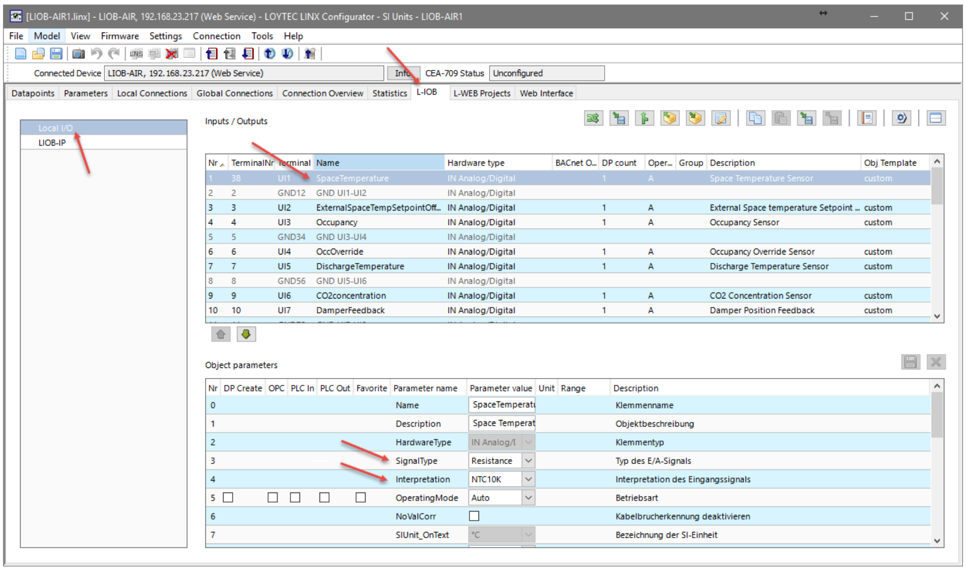


Figure 167: Modify the I/O configuration

The Local I/O can be modified to the project demands. For example, the Signal Type or the Interpretation of the Space Temperature input can be modified as shown in Figure 167.

After the configuration has been modified, it has to be downloaded from the configurator into the device.

Now the device is operating with the modified configuration.

If this modified configuration is needed in other devices also using the standard VAV application, a device backup of the modified device has to be created using the WebUI or the LINX configurator. This backup has to be restored in the other devices using the WebUI or the LINX configurator.

7.4.5 Parameter Settings in VAV-Box

The standard VAV application is running on the device. The next step is to enter all important parameters that are needed to provide a proper operation of the VAV. These are e.g. the air flow data. The parameters are entered at runtime of the system. That means that if some changes are needed later, it can also be applied during runtime.

7.4.5.1 Run the VAVstatus visualization Project

This is already described in chapter 7.2.12.1. This is the identical procedure using the standard VAV application.

7.4.5.2 Enter the Parameters

This is already described in chapter 7.2.12.2. This is the identical procedure using the standard VAV application.

The following parameters have to be set.

<u>Select the Engineering Unit System:</u> SI/US

<u>Enter Device Parameters:</u> VAV Box ID, Room ID, Language, Device Type, Project Name, Device Location

<u>Enter Air Flow Parameters:</u> Duct Area, Nominal Flow, Air Density, Pitot Factor, Min.Flow Cool, Max.Flow Cool, Min.Flow Heat, Max.Flow Heat, Min.Flow Unit Heat, Max.Flow Unit Heat

<u>Enter other Control Parameters:</u> e.g. Space Temperature control setpoints…..

Because the standard VAV application is operating standalone, it does not perform the internal serial communication. Therefore, the AHU communication and the VAV Group communication are not available. The regarding parameters do not need to be set.

Now the setup of the most important parameters of the VAV controller is finished. This has to be repeated in all other VAV controllers also.

The setup of parameters can also be done more efficiently using LWEB-900 parameter views. The LIOB-AIR devices have to be created manually in the LWEB-900 database because there is no L-STUDIO solution existing that could be imported. The procedure to create the parameter views is identical to chapter 7.2.14.2.

The commissioner and the balancer can start working now.

7.4.5.3 Backup Devices

It is recommended to create backups for all devices as described in chapter 7.2.15.

7.5 VAV Functions

The following chapters will explain the detailed functions of the VAV control application.

7.5.1 VAV-Box control general functions

In VAV systems, the building is supplied with conditioned air coming from a central air handling unit via a pressurized main air duct system. The room conditions are maintained by VAV-boxes, which vary the amount of the conditioned primary air supplied to the rooms.

In pressure independent systems, VAV-boxes always are operating a flow control unit to be able to deliver a defined air flow to the room despite of a varying supply duct static pressure.

The VAV Box functions will be explained using the following example setup. However, please note that multiple of variations of VAV Boxes are supported by the LIOB-AIR VAV controller.

After the short introduction of the example VAV Box instrumentation and the VAV Box control the detailed functions are explained in the following chapters.

7.5.1.1 VAV Box instrumentation

An example of a typical VAV Box control is shown in Figure 168

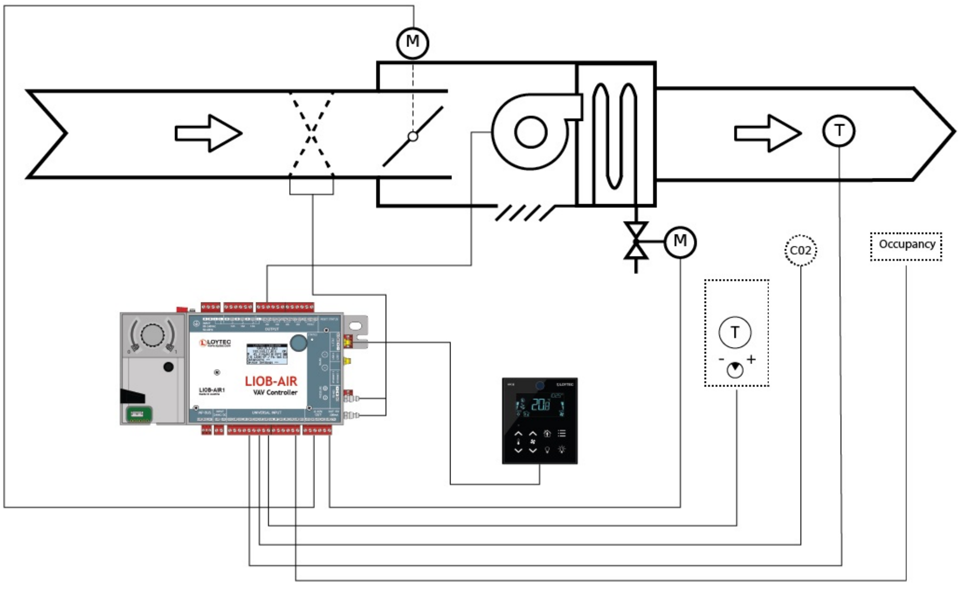


Figure 168: Example VAV-box control equipment

Basically, all VAV Boxes are equipped with a flow sensor and a damper with actuator to measure and control the air flow. Additionally, this example VAV-box also has a series fan and a hot water reheat coil. The series fan maintains constant discharge air volume to the room. It also sucks in return air from the plenum. Because the central air handling unit supplies cool air most of the time, the reheat is needed in cases of individual heating demand in the room. The reheat power can be controlled by a modulating valve actuator. The example VAV-box also is equipped with a discharge temperature sensor to allow a control the discharge air temperature.

To maintain the temperature conditions in the room there is a space temperature sensor needed in minimum. To increase the user comfort this sensor can have an additional setpoint adjustment.

Further, in the example system the room has an occupancy sensor to shift the space temperature setpoint depending on the occupancy state.

For an indoor air quality (IAQ) control, a CO_2 sensor also exists in the room.

These room sensors can be realized as dedicated sensors that are wired to the Universal Inputs of the LIOB-AIR device. However, all these sensors could be replaced by the LOYTEC L-STAT network thermostat directly connected to the L-STAT (Modbus) port of the LIOB-AIR device. The L-STAT is available with built in sensors for temperature, humidity, occupancy and CO_2. It also provides the setpoint adjustment and occupancy override using the touch buttons on the panel.

The damper and valve actuators as well as the fan are connected to the digital and analog outputs of the LIOB-Air device.

7.5.1.2 VAV Box control

The VAV control functions of the example are basically shown as a scheme in Figure 169.

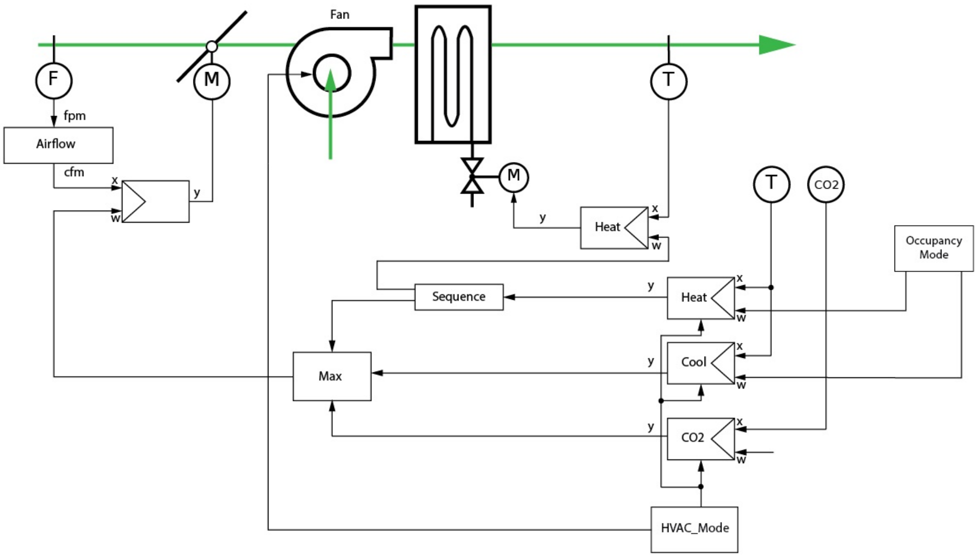


Figure 169: Example VAV-box control scheme

The VAV Box control maintains the room condition depending on the occupancy state of the room. In the example, the room has heating and cooling load and the CO_2 concentration is controlled also.

Depending on the HVAC mode of the central air handling unit (AHU), the primary supply air delivers cooling or heating energy to the VAV Box. The HVAC Mode, which is communicated from the central air handler AHU, enables or disables the cooling and heating and IAQ functions and releases the fan for operation. Therefore, the VAV Box functions are coordinated with the operation status of the air handler. The modes AUTO, HEAT, COOL, MRNG_WRMUP, NIGHT_PURGE, PRE_COOL, OFF are supported by the VAV controller.

The occupancy mode is shifted by a scheduler and an occupancy sensor. The effective occupancy mode selects the according space temperature setpoints for heating and cooling.

There are cooling and heating default setpoints defined for the occupancy states UNOCCUPIED, STANDBY and OCCUPIED as shown in Figure 170.

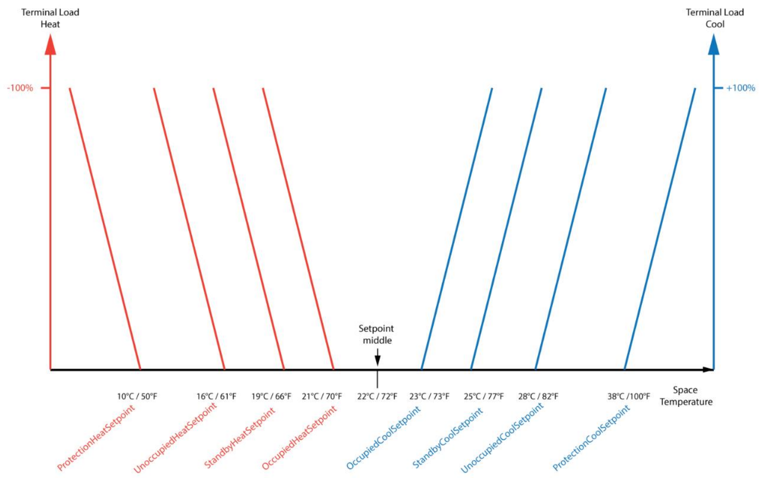


Figure 170: Space temperature setpoints, cooling and heating control outputs

The space temperature is controlled by dedicated cooling and heating controllers. They are maintaining the cooling and heating setpoints according to the effective occupancy mode. Depending on the actual space temperature, the cooling or heating controller is activated so there is only one of both controllers in use at the same time. Figure 170 shows the default setpoints and the control output with varying temperature (shown without the time-dependent integral component).

The cooling controller resets the air flow setpoint if cooling is needed. The heating controller however is using a heat sequence function to reset the air flow and to reset the setpoint of the discharge temperature.

Figure 171 shows the air flow setpoints that are calculated by the cooling and heating controllers and the discharge temperature setpoint calculated by the heating controller. Please note that the dead zone is realized by the different cooling and heating setpoints.

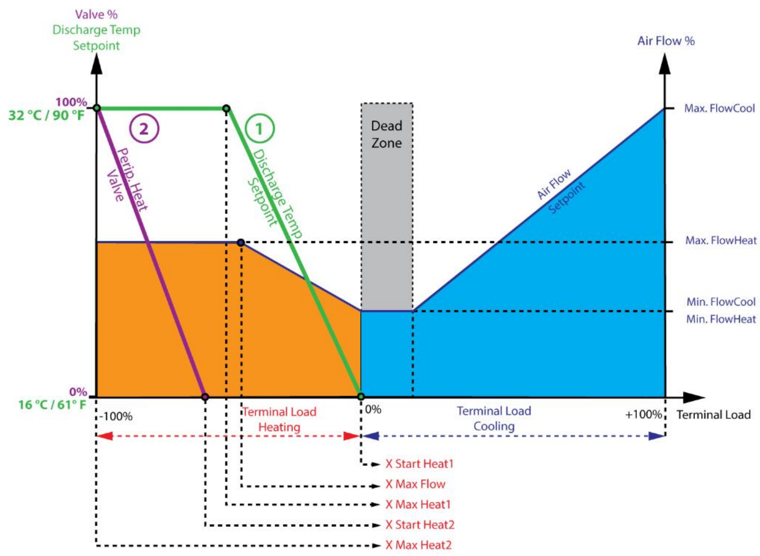


Figure 171: Sequence scheme of cooling and heating controller

The discharge temperature controller is maintaining the setpoint coming from the space temperature heating sequence and modulates the reheat valve.

The CO_2 concentration in the room is controlled by a CO_2 control function. The air flow setpoint is reset by the CO_2 controller if more primary air is needed to reduce the CO_2 concentration as shown in Figure 172.

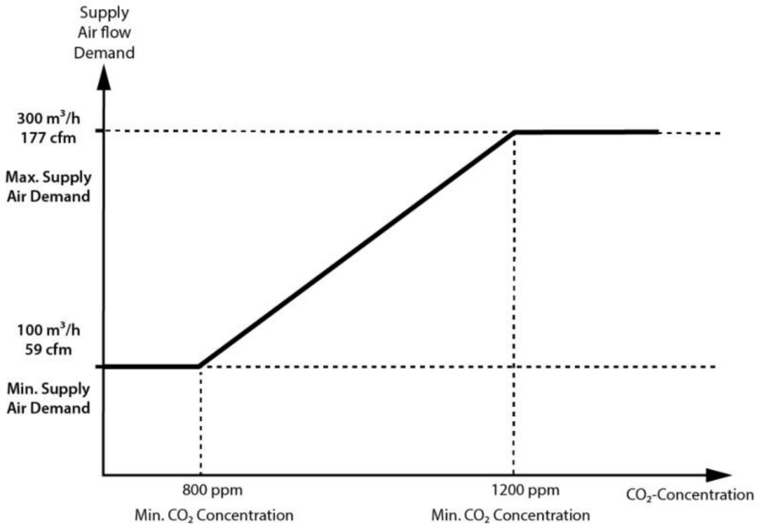


Figure 172: Air flow setpoint of the CO_2 controller

With a maximum selection function, the resulting air flow setpoint is calculated from the requests of the cooling heating and CO_2 controllers.

With the measured differential pressure, the air velocity is calculated and using the duct area the current air flow is resulting as the control value.

The air flow controller is maintaining the maximum setpoint from the cooling heating and CO_2 controllers and modulates the damper actuator.

7.5.2 AHU Communication Basic Information

VAV systems are always supplied by conditioned air by an air handling unit AHU. The AHU is providing supply air with a controlled fraction of fresh air and a controlled temperature.

The VAV controllers in the ductwork are controlling the space conditions to maintain the comfort of the room occupants.

To gain a proper and energy efficient operation of the AHU and the VAV controllers there is a communication needed between the VAV system and the AHU.

The VAV system has to aggregate and communicate information from all VAV controllers to the AHU regarding e.g. the request of AHU operation, the thermal requests and the air quality requests of all the rooms that are supplied. So the AHU control is able to operate the AHU according to the VAV requests in an energy efficient way.

The AHU control has to provide and communicate information to all VAV controllers regarding e.g. the current HVAC Mode (cooling, heating, off) or the outdoor air fraction (in some cases). So all VAV controllers perform their control functions regarding to the current AHU information.

This communication in the VAV system for AHU purposes is defined as the AHU Communication.

The LIOB-AIR system includes a powerful internal serial AHU Communication system that is to set up easily. Everything can be done using the LIOB-AIR devices only. There are no additional devices and no additional engineering needed to establish the AHU Communication.

The principle of the AHU communication is shown in Figure 173

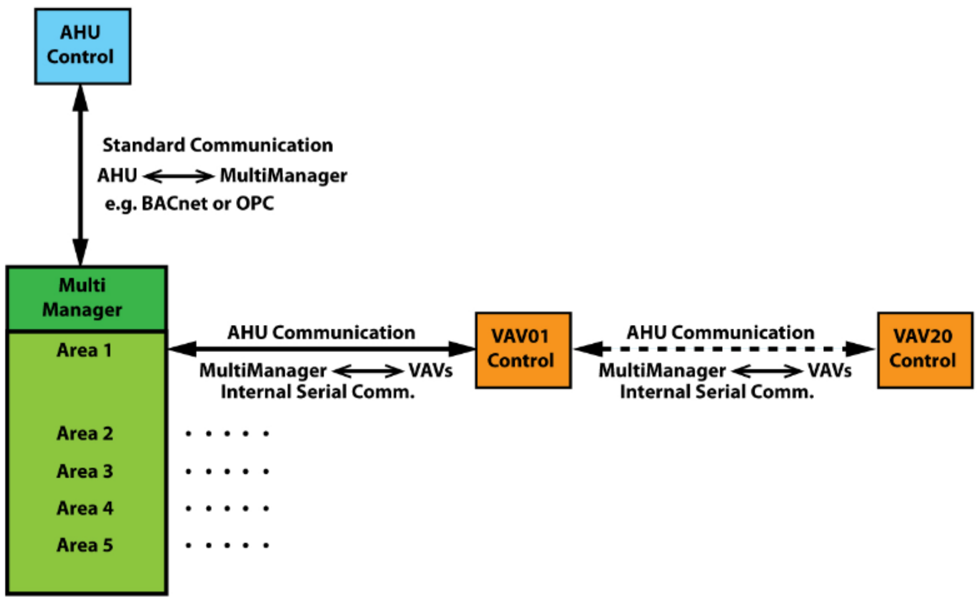


Figure 173: Principle of the AHU Communication

The central interface of the AHU Communication is the Multi Manager (in Adhoc Design). It is the interface between the VAV system and the AHU control.

The Multi Manager is a function that can be instantiated additionally to one of the VAV controllers of the VAV system, see chapter 7.2. Therefore, there is no extra device needed for the Multi Manager. For a VAV system with one dedicated AHU there must be only one LIOB-AIR device including the Multi Manager.

The AHU control is communicating bidirectional with the Multi Manager function using BACnet or OPC standard communication protocols. This communication between the AHU control and the LIOB-AIR hosting the Multi Manager has to be established by the system integrator.

The Multi Manager internally includes 5 Areas (Area Managers) that are aggregated and communicated internally by the Multi Manager. To each Area of the Multi Manager up to 20 VAV controllers can be connected see chapter 7.2. Therefore, a Multi Manager supports the AHU communication to up to 100 VAV controllers.

The Multi Manager is communicating bidirectional to the VAV controllers using the internal serial communication of the LIOB AIR system. Therefore, the VAV controllers have to be connected to the 5 Areas of the Multi Manager in a serial way using the L-STUDIO AIR engineering system. Then the devices are basically able to communicate to each other in a serial way. There is no additional engineering needed to set up the internal serial communication

An example of multiple VAV controllers connected to an Area of a Multi Manager is shown in Figure 174.

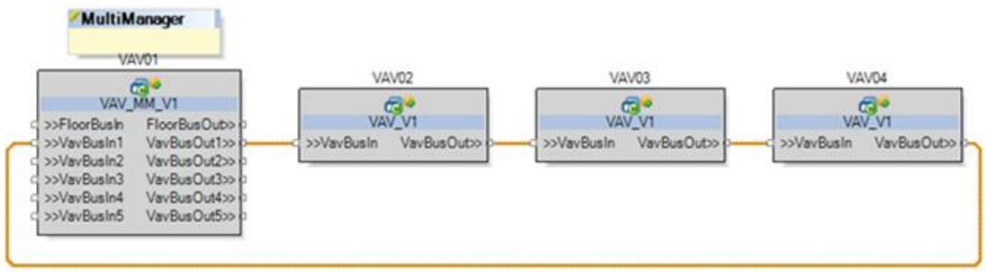


Figure 174: Example of Multi Manager in L-STUDIO AIR

The AHU Communication is established automatically if the Multi Manager and the VAV controllers have the same *AirSupplyZoneID* (e.g. AHU01). This is a parameter value that can be set using the *VAVstatus* visualization project in the VAV controllers and the *VAVmultiManagerStatus* visualization project in the Multi Manager additionally.

The AHU communication between the Multi Manager and the VAV controllers is monitored by watchdogs and Alarms are triggered if some communication failures occur.

The Multi Manager also supports the commissioning and duct balancing work with additional Balance Flow Commands that can operate all the connected VAV controllers to common air flow setpoints.

Please refer to chapters 7.6.1 and 7.7 for more details about AHU Communication.

The connection of the VAV controllers in L-STUDIO AIR and the serial communication is also required for the VAV Groups communication.

7.5.3 VAV Groups Basic Information

Bigger rooms are often equipped with multiple VAV-Boxes. To gain a proper function of the space temperature control, the IAQ control and the air flow control all VAV controllers in the room have to collaborate. This collaboration of multiple VAV controllers is established automatically in the LIOB-AIR application if a “VAV Group” is configured.

This chapter will give a short overview as basic information to understand the “VAV Groups” functions that are mentioned in the following multiple VAV functions chapters. The details of the “VAV Groups” will be described in chapter 7.6.2.

It is required that the VAV controllers are connected in L-STUDIO AIR to be able to use the internal serial communication as described in chapter 7.5.2. Groups can only be configured with VAV controllers that are connected to the same Area.

A “VAV Group” can be configured very easily during the runtime of the VAV controllers. There are only a few parameters to be set in the *VAVstatus* visualization project. These are the *Room ID* (e.g. Room111), the *Device Mode* (Master or Slave) and the *Air Function* (Supply or Exhaust).

A “VAV Group” is built automatically, if multiple VAV controllers have the same *Room ID* (e.g.: Room111). This is the name of the “VAV Group” and the communication is established automatically using this identical name in the multiple devices.

A “VAV Group” can have 2 or more members. One VAV controller has to be set as “Master” and all the other devices have to be set as “Slaves”. This setting has to be done on the *Device Mode* parameter. Multiple “Masters” are <u>not</u> allowed in a “VAV Group”.

Basically, the “Master” is executing the space temperature control, humidity control and the IAQ control. The “Slaves” receive the control outputs from the “Master” and execute the local heat sequences and local controls as air flow control, discharge air control, reheat control, fan control.

Which functions are operated in a “Master” or a “Slave” is displayed in Table 8 and Figure 175. The main control functions are operated in the “Master” and the control outputs are communicated to the “Slaves” automatically. The Slaves are operating the sequences and the control of their local sensors and actuators based on the leading signals of the “Master”.

	Master	**Slave**
HVAC Mode Control	Yes	No
Eff. Occupancy Control	Yes	No
Space Temperature Setpoints	Yes	No
Space Temperature Control	Yes	No
Discharge Temp. Control	Yes	Yes
Air Flow Cool Sequence	Yes	Yes
Air Flow Heat Sequence	Yes	Yes
Reheat / Periph. Sequence	Yes	Yes

	Master	Slave
Fan Heat Sequence	Yes	Yes
IAQ Control	Yes	No
Humidity Control	Yes	No
Flow Control	Yes	Yes
Damper Actuator Control	Yes	Yes
Fan Actuator Control	Yes	Yes
Reheat Actuator Control	Yes	Yes

Table 8: Functions in Master and Slave

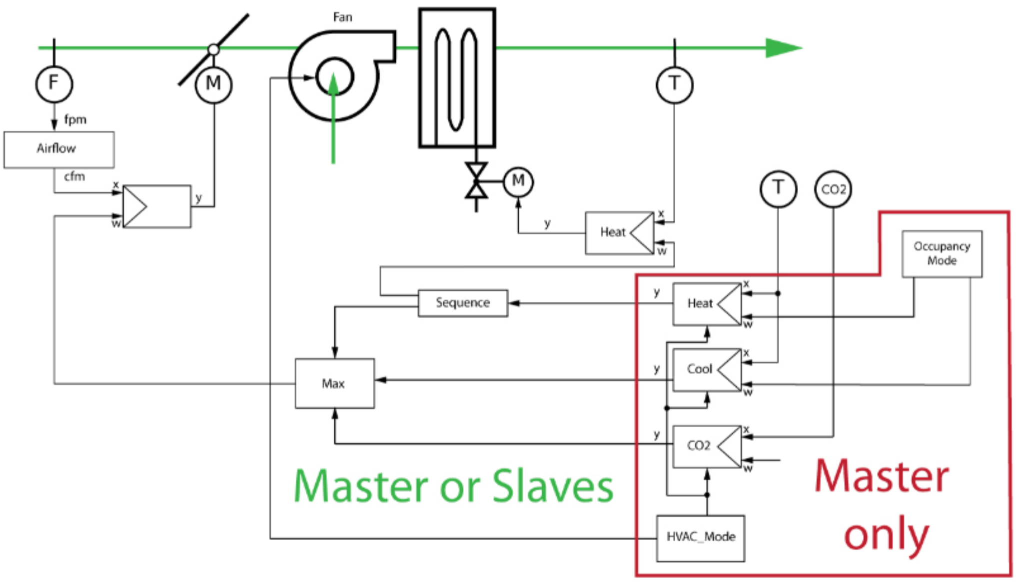


Figure 175: Functions in Master and Slave

Mainly VAV-Boxes are applied in the supply air of a room, but sometimes there are additional VAV-Boxes existing in the exhaust air. It has to be set up on the *Air Function* parameter if a VAV-Box is operating as "Supply Air" or "Exhaust Air". In the supply air, the VAV controllers have their full functionality. In the Exhaust air, they are only performing the flow control with the damper control. The air flow setpoint is calculated and transmitted from the "Master" automatically. Exhaust VAV-Boxes should always operate as a "Slave".

A room with multiple VAV-Boxes and multiple network thermostats is displayed in Figure 176.

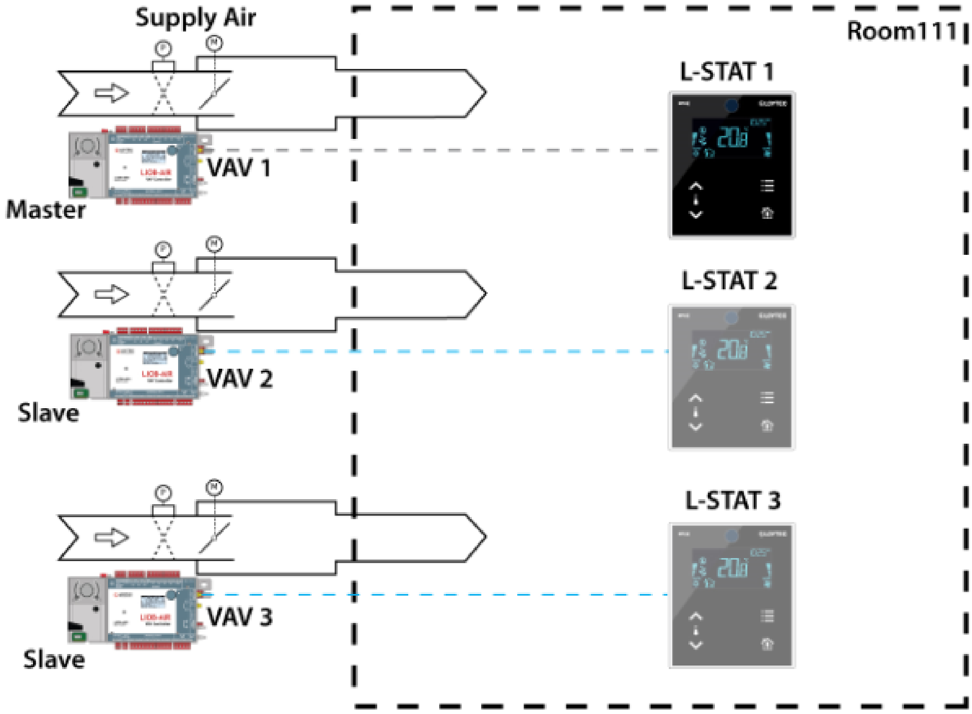


Figure 176: VAV Group with multiple VAV-Boxes

This is a typical setup of multiple VAV-Boxes in a room. The VAV controllers all have the same *RoomID* “Room111”. In VAV1, the *Device Mode* is “Master” and in VAV2 and 3 the *Device Mode* is “Slave”. In all VAV controllers, the *Air Function* is set to “Supply Air”.

Usually a network thermostat L-STAT is connected to the L-STAT Modbus “Master” device and is providing the sensor values and the button information to this VAV controller. The display functions of the L-STAT are also driven by the connected VAV controller. It is also possible to connect L-STATs to the other VAV controllers even if no L-STAT is connected to the “Master”. All the sensor values and button actions of the multiple L-STATs are aggregated and communicated to the “Master” automatically. All the L-STATs in the group will display the same values automatically.

If there are hardwired sensors connected to any VAV controller local I/O in the group, these values are also aggregated and communicated to the “Master” automatically even if no sensor is connected to the “Master”. Please note that either a network thermostat or hardwired sensors should be connected to a dedicated VAV controller to gain a proper function of the automatic aggregation and communication.

It is also possible to use third party network thermostats in a VAV Group. However, these will not provide the complete button and display functionality as L-STATs. The sensor values have to be connected to the regarding Favorites. These values will have the same functionality as hardwired sensors to the local I/O.

A room with multiple VAV-Boxes with supply and exhaust air function is displayed in Figure 177.

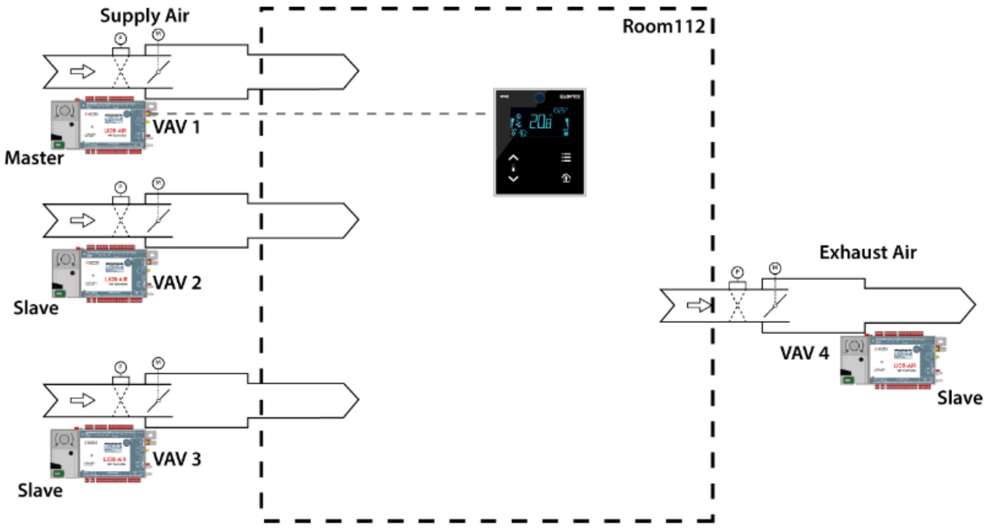


Figure 177: VAV Group with multiple VAV-Boxes

This is a typical setup of multiple VAV-Boxes with supply and exhaust air function in a room. There can be multiple exhaust boxes also. The VAV controllers all have the same *RoomID* “Room112”. In VAV1 the *Device Mode* is “Master” and in VAV2, 3 and 4 the *Device Mode* is “Slave”. In VAV1, 2 and 3 the *Air Function* is set to “Supply Air” and in VAV4 to “Exhaust Air”.

The functions of multiple L-STATs or multiple sensors or third party network thermostats are the same as described before.

In case of one or more exhaust boxes in the room, the “Master” device will take care about the air balance of the entire room. The “Master” will summarize the current air flow of all supply boxes and sends this value as the current air flow setpoint to the exhaust “Slave”. It can be adjusted in the “Master” on the *Exhaust Flow Rate* parameter as a percentage value if the exhaust air flow setpoint will be calculated equal or lower or greater than the summary of the current supply air flow. This allows operating the room with a controlled neutral pressure or overpressure or under pressure.

To ensure a minimum air flow through the ductwork if the AHU is requested by an occupancy override in a room during unoccupied times, the AHU can trigger an *Occupancy Override from AHU* to all VAV Boxes. It can be parameterized in the “Master” if the VAV Group will follow this override request or not.

Please refer to chapter 7.6.2 for more details about “VAV Groups”.

7.5.4 Device Settings

According to chapter *7.3.1Application Structure* the device data is a core function. It is always part of the application and it cannot be deleted. The flow control consists of the parts general settings, segment data, device data, system information, WebUI.

In the device, data function common information regarding the control device can be displayed and set. This helps for a better operation, overview and documentation.

The common device data is shown on the *Status Overview* page of the *VAVstatus* visualization project as shown in Figure 178. Here the *Device Type*, *Project Name* and *Device Type* are displayed. A click on this tile leads to more information pages.

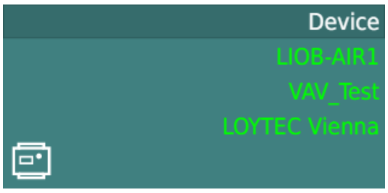


Figure 178: Device tile in Status Overview

7.5.4.1 General Settings and Segment Data

<u>General Settings:</u>

The general settings are the most important settings that have to be defined as the first step of parameterizing a LIOB-AIR device.

The LIOB-AIR supports SI and US engineering units and actually English and German languages. **The change of the engineering units causes a reboot of the device and sets all parameters back to the default values!** For that reason, the engineering units must be set first, before setting other parameters. It is possible to change the language during the runtime.

The general settings configuration can be done on the *VAV Box General Settings* page of the *VAVstatus* visualization project as shown in Figure 179.

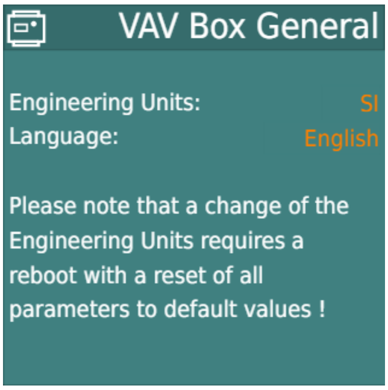


Figure 179: VAV Box General tile, normal view

If the Engineering Units are selected for change, the tile view show a hint that a reboot is needed and that all parameter values are reset to the default values. The reboot must be confirmed, as displayed in Figure 180.

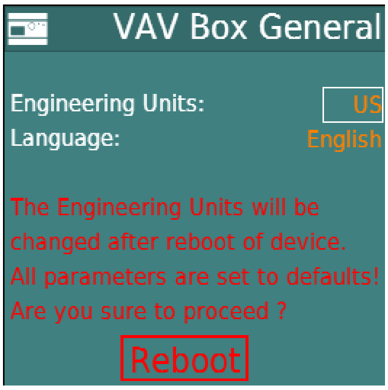


Figure 180: VAV Box General tile, reboot request

After the “Reboot“ button has been pressed, and the LIOB-AIR reboots, changes the unit system and sets all parameter values to useful default values according to the unit system. After about 90 seconds the system is ready for operation again.

Table 9 shows the VAV Box General Data parameters.

Path: User Registers.VAVcontrol.Core.General

Name on tile	Data point name	Default	Description
Engineering Units	EngineeringUnitsSet EngineeringUnitsFb	SI	Definition of the Engineering Unit system
Language	Language	English	Definition of the language of the visualization

Table 9: VAV Box General parameters

Engineering Units:

This defines if the LIOB-AIR device and the VAV application are operating in SI or US engineering units. **A change requires a reboot and resets all parameters to the default values!**

Language:

This defines in which language (English or German) the visualization is operating. It can be changed during the runtime.

Segment Data:

The LIOB-AIR controllers are using an internal serial communication system. These are the same communication mechanisms that are operating in the LOYTEC L-ROC room control system. In this philosophy, a VAV controller supports a segment. (An L-ROC controller supports up to 16 segments). The VAV controllers perform the AHU communication and Weather Data with the managers. The VAV Group communication is performed as well. To establish the serial communication between multiple VAV controllers the VAV Box Segment Data has to be set as a basic requirement.

Also in standalone controllers, the Segment Data has to be set for a proper function of the VAV controller.

The basic communication configuration can be done on the *VAV Box General Settings* page of the *VAVstatus* visualization project as shown in Figure 181.

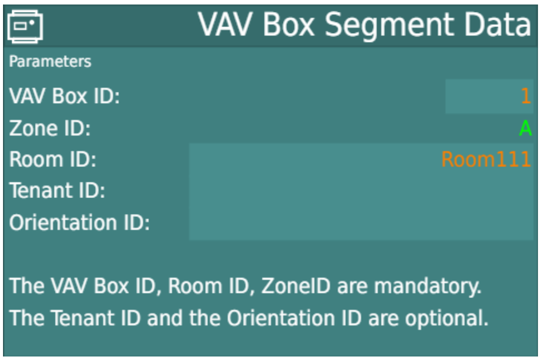


Figure 181: VAV Box segment data

Table 10 shows the VAV Box Segment Data parameters.

Path: User Registers.VAVcontrol.Core.SegmentCoupler.HmiLWeb

Name on tile	Data point name	Default	Description
VAV Box ID	idSeg idSegFb	--	Definition of the Segment ID Important: must have a valid number!
Zone ID	VAVgroupZoneId	A	Definition of the Zone ID Must be the same in a VAV Group
Room ID	idRoom idRoomFb	--	Definition of the Room ID. Controllers with the same Room ID build a VAV Group
Tenant ID	idTenant idTenantFb	--	Definition of the Tenant ID. for documentation purposes
Orientation ID	idOrientation idOrientationFb	--	Definition of the Orientation ID. for documentation purposes

Table 10: VAV Box segment data parameters

VAV Box ID:

This is the segment ID of the room in the serial communication system. It has to be set mandatory. In LIOB-AIR systems, every VAV controller supports one segment. This parameter is the most important one to be set to enable the serial communication system to work! This parameter value is set to “1” as default. It can be set to any number but it must not be empty. The user can enter a unique number to every dedicated device for a good order and overview. However, it will also work for VAV only systems if every VAV controller gets the same segment ID e.g. “1”.

Zone ID:

This ID divides the room into multiple zones. It has to be set mandatory. This parameter exists because of compatibility reasons to the L-ROC system. In VAV systems, multiple zones in a room are not supported, because it is only useful to have one space temperature controller and one IAQ controller in a room. So the default value of the *Zone ID* is “A” and it should not be changed to gain a proper communication function, e.g. to the L-STAT. The *Zone ID* cannot be modified on the VAV Box segment data tile. It can only be modified using the WebUI of the LIOB-AIR controller in rare exception cases. To establish the communication to the L-STAT the Zone ID must match the hcZoneId of the L-STAT, see chapter 7.8.3.4.

Room ID:

This defines the name of the room. It has to be set mandatory. This parameter needs to be entered if multiple VAV controllers have to collaborate in a VAV Group. The group communication is established automatically between all VAV controllers that have the same *Room ID*. However, even if no VAV Group communication may be needed in a project the *Room ID* should be set anyway. This prevents unnecessary communication between the VAV controllers and it provides a better overview to the user.

Tenant ID:

This defines the name of the tenant. This parameter can be set optionally. It does not have any function actually in the LIOB-AIR system and it is meant for documentation and overview purposes.

Orientation ID:

This defines the cardinal direction of the room the VAV controller is operating. This parameter can be set optionally. It does not have any function actually in the LIOB-AIR system and it is meant for documentation and overview purposes.

7.5.4.2 Device Data

To gain a better overview to the user some device data can be set on the *VAV Box Device Data* page of the *VAVstatus* visualization project as shown in Figure 182.

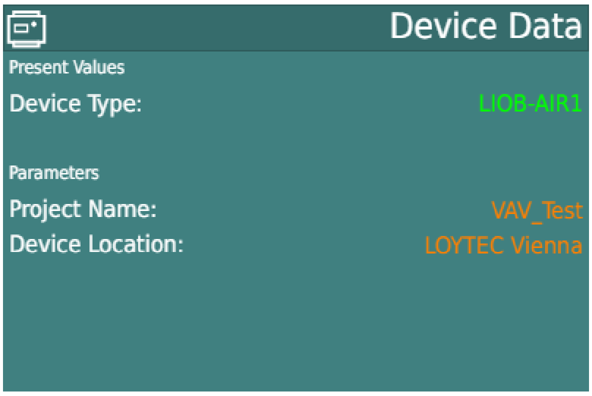


Figure 182: VAV Box device data

This device data does not have any functional effects in the VAV controller. It is only meant for documentation and overview purposes.

Table 11shows the VAV-Box VAV Box Device Data present values.

Path: User Registers.VAVcontrol.Core.Navigation.Label

Name on tile	**Data point name**	**Description**
Device Type	DeviceType	Information of the type of LIOB-AIR

Table 11: System Information present values

Device Type:

The type of LIOB-AIR device is provided here for user information. It is also shown on the Device tile on the *Status Overview* page of the *VAVstatus* visualization project.

Table 12 shows the VAV Box Device Data parameters.

Path: User Registers.VAVcontrol.Core.Navigation.Label

Name on tile	**Data point name**	**Default**	**Description**
Project Name	ProjectName	--	Definition of the project name
Device Location	DeviceLocation	Location?	Definition of the device location

Table 12: VAV Box device data parameters

Device Type:

The type of LIOB-AIR device can be entered here to provide this information to the user. This does not have any functional effect in the VAV controller. It is also shown on the Device tile on the *Status Overview* page of the *VAVstatus* visualization project.

Project Name:

The name of the project can be entered here to provide this information to the user. This does not have any functional effect in the VAV controller. It is also shown on the Device tile on the *Status Overview* page of the *VAVstatu*s visualization project. Please note: If the *Project Name* is empty, the name of the L-STUDIO solution is entered here automatically.

Device Location:

The location of the VAV controller can be entered here to provide this information to the user. This does not have any functional effect in the VAV controller. It is also shown on the Device tile on the *Status Overview* page of the *VAVstatu*s visualization project. It is also shown on the left tile of the headline on every page of the *VAVstatu*s visualization project as shown in Figure 183.

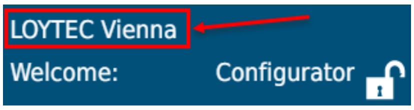


Figure 183: Device Location in left headline

7.5.4.3 System Information

The most important system data is shown on the *VAV Box System Information* page of the *VAVstatus* visualization project as shown in Figure 184. This can be used for commissioning and maintenance purposes. Please note that this information is also available on the regarding system data points available on the WebUI.

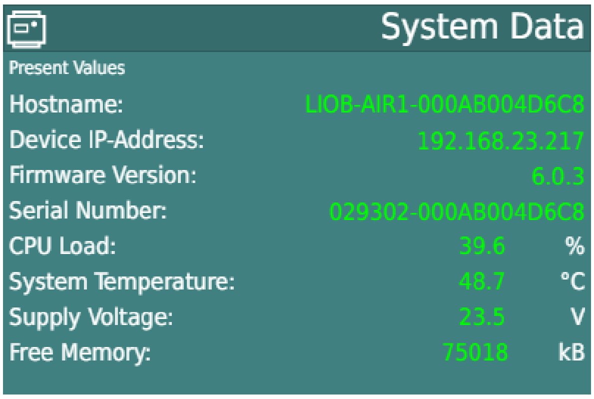


Figure 184: VAV Box system information

Table 13 shows the VAV-Box system information present values.

Path: User Registers.VAVcontrol.Core.Navigation.Label

Name on tile	**Data point name**	**Description**
Hostname	Hostname	Host name of the device
Device IP-Address	DeviceIPaddress	IP address of the device
Firmware Version	FirmwareVersion	Firmware version of the device
Serial Number	SerialNumber	Serial number of the device
CPU Load	CPUload	Current CPU load of the device
System Temperature	SystemTemp	Current system temperature of the device
Supply Voltage	SupplyVoltage	Current supply voltage of the device
Free Memory	FreeMemory	Current free memory space of the device

Table 13: System Information present values

Hostname:

This displays the host name of the device in the IP network.

Device IP-Address:

This displays the IP address of the device in the IP network.

Firmware Version:

This displays the version of the primary firmware image of the device.

Serial Number:

This displays the serial number of the device.

CPU Load:

This displays the current CPU load of the device.

System Temperature:

This displays the current system temperature of the device.

Supply Voltage:

This displays the current supply voltage of the device.

Free Memory:

This displays the current free memory space of the device.

7.5.4.4 WebUI Settings

Even if the Web User Interface (WebUI) is available directly in a browser, it is also available inside of the *VAVstatus* visualization project on the *Web User Interface* page of as shown in Figure 185.

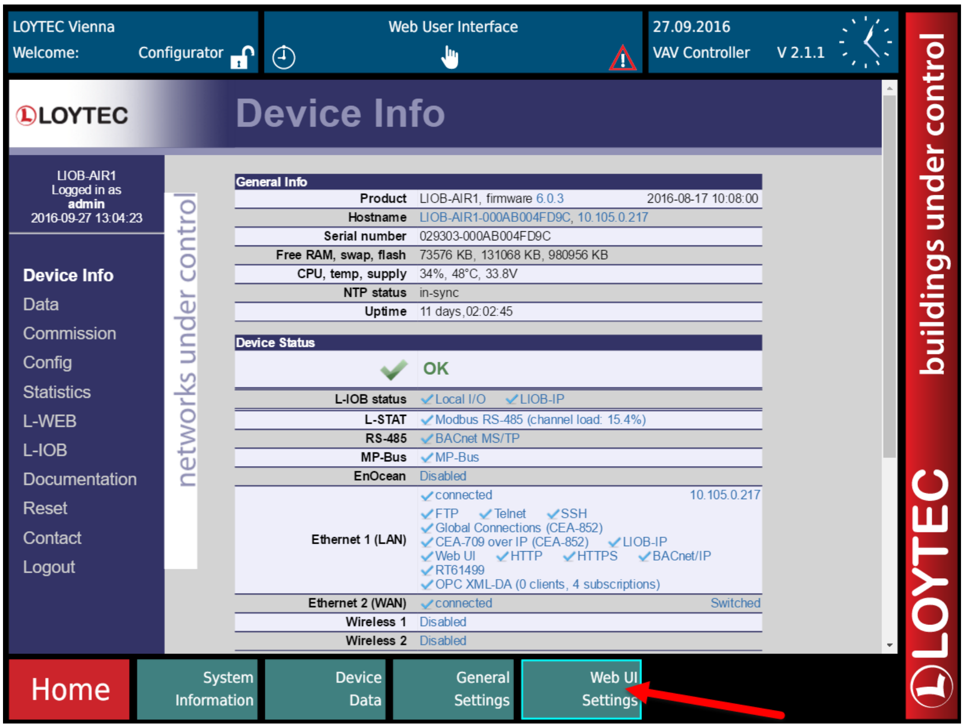


Figure 185: Web User Interface

This is meant for commissioning and maintenance purposes. Please note that the operation and the settings in the WebUI should only be done by LOYTEC trained people!

For more information using the WebUI, please refer to the LOYTEC Device User Manual [1].

7.5.5 Air Flow Control

According to chapter *7.3.1Application Structure* the flow control is a core function. It is always part of the application and it cannot be deleted. The flow control consists of the parts pressure measurement, air flow configuration, air flow controller, and air flow alarm and air flow calibration.

7.5.5.1 Pressure Measurement

General Function:

VAV-Boxes have a pickup probe to measure the difference between the total pressure and the static pressure. The differential pressure measurement is needed mandatory to calculate the current air velocity and the air flow in the VAV-Box.

The pressure display is shown on the *Status Overview* page of the *VAVstatus* visualization project as shown in Figure 186. Here the *Pressure damped* is displayed.

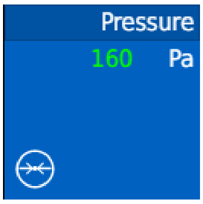


Figure 186: Pressure tile in Status Overview

Inputs:

The LIOB-AIR device has a built in differential pressure sensor that is available as *PRESSURE* in the Local I/O configuration (Terminal: *PRESS*). This is also part of the I/O Standard configuration described in chapter *7.3.2 Device Configuration*.

Favorites:

The Favorite of pressure measurement is shown in Table 14.

Path: Favorites.VAVcontrol.Core

Favorite name	**Description**
inPressure	Present value of pressure

Table 14: Pressure Favorites

inPressure:

The pressure measurement function has this one Favorite. To this Favorite the Local I/O *PRESSURE* is connected.

Detailed Function:

The quality of pressure measurement is defined by the placement of the pickup in the duct. If the pickup is located near a bend or some transition turbulences could result that lead to instable readings. For that reason, the pressure measurement has a PT1 damping function. However, please note that this damping function will not be able to compensate a bad pickup placement.

The pressure damping can be configured on the *Pressure Configuration* page of the *VAVstatus* visualization project as shown in Figure 187.

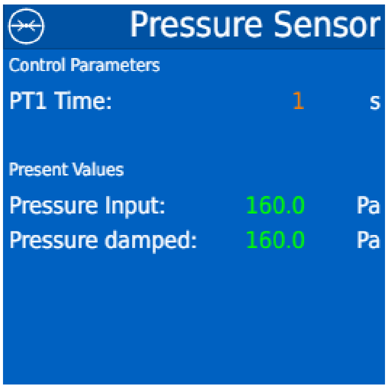


Figure 187: Pressure sensor tile

Table 15 shows the Pressure parameters.

Path: User Registers.VAVcontrol.Core

Name on tile	Data point name	Default	Description
PT1 Time	TimeConstantPressure	1 s	Time constant PT1 for damping the pressure value

Table 15: Pressure parameters

PT1 Time:

Time constant of the pressure damping. Higher time values lead to a stronger damping.

Table 16 shows the Pressure present values.

Path: User Registers.VAVcontrol.Core

Name on tile	Data point name	Description
Pressure Input	Pressure	Pressure not damped
Pressure damped	Pressure(damped)	Pressure damped

Table 16: Pressure present values

Pressure Input:

The present value of the differential pressure is shown as it comes from the Favorite not damped.

Pressure damped:

The present value of the damped pressure is shown and this is used for the further flow calculation.

Pressure Sensor Failure:

If the pressure sensor fails and transmits a very low value, the flow calculation would result in a very low air flow and the flow control would open the damper totally. To prevent this case, the pressure sensor failure function is implemented. If will detect this case and drive the damper to a predefined adjustable position.

If the pressure is lower than 1Pa (adjustable: *PressSensorFailLimit*) and the current flow *Control Output* is greater than 90% (adjustable: *PressSensorFailDamperLimit*) and the *HVAC Mode in VAV* is not "OFF" then the *Sensor Status* is set to "Failure" after 60 sec (adjustable: *PressSensorFailDelay*) have expired. The pressure sensor failure alarm is triggered.

If the pressure becomes greater than 1Pa or the flow *Control Output* is lower than 90% or the *HVAC Mode in VAV* becomes "OFF" then the *Sensor Status* is set to "Normal" after 60 sec have expired. The pressure sensor failure alarm is reset.

Please note that the pressure sensor failure alarm is triggered by this function and only this is described in this chapter. In the device, this alarm is operated as a "generic" alarm that is reported to BACnet alarm server in parallel. The complete alarming with alarm servers, alarm lists, alarm status, acknowledgement, alarm notification and further things are standard LOYTEC data point functions of the LIOB-AIR operating system.

The "Failure" is indicated on the *Status Overview* page of the *VAVstatus* visualization project as shown in Figure 188.

Figure 188: Pressure tile with Sensor Failure in Status Overview

In case of a Sensor Failure is detected, the damper actuator function is set on a failure position. There are two dedicated damper failure positions depending on if the space temperature control is heating or cooling.

The pressure damping can be watched and configured on the *Pressure Configuration* page of the *VAVstatus* visualization project as shown in Figure 191.

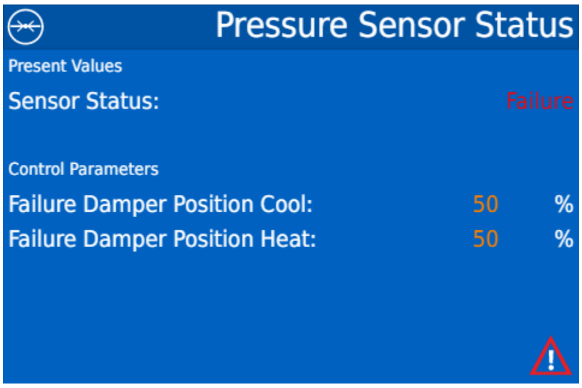


Figure 189: Pressure Sensor Status tile in Status Overview

Table 17 shows the Pressure Failure parameters.

Path: User Registers.VAVcontrol.Core

Name on tile	Data point name	Default	Description
Failure Damper Position Cool	PressSensFailDamperPosCool	50%	Failure damper position for cooling
Failure Damper Position Heat	PressSensFailDamperPosHeat	50%	Failure damper position for heating

Table 17: Pressure Failure parameters

Failure Damper Position Cool:

In case of a pressure sensor failure and the space temperature cooling controller is active; the damper actuator function is set to this position.

Failure Damper Position Heat:

In case of a pressure sensor failure and the space temperature heating controller is active, the damper actuator function is set to this position.

Table 18 shows the Pressure Failure present values.

Path: User Registers.VAVcontrol.Core

Name on tile	Data point name	Description
Sensor Status	PressureSensorFailure	Current Pressure sensor status

Table 18: Pressure Failure present values

Sensor Status:

The present value of the sensor status is shown here as “Normal” or “Failure”.

Pressure damped:

The present value of the damped pressure is shown and this is used for the further flow calculation.

7.5.5.2 Air Flow Configuration

General Function:

To calculate the air velocity and the air flow depending on the differential pressure measurement the physical data is needed mandatory. To adapt the VAV-Box to the designed room demands additional operational data is needed as well.

The Air Flow display is shown on the *Status Overview* page of the *VAVstatus* visualization project as shown in Figure 190. Here the air flow and the percentage of the maximum flow cooling are displayed.

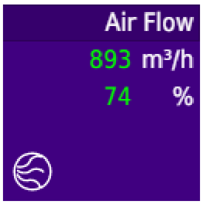


Figure 190: Air Flow tile in Status Overview

Detailed Function:

The air flow configuration can be done on the *Air Flow Data Configuration* page of the *VAVstatus* visualization project as shown in Figure 191.

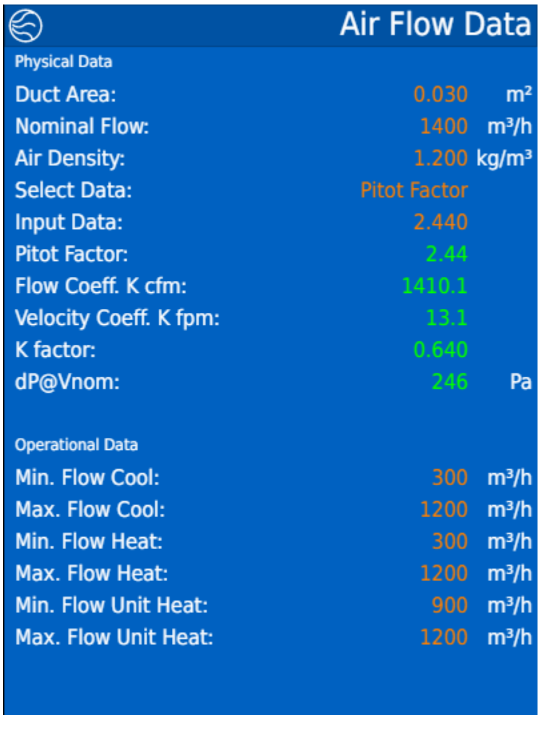


Figure 191: Air Flow Data tile in Air Flow Data Configuration

Table 19 shows the Air Flow Data parameters.

Path: User Registers.VAVcontrol.Core.Flow.FlowBoxData

Name on tile	**Data point name**	**Default**	**Description**
Duct Area	DuctArea	0,03m$^{2/}$ 0,32ft^2	Duct area of the VAV Box
Nominal Flow	NominalFlowBox	1400m^3/h 824cfm	Nominal flow value of the VAV Box
Air Density	Density	1,2kg/m^3 0,0749lb/ft^3	Local Air density of the plant area
Select Data	SelectFlowBoxData	Pitot Factor	Selection of which factor to input
Input Data	InputFlowBoxData	2,44	Input of the flow box data according to Select Data
Min. Flow Cool	MinFlowCooling	300m^3/h 177cfm	Minimum flow limit for cooling
Max. Flow Cool	MaxFlowCooling	1200m^3/h 706cfm	Maximum flow limit for cooling
Min. Flow Heat	MinFlowHeating	300m^3/h 177cfm	Minimum flow limit for heating
Max. Flow Heat	MaxFlowHeating	1200m^3/h 706cfm	Maximum flow limit for heating
Min. Flow Unit Heat	MinFlowHeating	900m^3/h 530cfm	Minimum flow limit for unit heating
Max. Flow Unit Heat	MaxFlowHeating	1200m^3/h 706cfm	Maximum flow limit for unit heating

Table 19: Air Flow Data parameters

Duct Area:

The duct area is part of the flow calculation. It is multiplied with the current air velocity to result in the current air flow.

Nominal Flow:

It is given by the manufacturer of the VAV Box and defines the maximum flow the box is able to stand with an acceptable pressure drop and noise level. Please note that the *Max. Flow Cool*, *Max. Flow Heat*, *Max. Flow Unit Heat* values cannot exceed above this value.

Air Density:

The standard value for the normal geographic altitude is 1,2 kg/m^3. The air flow is calculated with that constant value. If there are Buildings located in very high altitudes the *Air Density* can be modified to get a more accurate air flow calculation.

Select Data:

To calculate the air velocity based on the measured differential pressure a factor that defines the pickup probe must be provided by the VAV-Box manufacturer. Unfortunately, there is no common standard to describe this factor for the flow calculation. LIOB-AIR supports multiple factors: Pitot Factor, Velocity Coefficient K_{fpm}, Flow Coefficient K_{cfm}, K factor and ${}_{delta}P@V_{nom}$. The type of factor can be selected by Select Data first and then the data entered on Input Data by the user. After the factor has been put in, the other factors are calculated and displayed.

Input Data:

Relating on which factor is selected in Select Data (*Pitot Factor, Velocity Coefficient Kfpm, Flow Coefficient Kcfm, K factor and deltaP@Vnom*) the according value has to be put in here.

Min. Flow Cool:

This is the minimum flow the VAV Box control will not fall below in cooling mode. The space temperature cooling controller is modulating the flow setpoint and will not decrease the flow setpoint below this limit. See Figure 192 cooling.

Max. Flow Cool:

This is the maximum flow the VAV Box control will not exceed above in cooling mode. The space temperature cooling controller is modulating the flow setpoint and will not increase the flow setpoint above this limit. See Figure 192 cooling.

Min. Flow Heat:

This is the minimum flow the VAV Box control will not fall below in heating mode. The space temperature heating controller is modulating the flow setpoint and will dot decrease the flow setpoint below this limit. See Figure 192 heating.

Max. Flow Heat:

This is the maximum flow the VAV Box control will not exceed above in heating mode. The space temperature heating controller is modulating the flow setpoint and will not increase the flow setpoint above this limit. See Figure 192 heating.

Min. Flow Unit Heat:

This is the minimum flow the VAV Box control will not fall below in heating mode if the HVAC mode in the VAV Box is in MRNG_WRMUP or HEAT or the AHU control sends heat mode (contact from AHU to Manager). The space temperature heating controller is modulating the flow setpoint and will dot decrease the flow setpoint below this limit.

Max. Flow Unit Heat:

This is the maximum flow the VAV Box control will not exceed above in heating mode if the HVAC mode in the VAV Box is in MRNG_WRMUP or HEAT or the AHU control sends heat mode (contact from AHU to Manager). The space temperature heating controller is modulating the flow setpoint and will not increase the flow setpoint above this limit.

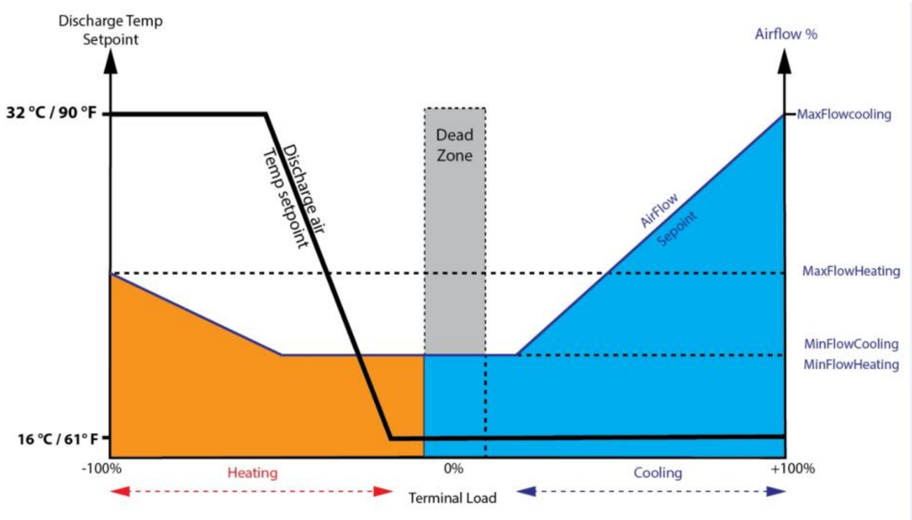


Figure 192: Sequence scheme air flow setpoints

Table 20 shows the Air Flow Data present values.

Path: User Registers.VAVcontrol.Core.Flow.FlowBoxData

Name on tile	**Data point name**	**Description**
Pitot Factor	PitotFactor	Pitot Factor of the pickup probe
Flow Coeff. K cfm	K_cfm	Flow coefficient of the VAV Box (includes the duct area)
Velocity Coeff. K fpm	K_fpm	Velocity coefficient of the pickup probe (independent of duct area)
K factor	K_factor	Correction factor of the pickup probe (independent of duct area)
dP@Vnom	DeltaPatVnom	Differential Pressure at nominal Flow (includes the duct area)

Table 20: Air Flow Data present values

Pitot Factor:

Depending on the inputs of Select Data and Input Data, the Pitot Factor is either displayed directly or calculated and displayed here. Sometimes the Pitot Factor is also found as Pickup Gain, Magnification or Velocity Pressure Factor in the literature.

Flow Coeff. K cfm:

Depending on the inputs of Select Data and Input Data, the Flow Coefficient K_{cfm} is either displayed directly or calculated and displayed here. This value includes the complete box data with duct area.

Velocity Coeff. K cfm:

Depending on the inputs of Select Data and Input Data, the Flow Coefficient K_{cfm} is either displayed directly or calculated and displayed here. This value only relates to the pickup probe and is independent of the duct area.

Correction K factor:

Depending on the inputs of Select Data and Input Data, the Correction K factor is either displayed directly or calculated and displayed here. This value only relates to the pickup probe and is independent of the duct area.

dP@Vnom:

Depending on the inputs of Select Data and Input Data, the differential pressure at nominal flow $_dP@V_{nom}$ is either displayed directly or calculated and displayed here. This value includes the complete box data with duct area.

7.5.5.3 Air Flow Controller

General Function:

The air flow is calculated using the damped differential pressure and the flow box data described in the last chapter. This used as the control value by the air flow controller that is maintaining the modulated air flow setpoint coming from a setpoint selection from multiple control functions like space temperature or CO2 controls. If the air flow is decreasing the flow controller is increasing the control output and vice versa. The air flow controller is modulating the damper actuator.

Detailed Function:

An optimized control algorithm for flow control purposes (dead band control) is operating here. The principle is shown in Figure 193.

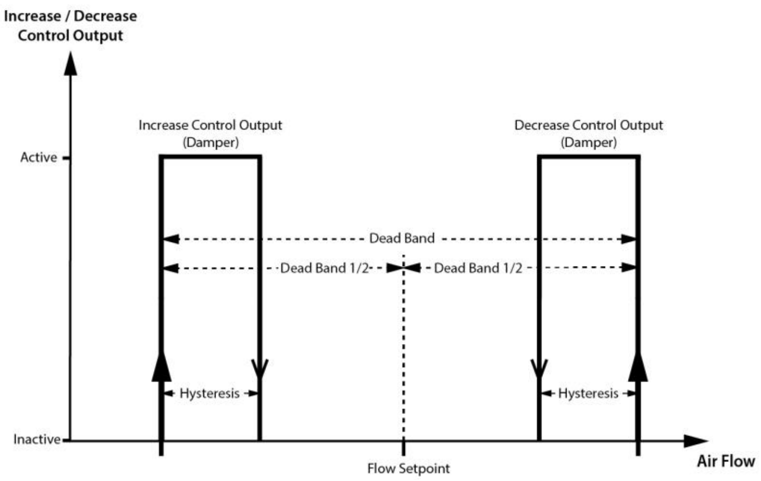


Figure 193: Principle of the Air Flow Controller

The air flow controller can be watched and parameterized on the *Air Flow Control* page of the *VAVstatus* visualization project as shown in Figure 194.

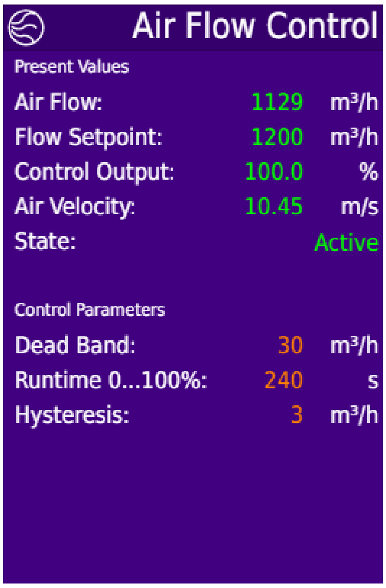


Figure 194: Air Flow Data tile in Air Flow Control

Table 21 shows the Air Flow Control parameters.

Path: User Registers.VAVcontrol.Core.Flow.FlowControl

Name on tile	Data point name	Default	Description
Dead Band	DeadBandFlowControl	$50m^3/h$ 29cfm	Dead band of the flow controller
Runtime 0…100%	RuntimeFlowControl	180s	Time the controller runs from 0% to 100% output
Hysteresis	HysteresisFlowControl	$5m^3/h$ 3cfm	Hysteresis to stop modulating the control output

Table 21: Air Flow Data parameters

Dead Band:

This defines the Dead Band Range of the flow control. If the control value (Air Flow) is inside this Dead Band Range:

Dead Band Range = *Flow Setpoint + - (Dead Band / 2),*

The flow controller stops and remains on its last control output value. If the control value is leaving this Dead Band Range, the controller is increasing or decreasing the control output as long as the control value reenters the Dead Band Range again. It at last stops modulating the control output with the *Hysteresis* value, see Figure 193. The speed of modulating the control output is defined in the *Runtime 0…100%* parameter.

A Smaller Dead Band leads to a more accurate maintenance of the flow setpoint flow control but raises the risk of an oscillating flow controller. A greater Dead Band leads to a less accurate maintenance of the flow setpoint but reduces the risk of an oscillating flow controller.

Note that the Dead Band must not be smaller than the natural oscillation of the air flow caused by the pressure measurement to ensure a stable control function. The flow controller is not meant to compensate the oscillation of the pressure measurement.

Runtime 0…100%:

This defines the time the control output takes to increase or decrease between 0…100%. The flow controller is operating with a constant speed defined by this runtime. Note that the speed is not depending on the value of the control deviation.

A smaller Runtime leads to faster change of the control output and speeds up the flow control but raises the risk of an oscillating flow controller. A greater Runtime leads to slower change of the control output and slows the flow control but reduces the risk of an oscillating flow controller.

Note that the Runtime should not be shorter that the physical runtime of the damper actuator in the range 0…100%.

Hysteresis:

This shall stabilize the flow controller when entering the Dead Band Range.

If the flow controller is increasing the control output, it stops and remains on the last value if *Air Flow* > *Flow Setpoint* - (*Dead Band* / 2) + *Hysteresis*

If the flow controller is decreasing the control output, it stops and remains on the last value if *Air Flow* > *Flow Setpoint* + (*Dead Band* / 2) - *Hysteresis*

This parameter has only marginal influence to the control quality. It should not be greater than (*Dead Band* / 2) * 0,3 and not smaller than (*Dead Band* / 2) * 0,1.

See Figure 193 for the details.

Table 22 shows the Air Flow Control present values.

Path: User Registers.VAVcontrol.Core.Flow.FlowControl

Name on tile	Data point name	Description
Air Flow	AirFlow	Present value of air flow
Flow Setpoint	AirFlowSetpoint	Current air flow setpoint of the controller
Control Output	ControlOutput	Current control output of the flow controller
Air Velocity	AirVelocity	Current air velocity in the VAV Box
State	State	Current flow controller state

Table 22: Air Flow Control present values

Air Flow:

The present value of the air flow in the VAV Box is displayed here. This is resulting of the air flow calculation based on the pressure measurement and the air flow data configuration. The flow controller is using this as the control value.

Flow Setpoint:

The present value of the air flow setpoint is displayed here. This is resulting of the air flow selection from multiple sources. The flow controller is using this as the control setpoint.

Control Output:

This is the current control output 0…100% of the air flow controller. The damper actuator is controlled by the control output.

Air Velocity:

The present value of the air velocity in the VAV Box is displayed here. This value is resulting of the air flow calculation based on the pressure measurement and the air flow data configuration. Its purpose is for user information only.

State:

The present value of the current state of the air flow controller is displayed here. It shows if the controller is “Active” or in “Calibration” if the control output is overruled by the calibration.

Air Flow Setpoint Selection:

There are multiple control instances that are modulating the flow setpoint of the air flow controller. A setpoint selection function decides from which source the setpoint is operated by the flow control. The air flow selection can be watched and parameterized on the *Air Flow Control* page of the *VAVstatu*s visualization project as shown in Figure 195.

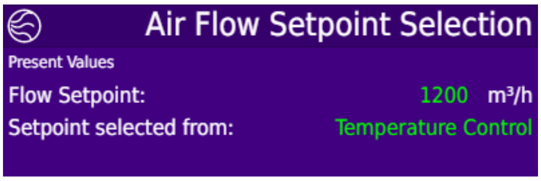


Figure 195: Air Flow Setpoint Selection in Air Flow Control

Table 23 shows the Air Flow Control present values.

Path: User Registers.VAVcontrol.Core.Flow.FlowControl

Name on tile	**Data point name**	**Description**
Flow Setpoint	AirFlowSetpoint	Current air flow setpoint of the controller
Setpoint selected from	AirFlowSetpointSelection	Current source the setpoint is selected from

Table 23: Air Flow Setpoint Selection present values

Flow Setpoint:

The present value of the air flow setpoint is displayed here. This is resulting of the air flow selection from multiple sources. The flow controller is using this value as the control setpoint.

Setpoint selected from:

This indicates from which source the *Flow Setpoint* is selected from:

1.Temperature Control: This is selected if the setpoint requested by the space temperature control using the maximum setpoint of space temperature control, IAQ control, (Humidity control)*. See chapter 7.5.6.5 for more details.

2.IAQ Control: This is selected if the setpoint requested by the IAQ control using the maximum setpoint of space temperature control, IAQ control, (Humidity control)*. See chapter 7.5.8.4 for more details.

3.Humidity Control: This is selected if the setpoint requested by the Humidity control using the maximum setpoint of space temperature control, IAQ control, (Humidity control)*.

)* Please note that the humidity control actually does <u>not</u> modify the flow setpoint in the VAV box. See chapter 7.5.10 for more details.

4.External Setpoint: Only if a “FlowSetpointExternal” sensor function is configured. There is no other control function possible in that case. See chapter 7.5.17 for more details.

5.Balance Flow Command: If a balance flow command is activated on any manager device, the flow setpoint is defined by the manager. This is for commissioning purposes.

6.Master Setpoint: This is selected if the VAV Box is an exhaust air “Slave” device. In this case, the Flow Setpoint is defined by the master device.

7.Calibration Setpoint: This is selected if the calibration is currently active in the VAV Box. The flow setpoint is defined by the calibration process. See chapter 7.5.5.5 for more details.

8.Fan Start: If the series or parallel fan requests an anti-backward rotation start, the flow setpoint is set to a zero value. See chapter 7.5.14.3 for more details.

9.Room Unoccupied: If the room is unoccupied and the *Damper Close Unocc* is “Enabled”, the flow setpoint is set to a zero value. See chapter 7.5.13.1 for more details.

10.HVAC_OFF, Fan On: If the HVAC Mode is OFF (AHU is off) and the series or parallel fan is switched on the flow setpoint is set to a zero value. See chapter 7.5.13.1 for more details.

11.Unoccupied Cool Request: If the room is unoccupied and the *Damper Close Unocc* is “Enabled” but there is a cooling request in the room the flow setpoint is set to the *Max. Flow Cool*. See chapter 7.5.14.3 for more details.

12:Pressurize: If the pressurize function is triggered the flow setpoint is set to the *Max. Flow Cool*.

13:Depressurize: If the depressurize function is triggered the flow setpoint is set to a zero value.

7.5.5.4 Air Flow Alarms

General Function:

The current air flow is monitored permanently to watch the proper function of the VAV Box. If the air flow is leaving a defined range according to the current setpoint a minimum or maximum Alarm is triggered with a time delay. The alarm function is enabled by the *HVAC Mode in VAV*.

Detailed Function:

There are a minimum and a maximum alarm function, which are relating to the current *Flow Setpoint*. Therefore, these alarm limits are sliding. If an alarm is triggered it can reset self-sufficiently in case the air flow returns to inside of the limits. The alarm can also be reset by the user.

The flow alarm function is disabled if the *HVAC Mode in VAV* is OFF and the alarm will be reset. In all other HVAC modes, the flow alarm function is enabled.

Please note that the flow alarms are triggered by this function and only this is described in this chapter. In the device, these alarms are operated as "generic" alarms that are reported to BACnet alarm server in parallel. The complete alarming with alarm servers, alarm lists, alarm status, acknowledgement, alarm notification and further things are standard LOYTEC data point functions of the LIOB-AIR operating system.

The principle of the Air Flow Alarms is displayed in

Figure 196.

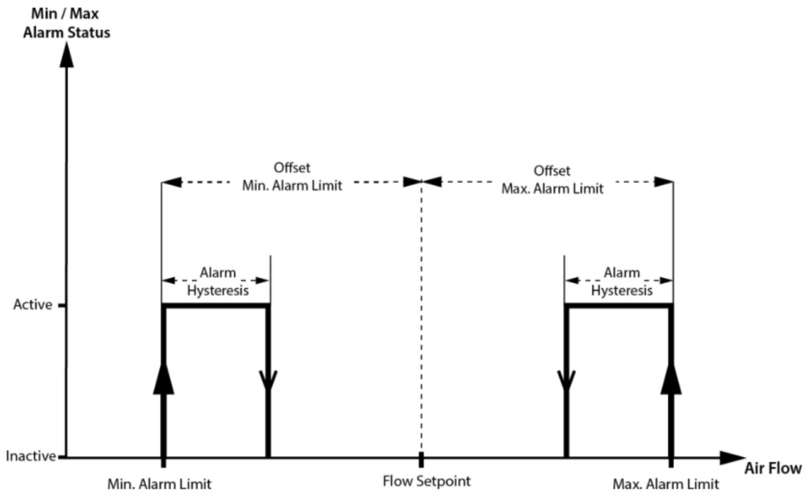


Figure 196: Principle of Air Flow Alarms

The Air Flow Alarms can be watched and parameterized on the *Air Flow Alarm Configuration* page of the *VAVstatus* visualization project as shown in Figure 197.

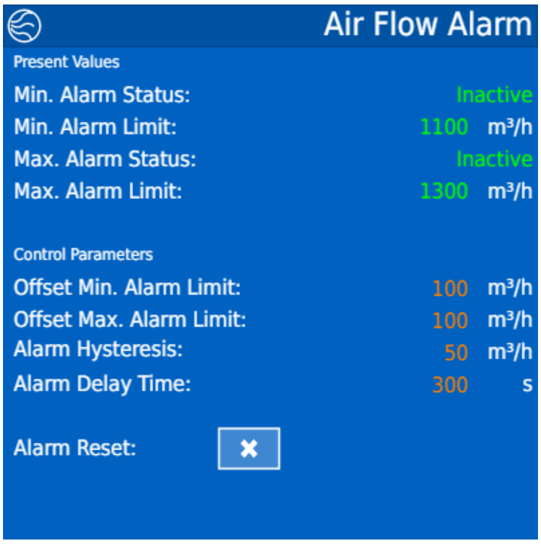


Figure 197: Air Flow Alarm configuration

Table 24 shows the Air Flow Alarm parameters.

Path: User Registers.VAVcontrol.Core.Flow.Alarm

Name on tile	**Data point name**	**Default**	**Description**
Offset Min.Alarm Limit	AirFlowOffsetMinAlarm Limit	100m^3/h 59cfm	Air flow offset as minimum alarm limit
Offset Max.Alarm Limit	AirFlowOffsetMaxAlarm Limit	100m^3/h 59cfm	Air flow offset as maximum alarm limit
AlarmHysteresis	AirFlowAlarmHysteresis	50m^3/h 29cfm	Flow hysteresis to reset the Alarm
Alarm Delay Time	AirFlowAlarmDelayTime	300s	Time delay to trigger a flow alarm
Alarm Reset	AirFlowAlarmReset	FALSE	Button to reset an active flow alarm

Table 24: Air Flow Alarm parameters

Offset Min Alarm Limit:

This defines the offset to the current flow setpoint to calculate the minimum flow alarm limit. Because the *Flow Setpoint* can be modulated by multiple control sources the resulting flow alarm limit is sliding, see Figure 196. The current Min.Alarm *Limit* is calculated as:

Min.Alarm Limit = Flow Setpoint – Offset Min.Alarm Limit

Offset Max Alarm Limit:

This defines the offset to the current flow setpoint to calculate the maximum flow alarm limit. Because the Flow Setpoint can be modulated by multiple control sources the resulting flow alarm limit is sliding, see Figure 196. The current *Max.Alarm Limit* is calculated as:

Max.Alarm Limit = Flow Setpoint – Offset Max.Alarm Limit

Alarm Hysteresis:

This defines the hysteresis the current flow must be greater than the Min.Alarm Limit or lower than the Max. Alarm Limit to reset the flow alarm self-sufficiently without any time delay, see Figure 196.

Alarm Delay Time:

If the current air flow is outside of the limits and the *HVAC Mode in VAV* is not OFF the min or max alarm is triggered with this time delay. The reset of the flow alarm is operated without any time delay.

Alarm Reset:

A triggered air flow alarm can be reset by the user pressing this button. However, if the current air flow is still outside of the limits the flow alarm will be retriggered again after the *Alarm Delay Time* has elapsed. Pressing this button will set the *Alarm Reset* to TRUE and releasing the button will set the *Alarm Reset* to FALSE (function of the visualization).

Table 25 shows the Air Flow Alarm present values.

Path: User Registers.VAVcontrol.Core.Flow.Alarm

Name on tile	**Data point name**	**Description**
Min.Alarm Status	MinimumAirFlowAlarm	Present value minimum air flow alarm
Min.Alarm Limit	AirFlowMinimumAlarmLimit	Present value of minimum alarm limit
Max.Alarm Status	MaximumAirFlowAlarm	Present value maximum air flow alarm
Max.Alarm Limit	AirFlowMaximumAlarmLimit	Present value of maximum alarm limit

Table 25: Air Flow Alarm present values

Min.Alarm Status:

This displays the actual state of the minimum air flow alarm trigger. It becomes active if the *Air Flow* is lower than the *Min.Alarm Limit*. It becomes inactive if *Air Flow* is greater than the (*Min.Alarm Limit + Alarm Hysteresis)* or the alarm is reset by the user or the flow alarm function is disabled by the HVAC mode, see Figure 196.

Min.Alarm Limit:

This is the current minimum limit relating on the current flow setpoint, see Figure 196.

Max.Alarm Status:

This displays the actual state of the maximum air flow alarm trigger. It becomes active if the *Air Flow* is greater than the *Max.Alarm Limit*. It becomes inactive if *Air Flow* is lower than the (*Max.Alarm Limit +-Alarm Hysteresis)* or the alarm is reset by the user or the flow alarm function is disabled by the HVAC mode, see Figure 196.

Max.Alarm Limit:

This is the current maximum limit relating on the current flow setpoint, see Figure 196.

7.5.5.5 Air Flow Calibration

General Function:

LIOB-AIR also supports a calibration of the VAV Box flow measurement. This is an easy way to determine the factor that defines the pickup probe. There are up to 3 points of calibration available: MAX Flow, MIN Flow, and ZERO Flow that can be calibrated optionally.

The calibration is available in the *VAVstatu*s visualization project. It is also available as a standalone *VAVmobileCalibration* visualization project that is optimized to run on mobile devices as mobile phones or tablets to support the calibration work process.

Detailed Function:

Please note that if the proper factor Pitot Factor, or Velocity Coefficient K_{fpm}, or Flow Coefficient K_{cfm}, or K factor or $_{delta}P@V_{nom}$ is available and parameterized on the *Air Flow Data Configuration* page, the system is parameterized in the best way! In this case, there is no need for a flow calibration! However, if in retrofit projects there are existing VAV Boxes, but the factors that define the pickup probes are not available from the manufacturers, and then the calibration function is a good choice to determine these factors.

MAX Flow calibration point:

This is the best point of calibration because usually there is enough air flow that causes a pressure that is sufficient for a proper flow calculation. The air flow value should be chosen as the *Max.Flow Cool* value to be near to the requested point of operation. If the MAX Flow has been calibrated the complete range of air flow is calculated properly according to this point. The Pitot Factor resulting from the MAX Flow calibration defines the square root curve of pressure and velocity for the pickup probe and this is valid for all points on this curve. Therefore, there is no need to do the MIN flow calibration additionally.

MIN Flow calibration point:

This is only an optional point that can be calibrated. Usually there is a little air flow that causes a low pressure and this can cause faulty readings. The calibration of the MIN Flow will not increase the accuracy of the flow measurement, but it is possible that the flow measurement is made worse by that. Please note that this is caused by reasons of the air physics. Typically, this air flow value should be chosen as the *Max.Flow Cool* value to be near to the requested point of operation. As a result, the calibration is calculating a sliding Pitot Factor depending on the results of the MAX Flow and MIN Flow calibration points.

ZERO Flow calibration point:

This can be executed if the damper is not closing properly due to mechanical reasons and this causes a leakage. All pressure values lower than the Zero Flow calibration point are suppressed and calculated with the value of “0,0” and so the resulting air flow values are also “0,0” (Zero pressure suppression). Therefore, this function can cover some minor mechanical problems. However, it is recommended to investigate and fix the possible issues.

Calibration user interface:

The flow calibration has an easy to use operator interface. The tiles with orange frames allow user actions. The tiles without orange frames only display values. However, during the calibration process some tiles will get an orange frame and can be operated by the user. The calibration operator interface is shown in Figure 198.

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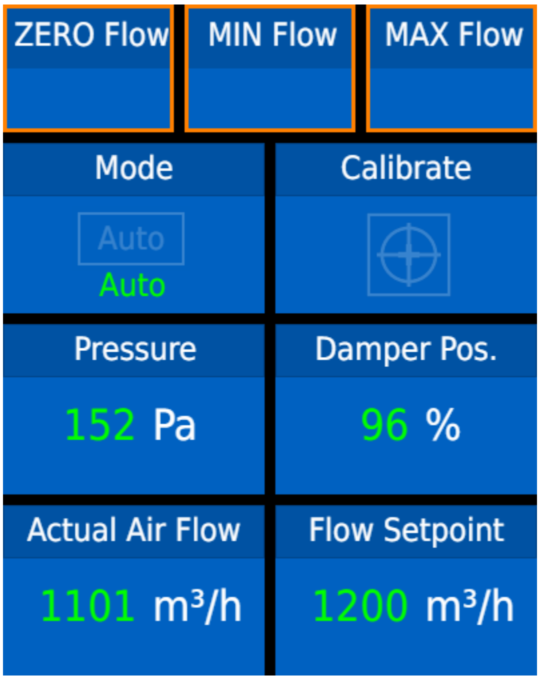

Figure 198: Air Flow Alarm Calibration

MAX Flow Tile:

This tile allows user operation due to the orange frame. A click on this tile starts the MAX Flow calibration process. Since the calibration has started this tile shows the text “active” and the frame switches to light blue color. This tile is no longer to be operated because the calibration process is active. If the calibration of this point was finished successfully, a checkmark is displayed on this tile.

MIN Flow Tile:

This tile allows user operation due to the orange frame. A click on this tile starts the MIN Flow calibration process. Since the calibration has started this tile shows the text “active” and the frame switches to light blue color. This tile is no longer to be operated because the calibration process is active. If the calibration of this point was finished successfully, a checkmark is displayed on this tile.

ZERO Flow Tile:

This tile allows user operation due to the orange frame. A click on this tile starts the ZERO Flow calibration process. Since the calibration has started this tile shows the text “active” and the frame switches to light blue color. This tile is no longer to be operated because the calibration process is active. If the calibration of this point was finished successfully, a checkmark is displayed on this tile.

Mode Tile:

In the normal VAV automatic operation, the calibration is not active and this tile shows the status “Auto” and cannot be operated by the user. Since one of the three calibration processes is started, this tile gets an orange frame and allows user operation. The status “Calibration” is displayed. A “Manual” indicator appears on the tile and a “Manual” alarm is triggered in the VAV controller. A click on this tile terminates any calibration process and switches back to the normal VAV automatic operation. The “Manual” indicator disappears and the “Manual” alarm is reset.

Calibrate Tile:

During the calibration process, this tile gets an orange frame and becomes operable if the actual air flow has a stable status. A proper calibration is only possible if there is a stable air flow. See description of *Actual Air Flow Tile* for more information. A click on this tile opens the “Input Value” dialog and the reading of the calibrator´s flow hood can be entered here as the reference flow. The dialog has to be finished pressing the “OK” button.

Pressure Tile:

This tile is only for calibrator information purposes and displays the current *Pressure damped* value. If a reference flow is entered on the “Calibrate Tile”, the corresponding pressure is stored also in the calibration data and a Pitot Factor is calculated for this calibration point.

Damper Pos. Tile:

The actual damper control output is displayed here. Since one of the three calibration processes is started, this tile gets an orange frame and allows user operation. Usually the *Min.Flow Cool* or *Max. Flow Cool* values are taken as the flow setpoint for the calibration process. The flow controller is maintaining that setpoint and controls the damper. If this seems to be too slow for the calibrator, a click in the *Damper Pos. Tile* opens the “Input Value” dialog and the requested Damper position can be entered manually. Because the Flow control has no access to the damper, the “Manual” indicator is shown on the tile. After the damper has reached the manual set position, a click on the related calibration start tile (*MAX Flow, MIN Flow, and ZERO Flow*) resets the damper control to the automatic mode. Then the air flow controller is controls the damper starting with the manual enters position value.

Actual Air Flow Tile:

This tile shows the current *Air Flow*. It also shows the state of the flow controller.

<u>goes Max</u>: The MAX Flow calibration is started and the flow controller is increasing the damper position to reach the *Max. Flow Cool* setpoint. Please wait until “stable” is shown there.

<u>goes Min</u>: The MIN Flow calibration is started and the flow controller is decreasing the damper position to reach the *Min. Flow Cool* setpoint. Please wait until “stable” is shown there.

<u>goes Zero</u>: The ZERO Flow calibration is started and the flow controller is decreasing the damper position to reach the zero flow setpoint. Please wait until “stable” is shown there.

<u>stable:</u> The flow controller has reached the relating setpoint and is stable longer than 5% of the *Runtime* of the air flow controller. Or the control output has reached an end position longer than 5% of the *Runtime* of the air flow controller. If “stable” is shown the Calibrate Tile becomes operable with an orange frame and the reference flow can be entered there. The calibration should always be performed only in a stable state to achieve some quality.

Flow Setpoint Tile:

This tile is only for calibrator information purposes and displays the current *Flow Setpoint* value the flow controller is maintaining actually.

Calibration procedure

As mentioned above the calibration is an optional process. Due to physical reasons, the MAX Flow calibration provides a much better quality than the MIN Flow calibration. So if you decide to use the calibration please perform the MAX Flow calibration. This procedure is described as follows.

1.Start the calibration:

Click on the MAX Flow Tile and the tile shows “active”, see Figure 199.

Figure 199: MAX Flow calibration active

The Mode Tile becomes operable now with an orange frame. The status “Calibration” is displayed and a “Manual” indicator appears on the tile as shown in Figure 200. A “Manual” alarm is triggered in the VAV controller.

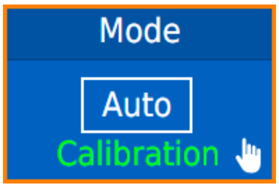

Figure 200: Calibration mode and Manual indicator

2. Air Flow goes Max:

The air flow controller now maintains the Max. Flow Cool setpoint displayed on the *Flow Setpoint Tile* and increases the damper position displayed on the *Damper Pos. Tile* to reach this. The increasing pressure can be watched on the *Pressure Tile*. The increasing air flow can be watched on the *Actual Air Flow Tile*, that also indicates “goes Max” as displayed in Figure 201.

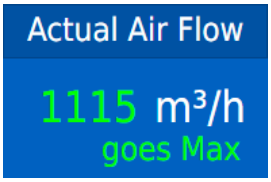

Figure 201: Actual Air Flow goes Max

Please note that if no MIN Flow or MAX Flow point was calibrated before, the calibration starts using the *Air Flow Data* (Pitot Factor) on the *Air Flow Data Configuration* page of the *VAVstatus* visualization project.

To indicate that the flow controller is actually using the flow setpoint coming from the calibration function this is displayed on the *Air Flow Selection Tile* on the *Air Flow Control* page of the *VAVstatu*s visualization project as shown in Figure 202.

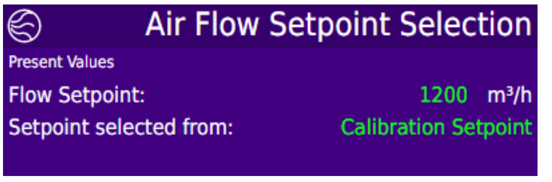

Figure 202: Selected Air Flow Calibration Setpoint

2a. <u>Optional</u> increase the speed:

If the calibrator wants to speed up the process, a manual damper position can be entered by clicking on the *Damper Pos Tile*. An “Input Value” dialog opens and the requested position can be entered and finished with the OK button. A “Manual” indicator is shown on the tile. See Figure 203 for details. The damper is now moving to the requested position and the flow control is not in operation.

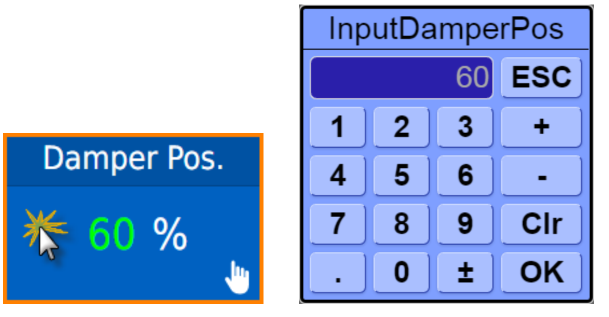

Figure 203: Input manual damper position

If now the *MAX Flow Tile* is clicked again, the air flow control is returning to automatic mode and takes control of the damper starting with the actual damper position value. The “Manual” indicator disappears from the *Damper Pos Tile* as shown in Figure 204.

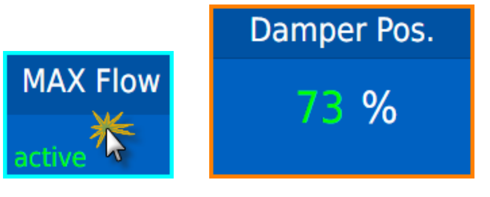

Figure 204: Input manual damper position

This option can save some working time because the calibrator does not have to wait if the flow controller has increased the damper position in case if a long *Runtime* has been parameterized.

3. Wait for a stable Air Flow:

Wait until “stable” is indicated on the *Actual Air Flow Tile* as displayed in Figure 205 because a proper calibration can only be done in a stable system.

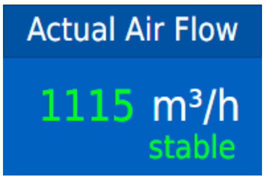

Figure 205: Actual Air Flow stable

4. Calibrate with reference air flow from flow hood:

If “stable” is indicated the *Calibrate Tile* becomes active and operable with an orange frame. A click on this tile opens the “Input Value” dialog. where the calibrator puts in the reading value from his flow hood and finishes with the OK button as shown in Figure 206.

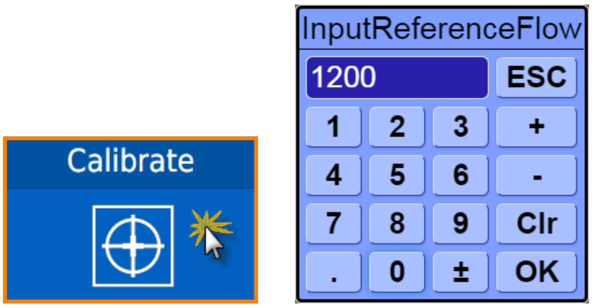

Figure 206: Calibrate with reference flow

The calibration is now stored for the selected flow point. Also the all parameter values of the complete controller are saved immediately in this moment. This prevents the loss of parameters that could be caused by an unpredictable power cycle.

The MAX Flow Tile now indicates with a “checkmark” that a calibration of the MAX Flow point has been performed as shown in Figure 208.

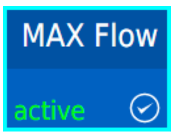

Figure 207: MAX Flow is calibrated

Internally a new Pitot Factor is calculated that is used by the flow calculation from now on. The Flow controller is using the actual calculated flow value now and maintains the actual calibration setpoint. If needed the input of the reference flow can be repeated multiple times.

5. Finish the calibration:

The calibration has to be finished by clicking on the Mode Tile as shown in Figure 208.

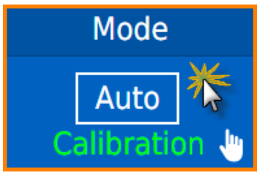

Figure 208: Finish the calibration

The mode switches back to “Auto” to indicate that the normal air flow control is operating now. In addition, the “Manual” indicator disappears and the “Manual” alarm is reset as shown in Figure 209.

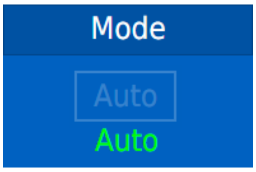

Figure 209: Display of Auto in Mode Tile

After the calibration has been finished, the calibration data can be watched and parameterized on the *Air Flow Calibration Data* page of the *VAVstatus* visualization project as shown in Figure 210.

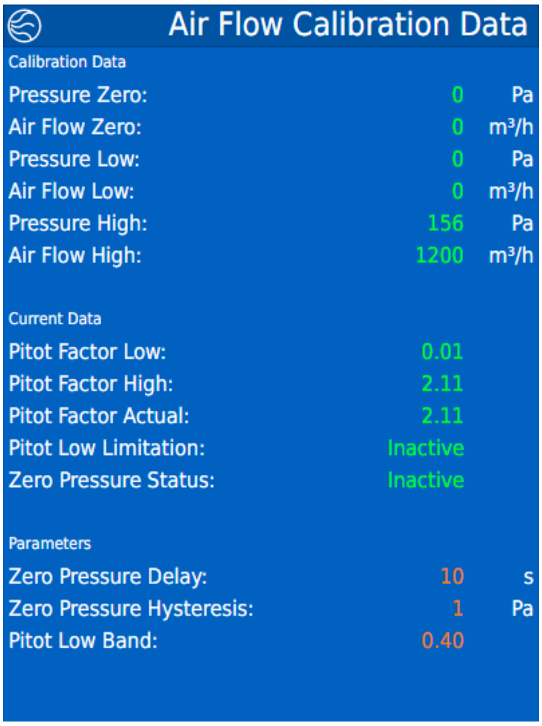

Figure 210: Air Flow Calibration Data

Table 26 shows the Air Flow Calibration Data parameters.

Path: User Registers.VAVcontrol.Core.Flow.FlowCalibration

Name on tile	**Data point name**	**Default**	**Description**
Zero Pressure Delay	PressureZeroDelay	10s	Delay of the Zero pressure suppression
Zero Pressure Hysteresis	PressureZeroHys	1Pa 0,004inWC	Hysteresis of the Zero pressure suppression
Pitot Low Band	PitotLowBand	0,4	Tolerance band of MIN Pitot factor related to MAX Pitot Factor

Table 26: Air Flow Calibration Data parameters

Zero Pressure Hysteresis:

This parameter is only used if the ZERO Flow calibration was performed. The current air flow value is set *to Air Flow Zero* value if the current *Pressure damped* value falls below the calibrated *Pressure Zero* value. The *Zero Pressure Status* is set to “active”. If the *Pressure damped* increases above (*Pressure Zero* + *Zero Pressure Hysteresis*) longer than the *Zero Pressure Delay* time the Zero pressure suppression is canceled and the current air flow is calculated normally. The *Zero Pressure Status* is set to “inactive”.

Zero Pressure Delay:

This parameter is only used if the ZERO Flow calibration was performed. If the *Pressure damped* increases above (*Pressure Zero* + *Zero Pressure Hysteresis*) longer than the *Zero Pressure Delay* time the Zero pressure suppression is canceled and the current air flow is calculated normally.

Pitot Low Band:

If the MIN Flow point and the MAX Flow point are calibrated the Pitot Low Band function ensures that the *Pitot Factor Actual* used by the flow calculation cannot differ more than (*Pitot Factor High* +- *Pitot Low Band* /2). This prevents that a bad calibration of a MIN Flow causes a worse calibration curve.

The *Pitot Factor Actual* is calculated as a sliding value between the *Pitot Factor High* and the *Pitot Factor Low* depending on the current *Pressure Damped* value. If a bad calibrated *Pitot Factor Low* would cause a *Pitot Factor Actual* value outside of the *Pitot Low Band* the value is limited accordingly and the *Pitot Factor Low Limitation* is displayed as “active”.

Table 27 shows the Air Flow Calibration Data present values.

Path: User Registers.VAVcontrol.Core.Flow.FlowCalibration

Name on tile	**Data point name**	**Description**
Pressure Zero	PressureCalibrationZeroFlow	Pressure calibration value for the ZERO Flow point
Air Flow Zero	AirFlowCalibrationZeroFlow	Air flow calibration value for the ZERO Flow point

Name on tile	Data point name	Description
Pressure Low	PressureCalibrationLowFlow	Pressure calibration value for the MIN Flow point
Air Flow Low	AirFlowCalibrationLowFlow	Air flow calibration value for the MIN Flow point
Pressure High	PressureCalibrationHighFlow	Pressure calibration value for the MAX Flow point
Air Flow High	AirFlowCalibrationHighFlow	Air flow calibration value for the MAX Flow point
Pitot Factor Low	PitotFactorLow	Calculated Pitot Factor of the MIN Flow calibration point
Pitot Factor High	PitotFactorHigh	Calculated Pitot Factor of the MAX Flow calibration point
Pitot Factor Actual	PitotFactorActual	Calculated Pitot Factor depending on the actual pressure by calibration
Pitot Low Limitation	PitotLowLimited	Indication if the Pitot Factor Actual is limited by the Piot Low Band
Zero Pressure Status	PressureZeroActive	Indication that the Zero pressure suppression is active

Table 27: Air Flow Calibration Data present values

Pressure Zero:

This displays the calibrated Pressure Zero limit. If the current *Pressure damped* value falls below the calibrated *Pressure Zero* value, the Zero pressure suppression is enabled and the current AirFlow value is set to zero value.

Air Flow Zero:

This displays the air flow value that is set to the Air Flow if the Zero pressure suppression is active. This value is always a zero value and cannot be changed.

Pressure Low:

This displays the *MIN Flow* calibrated *Pressure Low* value. Using the *AirFlow Low* and further data from the *Air Flow Configuration*, the *Pitot Factor Low* is calculated.

Air Flow Low:

This displays the *MIN Flow* calibrated *Air Flow Low* value. Using the *Pressure Low* and further data from the *Air Flow Configuration*, the *Pitot Factor Low* is calculated.

Pressure High:

This displays the *MAX Flow* calibrated *Pressure High* value. Using the *AirFlow High* and further data from the *Air Flow Configuration*, the *Pitot Factor High* is calculated.

Air Flow Low:

This displays the *MAX Flow* calibrated *Air Flow High* value. Using the *Pressure High* and further data from the *Air Flow Configuration,* the *Pitot Factor High* is calculated.

Pitot Factor Low:

This displays the current *Pitot Factor Low* of the MIN Flow calibration point. This is calculated based on the *Pressure Low* and the *Air Flow Low* calibration values and further data from the *Air Flow Configuration.*

Pitot Factor High:

This displays the current *Pitot Factor High* of the MAX Flow calibration point. This is calculated based on the *Pressure High* and the *Air Flow High* calibration values and further data from the *Air Flow Configuration.*

Pitot Factor Actual:

This displays the current Pitot Factor calculated by the calibration. If the MIN Flow is calibrated only (please don´t do that), the *Pitot Factor Actual* is equal to *Pitot Factor Low*. If the MAX Flow is calibrated only (that is ok), the *Pitot Factor Actual* is equal to *Pitot Factor High*. If both the MIN Flow and MAX Flow are calibrated, the *Pitot Factor Actual* is calculated as a sliding value depending on the current *Pressure damped* value between the *Pitot Factor Low* and the *Pitot Factor High*. The Pitot Low Band function limits the calculation of the *Pitot Factor Actual* in the lower range of the *Pressure damped.*

Pitot Low Limitation:

If the calculation of the Pitot Factor Actual is actually limited by the Pitot Low Band function (see *Pitot Low Band* parameter) the *Pitot Low Limitation* is set to “active“. If the calculation is executed without the limitation, the *Pitot Low Limitation* is set to “inactive”.

Zero Pressure Status:

If the ZERO Flow calibration was performed and the current *Pressure damped* value falls below the calibrated *Pressure Zero* value, the Zero pressure suppression is enabled and this is displayed on *Zero Pressure Status* as “active”.

<u>Reset of Calibration</u>

The calibration can be done multiple times to improve the quality of the calibration points. In this case, the old values are overwritten by the new calibration values. However, it is also possible to reset the complete calibration data. After a reset is performed, the air flow calculation operates with the data of the *Air Flow Data Configuration* page of the *VAVstatu*s visualization project.

The calibration reset can be operated *Air Flow Calibration Reset* page of the *VAVstatu*s visualization project as shown in Figure 211.

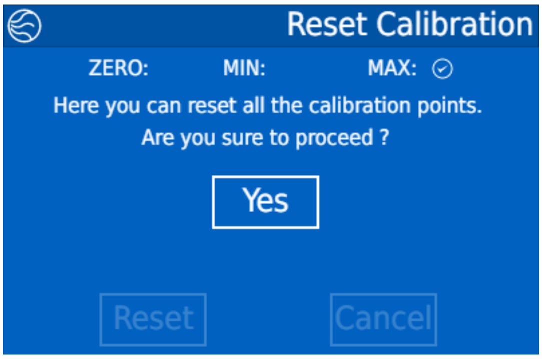

Figure 211: Air Flow Calibration Reset

The tile shown in Figure 211 shows which points (ZERO, MIN, MAX) have been calibrated and all of them will be reset when the function is executed. For that reason, the dialog asks to confirm by clicking the "Yes" button if the user wants to proceed.

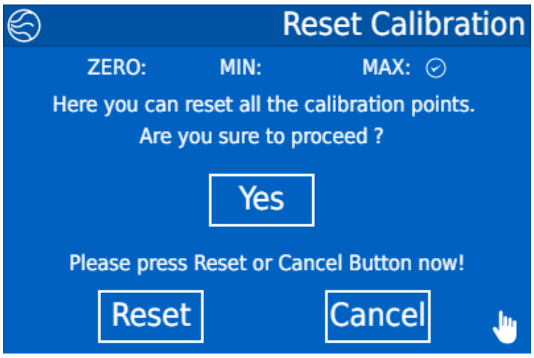

Figure 212: Air Flow Calibration Reset confirmation

In the following dialog shown in Figure 212 the user can confirm the reset by clicking on the "Reset" button, or cancel the process with the "Cancel" button.

7.5.6 Space Temperature Control

According to chapter *7.3.1 Application Structure* the temperature control is a sensor function. If the VAVspaceTemp sensor function is connected to the core, the space temperature cooling control function is enabled in the core application. It consists of the parts cooling setpoints, cooling control, cool alarm and summer compensation.

If one of the reheat actuator functions (VAVreheatHwMod, VAVreheatHwFloat, VAVreheatElMod, VAVreheatEl3St, and VAVnoReheat) is connected to the core also, the space temperature heating control function is enabled in the core application additionally. It consists of the parts heating setpoints heating control, heat sequence and heat alarm.

If the Space Temperature external Setpoint sensor function is connected to the core, the external setpoint shift function is enabled also. The space temperature setpoint can be shifted by an external setpoint sensor or by a connected L-STAT network thermostat or by the VAVstatus visualization in this case.

In this chapter, the cooling and heating controllers are described together for a better understanding. However, if no reheat actuator function is connected to the core the cooling controller is operating without any heating control function.

7.5.6.1 Space Temperature Measurement

General Function:

The space temperature is measured by a space temperature sensor connected to the local input of the LIOB-AIR device. It also can be measured by an L-STAT network thermostat or any other network thermostat that is connected to the LIOB-AIR device as well.

The space temperature display is shown on the *Status Overview* page of the *VAVstatus* visualization project as shown in Figure 213. This is the value the space temperature controllers are using as the control value.

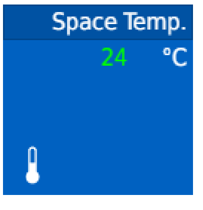

Figure 213: Space Temperature tile in Status Overview

Inputs:

In the LIOB-AIR I/O Standard configuration, the space temperature is located on the universal input UI1. For more information see chapter *7.3.2 Device Configuration*.

If an L-STAT network thermostat is connected, it can be configured to operate with the integrated sensor as the space temperature or to display the current space temperature the controller is operating with.

If there are multiple LIOB-AIR devices in a room, they have to be parameterized as a “VAV Group” to be able to operate a proper room control. Either a device can have hard-wired sensors or L-STATs connected (not both at the same time) or no sensor connected. The space temperature is calculated as the average value of all sensors and L-STATs in the VAV Group automatically and used as the control value.

Favorites:

The Favorite of space temperature is shown in Table 28: Space Temperature Favorite.

Path: Favorites.VAVcontrol.SpaceTemp

Favorite name	**Description**
inSpaceTemp	Present value of space temperature

Table 28: Space Temperature Favorite

inSpaceTemp:

The space temperature measurement function has this one Favorite. To this Favorite, the Local I/O *UI1* is connected (see I/O Standard configuration). In case of using a third party network thermostat, the data point of the space temperature coming from this device can be connected to the Favorite.

Heat Lockout:

It is possible to lock the heating function depending on the *Outdoor Temperature* in summer time. This is useful to save energy or in case, e.g. the central heating plant is not providing hot water in summer time. If the *Outdoor Temperature* increases above an adjustable limit (see chapter *7.5.15* for more details) the *Heat Lockout State* will become active. If the *Heat Lockout State* is active, the heating controller is locked and no heating function of the heating sequence will become active. Only cooling control is possible in this case. If the *Heat Lockout State* becomes active, this is indicated on the space temperature tile.

The active "Heat Lockout" is indicated on the *Status Overview* page of the *VAVstatus* visualization project as shown in Figure 215.

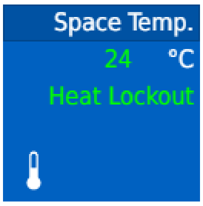

Figure 214: Space Temp. tile with active Heat Lockout in Status Overview

Space Temp Sensor Failure:

If the space temperature sensor is not detected immediately after reboot, the space temperature sensor function transmits a very low value. This causes the space temperature heating controller to request the reheat and the fan in a short time and a lot of heating energy is provided to the room.

This can happen if an L-STAT is acting as space temperature sensor and the L-STAT is not commissioned by the user. (This is an exception case, e.g. if there are wrong communication parameters set).

To prevent this case, the space temperature is watched after the reboot of the LIOB-AIR controller. If the space temperature is lower than 3°C / °F a sensor failure is detected and a space temperature sensor alarm is triggered. The space temperature control function is not initialized and will not operate in this case.

If the space temperature is greater than 3°C / °F the sensor failure is reset and the space temperature sensor alarm is reset also. The space temperature control function is initialized and will start to operate.

Please note that this space temperature failure detection only happens once after a reboot of the LIOB-AIR controller. During the runtime, this function is disabled.

Please note that the space temperature sensor failure alarm is triggered by this function and only this is described in this chapter. In the device, this alarm is operated as a "generic" alarm that is reported to BACnet alarm server in parallel. The complete alarming with alarm servers, alarm lists, alarm status, acknowledgement, alarm notification and further things are standard LOYTEC data point functions of the LIOB-AIR operating system.

The "Failure" is indicated on the *Status Overview* page of the *VAVstatus* visualization project as shown in Figure 215.

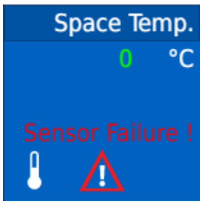

Figure 215: Space Temp. tile with Sensor Failure in Status Overview

Table 18 shows the Space Temp. Failure present values.

Path: User Registers.VAVcontrol.SpaceTemp

Name on tile	**Data point name**	**Description**
Sensor Failure	SpaceTempSensorFailure	Current Space Temp sensor status after reboot

Table 29: Space Temperature Failure present values

Sensor Status:

The present value of the sensor status is shown here as "Failure" after reboot of the LIOB-AIR device. The status "Normal" is not shown on the tile.

7.5.6.2 Space Temperature Setpoints

General Function:

The space temperature controller is maintaining the *Effective Space Temp. Setpoint* that is selected by the *Occupancy Status* and the active cooling or heating controller. There are dedicated cooling and heating setpoints defined for every *Occupancy Status*. For display purposes *a Display Space Temp. Setpoint* is calculated also.

Detailed Function:

To save energy and to ensure the comfort of the room occupants there are dedicated cooling and heating setpoints defined to the multiple occupancy states. The default setpoints and the *Terminal Load* with varying temperature (without the time-dependent integral component) are shown in Figure 216.

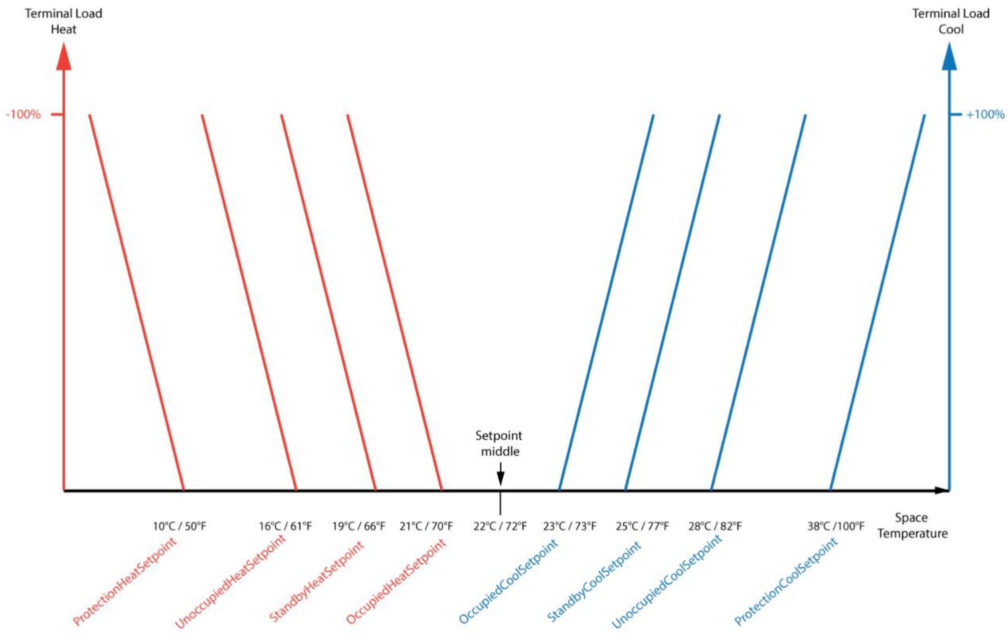

Figure 216: Space Temperature Setpoints and Occupancy states

Depending on the value of current space temperature, the required space temperature controller heating or cooling is activated. This happens after a time delay has elapsed and ensures that either the cooling or the heating controller is activated and never both controllers.

If the *Occupancy Status* is “Occupied” or “Bypass” the *Occupied Cool Setpoint* and the *Occupied Heat Setpoint* are selected. Which of these both is used as the *Effective Space Temp. Setpoint* is selected by the active space temperature cooling or heating controller.

If the *Occupancy Status* is “Standby”, the *Standby Cool Setpoint* and the *Standby Heat Setpoint* are selected. Which of these both is used as the *Effective Space Temp. Setpoint* is selected by the active space temperature cooling or heating controller.

If the *Occupancy Status* is “Unoccupied”, the *Unoccupied Cool Setpoint* and the *Unoccupied Heat Setpoint* are selected. Which of these both is used as the *Effective Space Temp. Setpoint* is selected by the active space temperature cooling or heating controller.

If a Window Contact sensor function is connected to the core, the Energy Hold Off function is enabled, see chapter 7.5.7. In case of an active Energy Hold Off (opened window), the *Protection Cool Setpoint* and the *Protection Heat Setpoint* are selected. Which of these both is used as the *Effective Space Temp. Setpoint* is selected by the active space temperature cooling or heating controller. This Energy Hold Off setpoint selection overrules the occupancy based setpoint selection. This prevents the waste of energy but it protects the room equipment caused by freezing or overheating.

If an external Space Temp. Setpoint sensor function is connected to the core, the *Effective Space Temp. Setpoint* can be modified externally. An *External Setpoint Offset* will shift the *Effective Space Temp. Setpoint* if the *Occupancy Status* is “Occupied” or “Bypass” or “Standby” based on the defined space temperature setpoints. An *External absolute Setpoint* will define new setpoints for “Occupied” and “Standby” based on the distance of the defined space temperature setpoints. See chapter 7.5.6.3 for more details.

A Summer Compensation function is always available in the Space Temperature control and can be enabled or disabled by the user. If enabled, the *Effective Space Temp. Setpoint* is raised with increasing *Outdoor Temperature*. This only happens if the space temperature cooling controller is active and the *Occupancy Status* is “Occupied” or “Bypass” or “Standby”. This shall save energy and protect the health of the occupants.

<u>Setpoints Overview:</u>

The first Overview of the VAV space temperature setpoints is shown on the *Space Temperature Setpoints Trend* page of the *VAVstatus* visualization project as shown in Figure 217.

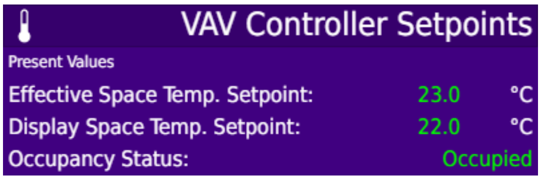

Figure 217: Present values of space temperature setpoints

Table 30 shows the present values of the space temperature setpoints.

Path: User Registers.VAVcontrol.SpaceTemp.Control

Name on tile	**Data point name**	**Description**
Effective Space Temp. Setpoint	EffectiveControlSetpoint	Current Setpoint for the active space temp. cooling or heating controller
Display Space Temp. Setpoint	DisplayControlSetpoint	Averaged space temperature setpoint fir display purposes
Occupancy Status *)	EffectiveOccupancy	Effective occupancy status of the room to select the space temp. setpoints
HVAC Mode *)	HVACmode	HVAC Mode, only shown in HVAC-Mode: MRNG_WRMUP or PRE_COOL
EnergyHoldOffState *)	EnergyHoldOffStatus	EnergyHoldOff State, only shown if EnergyHoldOff is active

Table 30: Present values of space temperature setpoints
*) are displayed alternatively depending on dedicated states

Effective Space Temp. Setpoint:

The present value of the *Effective Space Temp. Setpoint* that is selected by the *Occupancy Status* and the active cooling or heating controller. The *Occupancy Status* selects a *Current Cool Setpoint* and a *Current Heat Setpoint.* A comparison of the current *Space Temperature* with these current setpoints decides to activate the cooling or heating controller. If the cooling controller is active the *Effective Space Temp. Setpoint* equals the *Current Cool Setpoint.* If the heating controller is active the *Effective Space Temp. Setpoint* equals the *Current Heat Setpoint.*

In case of the HVAC mode MRNG_WRMUP is active; the *Standby Heat Setpoint* is set as the *Effective Space Temp. Setpoint.*

In case of the HVAC mode PRE_COOL is active, the *Occupied Cool Setpoint* is set as the *Effective Space Temp. Setpoint.*

In case of the EnergyHold Off is active (window is open) the *Protection Heat Setpoint* is set as the *Current Heat Setpoint* and the *Protection Cool Setpoint* is set as the *Current Cool Setpoint*.

The active cooling or heating space temperature controller is maintaining this *Effective Space Temp. Setpoint*.

Display Space Temp. Setpoint:

As described above the *Effective Space Temp. Setpoint* is switching depending on which controller cooling or heating is activated. However, for display purposes it is often better to have a more constant setpoint value to prevent confusing the room occupants. For that reason, the Display Space Temp. Setpoint is calculated as:

External Setpoint Offset + (*Occupied Cool Setpoint* + *Occupied Heat Setpoint*) / 2

Therefore, this is the “middle” occupied setpoint that is most understandable for the room occupants.

Regarding *External Setpoint Offset,* see chapter 7.5.6.3 for more details

Occupancy Status:

This displays the effective occupancy status of the room and selects the space temperature setpoints. For more information, refer to chapter *7.5.12*. This is the “normal” display if there is no HVAC-Mode MRNG_WRMUP or EnergyHoldOff active.

HVAC Mode:

If the *HVAC Mode* is on MRNG_WRMUP or PRE_COOL this display is activated. This indicates, that the *Standby Heat Setpoint* or the *Occupied Cool Setpoint* is set as the *Effective Space Temp. Setpoint.* There is no setpoint selection by the *Occupancy Status* in this case.

EnergyHoldOffState:

If the *EnergyHoldOffState* is active, this display is activated. This indicates that the *Protection Heat Setpoint* is set as the *Current Heat Setpoint* and the *Protection Cool Setpoint* is set as the *Current Cool Setpoint*. There is no setpoint selection by the *Occupancy Status* in this case.

Cooling Setpoints:

The cooling setpoints can be watched and parameterized on the *Space Temperature Setpoints* page of the *VAVstatus* visualization project as shown in Figure 218.

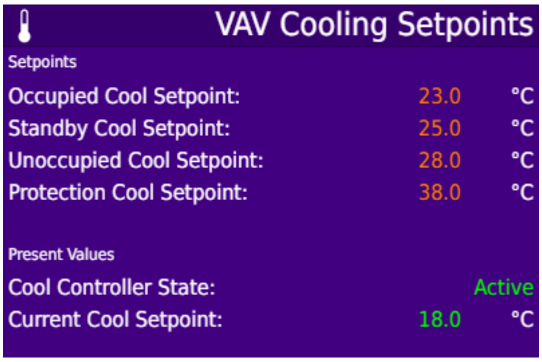

Figure 218: Space Temperature Cooling Setpoints

Table 31 shows the Cooling Setpoints parameters.

Path: User Registers.VAVcontrol.SpaceTemp.Control

Name on tile	**Data point name**	**Default**	**Description**
Occupied Cool Setpoint	OccupiedCoolSet point	23°C 73,4°F	Space temperature setpoint cool controller in occupancy mode “occupied”
Standby Cool Setpoint	StandbyCoolSetp oint	25°C 77°F	Space temperature setpoint cool controller in occupancy mode “standby”
Unoccupied Cool Setpoint	UnoccupiedCoolS etpoint	28°C 82,4°F	Space temperature setpoint cool controller in occupancy mode “unoccupied”
Protection Cool Setpoint	ProtectionCoolSet point	38°C 100,4°F	Space temperature setpoint cool controller if EnergyHoldOff is active

Table 31: Cooling Setpoints parameters

Occupied Cool Setpoint:

This is the space temperature setpoint for the cooling controller if the occupancy mode of the room is “occupied”.

Standby Cool Setpoint:

This is the space temperature setpoint for the cooling controller if the occupancy mode of the room is “standby”.

Unoccupied Cool Setpoint:

This is the space temperature setpoint for the cooling controller if the occupancy mode of the room is “unoccupied”.

Protection Cool Setpoint:

This is the space temperature setpoint for the cooling controller if the EnergyHoldOff function is active caused by an opened window. This overrules the setpoint selection of the occupancy mode.

Generally, the values of the cooling setpoints should be set as follows:

Occupied Cool Setpoint < Standby Cool Setpoint

Standby Cool Setpoint < Unoccupied Cool Setpoint

Unoccupied Cool Setpoint < Protection Cool Setpoint

Table 32shows the Cooling Setpoints present values.

Path: User Registers.VAVcontrol.SpaceTemp.Control

Name on tile	**Data point name**	**Description**
Cool Controller State	CoolControlEnabled	Indicates if cooling is enabled
Current Cool Setpoint	CurrentCoolSetpoint	Current setpoint of space temperature cooling controller

Table 32: Cooling Setpoints present values

Cool Controller State:

This indicates if cooling is enabled actually. The cool controller can be in operation or can be set to a fixed control output depending on the HVAC-Mode. Please refer to chapter 7.5.11 HVAC Modes in the VAV control for more details.

Current Cool Setpoint:

This displays the current setpoint of the space temperature cooling controller. This setpoint is selected by the room occupancy mode. It can be modified by the space temperature external setpoint function, see chapter 7.5.6.3 for more details.

Summer Compensation:

To save energy and to care for the health of the room occupants the Summer Compensation function can be enabled. With increasing *Outdoor Temperature*, it raises the space temperature cooling setpoint for the cooling controller if the *Occupancy Status* is “Occupied” or “Bypass” or “Standby”. This is a proportional curve. The principle is shown in Figure 219.

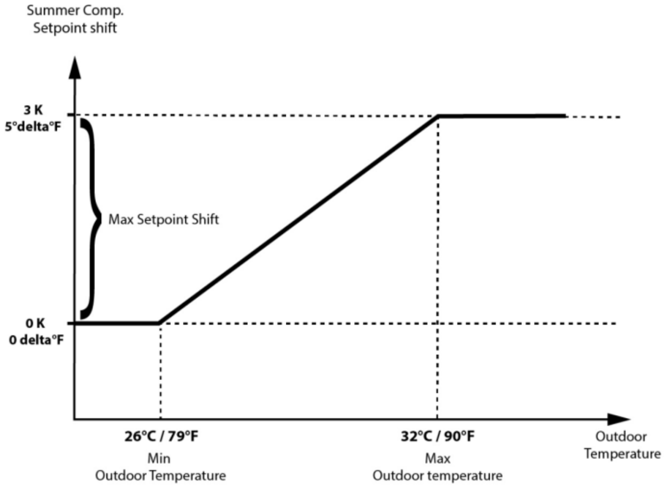

Figure 219: Summer Compensation curve

Because the Space Temperature Control is only operated by the “Master” device in a VAV Group the Summer Compensation function is only available in the “Master”.

Note: The Summer Compensation and the Energy Demand Limiting are operating in parallel. Internally there is a maximum selection of the *Summer Comp Setpoint Shift* and the *EDL Setpoint Shift*. Only the greatest of both values is added to the cooling setpoint; not both values are added to the cooling setpoint.

In case *Summer Comp Setpoint Shift* > *EDL Setpoint Shift:*

Current Cool Setpoint = Occupied Cool Setpoint + Summer Comp Setpoint Shift

Current Cool Setpoint = Standby Cool Setpoint + Summer Comp Setpoint Shift

The Summer Compensation function can be watched and parameterized on the *Space Temperature Setpoints* page of the *VAVstatus* visualization project is displayed as shown in Figure 220.

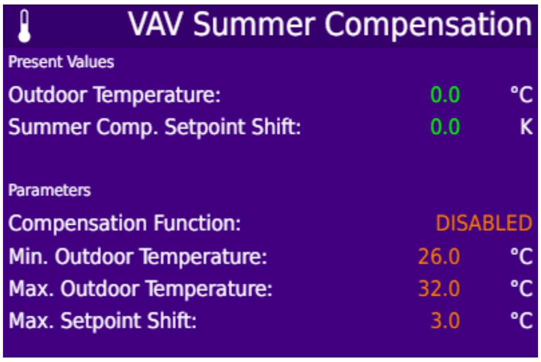

Figure 220: Summer Compensation

Table 33 shows the Summer Compensation parameters.

Path: User Registers.VAVcontrol.SpaceTemp.SummerComp

Name on tile	Data point name	Default	Description
Compensation Function	Enable	Disabled	Enables or disables the Summer compensation function
Min. Outdoor Temperature	MinimumOutdoor Temperature	26°C 78,8°F	Outdoor Temperature when the Setpoint Shift starts raising
Max. Outdoor Temperature	MaximumOutdoo rTemperature	32°C 89,6°F	Outdoor Temperature when the Setpoint Shift stops raising
Max Setpoint Shift	MaximumOffset	3K 5,4°Fdelta	Maximum setpoint shift between minimum and maximum ODT

Table 33: Summer Compensation parameters

Compensation Function:

Per default, the summer compensation is disabled. Therefore, no *Summer Comp. Setpoint Shift* is calculated and added to the space temperature cool setpoint. If the function is enabled, the *Summer Comp. Setpoint Shift* is calculated and added to the space temperature cool setpoint. This is a basic setting that should be done during the commissioning.

Min. Outdoor Temperature:

This value defines the point of *Outdoor Temperature* where the proportional curve starts raising the *Summer Comp. Setpoint Shift* using the proportional curve starting with zero. Below this limit, the *Summer Comp. Setpoint Shift* is constant zero.

Max. Outdoor Temperature:

This value defines the point of *Outdoor Temperature* where the proportional curve stops raising the *Summer Comp. Setpoint Shift* using the proportional curve ending with the *Max. Setpoint Shift* value. Above this limit, the *Summer Comp. Setpoint Shift* is constant *Max. Setpoint Shift* value.

Max. Setpoint Shift:

This value defines the slope of the proportional curve calculating the *Summer Comp. Setpoint Shift* between *Min. Outdoor Temperature* and *Max. Outdoor Temperature.*

Table 34 shows the Summer Compensation present values.

Path: User Registers.VAVcontrol.SpaceTemp.SummerComp

Name on tile	Data point name	Description
Outdoor Temperature	OutdoorTemperature	Present value of current outdoor temperature
Summer Comp. Setpoint Shift	SetpointShift	Current setpoint shift added to the cool setpoint

Table 34: Summer Compensation present values

Outdoor Temperature:

This displays the current *Outdoor Temperature* the summer compensation is using to calculate the *Summer Comp. Setpoint shift*. Usually this is communicated by the manager.

Summer Comp. Setpoint Shift:

This displays the current setpoint shift as the result of the proportional summer compensation curve. This value is added to the cool setpoints if the *Occupancy Status* is “Occupied” or “Bypass” or “Standby”.

Energy Demand Limiting (EDL):

To reduce cooling energy demand in the zones during summertime the AHU control can send a request for Energy Demand Limiting to the Multi Manager. This *EDL Request* is broadcasted to the VAV controllers using the AHU communication. If this *EDL Request* is active, the VAV controller raises the space temperature cooling setpoint for the cooling controller by the *EDL Setpoint Offset* if the *Occupancy Status* is “Occupied” or “Bypass” or “Standby”. For every VAV controller an individual *EDL Setpoint Offset* can be defined that is added to the current cooling setpoint as *EDL Setpoint Shift* in case the *EDL Request* is active.

Because the Space Temperature Control is only operated by the “Master” device in a VAV Group the Energy Demand Limiting function is only available in the “Master”.

Note: The Summer Compensation and the Energy Demand Limiting are operating in parallel. Internally there is a maximum selection of the *EDL Setpoint Shift* and the *Summer Comp Setpoint Shift.* Only the greatest of both values is added to the cooling setpoint; not both values are added to the cooling setpoint.

In case *EDL Setpoint Shift* > *Summer Comp Setpoint Shift:*

Current Cool Setpoint = Occupied Cool Setpoint + EDL Setpoint Shift

Current Cool Setpoint = Standby Cool Setpoint + EDL Setpoint Shift

The Energy Demand Limiting function can be watched and parameterized on the *Space Temperature Setpoints* page of the *VAVstatus* visualization project is displayed as shown in Figure 221.

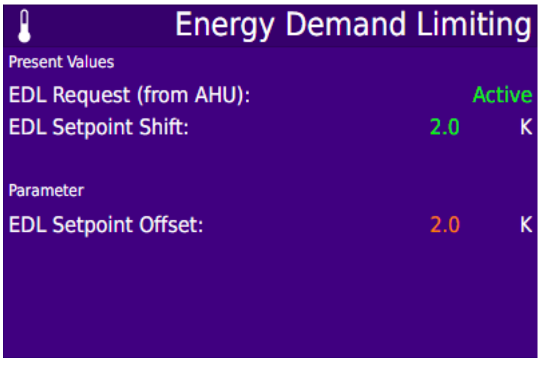

Figure 221: Energy Demand Limiting

Table 35 shows the Energy Demand Limiting parameter.

Path: User Registers.VAVcontrol.SpaceTemp.EnergyDemandLimiting

Name on tile	Data point name	Default	Description
EDL Setpoint Offset	EnergyDemandLimitOffset	2°C 3,6°F	Offset to raise the cooling setpoint on EDL request

Table 35: Energy Demand Limiting parameter

EDL Setpoint Offset:

This value defines the offset that is added to the cooling setpoint (Occupied or Standby) if the EDL Request (from AHU) is active. It allows an individual setting for every room.

Table 36 shows the Energy Demand Limiting present values.

Path: User Registers.VAVcontrol.SpaceTemp.EnergyDemandLimiting

Name on tile	Data point name	Description
EDL Request (from AHU)	EnergyDemandLimitActive	Present value of current request of Energy demand Limiting from AHU
EDL Setpoint Shift	EnergyDemandLimitSpShift	Current EDL setpoint shift added to the cool setpoint

Table 36: Energy Demand Limiting present values

EDL Request (from AHU):

This displays the current request of Energy Demand Limiting that is sent by the AHU control communicated by the manager.

EDL Setpoint Shift:

This displays the current setpoint shift that is activated if the *EDL Request (from AHU)* is active. If the *EDL Request (from AHU)* is inactive, the *EDL Setpoint Shift* is set to a zero value.

Heating Setpoints:

The heating setpoints function is available only one of the reheat actuator functions (VAVreheatHwMod, VAVreheatHwFloat, VAVreheatElMod, VAVreheatEl3St, and VAVnoReheat) is connected to the core.

The heating setpoints can be watched and parameterized on the *Space Temperature Setpoints* page of the *VAVstatu*s visualization project as shown in Figure 222.

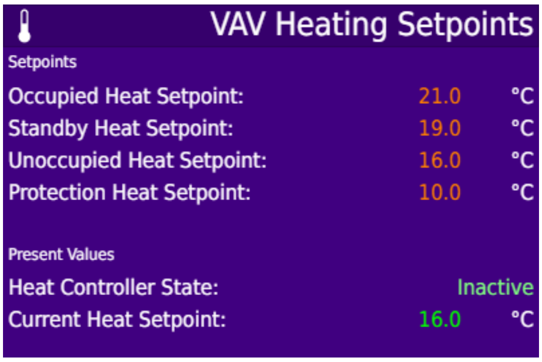

Figure 222: Space Temperature Heating Setpoints

Table 37 shows the Heating Setpoints parameters.

Path: User Registers.VAVcontrol.ReheatHwMod.HeatControl *)

Name on tile	**Data point name**	**Default**	**Description**
Occupied Heat Setpoint	OccupiedHeatSetpoint	21°C 69,8°F	Space temperature setpoint heat controller in occupancy mode “occupied”
Standby Heat Setpoint	StandbyHeatSetpoint	19°C 66,2°F	Space temperature setpoint heat controller in occupancy mode “standby”
Unoccupied Heat Setpoint	UnoccupiedHeatSetpoint	16°C 60,8°F	Space temperature setpoint heat controller in occupancy mode “unoccupied”
Protection Heat Setpoint	ProtectionHeatSetpoint	10°C 50°F	Space temperature setpoint heat controller if EnergyHoldOff is active

Table 37: Heating Setpoints parameters

*): Please note that the data point path for heating is depending on the connected reheat actuator using different folder names:

Hot Water Reheat, modulating	folder name: ReheatHwMod
Hot Water Reheat, floating	folder name: ReheatHwFloat
Electric Reheat, modulating	folder name: ReheatElMod
Electric Reheat, 3 stages	folder name: ReheatEl3St
No Reheat, but heat control	folder name: NoReheat

Occupied Heat Setpoint:

This is the space temperature setpoint for the heating controller if the occupancy mode of the room is “occupied”.

Standby Heat Setpoint:

This is the space temperature setpoint for the heating controller if the occupancy mode of the room is “standby”.

Unoccupied Heat Setpoint:

This is the space temperature setpoint for the heating controller if the occupancy mode of the room is “unoccupied”.

Protection Heat Setpoint:

This is the space temperature setpoint for the heating controller if the EnergyHoldOff function is active caused by an opened window. This overrules the setpoint selection of the occupancy mode.

Generally, the values of the heating setpoints should be set as follows:

Occupied Heat Setpoint > Standby Heat Setpoint

Standby Heat Setpoint > Unoccupied Heat Setpoint

Unoccupied Heat Setpoint > Protection Heat Setpoint

Table 38 shows the Heating Setpoints present values.

Path: User Registers.VAVcontrol.SpaceTemp.Control

Name on tile	Data point name	Description
Heat Controller State	HeatControlEnabled	Indicates if heating is enabled
Current HeatSetpoint	CurrentHeatSetpoint	Current setpoint of space temperature heating controller

Table 38: Heating Setpoints present values

Heat Controller State:

This indicates if heating is enabled actually. The heat controller can be in operation or can be set to a fixed control output depending on the HVAC-Mode. Please refer to chapter 7.5.11 HVAC Modes in the VAV control for more details.

Current Heat Setpoint:

This displays the current setpoint of the space temperature heating controller. This setpoint is selected by the room occupancy mode. It can be modified by the space temperature external setpoint function, see chapter 7.5.6.3 for more details.

7.5.6.3 Space Temperature external Setpoint

General Function:

As an additional function, it is possible to modify or shift the space temperature setpoint externally. There are two options of external setpoint modification, to shift the setpoint using an offset value and / or setting an absolute setpoint value.

The most useful option is to shift the space temperature setpoint by an offset value. In this case, the setpoint offset value is shifting the Current Cool Setpoint and the Current Heat Setpoint if the Occupancy Status is Occupied or Standby.

It can be enabled or disabled is reset the setpoint offset to a zero value in the night. If enabled the setpoint offset is reset to 0°C or 0°F at midnight every day. The reset function is available only if the device is the "Master" VAV Group.

If the absolute external setpoint is used, the occupied and standby setpoints are recalculated internally based on this external setpoint relating to the difference between the preset cooling and heating setpoints.

The setpoint offset value and the absolute external setpoint can be connected as sensors (e.g. from a 3rd party hardwired or network thermostat with setpoint reset) to the local inputs or the Favorites of the LIOB-AIR device.

Both values can also be displayed and adjusted by the VAVstatus visualization project.

The setpoint offset value is also adjustable by an L-STAT network thermostat automatically using the up and down arrow buttons.

The space temperature external setpoint display is shown on the *Status Overview* page of the *VAVstatus* visualization project as shown in Figure 223. This displays the current resulting values of the external offset value and the absolute external setpoint value.

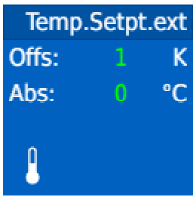

Figure 223: Space Temperature external Setpoint tile in Status Overview

Inputs:

In the LIOB-AIR I/O Standard configuration, the external space temperature setpoint offset is located on the universal input UI2. Because the external space temperature absolute setpoint is not needed very often, it is not included in the LIOB-AIR I/O Standard configuration. For more information see chapter *7.3.2 Device Configuration*.

If an L-STAT network thermostat is connected, it can be configured to modify the external space temperature offset by using the up and down arrow buttons. It can also be configured how the control setpoint shall be displayed on the L-STAT device.

If there are multiple LIOB-AIR devices in a room, they have to be parameterized as a "VAV Group" to be able to operate a proper room control. Either a device can have hard-wired sensors or L-STATs connected (not useful with both at the same time) or no sensor connected. The external offset value and the absolute external setpoint value are taken from the device where the last value modification was recognized.

Favorites:

The Favorites of the external space temperature setpoint are shown in Table 39.

Path: Favorites.VAVcontrol.SpaceTempSetpoint

Favorite name	**Description**
inExternalSetpointOffset	Input of External Setpoint Offset
inExternalSetpoint	Input of absolute External Setpoint
outExternalSetpointOffsetFb	Output of External Setpoint Offset Feedback
outExternalSetpointFb	Output of absolute External Setpoint Feedback
outEffectiveControlSetpoint	Output of Effective Control Setpoint Feedback
outDisplayControlSetpoint	Output of Display Control Setpoint Feedback

Table 39: External Space Temperature Setpoint Favorites

inExternalSetpointOffset (Input)

The external setpoint offset measurement function has this one Favorite. To this Favorite, the Local I/O *UI2* is connected (see I/O Standard configuration). In case of using a third party network thermostat, the data point of the external setpoint offset coming from this device can be connected to the Favorite.

inExternalSetpoint (Input)

The external absolute setpoint measurement function has this one Favorite. To this Favorite, no Local I/O is connected (see I/O Standard configuration). In case of using a third party network thermostat, the data point of the external absolute setpoint coming from this device can be connected to the Favorite.

outExternalSetpointOffsetFb (Output)

The present value of the current external setpoint offset feedback is displayed on this Favorite. In case of using a third party network thermostat the data point of the external setpoint offset feedback can be connected to the Favorite and will be sent as a feedback to the thermostat, e.g. for display purposes.

outExternalSetpointFb (Output)

The present value of the effective control setpoint feedback is displayed on this Favorite. In case of using a third party network thermostat the data point of the external absolute setpoint feedback can be connected to the Favorite and will be sent as a feedback to the thermostat, e.g. for display purposes.

outEffectiveControlSetpoint (Output)

The present value of the current *Effective Space Temp. Setpoint* (see chapter 7.5.6.2) feedback is displayed on this Favorite. In case of using an external controller device, the data point of the *Effective Space Temp. Setpoint* feedback can be connected to the Favorite and will be sent as a feedback, e.g. for display purposes.

outDisplayControlSetpoint (Output)

The present value of the current *Display Space Temp. Setpoint* (see chapter 7.5.6.2) feedback is displayed on this Favorite. In case of using an external controller device, the data point of the *Display Space Temp. Setpoint* feedback can be connected to the Favorite and will be sent as a feedback, e.g. for display purposes.

Detailed Function

As described in chapter 7.5.6.2 the *Current Cool Setpoint* and the *Current Heat Setpoint* are selected by the *Occupancy Status* from the multiple cooling and heating setpoints of the dedicated occupancy states. In the occupancy states "Occupied", "Bypass" or "Standby", the *Current Cool Setpoint* and the *Current Heat Setpoint* are shifted by adding the *External Setpoint Offset* value.

This setpoint shift is limited by the *Setpoint Shift Range* parameter. It defines the complete shift range "around" the setpoint (e.g. 10K means -5K…+5k).

The *External Absolute Setpoint* only becomes active on values that are >= 10 (°C or °F). In this case a "zero energy band" ZEB is calculated between the cooling and heating setpoints for the occupancy states "Occupied" or "Standby" (see chapter 7.5.6.2). The *External Absolute Setpoint* is in the "middle" of this ZEB and calculates the *Current Cool Setpoint* and the *Current Heat Setpoint* according to the current *Occupancy Status.* These setpoints are also shifted by using the *External Setpoint Offset* value.

If the cooling controller is active the *Effective Space Temp. Setpoint* equals the *Current Cool Setpoint.* If the heating controller is active the *Effective Space Temp. Setpoint* equals the *Current Heat Setpoint.*

The Space Temperature Setpoints External can be watched, modified and parameterized on the *External Space Temperature Setpoints* page of the *VAVstatus* visualization project as shown in Figure 224.

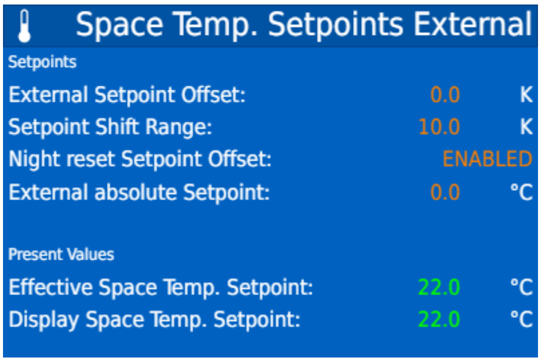

Figure 224: Space Temp. Setpoints External configuration

Table 40 shows the Space Temp. Setpoints External present values.

Path: User Registers.VAVcontrol.SpaceTempSetpoint

Name on tile	Data point name	Description
Effective Space Temp. Setpoint	EffectiveControlSetpoint	Current Setpoint for the active space temp. cooling or heating controller
Display Space Temp. Setpoint	DisplayControlSetpoint	Averaged space temperature setpoint for display purposes

Table 40: Space Temp. Setpoints External present values

Effective Space Temp. Setpoint:

The present value of the *Effective Space Temp. Setpoint* that is selected by the *Occupancy Status* and the active cooling or heating controller based on the *Current Cool Setpoint* and *Current Heat Setpoint.* In the occupancy states “Occupied”, “Bypass” or “Standby” these both setpoints are shifted by <u>adding</u> the *External Setpoint Offset* value.

This setpoint shift is limited by the *Setpoint Shift Range* parameter. It defines the complete shift range “around” the setpoint (e.g. 10K means -5K…+5k).

-*(Setpoint Shift Range* / 2*) <= External Setpoint Offset <= (Setpoint Shift Range* / 2*)*

If the *External Absolute Setpoint* only becomes active (>= 10 (°C or °F)), a “zero energy band” ZEB is calculated between the cooling and heating setpoints for the occupancy states “Occupied” or “Standby” (see chapter 7.5.6.2).

ZEBoccupied = (*Occupied Cool Setpoint - Occupied Heat Setpoint*) /2

ZEBstandby = (*Standby Cool Setpoint - Standby Heat Setpoint*) /2

The *External Absolute Setpoint* is in the “middle” of this ZEB and calculates the *Current Cool Setpoint* and the *Current Heat Setpoint* according to the current *Occupancy Status.*

If *Occupancy State* = “Occupied” then:

Current Cool Setpoint = External Absolute Setpoint + ZEBoccupied

Current Heat Setpoint = External Absolute Setpoint - ZEBoccupied

If *Occupancy State* = “Standby” then:

Current Cool Setpoint = External Absolute Setpoint + ZEBstandby

Current Heat Setpoint = External Absolute Setpoint - ZEBstandby

These setpoints are also shifted by using the *External Setpoint Offset* value!

If *Occupancy State* = “Unoccupied” then there is <u>no use</u> of the *External Setpoint Offset* or the *External Absolute Setpoint.*

The active cooling or heating space temperature controller is maintaining this *Effective Space Temp. Setpoint*.

Display Space Temp. Setpoint:

As described above the *Effective Space Temp. Setpoint* is switching depending on which controller cooling or heating is activated. However, for display purposes it is often better to have a more constant setpoint value to prevent confusing the room occupants. For that reason, the Display Space Temp. Setpoint is calculated as the “middle” occupied setpoint that is most understandable for the room occupants (see chapter 7.5.6.2).

Table 41 shows the Space Temp. Setpoints External parameters.

Path: User Registers.VAVcontrol.SpaceTempSetpoint

Name on tile	**Data point name**	**Default**	**Description**
External Setpoint Offset	ExternalSetpointOffset	0,0K 0,0°Fdelta	Space temperature Setpoint offset from external
Setpoint Shift Range	SetpointShiftRange	10K°C 18°Fdelta	Shift Range of the External Setpoint Offset
Night reset Setpoint Offset	OffsetNightReset	Disabled	Enable or disable the nightly reset to 0 of the setpoint offset
External absolute Setpoint	ExternalSetpoint	0°C 0°F	Absolute Setpoint from External

Table 41: Space Temp. Setpoints External parameters

External Setpoint Offset:

This External Setpoint Offset User Register shifts the *Current Cool Setpoint* and *Current Heat Setpoint* as described above. The Favorite *inExternalSetpointOffset* directly writes to this User Register. However, it also can be written directly by the Visualization (OPC) e.g. VAVstatus. If an L-STAT network thermostat is connected, it modifies the *External Setpoint Offset* User Register by using the up and down arrow buttons automatically.

Special Hints:

The *External Setpoint Offset* User Register also can be written and synchronized by the corresponding BACnet data point if the *External Setpoint Offset* shall be modified by an external BACnet device.

Setpoint Shift Range:

The range of shifting the setpoints by the *External Setpoint Offset* is limited by the *Setpoint Shift Range* as described above:

-*(Setpoint Shift Range* / 2*) <= External Setpoint Offset <= (Setpoint Shift Range* / 2*)*

Night reset Setpoint Offset:

This enables or disables the automatic reset of the External Setpoint Offset to 0°C or 0°F at midnight (0:00 am, fixed) every day. This function saves energy because the setpoint offset is reset every night the room occupant has to adjust the setpoint offset again every day due to his requirements. If the comfort of the user has more priority than the energy consumption, this function can be disabled. Then the setpoint offset will remain on its current value for days, weeks or months until the next change by the user. This function is only operating if the device is the “Master” of a VAV Group. “Slaves” do not perform this reset function.

External absolute Setpoint:

The *External absolute Setpoint* User Register allows defining a Setpoint from external as described above. It only becomes active if (>= 10 (°C or °F)). The Favorite *inExternalSetpoint* directly writes to this User Register. However, it also can be written directly by the Visualization (OPC) e.g. VAVstatus.

Special Hints:

The *External absolute Setpoint* User Register also can be written and synchronized by the corresponding BACnet data point if the *External absolute Setpoint* shall be modified by an external BACnet device.

7.5.6.4 Space Temperature Control

General Function:

The space temperature is controlled by 2 dedicated PI controllers, the cooling controller and the heating controller. The cooling controller is maintaining the cooling setpoints and the heating controller is maintaining the heating setpoints. Both controllers are operating alternatively they are never operating in parallel. Which controller is enabled, is decided automatically by a changeover function depending on the current space temperature relating to the current cooling and heating setpoints. The control outputs of the controllers are used by sequence functions to reset the air flow setpoints, control reheat and peripheral heat valves or reset a discharge air temperature setpoint and request fan operations. Both controllers can be parameterized separately and differently.

Detailed Function:

The principle of the space temperature control is shown as an example in Figure 225 (in the red box).

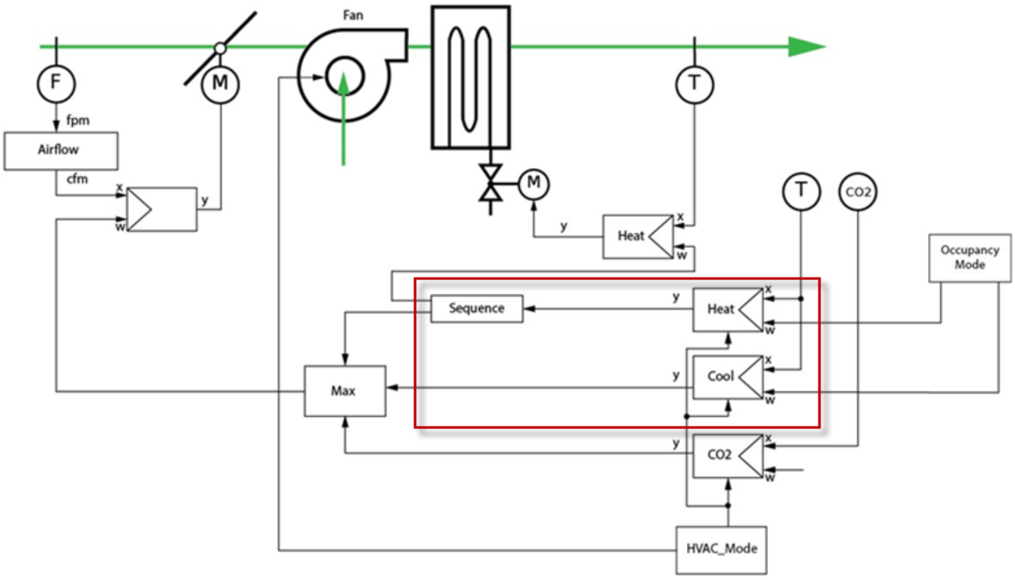

Figure 225: Example VAV-box space temperature control scheme

As described in chapter *7.5.6.2* the space temperature setpoints are selected by the *Occupancy State*. Depending on the value of current *Space Temperature* relating to the *Current Cool Setpoint* and *Current Heat Setpoint*, the required space temperature controller cooling or heating is activated. The state is indicated on *Cool Controller State* and *Heat Controller State*. This happens after a *Change Over Delay Time* delay has elapsed and ensures that either the cooling or the heating controller is activated and never both controllers.

The current active controller is controlling the space temperature maintaining the regarding setpoint. The *Cool Control Output* of the cooling controller only resets the air flow setpoint. The *Heat Control Output* of the heating controller is sequenced to reset the air flow setpoint and to reset the discharge air temperature setpoint as shown in Figure 226. This sequence function is depending on which sensors and actuators are connected to the core (chapter *7.3.1 Application Structure*) and so it would be also able to control reheat and peripheral heat valves directly as shown in Figure 227. All components of the sequence can be parameterized and so it can be adjusted exactly to the individual project requirements.

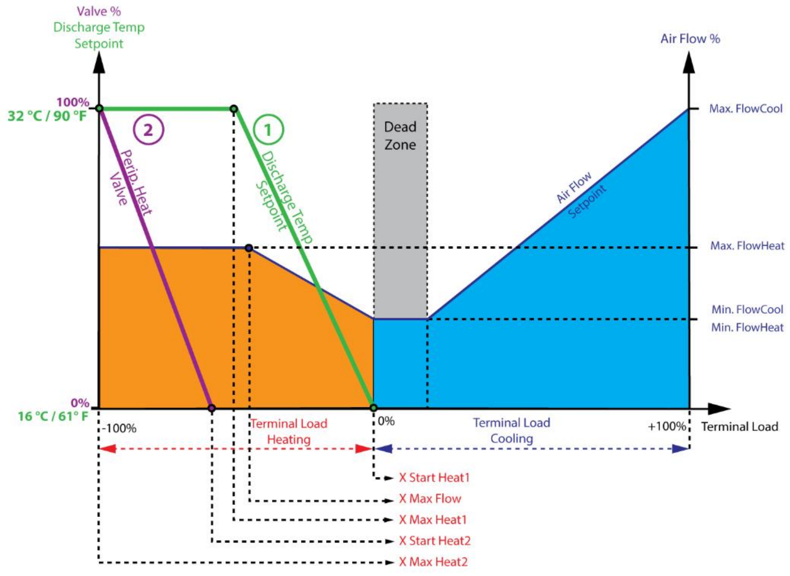

Figure 226: Example sequence scheme with discharge air sensor

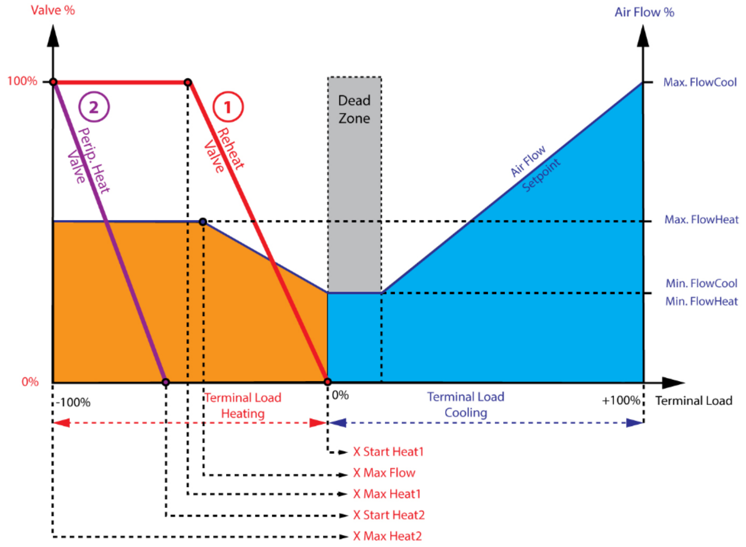

Figure 227: Example sequence scheme without discharge air sensor

Depending on the operating condition of the air handling unit (AHU) that provides cold or warm supply air the cooling and heating space temperature controller are released for operation. The AHU sets the *HVAC Mode* (AUTO, HEAT, COOL,….) in the manager and this is communicated to the VAV controllers. If the AHU provides warm supply air (HEAT, MRNG_WRMUP) only the heating space temperature controller is released for operation. The cooling controller is permanently locked in this case. If the AHU provides cold supply air in the normal mode (AUTO) then the space temperature control is allowed to use either the cooling or the heating controller. If the AHU provides cold supply air in the special modes (COOL, PRE_COOL) then only the cooling space temperature controller is released for operation. The heating controller is permanently locked in this case. If the AHU provides cold supply air the special mode NIGHT_PURGE, then the cooling and heating controller are permanently locked.

The *Terminal Load* indicates the need of heating and cooling energy of the room. It is calculated based on the control outputs of the cooling and heating controller. Cooling energy is needed in the range of 0…+100% terminal load. Heating energy is needed in the range of 0…-100% terminal load.

It is possible to lock the heating function depending on the *Outdoor Temperature* in summer time. This is useful to save energy or in case e.g. the central heating plant is not providing hot water in summer time. If the *Outdoor Temperature* increases above an adjustable limit (see chapter *7.5.15* for more details) the *Heat Lockout State* will become active. If the *Heat Lockout State* is active, the heating controller is locked and no heating function of the heating sequence will become active. Only cooling control is possible in this case.

The cooling and heating PI controllers have dedicated control parameters to achieve a stable and proper control function. Therefore, it is possible to do a separate and different parameterization of the *Prop. Gain Cool Controller*, *Integr. Time Cool Controller* and *Prop. Gain Heat Controller*, *Integr. Time Heat Controller*. These parameters are set to useful default values but they allow individual settings to match the VAV system setup.

If there are multiple LIOB-AIR devices in a room, they have to be parameterized as a “VAV Group” to be able to operate a proper room control. One device in the group has to be set as the “Master”. This “Master” device only is executing the space temperature control function with cooling and heating. The control outputs of the cooling and heating controllers are communicated from the “Master” to all “Slaves” in the group. The sequence functions to reset the air flow setpoints, control reheat and peripheral heat valves or reset a discharge air temperature setpoint or request fan operations are operated in the “Slaves” according to the control outputs of the “Master”. The “Slaves” do not perform a space temperature control. Please refer to chapter 7.6.2 for more information.

Cooling Controller (overview)

The first Overview of the VAV space temperature cooling controller is shown on the *Space Temp. Controller* page of the *VAVstatus* visualization project as shown in Figure 228. Only the most important present values are shown here without settings.

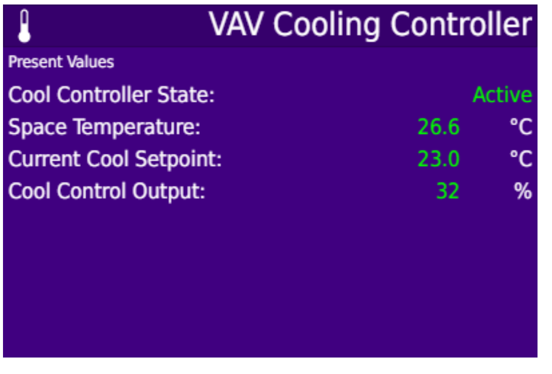

Figure 228: Space Temperature Cooling Controller (overview)

These present values are also shown on the complete cooling controller view as well and are described there.

Cooling Controller (complete view)

The cooling controller can be watched and parameterized completely on the *Space Temp. Controller Para.* page of the *VAVstatus* visualization project as shown in Figure 229.

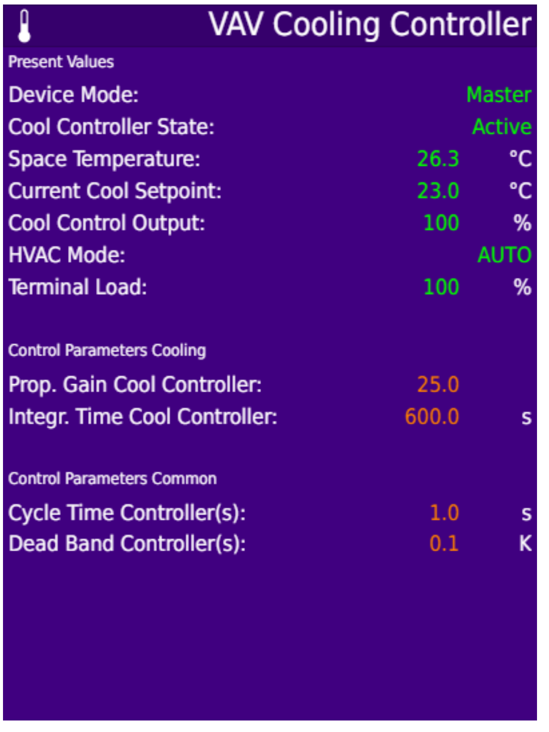

Figure 229: Space Temperature Cooling Controller (complete)

Table 42 shows the present values of the space temperature cooling controller.

Path: User Registers.VAVcontrol.SpaceTemp.Control

Name on tile	**Data point name**	**Description**
Device Mode	VAVgroupDeviceMode	Indicates if the device is Master or Slave in a VAV Group
Cool Controller State	CoolControlEnabled	Indicates if the controller is active or not
Space Temperature	SpaceTemperature	Present value of the space temperature
Current Cool Setpoint	CurrentCoolSetpoint	Present value of the current space temperature cooling setpoint
Cool Control Output	CoolControlOutput	Present value of the cooling controller output
HVAC Mode	HVACmode	Present value of HVAC mode in the VAV
Terminal Load	TerminalLoad	Present value of terminal load cooling or heating

Table 42: Present values of space temperature cooling control

Device Mode:

Indicates if the device is set as the “Master” or as a “Slave” in the “VAV-Group”. Only the Master is executing the space temperature control and it sends the *Cool Control Output* and *Heat Control Output* to the “Slaves”. The “Slaves” do not execute any space temperature control, and so the cooling controller cannot be watched in a “Slave”. The “Slaves” are operating the sequence functions to reset the air flow setpoints, control reheat and peripheral heat valves or reset a discharge air temperature setpoint or request fan operations according to the control outputs of the “Master”.

Cool Controller State:

This indicates if cooling is enabled actually. The cool controller can be in operation or can be set to a fixed control output depending on the HVAC-Mode. Please refer to chapter 7.5.11 HVAC Modes in the VAV control for more details. If the *Space Temperature* is greater than the *Current Cool Setpoint*, the cooling controller will be enabled. It will be disabled if the *Space Temperature* decreases below the *Current Cool Setpoint* AND the *Cool Control Output* is < 0,5%. The cooling controller will also be disabled if the heating controller is enabled.

Space Temperature:

Here the present value of the *Space Temperature* is displayed. It is used by the space temperature cooling and heating controllers as the control value. This value comes from the local wired hardware input UI1 linked to the inSpaceTemp Favorite (see standard I/O configuration, chapter *7.3.2 Device Configuration*) or from a connected L-STAT automatically. It is also possible to connect a supported network sensor of any vendor to the inSpaceTemp Favorite. If there are multiple LIOB-AIR devices in a room building a “VAV-Group” (chapter 7.6.2) which have any sensors or stats connected, the Space Temperature is calculated as the average value in the master device automatically. Please note that a dedicated device only supports either a sensor connected to the Favorite or an L-STAT, but not both at the same time.

Current Cool Setpoint:

This displays the current setpoint of the space temperature cooling controller. This setpoint is selected by the room occupancy mode and can be modified by the user with the external setpoint function. If the cooling controller is active, it maintains this *Current Cool Setpoint*.

Cool Control Output:

This displays the current control output of the space temperature cooling controller. This output is forwarded to the *Air Flow Cool Sequence* that calculates the air flow setpoint for the flow controller. In a “VAV Group”, the “Master” communicates the *Cool Control Output* to the “Slaves”. The *Air Flow Cool Sequence* is operated in every slave individually. The value range is 0…100%.

HVAC Mode:

The *HVAC Mode* coming from the AHU releases the space temperature cooling and heating controllers for operation:

AUTO:	cooling or heating is possible
HEAT:	only heating is possible, cooling is locked
MRNG_WRMUP:	only heating is possible with Standby setpoint only, cooling is locked

COOL: only cooling possible, heating is locked

NIGHT_PURGE: no temperature control, cooling and heating are locked

PRE_COOL: only cooling possible, heating is locked

OFF: cooling or heating is possible

Note: Because there is no primary air in HVAV Mode OFF, the cooling controller will run to Cool Control Output 100% if cooling is active. This is the normal behavior.

Terminal Load:

The Terminal Load indicates the energy demand of the room based on the Cool Control Output and the Heat Control Output. This is aggregated and communicated by the manager to the AHU control. It is used in the AHU control for an energy optimal operation of the air handler.

Terminal Load = *Cool Control Output – Heat Control Output*

Terminal Load 0…100% is the demand of cooling energy

Terminal Load 0…-100% is the demand of heating energy

Table 43 shows the present values of the space temperature cooling controller.

Path: User Registers.VAVcontrol.SpaceTemp.Control

Name on tile	**Data point name**	**Default**	**Description**
Prop. Gain Cool Controller	ProportionalGainCooling Control	25,0 (SI) 13,9 (US)	Proportional gain of the cooling controller
Integr. Time Cool Controller	IntegralTimeCoolingCont rol	600s	Integral time of the cooling controller
Cycle Time Controller(s)	CycleTime	1,0s	Cycle time of the cooling and heating controller(s)
Dead Band Controller(s)	DeadBandControllers	0,0K 0,0d°F	Dead band valid for the cooling and heating controller(s)

Table 43: Parameters of space temperature cooling control

Prop. Gain Cool Controller:

The *Prop. Gain Cool Controller* parameter (also known as K_p) defines the direct reaction to the control difference (which is the difference between the *Space Temperature* and the *Current Cool Setpoint*). If the gain is 25 then an input change by 1 °C results in a *Cool Control Output* of 25%. The proportional band is calculated by 100%/gain. In the example, it requires a control difference of 4 °C to reach 100% control output. Higher values will lead to a faster response of the controller but will also increase the possible overshot and the risk of oscillation. Lower values will lead to a slower response of the controller but will also decrease the possible overshot and the risk of oscillation.

Integr. Time Cool Controller:

The *Integr. Time Cool Controller* parameter (also known as reset time T_i) determines the influence of the integral component to the controller output. In the step response, it represents the time the integral component needs to reach the same amount as the proportional component. Lower values will lead to a faster response of the controller but will also increase the possible overshot and the risk of oscillation. Higher values will lead to a slower response of the controller but will also decrease the possible overshot and the risk of oscillation.

The control output as a step response is shown basically in Figure 230.

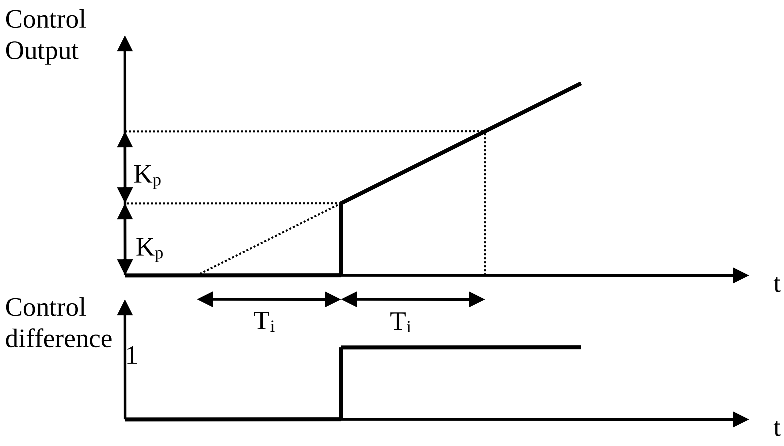

Figure 230: PI Controller step response

Cycle Time Controller(s):

The *Cycle Time Controller(s)* parameter defines the time cycle the cooling and heating controllers are executed commonly. The default value of 1s is pretty good for the VAV space temperature cooling and heating controllers. Shorter cycle times can increase the accuracy of the control function only in very special cases.

Dead Band Controller(s):

The *Dead Band Controller(s)* parameter defines a dead band in which the control difference is considered zero. This parameter is valid for the cooling and the heating controller in common. It is used to silence the controller at nearly zero control difference. Usually, the default value of zero (no deadback) can be used for the space temperature controller, as there is a resulting dead zone between the heating and cooling setpoints anyway.

Heating Controller (overview)

The first Overview of the VAV space temperature heating controller setpoints is shown on the *Space Temp. Controller* page of the *VAVstatus* visualization project as shown in Figure 231. Only the most important present values are shown here without settings.

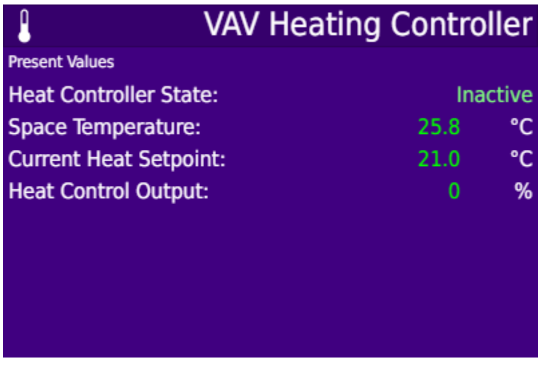

Figure 231: Space Temperature Heating Controller (overview)

These present values are also shown on the complete heating controller view as well and are described there.

Heating Controller (complete view)

The heating controller can be watched and parameterized completely on the *Space Temp. Controller Para.* page of the *VAVstatus* visualization project as shown in Figure 232.

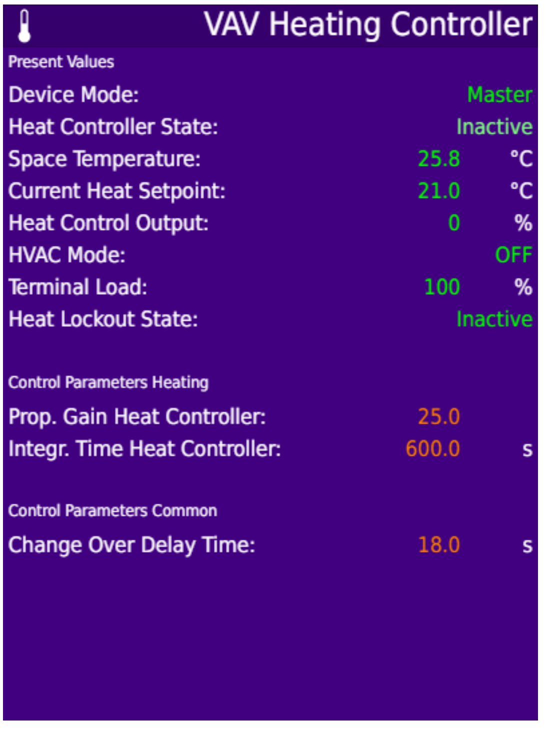

Figure 232: Space Temperature Heating Controller (complete)

Table 44 shows the present values of the space temperature heating controller.

Path: User Registers.VAVcontrol.ReheatHwMod.HeatControl *)

Name on tile	Data point name	Description
Device Mode	VAVgroupDeviceMode	Indicates if the device is Master or Slave in a VAV Group
Heat Controller State	HeatControlEnabled	Indicates if the controller is active or not
Space Temperature	SpaceTemperature	Present value of the space temperature
Current Heat Setpoint	CurrentHeatSetpoint	Present value of the current space temperature heating setpoint
Heat Control Output	HeatControlOutput	Present value of the heating controller output
HVAC Mode	HVACmode	Present value of HVAC mode in the VAV
Terminal Load	TerminalLoad	Present value of terminal load cooling or heating
Heat Lockout State	HeatLockoutState	Present value of heat lockout state

Table 44: Present values of space temperature heating control

*): Please note that the data point path for heating is depending on the connected reheat actuator using different folder names:

Hot Water Reheat, modulating folder name: ReheatHwMod

Hot Water Reheat, floating folder name: ReheatHwFloat

Electric Reheat, modulating folder name: ReheatElMod

Electric Reheat, 3 stages folder name: ReheatEl3St

No Reheat, but heat control folder name: NoReheat

Device Mode:

See *Device Mode* in Cooling Controller.

Heat Controller State:

This indicates if heating is enabled actually. The heat controller can be in operation or can be set to a fixed control output depending on the HVAC-Mode. Please refer to chapter 7.5.11 HVAC Modes in the VAV control for more details. If the *Space Temperature* is lower than the *Current Heat Setpoint*, the cooling controller will be enabled. It will be disabled if the *Space Temperature* increases above the *Current Heat Setpoint* AND the *Heat Control Output* is < 0,5%. The heating controller will also be disabled if the cooling controller is enabled.

Space Temperature:

See *Space Temperature* in Cooling Controller.

Current Heat Setpoint:

This displays the current setpoint of the space temperature heating controller. This setpoint is selected by the room occupancy mode and can be modified by the user with the external setpoint function. If the heating controller is active, it maintains this *Current Heat Setpoint*.

Heat Control Output:

This displays the current control output of the space temperature heating controller. This output is forwarded to the *Air Flow Heat Sequence* that calculates the air flow setpoint for the flow controller. In addition, this output is forwarded to the *Reheat/Periph. Sequence* that calculates the outputs for the reheat and peripheral heat valves. Or the sequence calculates the setpoint for the discharge temperature if the discharge temp sensor is connected to the core as well. In addition, this output is connected to the Fan Heat Sequence that calculates some requests for the fan.

HVAC Mode:

See *HVAC Mode* in Cooling Controller.

Terminal Load:

See *Terminal Load* in Cooling Controller.

Heat Lockout State:

This displays if the heating function is locked depending on the *Outdoor Temperature* in summer time (see chapter *7.5.15* for more details). If the *Heat Lockout State* is active, the space temperature heating controller is locked.

Table 45 shows the present values of the space temperature cooling controller.

Path: User Registers.VAVcontrol.ReheatHwMod.HeatControl *)

Name on tile	**Data point name**	**Default**	**Description**
Prop. Gain Heat Controller	ProportionalGainHeatingControl	25,0 (SI) 13,9 (US)	Proportional gain of the heating controller
Integr. Time Heat Controller	IntegralTimeHeatingControl	600s	Integral time of the heating controller
Change Over Delay Time	ChangeOverDelayTime	18,0s	Change over delay time between the cooling and heating controller(s)

Table 45: Parameters of space temperature heating control

*): Please note that the data point path for heating is depending on the connected reheat actuator using different folder names:

Hot Water Reheat, modulating	folder name: ReheatHwMod
Hot Water Reheat, floating	folder name: ReheatHwFloat
Electric Reheat, modulating	folder name: ReheatElMod
Electric Reheat, 3 stages	folder name: ReheatEl3St
No Reheat, but heat control	folder name: NoReheat

Prop. Gain Heat Controller:

See *Prop. Gain Cool Controller* in Cooling Controller in principal.

Integr. Time Heat Controller:

See *Integr. Time Cool Controller* in Cooling Controller in principal.

Change Over Delay Time:

The *Change Over Delay Time* parameter defines a time delay between the automatic deactivation of the cooling controller and activation of the heating controller and vice versa. This shall stabilize the operation of the space temperature control in transition situations. During the *Change Over Delay Time,* both controllers are inactive.

7.5.6.5 Space Temperature Control Sequences

General Function:

The control outputs of the space temperature cooling and heating controllers are used to control the air flow setpoint, the reheat valve or the discharge air temperature setpoint and the peripheral heat setpoint. The fan can also be requested by the heating controller output.

These multiple control outputs are calculated by the control sequences. The Air Flow Cool Sequence calculates the *Setpoint Air Flow Cooling*. The Air Flow Heat Sequence calculates the *Setpoint Air Flow Heating*. The Reheat/Periph. Sequence calculates the control outputs for the reheat or the discharge air temp. setpoint and the control output for the peripheral heat. The Fan Heat Sequence calculates the fan request.

Air Flow Cool Sequence

The *Cool Control Output* of the space temperature cooling controller is directly forwarded to the *Air Flow Cool Sequence* if the LIOB-AIR is operating as a “Master”. If it is operating as a “Slave”, it receives the *Cool Control Output* from the “Master” and this is forwarded to the *Air Flow Cool Sequence*. The *Air Flow Cool Sequence* calculates the *Setpoint Air Flow Cooling* that will be maintained by the *Air Flow Controller*.

The setpoint calculation is based on a linear curve with gets the *Cool Control Output* as input of 0…100% and generates the *Setpoint Air Flow Cooling* as output between the *Min.Air Flow Cool* and *Max. Air Flow Cool*, see Figure 233.

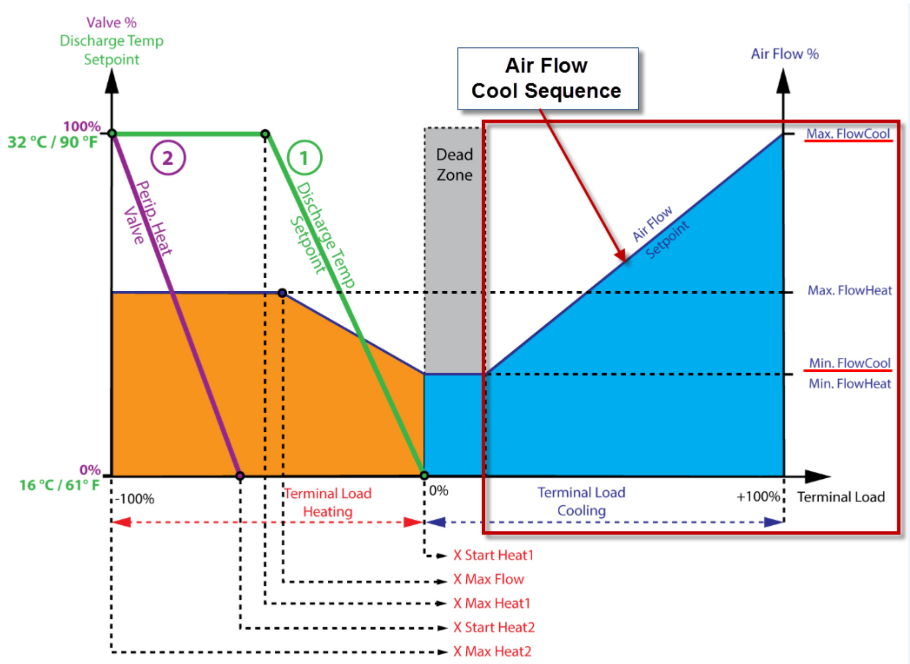

Figure 233: Air Flow Cool Sequence scheme

The *Air Flow Cool Sequence* can be watched on the *Temp.Sequence Air Flow* page of the *VAVstatus* visualization project as shown in Figure 234.

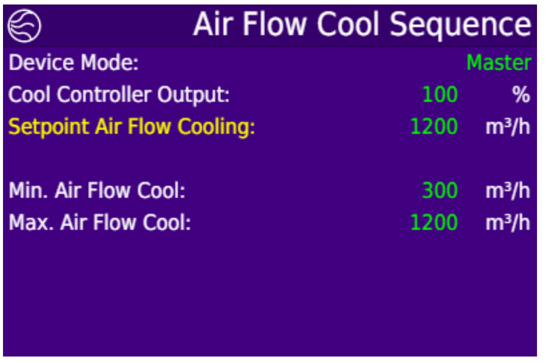

Figure 234: Air Flow Cool Sequence

Table 42 shows the present values of the space temperature cooling controller.

Path: User Registers.VAVcontrol.Core.Temperature

Name on tile	**Data point name**	**Description**
Device Mode	VAVgroupDeviceMode	Indicates if the device is Master or Slave in a VAV Group
Cool Control Output	CoolControlOutput	Present value of the cooling controller output
Setpoint Air Flow Cooling	SetpointAirFlowCooling	Resulting Air Flow Cooling from the Air Flow Cool Sequence
Min. Air Flow Cool	MinFlowCooling	Present value of Min Air Flow Cool
Max. Air Flow Cool	MaxFlowCooling	Present value of Max Air Flow Cool

Table 46: Present values of Air Flow Cool Sequence

Device Mode:

Indicates if the device is set as the “Master” or as a “Slave” in the “VAV-Group”. Only the Master is executing the space temperature control and it sends the *Cool Control Output* to the “Slaves”. The “Slaves” do not execute any space temperature control but they receive the *Cool Control Output* from the “Master” and are operating the *Air Flow Cool Sequence* to reset the air flow setpoint accordingly.

Cool Control Output:

This displays the current control output of the space temperature cooling controller. The *Air Flow Cool Sequence* calculates the air flow setpoint for the flow controller according to this value. In case of “Master” the *Cool Control Output* taken from the space temperature cooling controller in the “own” device. In case of “Slave”, the *Cool Control Output* taken from the space temperature cooling controller communicated from the “Master” device. The value range is 0…100%.

Setpoint Air Flow Cooling:

This displays the current *Setpoint Air Flow Cooling* as the result of the *Air Flow Cool Sequence* linear curve that is forwarded to the *Air Flow Setpoint Selection* of the *Air Flow Control.* The *Air Flow Setpoint Selection* is executing a maximum setpoint selection of the space temperature, IAQ control and humidity control. The selected setpoint is maintained by the *Air Flow Control.*

Min. Air Flow Cool:

This displays the current *Min. Air Flow Cool* that is the minimum output of the linear curve function if the *Cool Controller Output* is 0%. Please note that this value is only displayed here. It has to be parameterized on the *Min Flow Cool* parameter on the *Air Flow Data Configuration* page of the *VAVstatu*s visualization project as shown in Figure 191.

Max. Air Flow Cool:

This displays the current *Max. Air Flow Cool* that is the maximum output of the linear curve function if the *Cool Controller Output* is 100%. Please note that this value is only displayed here. It has to be parameterized on the *Max Flow Cool* parameter on the *Air Flow Data Configuration* page of the *VAVstatu*s visualization project as shown in Figure 191.

<u>Air Flow Heat Sequence</u>

The *Heat Control Output* of the space temperature heating controller is directly forwarded to the *Air Flow Heat Sequence* if the LIOB-AIR is operating as a “Master”. If it is operating as a “Slave”, it receives the *Heat Control Output* from the “Master” and this is forwarded to the *Air Flow Heat Sequence*. The *Air Flow Heat Sequence* calculates the *Setpoint Air Flow Heating* that will be maintained by the *Air Flow Controller*.

The setpoint calculation is based on a linear curve with gets the *Heat Control Output* as input of 0…100% and generates the *Setpoint Air Flow Heating* as output between the *Min.Air Flow Heat* and *Max. Air Flow Heat*. The percentage of *Heat Control Output* where the *Max. Air Flow Heat* is reached can be defined also. For details, see Figure 235.

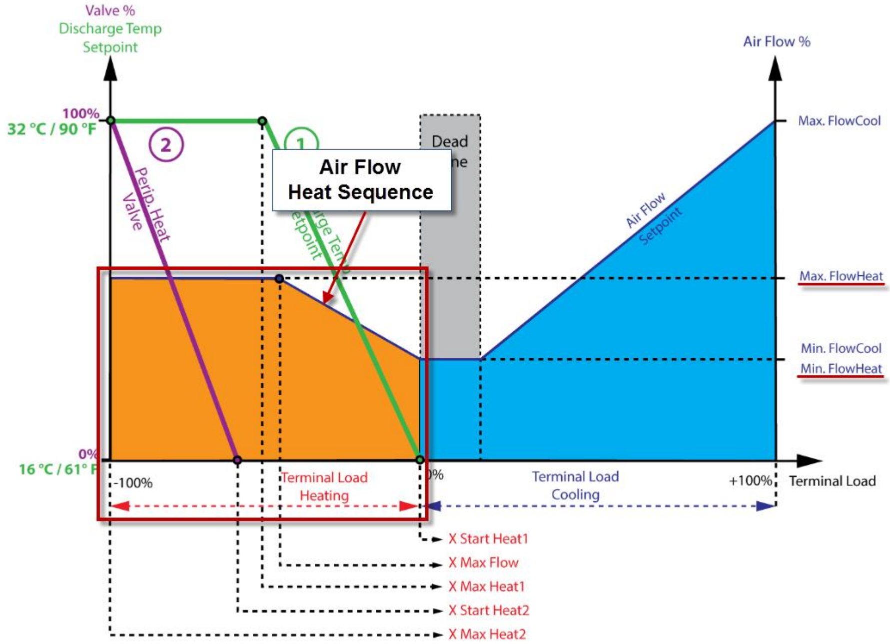

Figure 235: Air Flow Heat Sequence scheme

The *Air Flow Heat Sequence* can be watched on the *Temp.Sequence Air Flow* page of the *VAVstatus* visualization project as shown in Figure 236.

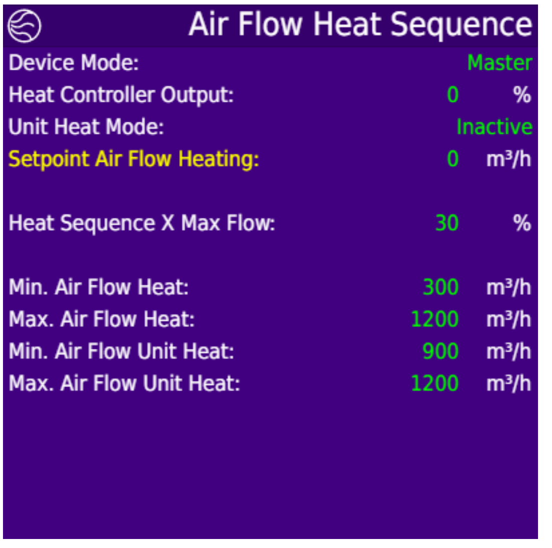

Figure 236 : Air Flow Heat Sequence

Table 47 shows the present values of the Air Flow Heat Sequence.

Path: User Registers.VAVcontrol.Core.Temperature

Name on tile	**Data point name**	**Description**
Device Mode	VAVgroupDeviceMode	Indicates if the device is Master or Slave in a VAV Group
Heat Control Output	HeatControlOutput	Present value of the heating controller output
Unit Heat Mode	UnitHeatMode	Status if the Air Handling Unit is heating or not
Setpoint Air Flow Heating	SetpointAirFlowHeating	Resulting Air Flow Heating from the Air Flow Heat Sequence
Heat Sequence X Max Flow	HeatSequenceXmaxFlow	Present Heat Sequence X Max Flow
Min. Air Flow Heat	MinFlowHeating	Present value of Min Air Flow Heat
Max. Air Flow Heat	MaxFlowHeating	Present value of Max Air Flow Heat
Min. Air Flow Unit Heat	MinFlowUnitHeating	Present value of Min Air Flow Unit Heat
Max. Air Flow Unit Heat	MaxFlowUnitHeating	Present value of Max Air Flow Unit Heat

Table 47: Present values of Air Flow Heat Sequence

Device Mode:

Indicates if the device is set as the “Master” or as a “Slave” in the “VAV-Group”. Only the Master is executing the space temperature control and it sends the *Heat Control Output* to the “Slaves”. The “Slaves” do not execute any space temperature control but they receive the *Heat Control Output* from the “Master” and are operating the *Air Flow Heat Sequence* to reset the air flow setpoint accordingly.

Heat Control Output:

This displays the current control output of the space temperature heating controller. The *Air Flow Heat Sequence* calculates the air flow setpoint for the flow controller according to this value. In case of “Master” the *Heat Control Output* taken from the space temperature cooling controller in the “own” device. In case of “Slave”, the *Heat Control Output* is taken from the space temperature heating controller communicated from the “Master” device. The value range is 0…100%.

Unit Heat Mode:

The *Unit Heat Mode* indicates if the AHU is in heating mode and is supplying warm air. This is recognized if the manager receives the HVAC_Modes HEAT or MRNG_WRMUP from the AHU control. If Unit Heat Mode is active, the *Air Flow Heat Sequence* is using the *Min.Air Flow Unit Heat* and the *Max.Air Flow Unit Heat* values to calculate the *Setpoint Air Flow Heating.* If Unit Heat Mode is inactive, the *Air Flow Heat Sequence* is using the *Min.Air Flow Heat* and the *Max.Air Flow Heat* values to calculate the *Setpoint Air Flow Heating.*

Setpoint Air Flow Heating:

This displays the current *Setpoint Air Flow Heating* as the result of the *Air Flow Heat Sequence* linear curve that is forwarded to the *Air Flow Setpoint Selection* of the *Air Flow Control.* The *Air Flow Setpoint Selection* is executing a maximum setpoint selection of the space temperature, IAQ control and humidity control. The selected setpoint is maintained by the *Air Flow Control.*

Heat Sequence X Max Flow:

This displays the current *Heat Sequence X Max Flow*. That is the value of the *Heat Controller Output* where the linear curve function reaches *Max. Air Flow Heat* for the *Setpoint Air Flow Heating* as the output. It has to be parameterized on the *Heat Sequence X Max Flow* parameter on the *Heat Sequence Parameters* (reheat) page of the *VAVstatu*s visualization project as shown in Figure 333 in chapter 7.5.15.

Min. Air Flow Heat:

This displays the current *Min. Air Flow Heat* that is the minimum output of the linear curve function if the *Heat Controller Output* is 0% in case the *Unit Heat Mode* is inactive. Please note that this value is only displayed here. It has to be parameterized on the *Min Flow Heat* parameter on the *Air Flow Data Configuration* page of the *VAVstatu*s visualization project as shown in Figure 191.

Max. Air Flow Heat:

This displays the current *Max. Air Flow Cool* that is the maximum output of the linear curve function if the *Heat Controller Output* is equal to *Heat Sequence X Max Flow* in case the *Unit Heat Mode* is inactive. Please note that this value is only displayed here. It has to be parameterized on the *Max Flow Heat* parameter on the *Air Flow Data Configuration* page of the *VAVstatu*s visualization project as shown in Figure 191.

Min. Air Flow Unit Heat:

This displays the current *Min. Air Flow Unit Heat* that is the minimum output of the linear curve function if the *Heat Controller Output* is 0% in case the *Unit Heat Mode* is active. Please note that this value is only displayed here. It has to be parameterized on the *Min Flow Unit Heat* parameter on the *Air Flow Data Configuration* page of the *VAVstatus* visualization project as shown in Figure 191.

Max. Air Flow Unit Heat:

This displays the current *Max. Air Flow Cool* that is the maximum output of the linear curve function if the *Heat Controller Output* is equal to *Heat Sequence X Max Flow* in case the *Unit Heat Mode* is active. Please note that this value is only displayed here. It has to be parameterized on the *Max Flow Unit Heat* parameter on the *Air Flow Data Configuration* page of the *VAVstatu*s visualization project as shown in Figure 191.

Reheat/ Periph. Sequence

The *Heat Control Output* of the space temperature heating controller is directly forwarded to the *Reheat/ Periph. Sequence* if the LIOB-AIR is operating as a “Master”. If it is operating as a “Slave”, it receives the *Heat Control Output* from the “Master” and this is forwarded to the *Reheat/ Periph. Sequence*.

The *Reheat/ Periph. Sequence* calculates the *Reheat Control Output* and the *Peripheral Heat Control Output* in case there is no discharge air temperature sensor function connected to the core, see Figure 237.

The *Reheat/ Periph. Sequence* calculates the *Setpoint Discharge Temp.* and the *Peripheral Heat Control Output* in case there is a discharge air temperature sensor function connected to the core, see Figure 238.

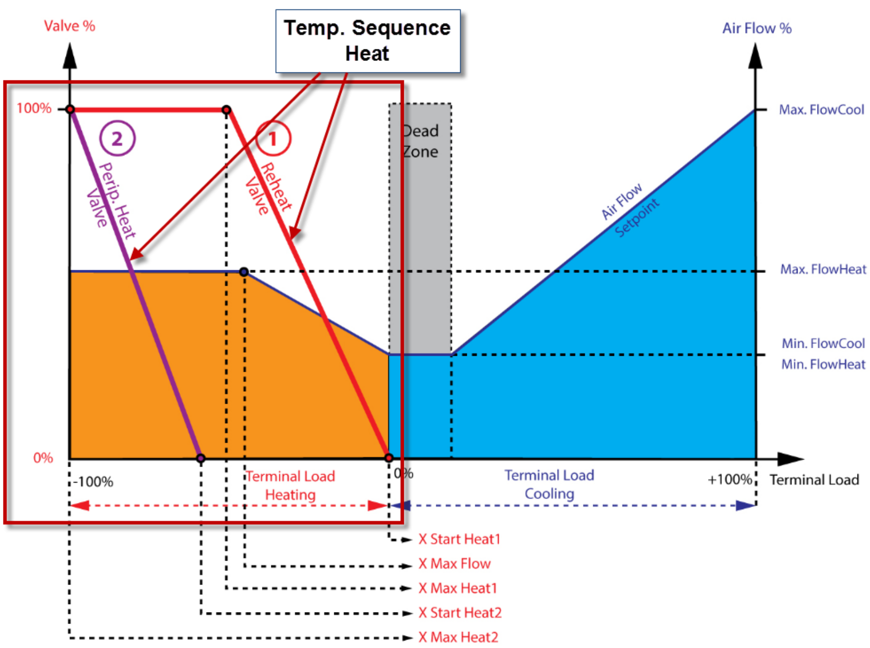

Figure 237: Reheat/ Periph. Sequence scheme without discharge air temp sensor function

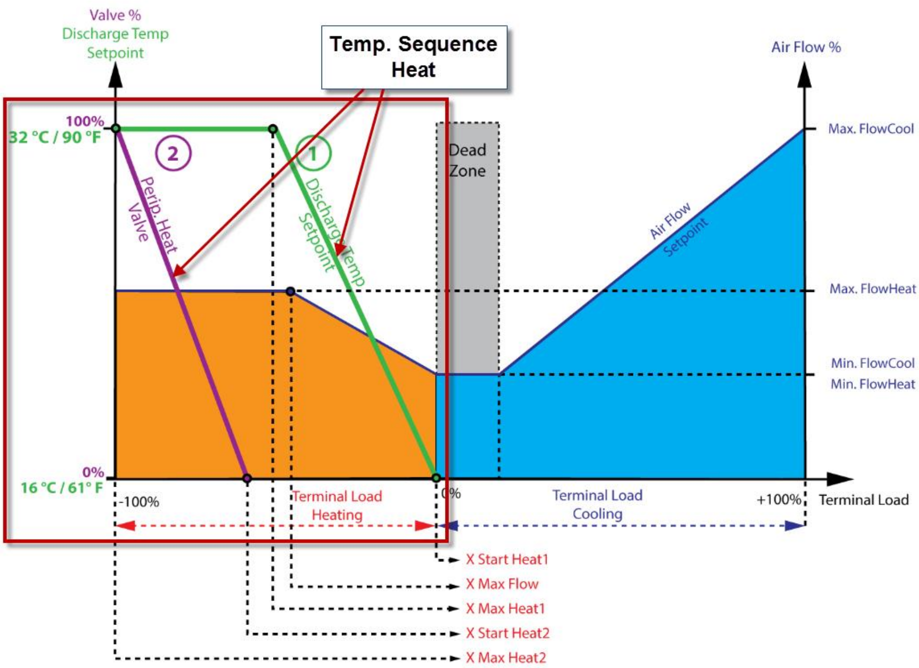

Figure 238: Reheat/ Periph. Sequence scheme with discharge air temp sensor function

The sequence order of 1.reheat/discharge temp and 2.peripheral heat can be parameterized 1 ➔ 2 or 2 ➔ 1.

The *Reheat/ Periph. Sequence* can be watched on the *Temp.Sequence Heat* page of the *VAVstatus* visualization project as shown in Figure 239 and Figure 240.

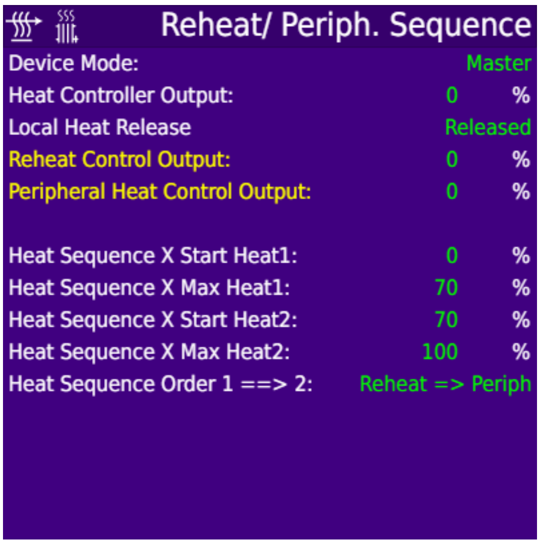

Figure 239 : Reheat/ Periph. Sequence without discharge air temp sensor function

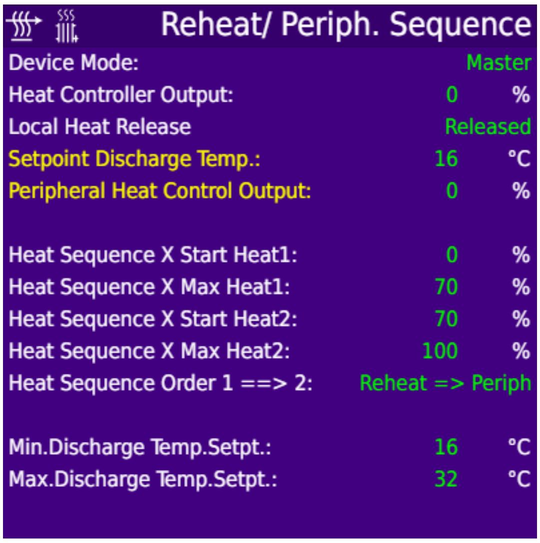

Figure 240 : Reheat/ Periph. Sequence with discharge air temp sensor function

Table 48 shows the present values of the Reheat/ Periph. Sequence.

Path: User Registers.VAVcontrol.Core.Temperature

Name on tile	**Data point name**	**Description**
Device Mode	VAVgroupDeviceMode	Indicates if the device is Master or Slave in a VAV Group
Heat Control Output	HeatControlOutput	Present value of the heating controller output
Local Heat Release	LocalHeatRelease	Indicates if local heat with reheat and periph. heat is released actually
Setpoint Discharge Temp. [1])	SetpointDischargeTemp	Present value of resulting setpoint of discharge temp control
Reheat Control Output [2])	ReheatControlOutput	Present value of Reheat Control Output
Peripheral Heat Control Output	PeriphHeatControlOutput	Present value of Peripheral Heat Control Output
Heat Sequence X Start Heat1	HeatSequenceXstartHeat1	Present value of Heat Sequence X Start Heat1, first sequence
Heat Sequence X Max Heat1	HeatSequenceXmaxHeat1	Present value of Heat Sequence X Max Heat1, first sequence
Heat Sequence X Start Heat2	HeatSequenceXstartHeat2	Present value of Heat Sequence X Start Heat2, second sequence
Heat Sequence X Max Heat2	HeatSequenceXmaxHeat2	Present value of Heat Sequence X Max Heat2, second sequence
Heat Sequence Order 1==>2	HeatSequenceOrder	Present value of Heat Sequence Order 1==>2

Name on tile	Data point name	Description
Min.Discharge Temp.Setpt.	MinDischargeTempSetpoint	Present value of Minimum Discharge Temp. Setpoint.
Max.Discharge Temp.Setpt.	MaxDischargeTempSetpoint	Present value of Maximum Discharge Temp. Setpoint.

Table 48: Present values of Reheat/ Periph. Sequence

[1]) Only available if discharge air temperature sensor function is connected to the core

[2]) Only available if <u>no</u> discharge air temperature sensor function is connected to the core

Device Mode:

Indicates if the device is set as the "Master" or as a "Slave" in the "VAV-Group". Only the Master is executing the space temperature control and it sends the *Heat Control Output* to the "Slaves". The "Slaves" do not execute any space temperature control but they receive the *Heat Control Output* from the "Master" and are operating the *Reheat/ Periph. Sequence* to calculate the *Reheat Control Output* or the *Setpoint Discharge Temp.* and the *Peripheral Heat Control Output*.

These sequence parameters are also sent from the "Master" to the "Slaves" and so they only have to be set in the "Master": *Heat Sequence X Start Heat1*, *Heat Sequence X Max Heat1*, *Heat Sequence X Start Heat2*, *Heat Sequence X Max Heat2*, *Heat Sequence Order 1==>2*, *Min.Discharge Temp.Setpt.*, *Max.Discharge Temp.Setpt.* This ensures that all *Reheat/ Periph. Sequences* have the same values and are operating in parallel.

Heat Control Output:

This displays the current control output of the space temperature heating controller. The *Reheat/ Periph. Sequence* calculates the *Reheat Control Output* or the *Setpoint Discharge Temp.* and the *Peripheral Heat Control Output* according to this value. In case of "Master" the *Heat Control Output* taken from the space temperature cooling controller in the "own" device. In case of "Slave", the *Heat Control Output* is taken from the space temperature heating controller communicated from the "Master" device. The value range is 0…100%.

Local Heat Release:

This indicates if the local heat is released actually. If the local heat is released the current control output of the space temperature heating controller 0…100% is forwarded to the *Reheat/ Periph. Sequence.* If the local heat is prohibited a constant value of 0% is forwarded to the *Reheat/ Periph. Sequence.* This causes 0% of *Reheat Control Output* or deactivates the *Discharge Temp.* controller and causes 0% of *Peripheral Heat Control Output* as well. The *Local Heat Release* is important in the *HVAC Mode* MRNG_WRMUP only. It can be parameterized on *Local Heat Control in WARMUP* (*HVAC Mode Control Status*, see chapter 7.5.11) if local heat will be released during MRNG_WRMUP or not.

Setpoint Discharge Temp.:

This is displayed only if the discharge air temperature sensor function is connected to the core (see chapter 7.3.1). The *Setpoint Discharge Temp.* is calculated by a linear curve depending on the *Heat Controller Output*:

If the *Heat Sequence Order 1==>2* is "Reheat ➔ Periph" then:

Heat Controller Output <= *Heat Sequence X Start Heat1* ➔ *Min.Discharge Temp.Setpt.*

Heat Controller Output >= *Heat Sequence X Max Heat1*➔ *Max.Discharge Temp.Setpt.*

or if the *Heat Sequence Order ==>2* is “Periph ➔ Reheat” then:

Heat Controller Output <= *Heat Sequence X Start Heat2*➔ *Min.Discharge Temp.Setpt.*

Heat Controller Output >= *Heat Sequence X MaxHeat2*➔ *Max.Discharge Temp.Setpt.*

The *Setpoint Discharge Temp.* is forwarded to the discharge air temperature controller as the current control setpoint.

Reheat Control Output:

This is displayed only if no discharge air temperature sensor function is connected to the core (see chapter 7.3.1).The *Reheat Control Output* is calculated by a linear curve depending on the *Heat Controller Output*:

If the *Heat Sequence Order 1==>2* is “Reheat ➔ Periph” then:

Heat Controller Output <= *Heat Sequence X Start Heat1*➔ 0%

Heat Controller Output >= *Heat Sequence X Max Heat1*➔ 100%

or if the *Heat Sequence Order 1==>2* is “Periph ➔ Reheat” then:

Heat Controller Output <= *Heat Sequence X Start Heat2*➔ 0%

Heat Controller Output >= *Heat Sequence X MaxHeat2*➔ 100%

The *Reheat Control Output* is forwarded to the reheat actuator.

Peripheral Heat Control Output:

The *Peripheral Heat Control Output* is calculated by a linear curve depending on the *Heat Controller Output*:

If the *Heat Sequence Order 1==>2* is “Reheat ➔ Periph” then:

Heat Controller Output <= *Heat Sequence X Start Heat2*➔ 0%

Heat Controller Output >= *Heat Sequence X Max Heat2*➔ 100%

or if the *Heat Sequence Order 1==>2* is “Periph ➔ Reheat” then:

Heat Controller Output <= *Heat Sequence X Start Heat1*➔ 0%

Heat Controller Output >= *Heat Sequence X MaxHeat1*➔ 100%

The *Peripheral Heat Control Output* is forwarded to the peripheral heat actuator.

Heat Sequence X Start Heat1:

This value defines on which value of the *Heat Control Output* the first heating sequence output starts increasing by the linear curve. What actuator (reheat/discharge or periph. heat) is applied to the first sequence is defined by the *Heat Sequence Order 1==>2*. The *Heat Sequence X Start Heat1* value has to be parameterized on the *Heat Sequence X Start Heat1* parameter on the *Reheat Sequence parameters* page of the *VAVstatu*s visualization project in the “Master” device as shown in Figure 333 in chapter 7.5.15.

Heat Sequence X Max Heat1:

This value defines on which value of the *Heat Control Output* the first heating sequence output reaches the maximum value by the linear curve. What actuator (reheat/discharge or periph. heat) is applied to the first sequence is defined by the *Heat Sequence Order 1==>2*. The *Heat Sequence X Max Heat1* value has to be parameterized on the *Heat Sequence X Max Heat1* parameter on the *Reheat Sequence parameters* page of the *VAVstatu*s visualization project in the “Master” device as shown in Figure 333 in chapter 7.5.15.

Heat Sequence X Start Heat2:

This value defines on which value of the *Heat Control Output* the first heating sequence output starts increasing by the linear curve. What actuator (reheat/discharge or periph. heat) is applied to the second sequence is defined by the *Heat Sequence Order 1==>2*. The *Heat Sequence X Start Heat2* value has to be parameterized on the *Heat Sequence X Start Heat2* parameter on the *Reheat Sequence parameters* page of the *VAVstatu*s visualization project in the “Master” device as shown in Figure 333 in chapter 7.5.15.

Heat Sequence X Max Heat2:

This value defines on which value of the *Heat Control Output* the first heating sequence output reaches the maximum value by the linear curve. What actuator (reheat/discharge or periph. heat) is applied to the second sequence is defined by the *Heat Sequence Order 1==>2*. The *Heat Sequence X Max Heat2* value has to be parameterized on the *Heat Sequence X Max Heat2* parameter on the *Reheat Sequence parameters* page of the *VAVstatu*s visualization project in the “Master” device as shown in Figure 333 in chapter 7.5.15.

Heat Sequence Order 1 ==>2:

This value defines which actuator (reheat/discharge or periph. heat) is applied to the first and the second sequence. See Figure 237 and Figure 238 in chapter 7.5.6.5 for more information. The *Heat Sequence Order 1==>2* value has to be parameterized on the *Heat Sequence Order 1==>2* parameter on the *Reheat Sequence parameters* page of the *VAVstatu*s visualization project in the “Master” device as shown in Figure 333 in chapter 7.5.15.

Min.Discharge Temp.Setpt.:

This is displayed only if the discharge air temperature sensor function is connected to the core (see chapter 7.3.1). This defines the minimum discharge temperature setpoint that is calculated by the first or the second sequence. The *Min.Discharge Temp.Setpt.* will not decrease below this limit. The *Min.Discharge Temp.Setpt.* value has to be parameterized on the *Min.Discharge Temp.Setpt.* parameter on the *Discharge Temperature Control Setpoints* page of the *VAVstatu*s visualization project in the “Master” device as shown in chapter 7.5.8.2.

Max.Discharge Temp.Setpt.:

This is displayed only if the discharge air temperature sensor function is connected to the core (see chapter 7.3.1). This defines the maximum discharge temperature setpoint that is calculated by the first or the second sequence. The *Max.Discharge Temp.Setpt.* will not increase above this limit. The *Max.Discharge Temp.Setpt.* value has to be parameterized on the *Max.Discharge Temp.Setpt.* parameter on the *Discharge Temperature Control Setpoints* page of the *VAVstatu*s visualization project in the “Master” device as shown in chapter 7.5.8.2.

Fan Heat Sequence

Every time the space temperature heating controller is requesting heat, the fan request is calculated by the *Fan Heat Sequence*. If there is no heat request from the space temperature heating controller the fan request is reset with a time delay. This heat request is forwarded to the series or parallel fan actuator control. There are operating additional functions to decide if the fan is switched on or off, see chapter 7.5.14.

The *Fan Heat Sequence* can be watched on the *Temp.Sequence Heat* page of the *VAVstatus* visualization project as shown in Figure 241.

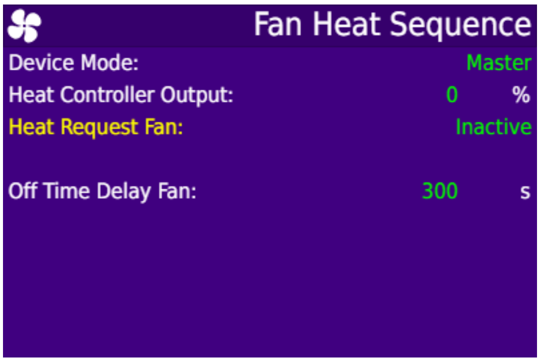

Figure 241 : Fan Heat Sequence

Table 48 shows the present values of the Fan Heat Sequence.

Path: User Registers.VAVcontrol.Core.Temperature

Name on tile	**Data point name**	**Description**
Device Mode	VAVgroupDeviceMode	Indicates if the device is Master or Slave in a VAV Group
Heat Control Output	HeatControlOutput	Present value of the heating controller output
Heat Request Fan	HeatRequestFan	Current status of the Heat Request Fan
Off Time Delay Fan	OffDelayFan	Present value of the Off Time Delay Fan

Table 49: Present values of Fan Heat Sequence

Device Mode:

Indicates if the device is set as the “Master” or as a “Slave” in the “VAV-Group”. Only the Master is executing the space temperature control and it sends the *Heat Control Output* to the “Slaves”. The “Slaves” do not execute any space temperature control but they receive the *Heat Control Output* from the “Master” and are operating the *Fan Heat Sequence* to calculate the Heat Fan Request.

The sequence parameter Off Time Delay Fan is also sent from the “Master” to the “Slaves” and so it only has to be set in the “Master”: This ensures that all *Fan Heat Sequences* have the same values and are operating in parallel.

Heat Control Output:

This displays the current control output of the space temperature heating controller. The *Fan Heat Sequence* calculates the *Heat Request Fan* according to this value. In case of “Master” the *Heat Control Output* is taken from the space temperature cooling controller in the “own” device. In case of “Slave”, the *Heat Control Output* is taken from the space temperature heating controller communicated from the “Master” device. The value range is 0…100%.

Heat Request Fan:

The *HeatRequestFan* is calculated depending on the *Heat Controller Output*:

Heat Controller Output >= 1% ➔ *HeatRequestFan* is <u>Active</u>

Heat Controller Output <= 0,1%➔ *HeatRequestFan* is <u>Inactive</u> (after *Off Time Delay Fan*)

Off Time Delay Fan:

This value defines the off delay time when the Heat Request Fan is set inactive after the space temperature heating controller does no longer request heat. The *Off Time Delay Fan* value has to be parameterized on the *Off Delay Time* parameter on the *Fan Configuration* page of the *VAVstatu*s visualization project in the “Master” device as shown in Figure 326 or Figure 329 in chapter 7.5.14.

7.5.6.6 Space Temperature Alarms

General Function:

The current space temperature is monitored permanently to watch the room condition. If the space temperature is leaving a defined range according to the current cooling and heating setpoints a minimum or maximum Alarm is triggered with a time delay. The range can be defined individually for the dedicated occupancy states. The alarm function is enabled permanently.

Detailed Function:

There are a minimum and a maximum alarm function, which are relating to the current space temperature setpoints. The maximum alarm limit is relating to the *Current Cool Setpoint* of the space temperature cooling controller. The minimum alarm limit is relating to the *Current Heat Setpoint* of the space temperature heating controller. Therefore, these alarm limits are varying if the setpoints are switched by the Occupancy Status, see chapter 7.5.6.2. The alarm limits are calculated using offset parameters to the current cooling and heating setpoints. These offset parameters can be set individually for the multiple occupancy states dedicated for the minimum and maximum alarm function. If an alarm is triggered it can reset self-sufficiently in case the space temperature returns to inside of the limits. The alarm can also be reset by the user.

Please note that the space temperature alarms are triggered by this function and only this is described in this chapter. In the device, these alarms are operated as "generic" alarms that are reported to BACnet alarm server in parallel. The complete alarming with alarm servers, alarm lists, alarm status, acknowledgement, alarm notification and further things are standard LOYTEC data point functions of the LIOB-AIR operating system.

The principle of the Space Temperature Alarms is displayed in Figure 242.

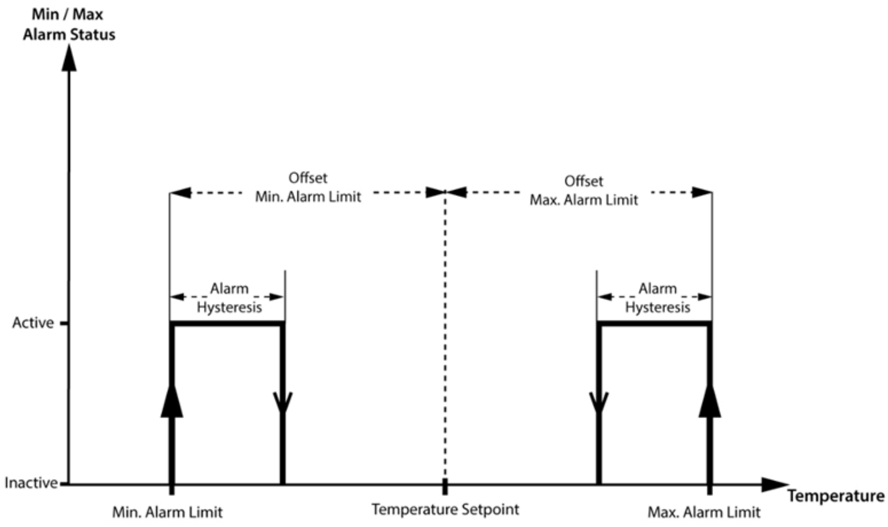

Figure 242: Principle of Space Temperature Min. and Max. Alarms

Space Temperature Max. Alarm

The Space Temperature Max Alarm can be watched and parameterized on the *Space Temperature Alarm Parameters* page of the *VAVstatus* visualization project as shown in Figure 243.

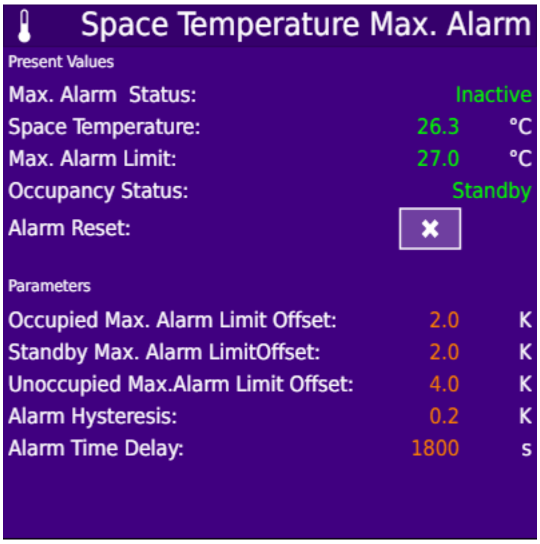

Figure 243: Space Temp. Max. Alarm configuration

Table 50 shows the Space Temp. Max.Alarm present values.

Path: User Registers.VAVcontrol.SpaceTemp.CoolAlarm

Name on tile	Data point name	Description
Max.Alarm Status	SpaceTempMaxAlarm	Present value space temperature maximum alarm
Space Temperature	SpaceTemperature	Present value of space temperature
Max.Alarm Limit	SpaceTempMaxAlarmLimit	Present value of space temp maximum alarm limit
Occupancy Status	EffectiveOccupancy	Present value of occupancy status

Table 50: Space Temp. Max. Alarm present values

Max.Alarm Status:

This displays the actual state of the maximum space temperature alarm trigger. It becomes active if the *Space Temperature* is greater than the current *Max.Alarm Limit* delayed with the *Alarm Time Delay*. It becomes inactive if *Space Temperature* is lower than the (*Max.Alarm Limit - Alarm Hysteresis)* without any delay or the alarm is reset by the user, see Figure 242.

Space Temperature:

Here the present value of the *Space Temperature* is displayed. It is monitored by the space temperature max alarm function.

Max.Alarm Limit:

This is the current maximum limit depending on the *Occupancy Status* and resulting from the following calculation:

If *Occupancy Status* is Occupied or Bypass, then:

Max.Alarm Limit = Occupied Cool Setpoint + Occupied Max.Alarm Limit Offset

If *Occupancy Status* is Standby, then:

Max.Alarm Limit = Standby Cool Setpoint + Standby Max.Alarm Limit Offset

If *Occupancy Status* is Unoccupied, then:

Max.Alarm Limit = Unoccupied Cool Setpoint + Unoccupied Max.Alarm Limit Offset

Occupancy Status:

This displays the effective occupancy status of the room and selects the space temperature setpoints and the max. alarm limit offsets. Based on these values the *Max. Alarm Limit* is calculated. For more information about occupancy, refer to chapter *7.5.12*.

Table 51 shows the Space Temperature Max. Alarm parameters.

Path: User Registers.VAVcontrol.SpaceTemp.CoolAlarm

Name on tile	**Data point name**	**Default**	**Description**
Occupied Max. Alarm Limit Offset	SpaceTempAlarmLimitOffsetOccupiedCool	2,0K 3,6d°F	Alarm Offset to Occupied Space Temp Setpoint Cool
Standby Max. Alarm Limit Offset	SpaceTempAlarmLimitOffsetStandbyCool	2,0K 3,6d°F	Alarm Offset to Standby Space Temp Setpoint Cool
Unoccupied Max. Alarm Limit Offset	SpaceTempAlarmLimitOffsetUnoccupiedCool	4,0K 7,2d°F	Alarm Offset to Unoccupied Space Temp Setpoint Cool
AlarmHysteresis	SpaceTempAlarmHysteresis	0,2K 0,4d°F	Hysteresis to reset the Space Temp Min or Max Alarm
Alarm Time Delay	SpaceTempAlarmDelayTime	1800s	Time delay to trigger a Space Temp Min or Max Alarm
Alarm Reset	SpaceTempAlarmReset	FALSE	Button to reset an active Space Temp Min or Max Alarm

Table 51: Space Temp. Max. Alarm parameters

Occupied Max Alarm Limit Offset:

This defines the offset to the current *Occupied Cool Setpoint* to calculate the *Max.Alarm Limit* if *Occupancy Status* is Occupied or Bypass. For details, see *Max.Alarm Limit.*

Standby Max Alarm Limit Offset:

This defines the offset to the current *Standby Cool Setpoint* to calculate the *Max.Alarm Limit* if *Occupancy Status* is Standby. For details, see *Max.Alarm Limit.*

Unoccupied Max Alarm Limit Offset:

This defines the offset to the current *Unoccupied Cool Setpoint* to calculate the *Max.Alarm Limit* if *Occupancy Status* is Unoccupied. For details, see *Max.Alarm Limit.*

Alarm Hysteresis:

This is valid for the maximum <u>and</u> the minimum space temperature alarm function. It defines the hysteresis the current space temperature be lower than the *Max.Alarm Limit* or greater than the *Min. Alarm Limit* to reset the space temperature max or min alarm self-sufficiently without any time delay, see Figure 242.

Alarm Time Delay:

This is valid for the maximum <u>and</u> the minimum space temperature alarm function. If the current *Space Temperature* is outside of the limits, the min or max alarm is triggered with this time delay. The reset of the space temperature min or max alarm is operated without any time delay.

Alarm Reset:

A triggered space temperature maximum or minimum alarm can be reset by the user pressing this button. However, if the current *Space Temperature* is still outside of the limits the space temperature maximum or minimum alarm will be retriggered again after the *Alarm Time Delay* has elapsed. Pressing this button will set the *Alarm Reset* to TRUE and releasing the button will set the *Alarm Reset* to FALSE (function of the visualization).

Space Temperature Min. Alarm

The Space Temperature Min Alarm can be watched and parameterized on the *Space Temperature Alarm Parameters* page of the *VAVstatus* visualization project as shown in Figure 244.

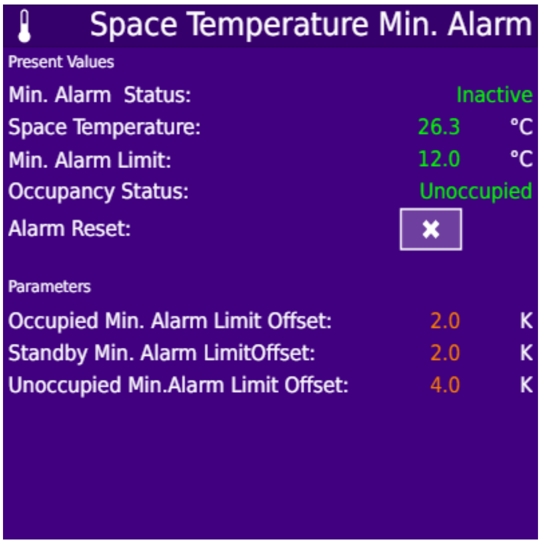

Figure 244: Space Temp. Min. Alarm configuration

Table 52 shows the Space Temp. Min.Alarm present values.

Path: User Registers.VAVcontrol.ReheatHwMod.HeatAlarm *)

Name on tile	Data point name	Description
Min.Alarm Status	SpaceTempMinAlarm	Present value space temperature minimum alarm
Space Temperature	SpaceTemperature	Present value of space temperature
Min.Alarm Limit	SpaceTempMinAlarmLimit	Present value of space temp minimum alarm limit
Occupancy Status	EffectiveOccupancy	Present value of occupancy status

Table 52: Space Temp. Min. Alarm present values

*): Please note that the data point path for heating is depending on the connected reheat actuator using different folder names:

Hot Water Reheat, modulating folder name: ReheatHwMod

Hot Water Reheat, floating folder name: ReheatHwFloat

Electric Reheat, modulating folder name: ReheatElMod

Electric Reheat, 3 stages folder name: ReheatEl3St

No Reheat, but heat control folder name: NoReheat

Min.Alarm Status:

This displays the actual state of the minimum space temperature alarm trigger. It becomes active if the *Space Temperature* is lower than the current *Min.Alarm Limit* delayed with the *Alarm Time Delay*. It becomes inactive if *Space Temperature* is greater than the (*Min.Alarm Limit + Alarm Hysteresis)* without any delay or the alarm is reset by the user, see Figure 242.

Space Temperature:

Here the present value of the *Space Temperature* is displayed. It is monitored by the space temperature min alarm function.

Min.Alarm Limit:

This is the current minimum limit depending on the *Occupancy Status* and resulting from the following calculation:

If *Occupancy Status* is Occupied or Bypass, then:

Min.Alarm Limit = Occupied Heat Setpoint - Occupied Min.Alarm Limit Offset

If *Occupancy Status* is Standby, then:

Min.Alarm Limit = Standby Heat Setpoint - Standby Min.Alarm Limit Offset

If *Occupancy Status* is Unoccupied, then:

Min.Alarm Limit = Unoccupied Heat Setpoint - Unoccupied Min.Alarm Limit Offset

Occupancy Status:

This displays the effective occupancy status of the room and selects the space temperature setpoints and the min. alarm limit offsets. Based on these values the *Min.Alarm Limit* is calculated. For more information about occupancy, refer to chapter *7.5.12*.

Table 53 shows the Space Temperature Min. Alarm parameters.

Path: User Registers.VAVcontrol.ReheatHwMod.HeatAlarm *)

Name on tile	**Data point name**	**Default**	**Description**
Occupied Min. Alarm Limit Offset	SpaceTempAlarmLimitOffsetOccupiedHeat	2,0K 3,6d°F	Alarm Offset to Occupied Space Temp Setpoint Heat
Standby Min. Alarm Limit Offset	SpaceTempAlarmLimitOffsetStandbyHeat	2,0K 3,6d°F	Alarm Offset to Standby Space Temp Setpoint Heat
Unoccupied Min. Alarm Limit Offset	SpaceTempAlarmLimitOffsetUnoccupiedHeat	4,0K 7,2d°F	Alarm Offset to Unoccupied Space Temp Setpoint Heat
Alarm Reset	SpaceTempAlarmReset	FALSE	Button to reset an active Space Temp Min or Max Alarm

Table 53: Space Temp. Min. Alarm parameters

*): Please note that the data point path for heating is depending on the connected reheat actuator using different folder names:

Hot Water Reheat, modulating	folder name: ReheatHwMod
Hot Water Reheat, floating	folder name: ReheatHwFloat
Electric Reheat, modulating	folder name: ReheatElMod
Electric Reheat, 3 stages	folder name: ReheatEl3St
No Reheat, but heat control	folder name: NoReheat

Occupied Min Alarm Limit Offset:

This defines the offset to the current *Occupied Heat Setpoint* to calculate the *Min.Alarm Limit* if *Occupancy Status* is Occupied or Bypass. For details, see *Min.Alarm Limit.*

Standby Min Alarm Limit Offset:

This defines the offset to the current *Standby Heat Setpoint* to calculate the *Min.Alarm Limit* if *Occupancy Status* is Standby. For details, see *Min.Alarm Limit.*

Unoccupied Min Alarm Limit Offset:

This defines the offset to the current *Unoccupied Heat Setpoint* to calculate the *Min.Alarm Limit* if *Occupancy Status* is Unoccupied. For details, see *Min.Alarm Limit.*

Alarm Reset:

A triggered space temperature maximum or minimum alarm can be reset by the user pressing this button. However, if the current *Space Temperature* is still outside of the limits the space temperature maximum or minimum alarm will be retriggered again after the *Alarm Time Delay* has elapsed. Pressing this button will set the *Alarm Reset* to TRUE and releasing the button will set the *Alarm Reset* to FALSE (function of the visualization).

7.5.7 Energy Hold Off (Window Contact)

General Function:

According to chapter *7.3.1 Application Structure*, the Energy Hold Off control is a sensor function. If the VAVwindowCont sensor function is connected to the core, the energy hold off control function is enabled in the core application.

It prevents wasting energy if windows are opened. In this case cooling and heating protection setpoints are selected as space temperature setpoints that are maintained by the space temperature control. The Energy hold off function is triggered if a window is opened with an adjustable delay time. It is reset if all windows are closed also with an adjustable time delay. The time delays prevent the space temperature control from bumps if the window is opened or closed only a short time.

7.5.7.1 Window Contact Sensor

The status of the window(s) of the room is detected by a window contact sensor connected to the local input of the LIOB-AIR device.

The window contact sensor display is shown on the *Status Overview* page of the *VAVstatus* visualization project as shown in Figure 245. This tile also shows if the resulting current *EnergyHoldOff State* is active and an alarm indicator as well.

Figure 245: Window Contact Sensor tile in Status Overview

Inputs:

In the LIOB-AIR I/O Standard configuration, the window contact sensor is located on the universal input UI8. For more information see chapter *7.3.2 Device Configuration*.

If there are multiple LIOB-AIR devices in a room, they have to be parameterized as a “VAV Group” to be able to operate a proper room control. Either a device can have hard-wired sensors or no sensor connected. The resulting window state is calculated as the maximum value (window open) of all sensors in the VAV Group automatically and used as the control value to detect the *EnergyHoldOff State*.

Favorites:

The Favorite of occupancy sensor is shown in Table 113.

Path: Favorites.VAVcontrol.Window

Favorite name	**Description**
inWindowContact	Present value of window contact sensor

Table 54: Window Contact Sensor Favorite

inWindowContact:

The Window Contact function has this one Favorite. To this Favorite, the Local I/O *UI8* is connected (see I/O Standard configuration).

7.5.7.2 Energy Hold Off State

The window contact sensor as described above detects if one or more windows are opened in the room. This shall set the *EnergyHoldOff State* to “Active” with the *EnergyHoldOff Delay On* time. If all windows are closed in the room, the *EnergyHoldOff State* is reset to “Inactive” with the *EnergyHoldOff Delay Off* time.

As described in chapter 7.5.6.2, if the *EnergyHoldOff State* becomes “Active” the *Protection Cool Setpoint* and the *Protection Heat Setpoint* are selected to be maintained by the space temperature control.

If the *EnergyHoldOff State* becomes “Active” an Alarm is triggered. If the *EnergyHoldOff State* becomes “Inactive” an Alarm is reset.

Please note that the energy hold off alarms is triggered by this function and only this is described in this chapter. In the device, this alarm is operated as a “generic” alarm that is reported to BACnet alarm server in parallel. The complete alarming with alarm servers, alarm lists, alarm status, acknowledgement, alarm notification and further things are standard LOYTEC data point functions of the LIOB-AIR operating system.

If there are multiple LIOB-AIR devices in a room, they have to be parameterized as a “VAV Group” to be able to operate a proper room control. One device in the group has to be set as the “Master”. This “Master” device only is executing the energy hold off control function and the space temperature control function The control outputs of the cooling and heating controllers are communicated from the “Master” to all “Slaves” in the group. The “Slaves” do not perform an energy hold off control function. Please refer to chapter 7.6.2 for more information.

The energy hold off function can be watched and parameterized completely on the *Window / EnergyHoldOff Configuration* page of the *VAVstatu*s visualization project as shown in Figure 246.

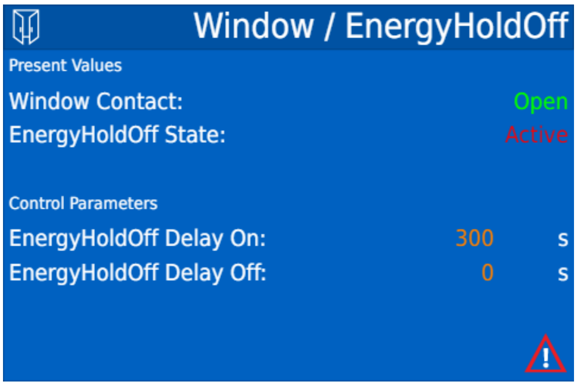

Figure 246: EnergyHoldOff Configuration tile

Table 55 shows the present values of the energy hold off sensor configuration.

Path: User Registers.VAVcontrol.Window

Name on tile	Data point name	Description
Window Contact	WindowContact	Present value of the window contact sensor (s)
EnergyHoldOff State	EnergyHoldOffStatus	Present value of the energy hold off state including the on and off time delays

Table 55: Present values of EnergyHoldOff Configuration

Occupancy Sensor:

This shows state of the window contact sensor. This value comes from the local wired hardware input UI8 linked to the inWindow Favorite (see standard I/O configuration, chapter *7.3.2 Device Configuration*). If there are multiple LIOB-AIR devices in a room building a "VAV-Group" (chapter 7.6.2) which have any sensors connected, the window contact is calculated as the maximum value (window open) in the master device automatically.

EnergyHoldOff State:

This indicates the state of the *EnergyHoldOff State* that is calculated with the *EnergyHoldOff Delay Off* and the *EnergyHoldOff Delay On* time delays. The Space Temperature Setpoints Control is using this state to calculate the *Effective Space Temp Setpoint* as described in chapter 7.5.6.2.

Table 56 shows the EnergyHoldOff Configuration parameters.

Path: User Registers.VAVcontrol.Window

Name on tile	Data point name	Default	Description
EnergyHoldOff Delay On	EnergyHoldOffDelayOn	300s	Defines the on time delay of the EnergyHoldOff State
EnergyHoldOff Delay Off	EnergyHoldOffDelayOff	0s	Defines the on time delay of the EnergyHoldOff State

Table 56: EnergyHoldOff Configuration parameters

EnergyHoldOff Delay On:

This defines the on time delay the *EnergyHoldOff State* is set "Active" after the window contact sensor indicates an opened window.

EnergyHoldOff Delay Off:

This defines the off time delay the *EnergyHoldOff State* is set "Inactive" after the window contact sensor indicates a closed window.

7.5.8 Discharge Air Temperature Control

General Function:

According to chapter *7.3.1 Application Structure,* the discharge air temperature control is a sensor function. If the VAVdischargeTemp sensor function is connected to the core, the discharge air temperature heating control function is enabled in the core application. It consists of the parts discharge air temperature setpoint, discharge air temperature control and discharge air temperature alarm.

7.5.8.1 Discharge Air Temperature Measurement

General Function:

The discharge air temperature is measured by a discharge air temperature sensor connected to the local input of the LIOB-AIR device.

The discharge air temperature display is shown on the *Status Overview* page of the *VAVstatus* visualization project as shown in Figure 247. This is the value the discharge air controller is using as the control value.

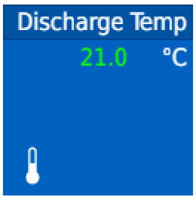

Figure 247: Discharge Air Temperature tile in Status Overview

Inputs:

In the LIOB-AIR I/O Standard configuration, the discharge air temperature is located on the universal input UI5. For more information see chapter *7.3.2 Device Configuration*.

Favorites:

The Favorite of discharge air temperature is shown in Table 57.

Path: Favorites.VAVcontrol.DischargeTemp

Favorite name	**Description**
inDischargeTemp	Present value of discharge air temperature

Table 57: Discharge Air Temperature Favorite

inDischargeTemp:

The discharge temperature measurement function has this one Favorite. To this Favorite, the Local I/O *UI5* is connected (see I/O Standard configuration).

7.5.8.2 Discharge Air Temperature Setpoint & Control

General Function:

The discharge air temperature is controlled by a PI heating controller. It is maintaining the discharge air temperature setpoint coming from the *Reheat/ Periph. Sequence*. The *Reheat/ Periph. Sequence* is calculating the discharge air temperature setpoint based on the space temperature heating controller output. This discharge air temperature setpoint is operating based on a linear setpoint curve that is limited between a minimum and a maximum setpoint value. This is a typical control cascade. To prevent stratification of warm air in the room and to ensure venitaltion effectiveness, the maximum setpoint is limited to a maximum difference value between the current space temperature and the discharge temperature setpoint. The discharge air temperature controller is controlling the reheat actuator as the control output. The discharge air temperature controller is enabled only if the space temperature heating controller is active.

Detailed Function:

The principle of the discharge air temperature control is shown as an example in Figure 248 (in the red box).

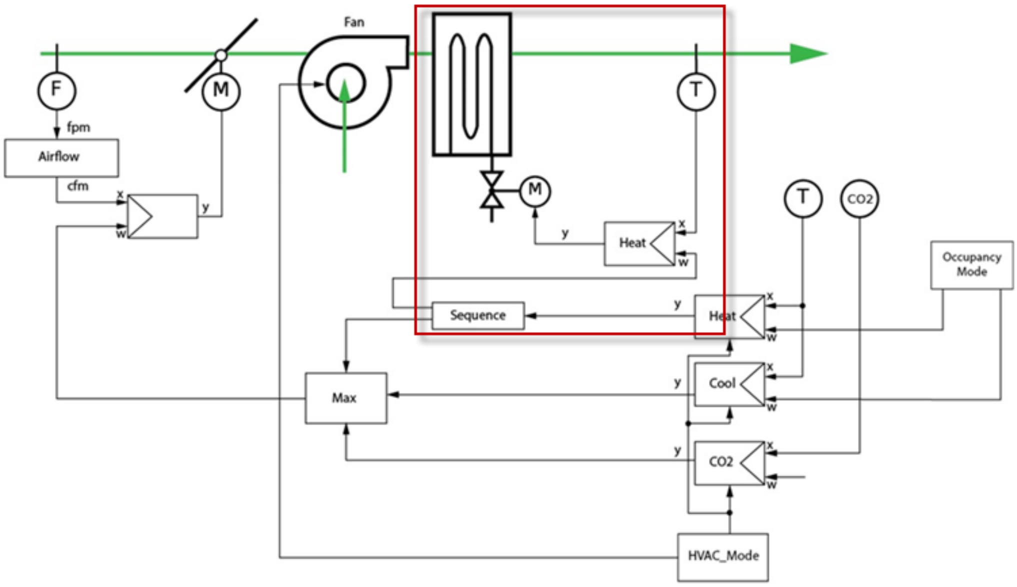

Figure 248: Example VAV-box discharge air temperature control scheme

As described in chapter 7.5.6.5 the discharge air temperature setpoint is calculated by the *Reheat/ Periph. Sequence* depending on the control output of the space temperature heating controller. This is displayed in Figure 249 (in the red box).

This is a linear curve function that is operating between the minimum and maximum discharge air setpoint. With increasing heating demand, the discharge air temperature setpoint will be increased and vice versa. The curve is limited between these both values and will operate only inside of this range. Therefore, the controlled discharge air temperature will also stay in this range in the normal operation. Therefore, there is no need for additional discharge air temperature limiting functions.

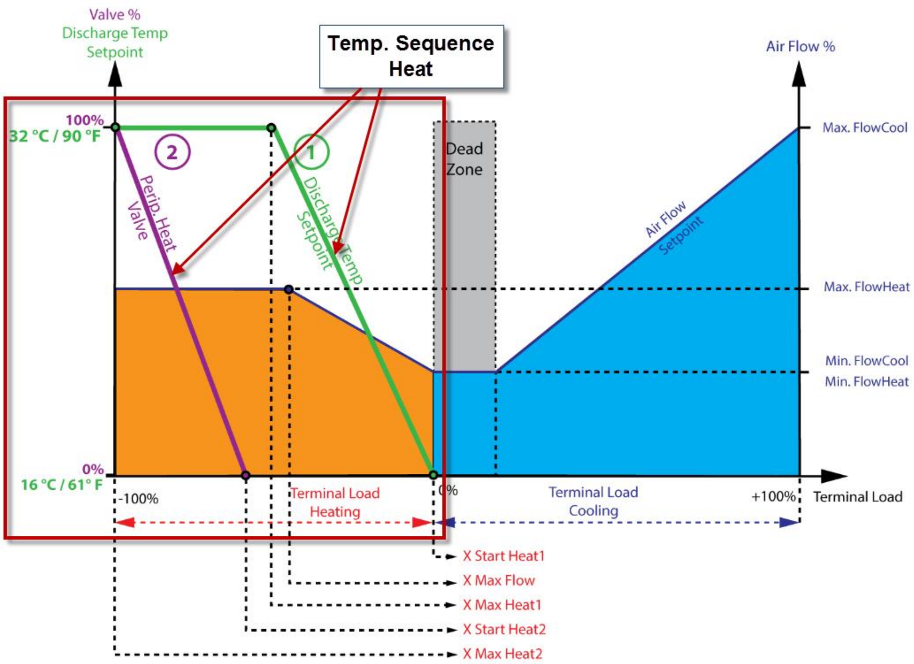

Figure 249: Reheat/ Periph. Sequence scheme with discharge air temp sensor function

Stratification Limiting:

To prevent stratification of warm air in the room and to ensure ventilation effectiveness, the maximum discharge air setpoint is additionally limited to an adjustable maximum difference between the current space temperature and the discharge temperature as shown in Figure 250.

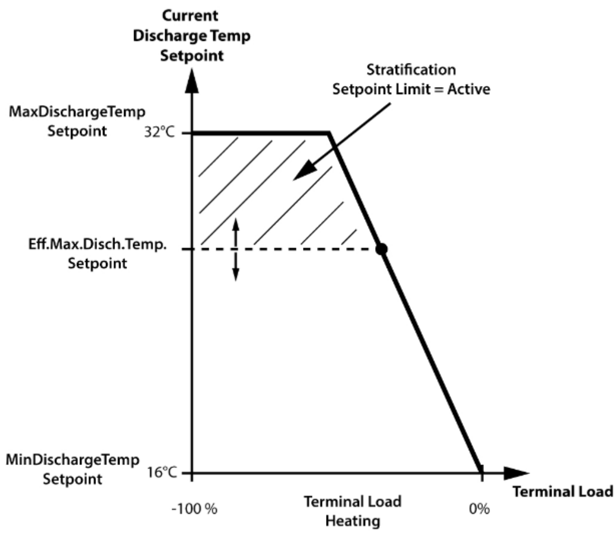

Figure 250: Discharge Temperature Setpoint curve with Stratification Limiting

The maximum difference value the discharge temperature can increase above the current space temperature can be adjusted on the *Stratification Max. Offset* parameter.

The *Eff. Max. Disch. Temp Setpoint* is calculated as:

Eff. Max. Disch. Temp Setpoint = Space Temperature + *Stratification Max. Offset*

The *Eff. Max. Disch. Temp Setpoint* is maximum limited to the *Max. Discharge Temp Setpoint* value.

If the *Setpoint Discharge Temp.* value coming from the *Reheat/ Periph. Sequence* increases above the *Eff. Max. Disch. Temp Setpoint,* it will be maximum limited to this value as the *Current Discharge Temp. Setpoint.* In this case, the status of limitation is indicated as "Active" on the *Stratification Setpoint Limit*.

The stratification limit is a dynamic process and it ensures that the discharge air will not become to warm relative to the space temperature to prevent stratification.

Temperature Controller:

The *Discharge Temperature* is controlled by a PI controller maintaining the *Current Setpoint* from the *Reheat/ Periph. Sequence.* The *Control Output* is forwarded to the reheat actuator.

The *Controller State* is active if the space temperature heating controller is active. Therefore, there is no discharge air temperature control if the space temperature cooling controller is in operation.

In addition, the *HVAC Mode in VAV* must be in a state where heating is allowed to set the *Controller State* to active: AUTO, HEAT, MRNG_WRMUP, OFF.

It can be set up on the *Local Heat Control in WARMUP* parameter (on the *Status Overview* page of the *VAVstatus* visualization project) if the Discharge air temperature controller will be released for operation in the HVAC mode MRNG_WRMUP, see chapter 7.5.11. This is indicated on *Local Heat Release*.

It is possible to lock the discharge air temperature controller depending on the *Outdoor Temperature* in summer time. This is useful to save energy or in case, e.g. the central heating plant is not providing hot water in summer time. If the *Outdoor Temperature* increases above an adjustable limit (see chapter *7.5.15* for more details) the *Heat Lockout State* will become active. If the *Heat Lockout State* is active, the discharge air temperature controller is locked.

The control parameters of the PI controller *Prop. Gain Controller*, *Integr. Time Controller* can be parameterized to achieve a stable and proper control function. These parameters are set to useful default values but they allow individual settings to match the VAV system setup.

Discharge Control Setpoints

The discharge air setpoint is calculated by a linear curve function in the *Reheat/ Periph. Sequence* as shown in Figure 249 depending on the *Heat Control Output* of the space temperature heating controller, see chapter 7.5.6.5. The discharge air setpoint is also limited by the stratification limitation, see Figure 250.

The *Heat Control Output* of the space temperature heating controller is directly forwarded to the *Reheat/ Periph. Sequence* if the LIOB-AIR is operating as a "Master". If it is operating as a "Slave" it receives the *Heat Control Output* from the "Master" and this is forwarded to the *Reheat/ Periph. Sequence*. Please refer to chapter 7.6.2 for more information.

The *Min.Discharge Temp.Setpoint*, the *Max.Discharge Temp.Setpoint* and the *Stratification Max. Offset* parameters are sent from the “Master” to all “Slaves” in a “VAV-Group”. This ensures a coordinated operation of all discharge controllers in the “VAV-Group”.

The settings of the X axis parameters *Heat Sequence X Start Heat1, Heat Sequence X Max Heat1* or *Heat Sequence X Start Heat2, Heat Sequence X Max Heat2* have to be set on the *Reheat Sequence parameters* page of the *VAVstatus* visualization project in the “Master” device as shown in chapter 7.5.15.

The discharge controller setpoints can be watched and parameterized completely on the *Discharge Temperature Control Setpoints* page of the *VAVstatus* visualization project as shown in Figure 251.

Figure 251: Discharge Control Setpoints

Table 60 shows the present values of the space temperature cooling controller.

Path: User Registers.VAVcontrol.DischargeTemp.Control

Name on tile	**Data point name**	**Description**
Device Mode	VAVgroupDeviceMode	Indicates if the device is Master or Slave in a VAV Group
Disch.Temp. Controller State	DischTempControlActive	Indicates if the controller is active or not
Current Discharge Temp. Setpoint	DischargeTempSetpoint	Present value of the current discharge temperature setpoint
Eff. Max. Temp. Setpoint	MaxDischTempSetpointEff	Present value of the effective maximum discharge temperature setpoint
Stratification Setpoint Limit	StratificationLimitActive	Present status of stratification limitation

Table 58: Present values of discharge control setpoints

Device Mode:

Indicates if the device is set as the “Master” or as a “Slave” in the “VAV-Group”. Only the Master is executing the space temperature control and it sends the *Heat Control Output* to the “Slaves”. The “Slaves” do not execute any space temperature control, and so the controller cannot be watched in a “Slave”. The “Slaves” are operating the *Reheat/ Periph. Sequence* function to reset the discharge air temperature setpoint according to the heat control output of the “Master”. The “Slaves” also operate the stratification limitation.

Disch.Temp. Controller State:

This indicates if the controller is enabled actually. Details see below.

Current Discharge Temp. Setpoint:

This displays the *Current Setpoint* of the discharge temperature controller. This setpoint is calculated by the linear curve function in the *Reheat/ Periph. Sequence,* see Figure 249, and it is limited by the stratification limitation, see Figure 251. If the controller is active, it maintains this *Current Setpoint*.

Eff. Max. Disch. Temp. Setpoint:

This displays the effective maximum setpoint limitation. This can be lower or equal the Max. Discharge Temp. Setpoint depending on the stratification limitation function. It is calculated depending on the Space Temperature value and *Stratification Max. Offset* value. The Current *Discharge Temp. Setpoint* will not increase above this limit.

Stratification Setpoint Limit:

This displays if the *Current Dischage Temp Setpoint* is currently maximum limited by the *Eff. Max. Disch.temp. Setpoint*. In this case, the Setpoint Discharge Temp. calculated by the *Reheat/ Periph. Sequence* requests a higher value.

Table 59 shows the Discharge Control Setpoints parameters.

Path: User Registers.VAVcontrol.DischargeTemp.Control

Name on tile	Data point name	Default	Description
Min.Discharge Temp. Setpoint	MinDischargeTemp Setpoint	16°C 61°F	Minimum discharge temp setpoint output of linear curve
Max.Discharge Temp. Setpoint	MaxDischargeTemp Setpoint	32°C 90°F	Maximum discharge temp setpoint output of linear curve
Stratification Max. Offset	StratificationMax Offset	8,3°C 15°F	Maximum allowed difference between space temp and discharge temp

Table 59: Discharge Control Setpoints parameters

Min. Discharge Temp.Setpoint:

This defines the minimum setpoint output of the linear curve function in the *Reheat/ Periph. Sequence,* see Figure 249. The *Current Discharge Temp.Setpoint* will never decrease below this value. If the device is a “Slave”, this parameter is overwritten by the “Master” device of the “VAV-Group”.

Max. Discharge Temp.Setpoint:

This defines the maximum setpoint output of the linear curve function in the *Reheat/ Periph. Sequence,* see Figure 249. The *Current Discharge Temp.Setpoint* will never increase above this value. If the device is a “Slave”, this parameter is overwritten by the “Master” device of the “VAV-Group”.

Generally, the values of the discharge setpoints should be set as follows to gain a proper control direction:

Min. Discharge Temp.Setpoint < Max. Discharge Temp.Setpoint

Stratification Max. Offset:

This defines the maximum difference the discharge temperature can be warmer than the space temperature to prevent stratification of warm air in the room. If the device is a “Slave”, this parameter is overwritten by the “Master” device of the “VAV-Group”.

<u>Discharge Controller (overview)</u>

The first Overview of the VAV discharge controller is shown on the *Discharge Temp. Controller* page of the *VAVstatus* visualization project as shown in Figure 252. Only the most important present values are shown here without settings.

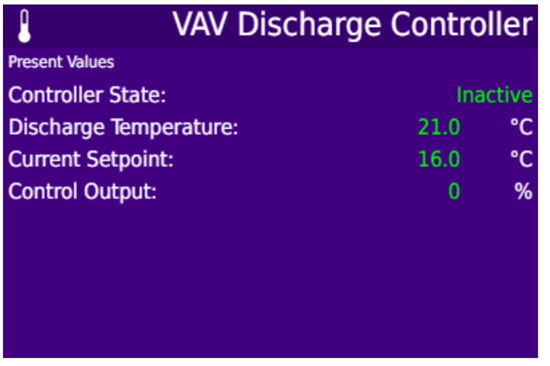

Figure 252: Discharge Controller (overview)

These present values are also shown on the complete discharge controller view as well and are described there.

<u>Discharge Controller (complete view)</u>

The discharge controller can be watched and parameterized completely on the *Discharge Temperature Controller Parameter* page of the *VAVstatus* visualization project as shown in Figure 253.

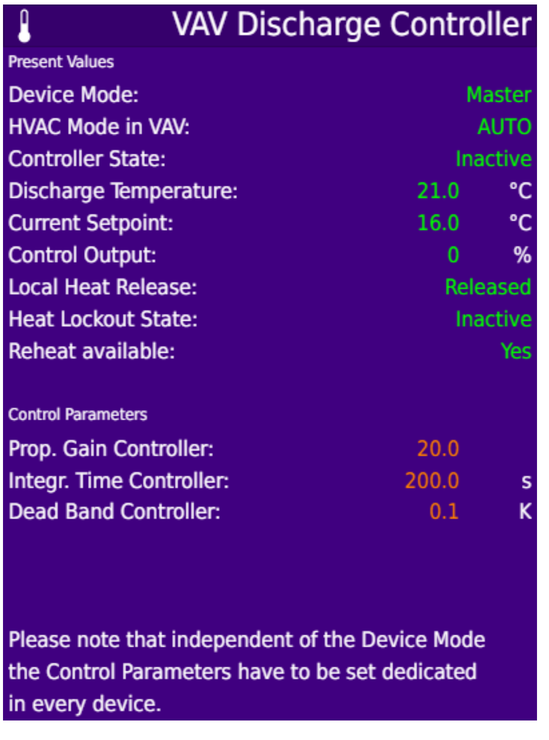

Figure 253: Discharge Controller (complete)

Table 60 shows the present values of the space temperature cooling controller.

Path: User Registers.VAVcontrol.DischargeTemp.Control

Name on tile	**Data point name**	**Description**
Device Mode	VAVgroupDeviceMode	Indicates if the device is Master or Slave in a VAV Group
HVAC Mode in VAV	HVACmodeVAV	Present value of HVAC mode in the VAV
Controller State	DischTempControlActive	Indicates if the controller is active or not
Discharge Temperature	DischargeTemp	Present value of the discharge temperature
Current Setpoint	DischargeTempSetpoint	Present value of the current discharge temperature setpoint
Control Output	YdischTempControlOutput	Present value of the discharge controller output
Local Heat Release	LocalHeatRelease	Present value of the local heat release of the controller
Heat Lockout State	HeatLockoutState	Present value of the heat lockout state (summertime)
Reheat available	ReheatAvailable	Indicates if a reheat is available in the config

Table 60: Present values of discharge control

Device Mode:

Indicates if the device is set as the “Master” or as a “Slave” in the “VAV-Group”. Only the Master is executing the space temperature control and it sends the *Heat Control Output* to the “Slaves”. The “Slaves” do not execute any space temperature control, and so the controller cannot be watched in a “Slave”. The “Slaves” are operating the *Reheat/ Periph. Sequence* function to reset discharge air temperature setpoint according to the control outputs of the “Master”.

HVAC Mode in VAV:

The *HVAC Mode in VAV* coming from the AHU releases the discharge controller for operation:

AUTO:	discharge control is possible
HEAT:	discharge control is possible
MRNG_WRMUP:	discharge control is possible, if *Local Heat Release* is released
COOL:	discharge control is locked
NIGHT_PURGE:	discharge control is locked
PRE_COOL:	discharge control is locked
OFF:	discharge control is possible

Controller State:

This indicates if the controller is enabled actually. If the controller is disabled, the *Control Output* is set to 0%. The controller is active if:

space temperature *Heat Controller State* is active and

HVAC mode in VAV is AUTO or HEAT or MRNG_WRMUP or OFF and

Local Heat Release is released and

Heat Lockout State is inactive

Discharge Temperature:

Here the present value of the *Discharge Temperature* is displayed. It is used by the discharge temperature controller as the control value. This value comes from the local wired hardware input UI5 linked to the inDischargeTemp Favorite (see standard I/O configuration, chapter *7.3.2 Device Configuration*).

Current Setpoint:

This displays the *Current Setpoint* of the discharge temperature controller. This setpoint is calculated by the linear curve function in the *Reheat/ Periph. Sequence* and limitded by the stratification limitation. If the controller is active, it maintains this *Current Setpoint*.

Control Output:

This displays the current *Control Output* of the discharge temperature controller. This output is forwarded to the reheat actuator, see chapter 7.5.15. The value range is 0…100%.

Local Heat Release:

This displays the *Local Heat Release* of the discharge temperature controller. Usually this is released in most cases. Only in case of *HVAC Mode in VAV* is MRNG_WRMUP and the *Local Heat Control in WARMUP* is disabled then the *Local Heat Release* is disabled. This locks the discharge controller and the reheat actuator.

Heat Lockout State:

This displays if the heating function is locked depending on the *Outdoor Temperature* in summer time (see chapter *7.5.15* for more details). If the *Heat Lockout State* is active, the discharge air temperature controller is locked.

Reheat available:

This indicates if a reheat actuator function is connected to the core according to chapter *7.3.1 Application Structure*. This ensures a proper function of the discharge control.

Table 61 shows the parameter values of the discharge temperature controller.

Path: User Registers.VAVcontrol.DischargeTemp.Control

Name on tile	Data point name	Default	Description
Prop. Gain Controller	ProportionalGainDischargeTempControl	20,0 (SI) 11,1 (US)	Proportional gain of the discharge controller
Integr. Time Controller	IntegralTimeDischargeTempControl	600s	Integral time of the discharge controller
Dead Band Controller	DeadBandTimeDischargeTempControl	0,1K 0,2d°F	Dead band valid for the discharge controller

Table 61: Parameters of discharge temperature control

Prop. Gain Controller:

The *Prop. Gain Controller* parameter (also known as K_p) defines the direct reaction to the control difference (which is the difference between the *Discharge Temperature* and the *Current Setpoint*). If the gain is 20 then an input change by 1 °C results in a *Control Output* of 20%. The proportional band is calculated by 100%/gain. In the example, it requires a control difference of 5 °C to reach 100% control output. Higher values will lead to a faster response of the controller but will also increase the possible overshot and the risk of oscillation. Lower values will lead to a slower response of the controller but will also decrease the possible overshot and the risk of oscillation.

Integr. Time Controller:

The *Integr. Time Controller* parameter (also known as reset time T_i) determines the influence of the integral component to the controller output. In the step response, it represents the time the integral component needs to reach the same amount as the proportional component. Lower values will lead to a faster response of the controller but will also increase the possible overshot and the risk of oscillation. Higher values will lead to a slower response of the controller but will also decrease the possible overshot and the risk of oscillation.

The control output as a step response is shown basically in Figure 230.

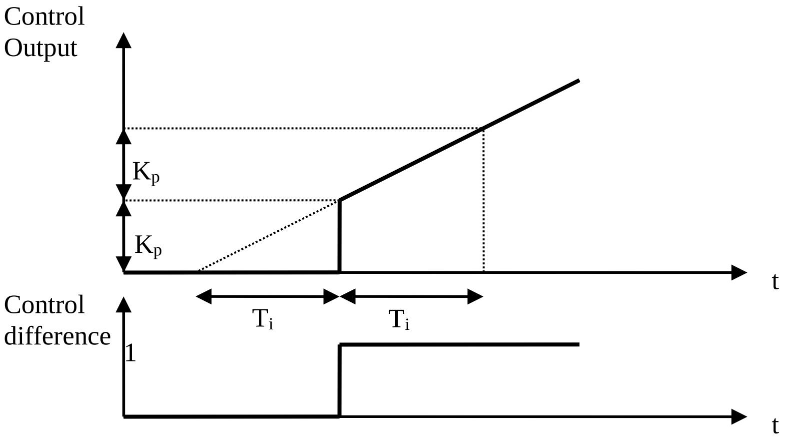

Figure 254: PI Controller step response

Dead Band Controller:

The *Dead Band Controller(s)* parameter defines a dead band in which the control difference is considered zero. It is used to silence the controller at nearly zero control difference.

7.5.8.3 Discharge Temperature Alarms

General Function:

The current discharge temperature is monitored to watch the discharge air condition to the room. If the discharge temperature is leaving a defined range according to the current discharge setpoint, a minimum or maximum Alarm is triggered with a time delay. The range can be defined individually for the minimum and maximum alarms. The alarm function is enabled if the discharge controller is active.

Detailed Function:

There are a minimum and a maximum alarm function, which are relating to the current discharge temperature setpoint. Therefore, these alarm limits are varying if the setpoint is reset by the linear curve function in the *Reheat/ Periph. Sequence*, see chapter 7.5.8.2. The alarm limits are calculated using offset parameters to the current discharge setpoint. These offset parameters can be set dedicated for the minimum and maximum alarm function. If an alarm is triggered it can reset self-sufficiently in case the discharge temperature returns to inside of the limits. The alarm can also be reset by the user.

The maximum and minimum alarm parameters are sent from the “Master” to all “Slaves” in a “VAV-Group”. This ensures a coordinated monitoring of all discharge temperatures in the “VAV-Group”. However, the maximum and minimum alarm function is operating in each device of the “VAV-Group” independently, because every VAV-Box has its own discharge air temperature control.

Please note that the discharge temperature alarms are triggered by this function and only this is described in this chapter. In the device, these alarms are operated as “generic” alarms that are reported to BACnet alarm server in parallel. The complete alarming with alarm servers, alarm lists, alarm status, acknowledgement, alarm notification and further things are standard LOYTEC data point functions of the LIOB-AIR operating system.

The principle of the Discharge Temperature Alarms is displayed in Figure 255.

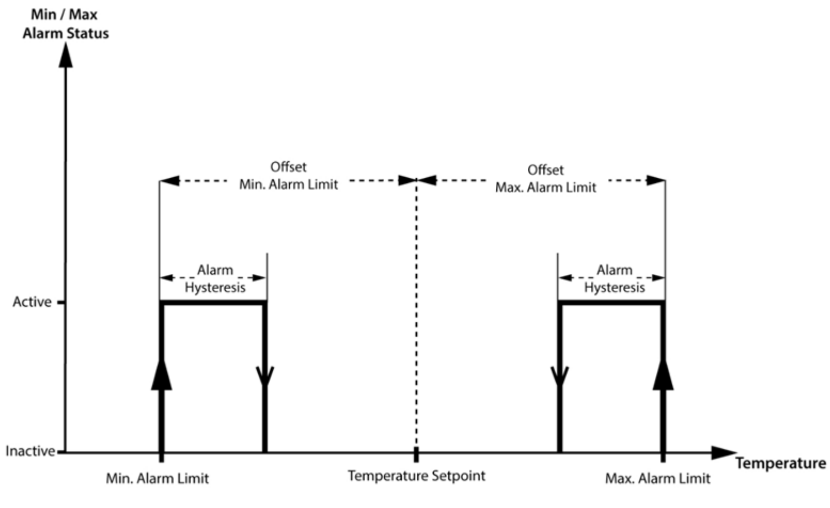

Figure 255: Principle of Discharge Temperature Min. and Max. Alarms

Discharge Temperature Max. Alarm

The Discharge Temperature Max Alarm can be watched and parameterized on the *Discharge Temperature Alarm Parameters* page of the *VAVstatus* visualization project as shown in Figure 256.

Figure 256: Discharge Temp. Max. Alarm configuration

Table 62 shows the Discharge Temp. Max. Alarm present values.

Path: User Registers.VAVcontrol.DischargeTemp.Alarm

Name on tile	**Data point name**	**Description**
Max.Alarm Status	DischTempMaxAlarm	Present value discharge temperature maximum alarm
Discharge Temperature	DischTemperature	Present value of discharge temperature
Max.Alarm Limit	DischTempMaxAlarmLimit	Present value of discharge temp maximum alarm limit
Device Mode	VAVgroupDeviceMode	Indicates if the device is Master or Slave in a VAV Group

Table 62: Discharge Temp. Max. Alarm present values

Max.Alarm Status:

This displays the actual state of the maximum discharge temperature alarm trigger. It becomes active if the *Discharge Temperature* is greater than the current *Max.Alarm Limit* delayed with the *Alarm Time Delay*. It becomes inactive if *Discharge Temperature* is lower than the (*Max.Alarm Limit - Alarm Hysteresis)* without any delay or the alarm is reset by the user, see Figure 255.

Discharge Temperature:

Here the present value of the *Discharge Temperature* is displayed. It is monitored by the discharge temperature max alarm function.

Max.Alarm Limit:

This is the current maximum limit depending on the *Current Setpoint* of discharge temperature and resulting from the following calculation:

Max.Alarm Limit = Current Setpoint + Max.Alarm Limit Offset

Device Mode:

Indicates if the device is set as the “Master” or as a “Slave” in the “VAV-Group”. The alarm function is operated dedicated in every device, no matter if it is a “Master” or a “Slave”. However, to ensure that all devices are operating with the same parameter values the *Max. Alarm limit Offset*, the *Alarm Hysteresis* and the *Alarm Time Delay* are written from the “Master” to all “Slaves” in the “VAV-Group”.

Table 63 shows the Discharge Temperature Max. Alarm parameters.

Path: User Registers.VAVcontrol.DischargeTemp.Alarm

Name on tile	Data point name	Default	Description
Max. Alarm Limit Offset	DischTempMaxAlarmLimitOffset	2,0K 3,6d°F	Maximum Alarm Offset to the current control setpoint
AlarmHysteresis	DischTempAlarmHysteresis	0,2K 0,4d°F	Hysteresis to reset the Disch Temp Min or Max Alarm
Alarm Time Delay	DischTempAlarmDelayTime	1800s	Time delay to trigger a Disch Temp Min or Max Alarm
Alarm Reset	DischTempAlarmReset	FALSE	Button to reset an active Disch Temp Min or Max Alarm

Table 63: Discharge Temp. Max. Alarm parameters

Max Alarm Limit Offset:

This defines the offset to the current *Setpoint* of discharge temperature to calculate the *Max.Alarm Limit*. For details, see *Max.Alarm Limit.* If the device is a “Slave”, this parameter is overwritten by the “Master” device of the “VAV-Group”.

Alarm Hysteresis:

This is valid for the maximum <u>and</u> the minimum discharge temperature alarm function <u>and</u> for the Stratification Alarm function as well. It defines the hysteresis the current discharge temperature to be lower than the *Max.Alarm Limit* or greater than the *Min. Alarm Limit* to reset the discharge temperature max or min alarm self-sufficiently without any time delay, see Figure 255. If the device is a “Slave”, this parameter is overwritten by the “Master” device of the “VAV-Group”.

Alarm Time Delay:

This is valid for the maximum <u>and</u> the minimum discharge temperature alarm function. If the current *Discharge Temperature* is outside of the limits, the min or max alarm is triggered with this time delay. The reset of the discharge temperature min or max alarm is operated without any time delay. If the device is a “Slave”, this parameter is overwritten by the “Master” device of the “VAV-Group”

Alarm Reset:

A triggered discharge temperature maximum or minimum alarm can be reset by the user pressing this button. However, if the current *Discharge Temperature* is still outside of the limits the discharge temperature maximum or minimum alarm will be retriggered again after the *Alarm Time Delay* has elapsed. Pressing this button will set the *Alarm Reset* to TRUE and releasing the button will set the *Alarm Reset* to FALSE (function of the visualization). This also resets the Stratification Alarm. This reset will be forwarded from the “Master” to the “Slaves” in a “VAV Group” to gain a common reset of all devices.

Discharge Temperature Min. Alarm

The Discharge Temperature Min Alarm can be watched and parameterized on the *Discharge Temperature Alarm Parameters* page of the *VAVstatus* visualization project as shown in Figure 257.

Figure 257: Discharge Temp. Min. Alarm configuration

Table 52 shows the Discharge Temp. Min.Alarm present values.

Path: User Registers.VAVcontrol.DischargeTemp.Alarm

Name on tile	**Data point name**	**Description**
Min.Alarm Status	DischTempMinAlarm	Present value discharge temperature minimum alarm
Discharge Temperature	DischTemperature	Present value of discharge temperature
Min.Alarm Limit	DischTempMinAlarmLimit	Present value of discharge temp minimum alarm limit
Device Mode	VAVgroupDeviceMode	Indicates if the device is Master or Slave in a VAV Group

Table 64: Discharge Temp. Min. Alarm present values

Min.Alarm Status:

This displays the actual state of the minimum discharge temperature alarm trigger. It becomes active if the *Discharge Temperature* is lower than the current *Min.Alarm Limit* delayed with the *Alarm Time Delay*. It becomes inactive if *Discharge Temperature* is greater than the (*Min.Alarm Limit + Alarm Hysteresis)* without any delay or the alarm is reset by the user, see Figure 242.

Discharge Temperature:

Here the present value of the *Discharge Temperature* is displayed. It is monitored by the discharge temperature min alarm function.

Min.Alarm Limit:

This is the current minimum limit depending on the *Current Setpoint* of discharge temperature and resulting from the following calculation:

Min.Alarm Limit = Current Setpoint - Min.Alarm Limit Offset

Device Mode:

Indicates if the device is set as the “Master” or as a “Slave” in the “VAV-Group”. The alarm function is operated dedicated in every device, no matter if it is a “Master” or a “Slave”. However, to ensure that all devices are operating with the same parameter values the *Max. Alarm limit Offset,* the *Alarm Hysteresis* and the *Alarm Time Delay* are written from the “Master” to all “Slaves” in the “VAV-Group”.

Table 65 shows the Discharge Temperature Min. Alarm parameters.

Path: User Registers.VAVcontrol.DischargeTemp.Alarm

Name on tile	**Data point name**	**Default**	**Description**
Min. Alarm Limit Offset	DischTempMinAlarmLimitOffset	2,0K 3,6d°F	Maximum Alarm Offset to the current control setpoint
AlarmHysteresis	DischTempAlarmHysteresis	0,2K 0,4d°F	Hysteresis to reset the disch Temp Min or Max Alarm
Alarm Time Delay	DischTempAlarmDelayTime	1800s	Time delay to trigger a Disch Temp Min or Max Alarm
Alarm Reset	DischTempAlarmReset	FALSE	Button to reset an active Disch Temp Min or Max Alarm

Table 65: Space Temp. Min. Alarm parameters

Min Alarm Limit Offset:

This defines the offset to the current *Setpoint* of discharge temperature to calculate the *Min.Alarm Limit*. For details, see *Min.Alarm Limit.* If the device is a “Slave”, this parameter is overwritten by the “Master” device of the “VAV-Group”.

Alarm Hysteresis:

This is valid for the maximum <u>and</u> the minimum discharge temperature alarm function. It defines the hysteresis the current discharge temperature to be lower than the *Max.Alarm Limit* or greater than the *Min. Alarm Limit* to reset the discharge temperature max or min alarm self-sufficiently without any time delay, see Figure 255. If the device is a “Slave”, this parameter is overwritten by the “Master” device of the “VAV-Group”.

Alarm Time Delay:

This is valid for the maximum <u>and</u> the minimum discharge temperature alarm function. If the current *Discharge Temperature* is outside of the limits, the min or max alarm is triggered with this time delay. The reset of the discharge temperature min or max alarm is operated without any time delay. If the device is a “Slave”, this parameter is overwritten by the “Master” device of the “VAV-Group”

Alarm Reset:

A triggered discharge temperature maximum or minimum alarm can be reset by the user pressing this button. However, if the current *Discharge Temperature* is still outside of the limits the discharge temperature maximum or minimum alarm will be retriggered again after the *Alarm Time Delay* has elapsed. Pressing this button will set the *Alarm Reset* to TRUE and releasing the button will set the *Alarm Reset* to FALSE (function of the visualization).

7.5.8.4 Stratification Alarm

General Function:

If the discharge air is too hot relative to the current space temperature, a stratification of warm air happens in the room and that reduces the ventilation efficiency. The discharge air temperature setpoint and control function uses the stratification limitation to limit the current discharge temperature setpoint relative to the current space temperature, see chapter 7.5.8.2. This stratification limitation function is monitored by the stratification alarm function that is described in this chapter. It calculates and watches the difference the current discharge temperature is above the current space temperature. If this difference increases above an adjustable limit, the Stratification Alarm is triggered. The alarm function is enabled if the discharge controller is active.

Detailed Function:

The Discharge Over Temperature is calculated as:

Discharge Over Temperature = curr. *Discharge Temperature* - curr. *Space Temperature*

There is a maximum alarm function, which monitors the *Discharge Over Temperature* relative to an adjustable *Max. Alarm Limit*. are relating to the current discharge temperature setpoint. If an alarm is triggered it can reset self-sufficiently in case the *Discharge Over Temperature* returns to below the limit. The alarm can also be reset by the user.

The *Max. Alarm Limit* is sent from the “Master” to all “Slaves” in a “VAV-Group”. This ensures a coordinated monitoring of all *Discharge Over Temperature* in the “VAV-Group”. However, the Stratification Alarm function is operating in each device of the “VAV-Group” independently, because every VAV-Box has its own discharge air temperature control.

Please note that the Stratification Alarm is triggered by this function and only this is described in this chapter. In the device, this alarm is operated as a “generic” alarm that is reported to BACnet alarm server in parallel. The complete alarming with alarm servers, alarm lists, alarm status, acknowledgement, alarm notification and further things are standard LOYTEC data point functions of the LIOB-AIR operating system.

The principle of the Stratification Alarm is displayed in Figure 258.

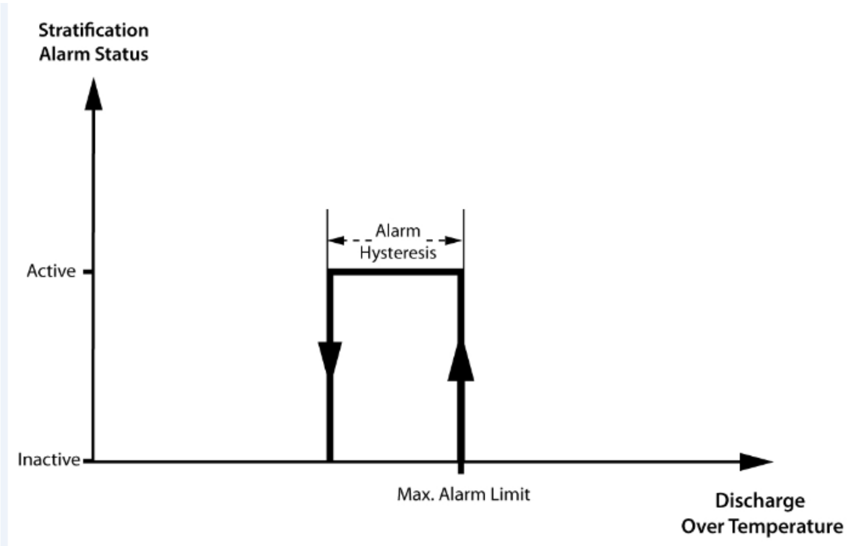

Figure 258: Principle of Stratification Alarm

The Stratification Alarm can be watched and parameterized on the *Discharge Stratification Alarm Parameters* page of the *VAVstatus* visualization project as shown in Figure 259.

Figure 259: Stratification Alarm configuration

Table 66 shows the Stratification Alarm present values.

Path: User Registers.VAVcontrol.DischargeTemp.Alarm

Name on tile	**Data point name**	**Description**
Alarm Status	StratificationAlarm	Present value of stratification alarm
Discharge Over Temperature	DischOverTemp	Present value of discharge over temperature
Max.Alarm Limit	StratificationAlarmLimit	Present value of stratification alarm limit
Device Mode	VAVgroupDeviceMode	Indicates if the device is Master or Slave in a VAV Group

Table 66: Stratification Alarm present values

Alarm Status:

This displays the actual state of the stratification alarm trigger. It becomes active if the *Discharge Over Temperature* is greater than the current *Max.Alarm Limit* delayed with the *Alarm Time Delay*. It becomes inactive if *Discharge Over Temperature* is lower than the (*Max.Alarm Limit - Alarm Hysteresis)* without any delay or the alarm is reset by the user, see Figure 258.

Discharge Over Temperature:

Here the present value of the *Discharge Over Temperature* is displayed resulting from the following calculation:

Discharge Over Temperature = curr. *Discharge Temperature* - curr. Space Temperature

It is monitored by the stratification alarm function.

Max.Alarm Limit:

This is the current maximum limit of the *Discharge Over Temperature.* This is a fix value that can be adjusted on the *Max.Alarm Limit* parameter.

Device Mode:

Indicates if the device is set as the “Master” or as a “Slave” in the “VAV-Group”. The alarm function is operated dedicated in every device, no matter if it is a “Master” or a “Slave”. However, to ensure that all devices are operating with the same parameter values the *Max. Alarm limit*, the *Alarm Hysteresis* and the *Alarm Time Delay* are written from the “Master” to all “Slaves” in the “VAV-Group”.

Table 67 shows the Stratification Alarm parameters.

Path: User Registers.VAVcontrol.DischargeTemp.Alarm

Name on tile	**Data point name**	**Default**	**Description**
Max. Alarm Limit	StratificationAlarmLimit	10,0K 18,0d°F	Maximum Alarm limit of the discharge over temperature
AlarmHysteresis	DischTempAlarmHysteresis	0,2K 0,4d°F	Hysteresis to reset the Stratification Alarm
Alarm Time Delay	StratificationAlarmDelay	600s	Time delay to trigger a Stratification Alarm
Alarm Reset	DischTempAlarmReset	FALSE	Button to reset an active Stratification Alarm

Table 67: Stratification Alarm parameters

Max. Alarm Limit:

This defines the maximum limit of the *Discharge Over Temperature* to trigger a Stratification Alarm. If the device is a “Slave” this parameter is overwritten by the “Master” device of the “VAV-Group”.

Alarm Hysteresis:

This is valid for the Stratification Alarm <u>and</u> also for the maximum <u>and</u> the minimum discharge temperature alarm function. It defines the hysteresis the current *Discharge Over Temperature* to be lower than the *Min. Alarm Limit* to reset the Stratification Alarm self-sufficiently without any time delay, see Figure 258. If the device is a “Slave”, this parameter is overwritten by the “Master” device of the “VAV-Group”.

Alarm Time Delay:

This is valid for the Stratification Alarm. If the current *Discharge Over Temperature* is above the Max. Alarm Limit the Stratification Alarm is triggered with this time delay. The reset of the Stratification Alarm is operated without any time delay. If the device is a “Slave”, this parameter is overwritten by the “Master” device of the “VAV-Group”.

Alarm Reset:

A triggered Stratification Alarm can be reset by the user pressing this button. However, if the current *Discharge Over Temperature* is still outside of the limits the Stratification Alarm will be retriggered again after the *Alarm Time Delay* has elapsed. Pressing this button will set the *Alarm Reset* to TRUE and releasing the button will set the *Alarm Reset* to FALSE (function of the visualization). This also resets the discharge temperature maximum or minimum alarm. This reset will be forwarded from the “Master” to the “Slaves” in a “VAV Group” to gain a common reset of all devices.

7.5.9 IAQ Control

General Function:

In this chapter the Indoor Air Quality (IAQ) Control or Demand Controlled Ventilation (DCV) are described. This concept is relating to the ASHRAE Standard 62.1. To save energy the central AHU is equipped with an economizer and mixes the outdoor air with recirculated air. So the multiple rooms and zones are supplied with a mixture of outdoor air and recirculated air.

There are 2 different methods to be chosen during the setup of the VAV control to realize the DCV function.

Method 1: Demand of Supply Air Flow SA (less accuracy)

Method 2: Demand of Outdoor Air Flow OA (high accuracy)

According to chapter *7.3.1 Application Structure* the IAQ control is a sensor function.

If the VAViaqCO2_SA sensor function is connected to the core, the "Demand of Supply Air Flow SA" (Method 1) is enabled in the core application. It consists of the parts CO_2 curve supply air demand and CO_2 max. alarm.

If the VAViaqSensors_OA sensor function is connected to the core, the "Demand of Outdoor Air Flow OA" (Method 2) is enabled in the core application. It supports CO_2 sensors, VOC sensors, People Counter and Effective Occupancy. It consists of the parts CO_2 curve outdoor air Demand and CO_2 max. alarm, VOC curve outdoor air Demand and VOC max. alarm, People curve outdoor air Demand and People max. alarm, Occupancy curve outdoor air Demand. With Method 2 a dedicated LIOB-AIR device can only support one type of IAQ sensors, but because they all calculate "Demand of Outdoor Air Flow OA" the multiple sensor types can be mixed in system. Which sensor is used is decided by which Favorite is connected to a sensor.

7.5.9.1 Indoor Air Quality Measurement

General Function Method 1:

If the VAViaqCO2_SA sensor function is connected to the core, the "Demand of Supply Air Flow SA" (Method 1) is enabled in the core application.

The CO_2 concentration is measured by a CO_2 sensor connected to the local input of the LIOB-AIR device.

The CO_2 concentration display is shown on the *Status Overview* page of the *VAVstatus* visualization project as shown in Figure 260. This is the value the IAQ controller is using as the control value.

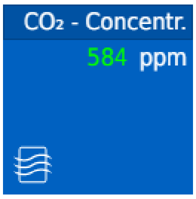

Figure 260: CO_2 concentration tile in Status Overview

Inputs:

In the LIOB-AIR I/O Standard configuration, the CO_2 concentration is located on the universal input UI6. For more information see chapter *7.3.2 Device Configuration*.

If an L-STAT network thermostat with integrated CO_2 sensor is connected, it can be configured to operate with the integrated sensor as the CO_2 sensor or to display the current CO_2 concentration the controller is operating with.

If there are multiple LIOB-AIR devices in a room, they have to be parameterized as a “VAV Group” to be able to operate a proper room control. Either a device can have hard-wired sensors or L-STATs connected (not both at the same time) or no sensor connected. The CO_2 concentration is calculated as the maximum value of all sensors and L-STATs in the VAV Group automatically and used as the control value in the “Master” device.

Favorites:

The Favorite of CO_2 concentration is shown in Table 68.

Path: Favorites.VAVcontrol.IAQ_CO2_SA

Favorite name	Description
inCO2concentration	Present value of CO_2 concentration

Table 68: CO_2 concentration Favorite (Method 1)

inCO2concentration:

The “Demand of Supply Air Flow SA” (Method 1) measurement function has this one Favorite. To this Favorite, the Local I/O *UI5* is connected (see I/O Standard configuration).

General Function Method 2:

If the VAViaqSensors_OA sensor function is connected to the core, the “Demand of Outdoor Air Flow OA” (Method 2) is enabled in the core application. It supports CO_2 sensors, VOC sensors, People Counter and occupancy sensors.

Which sensor is used is decided by which Favorite is connected to a sensor and by the *IAQ Sensor Selection* dialog on the *IAQ Sensor Selection* page of the *VAVstatus* visualization project as shown in Figure 261.

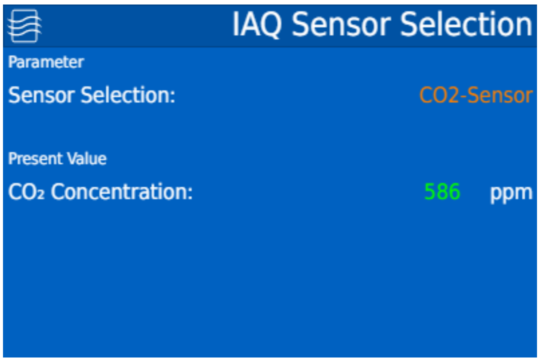

Figure 261: IAQ Sensor Selection (only in Method 2)

It is selectable on the *Sensor Selection* parameter which sensor function shall be operated by the VAV controller: "CO2-Senor / VOC-Sensor / People-Counter / Eff. Occupancy. The visualization is also adapted to the *Sensor Selection* automatically. Please note that this selection has to match with the sensor type connected to the relating Favorite.

CO_2 Sensor:

If a CO_2 sensor is connected to the relating Favorite this sensor has to be selected in the *Sensor Selection* as shown in Figure 261.

The CO_2 concentration is measured by a CO_2 sensor connected to the local input of the LIOB-AIR device.

The CO_2 concentration display is shown on the *Status Overview* page of the *VAVstatus* visualization project as shown in Figure 262. This is the value the IAQ controller is using as the control value.

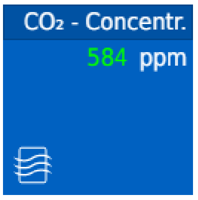

Figure 262: CO_2 concentration tile in Status Overview

In the LIOB-AIR I/O Standard configuration, the CO_2 concentration is located on the universal input UI6. For more information see chapter *7.3.2 Device Configuration*.

If an L-STAT network thermostat with integrated CO_2 sensor is connected, it can be configured to operate with the integrated sensor as the CO_2 sensor or to display the current CO_2 concentration the controller is operating with.

If there are multiple LIOB-AIR devices in a room, they have to be parameterized as a "VAV Group" to be able to operate a proper room control. Either a device can have hard-wired sensors or L-STATs connected (not both at the same time) or no sensor connected. The CO_2 concentration is calculated as the maximum value of all sensors and L-STATs in the VAV Group automatically and used as the control value in the "Master" device.

VOC Sensor:

If a VOC sensor is connected to the relating Favorite this sensor has to be selected in the *Sensor Selection* as shown in Figure 261.

The VOC concentration is measured by a VOC sensor connected to the local input of the LIOB-AIR device.

The VOC concentration display is shown on the *Status Overview* page of the *VAVstatus* visualization project as shown in Figure 263. This is the value the IAQ controller is using as the control value.

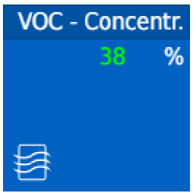

Figure 263: VOC concentration tile in Status Overview

In the LIOB-AIR I/O Standard configuration the VOC concentration not located on any universal input. It has to be configured manually in the VAV Device Type configuration and linked to the Favorite. For more information see chapter *7.3.2 Device Configuration*.

If there are multiple LIOB-AIR devices in a room, they have to be parameterized as a “VAV Group” to be able to operate a proper room control. A device can have hard wired sensors connected or no sensor connected. The VOC concentration is calculated as the maximum value of all sensors in the VAV Group automatically and used as the control value in the “Master” device.

People Counter:

If a People Counter is connected to the relating Favorite, this sensor has to be selected in the *Sensor Selection* as shown in Figure 261.

The room population is measured by a People Counter sensor connected to the local input of the LIOB-AIR device.

The People Counter display is shown on the *Status Overview* page of the *VAVstatus* visualization project as shown in Figure 264: People Counter tile in Status Overview. This is the value the IAQ controller is using as the control value.

Figure 264: People Counter tile in Status Overview

In the LIOB-AIR I/O Standard configuration the People Counter not located on any universal input. It has to be configured manually in the VAV Device Type configuration and linked to the Favorite. For more information see chapter *7.3.2 Device Configuration*.

Effective Occupancy:

If no one of the sensors above is available, an IAQ control can be realized anyway. In this case, the Eff. Occupancy sensor has to be selected in the *Sensor Selection* as shown in Figure 261.

The room population will be indicated by the current status of the *Effective Occupancy* function. There is no additional sensor needed to be connected to the local input of the LIOB-AIR device.

The IAQ Occupancy display is shown on the *Status Overview* page of the *VAVstatus* visualization project as shown in Figure 265. This is the value the IAQ controller is using as the control value.

Figure 265: IAQ Occupancy tile in Status Overview

Favorites:

The “Demand of Supply Air Flow OA” (Method 2) measurement function has 3 Favorites. These are shown in Table 69.

Path: Favorites.VAVcontrol.IAQ_Sensors_OA

Favorite name	**Description**
inCO2concentration	Present value of CO_2 concentration
inVOCconcentration	Present value of VOC concentration
inPeopleCounter	Present value of People Counter

Table 69: Demand of Outdoor Air Flow OA Favorites (Method 2)

inCO2concentration:

To this Favorite, the Local I/O *UI5* is connected (see I/O Standard configuration).

inVOCconcentration:

To this Favorite no Local I/O is connected. If needed, a VOC sensor has to be configured in the I/O configuration and connected to this Favorite.

inPeopleCounter:

To this Favorite no Local I/O is connected. If needed, a People Counter sensor has to be configured in the I/O configuration and connected to this Favorite.

7.5.9.2 IAQ Setpoint & Control (Method 1)

General Function (Supply Air Flow Demand):

In this method, there is no measurement of the outdoor air intake flow existing in the AHU. In the rooms, the IAQ-Control detects the air quality by measurement of the CO_2 concentration. This CO_2 is aggregated (as maximum selection) for all rooms and is communicated to the AHU. In the AHU-control there is a CO_2- controller maintaining a CO_2 setpoint and controlling the dampers of the economizer in parallel to the AHU temperature control. The IAQ-Control in the room does not "know" how much outdoor air is included in the actual supply air flow. Therefore, the IAQ-Control in the room simply controls the setpoint of the supply air flow based on a linear curve function.

The IAQ Control is only enabled in the HVAC modes: AUTO, HEAT, and COOL.

Detailed Function:

The principle of the IAQ control is shown as an example in Figure 266 (in the red box).

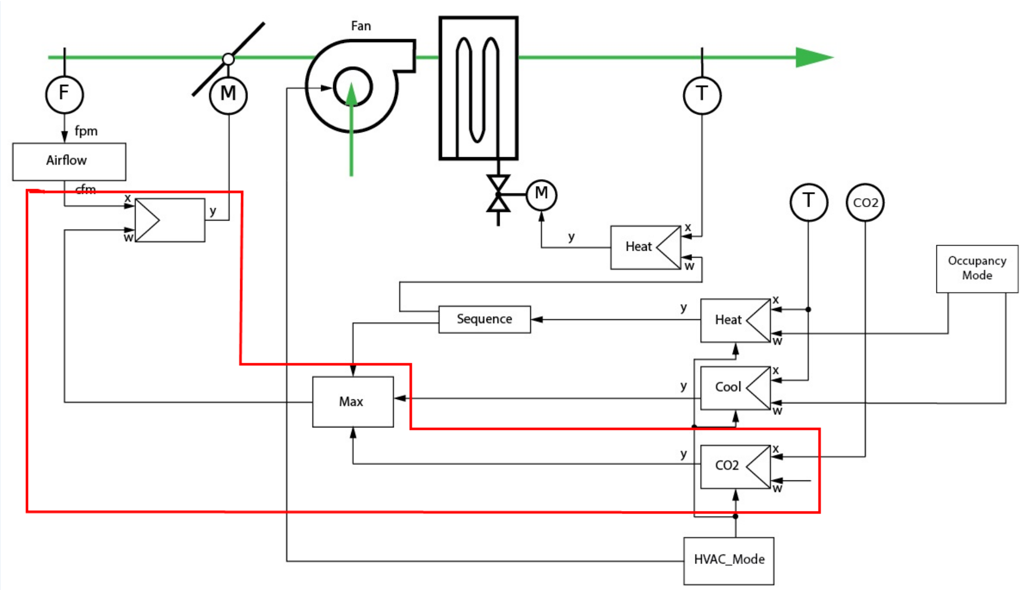

Figure 266: Example VAV-box CO_2 control scheme

From the air condition system design for every room, the following values are defined: "Minimum and Maximum Air Flow for Cooling, Heating and Unit Heat".

But this is only the supply air flow which is needed to supply the heating or cooling energy to the room. There is no information which outdoor air rate is included.

Based on the area and the population of the room the demand of outdoor air flow is defined by design also: "Minimum and Maximum Outdoor Air Flow"

The Minimum Outdoor Air Flow is needed if no person occupies the room.
The Maximum Outdoor Air Flow is needed if the room is populated by the designed maximum of persons.

However, the information of current outdoor air flow from the AHU is not available in this method. This is caused by the higher cost of an outdoor air rate measurement or by the difficulty to measure the air flow at the outside air intake.

In this method, the CO_2-Sensor is the only type of air quality detection available and supported by the VAV-Controller.

The IAQ control function in the room is a linear curve, which calculates the supply air flow demand depending on the measured CO_2 concentration in the room. So basically more supply air flow will also provide more outdoor air flow and vice versa. See Figure 267.

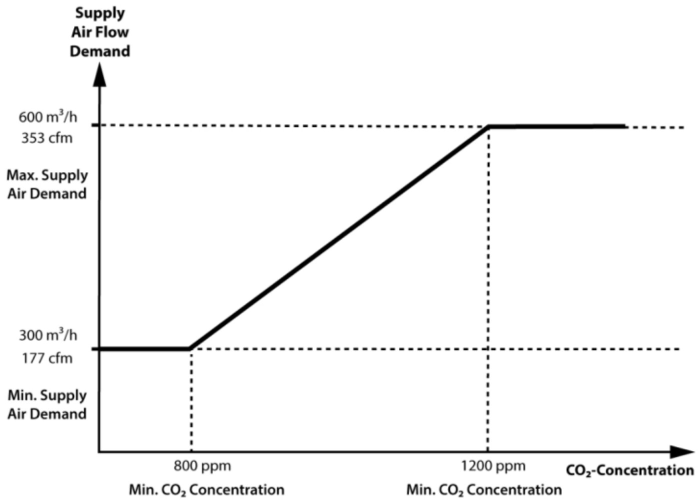

Figure 267: IAQ Control, Supply Air Flow Demand Curve

This curve has to be parameterized dedicated for every room by the system integrator according to the system design values of the room. If the CO_2 concentration is increasing, the demand of supply air flow is increased steadily between the Min and Max supply air demand CFM values and vice versa.

If there are multiple LIOB-AIR devices in a room, they have to be parameterized as a "VAV Group" to be able to operate a proper room control. One device in the group has to be set as the "Master". This "Master" device only is executing the IAQ control function with calculating the summary supply air flow demand of the room for all VAV Boxes. The supply air flow demand of the room is communicated as a percentage value (control output) from the "Master" to all "Slaves" in the group. The members of the "VAV Group" calculate the current supply air flow demand based on the control output of the "Master" as a percentage of their individual *Max Flow Cool* value. The "Slaves" do not perform an IAQ control but they only follow the control output of the "Master". Please refer to chapter 7.6.2 for more information.

The current supply air flow demand from the IAQ control is forwarded to the *Air Flow Setpoint Selection* of the Flow Control in the dedicated VAV Boxes. Please refer to chapter 7.5.5.3 for more information.

CO_2 Sensor Function:

The CO_2 sensor has a PT1 damping function. The damping affects the speed of the measurement and the IAQ control function. The IAQ control is using the damped CO_2 value as the control value. Higher PT1 Time values will increase the damping and slow down the speed of value changes. This will slow down the speed of the IAQ control output value changes also.

The CO_2 sensor with the PT1 damping function can be watched and parameterized completely on the *IAQ Sensor Configuration* page of the *VAVstatu*s visualization project as shown in Figure 268.

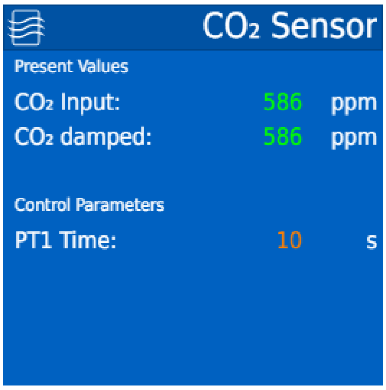

Figure 268: CO_2 Sensor damping

Table 70 shows the present values of the IAQ sensor configuration.

Path: User Registers.VAVcontrol.IAQ_CO2_SA

Name on tile	**Data point name**	**Description**
CO_2 Input	CO2concentration	Present value of CO2 sensor (not damped)
CO_2 damped	CO2concentration(damped)	Present value of CO2 sensor (damped)

Table 70: Present values of IAQ sensor configuration

CO_2 Input:

This shows the not damped value of the CO_2 sensor. The IAQ control does not operate with this value.

CO_2 damped:

This shows the damped value of the CO2 sensor. The IAQ control operates this as the control value.

Table 71 shows the IAQ sensor configuration parameters.

Path: User Registers.VAVcontrol.IAQ_CO2_SA

Name on tile	**Data point name**	**Default**	**Description**
PT1 Time	TimeConstantCO2	10s	PT1 time constant for CO2 sensor damping

Table 71: IAQ sensor configuration parameters

PT1 Time:

This defines PT1 time constant for the CO_2 sensor damping function. With increasing values, the damping will be increased and slow down the response of the damped resulting value. The *CO2 Input* is the input to the PT1 function. The result is the *CO2 damped* value.

Calculation of Supply Air Demand:

The *CO_2 damped* value is the input of the linear curve, which calculates the supply air flow demand of the room. This linear curve function can be watched and parameterized on the *IAQ Controller* page of the *VAVstatus* visualization project as shown in Figure 269. Please note that this function is only available in the “Master” device of a “VAV Group”.

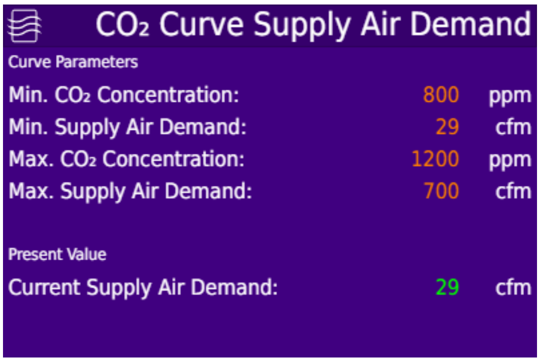

Figure 269: CO_2 curve supply air demand

Table 72 shows the CO_2 curve supply air demand parameters.

Path: User Registers.VAVcontrol.IAQ_CO2_SA.CO2control_SA

Name on tile	Data point name	Default	Description
Min. CO_2 Concentration	CO2MinConcentrMinSA	800ppm	Minimum CO_2 concentration of minimum supply air demand
Min. Supply Air Demand	CO2MinSupplyAirFlow	300m^3/h 177cfm	Minimum supply air flow demand (curve)
Max. CO_2 Concentration	CO2MaxConcentrMaxSA	1200ppm	Maximum CO_2 concentration of maximum supply air demand
Max. Supply Air Demand	CO2MaxSupplyAirFlow	600m^3/h 353cfm	Maximum supply air flow demand (curve)

Table 72: CO_2 curve supply air demand parameters

Min. CO_2 Concentration:

This defines the CO_2 concentration in the room that causes the linear curve function to calculate the *Min. Supply Air Demand* as the output value, see Figure 267. The *Min. CO2 Concentration* is a value for a good air quality. This is the concentration that is measured if no person occupies the room.

Min. Supply Air Demand:

This defines minimum supply air demand of the room that is needed by design if no person occupies the room. This supply air demand has to be taken from the system design values that are based on the designed AHU outdoor air fraction. If there are multiple VAV Boxes in a room this value has to be the summary *Min. Supply Air Flow Demand* of all boxes in the “VAV Group”.

Max. CO_2 Concentration:

This defines the CO_2 concentration in the room that causes the linear curve function to calculate the *Max. Supply Air Demand* as the output value, see Figure 267. The *Max. CO2 Concentration* is a value for a just good enough air quality. This is the concentration that is measured if the maximum number of persons is occupying the room.

Max. Supply Air Demand:

This defines maximum supply air demand of the room that is needed by if the maximum number of persons is occupying the room. This supply air demand has to be taken from the system design values that are based on the designed AHU outdoor air fraction. If there are multiple VAV Boxes in a room this value has to be the summary *Max. Supply Air Flow Demand* of all boxes in the "VAV Group".

Table 73 shows the present values of the IAQ sensor configuration.

Path: User Registers.VAVcontrol.IAQ_CO2_SA. CO2control_SA

Name on tile	Data point name	Description
Current Supply Air Demand	IAQsumSupplyAirFlowDemand	Present value of the summary supply air flow demand of the room (curve output)

Table 73: Present value of CO_2 curve supply air demand

Current Supply Air Flow Demand:

This shows the result of the linear curve function and displays the Current Supply Air flow demand of the room depending on the actual CO_2 concentration. If there are multiple VAV Boxes in a room this value is the summary *Current Supply Air Flow Demand* setpoint of all boxes in the "VAV Group".

IAQ Controller Group Function:

As described above, the linear curve function to calculate the *Current Supply Air Flow Demand* is operating only in the "Master" device of a "VAV Group". This is the summary *Current Supply Air Flow Demand* of all VAV Boxes in the room. Therefore, the *Min. Supply Air Flow Demand* and the *Max. Supply Air Flow Demand* parameters have to be the summary of all these values of the "Master" and all "Slave" VAV Boxes in the "VAV Group".

Because the VAV Boxes in a "VAV Group" can have different sizes, the *Current Supply Air Flow Demand* is calculated as a percentage *IAQ Control Output* that is communicated from the "Master" to the "Slaves". In the "VAV Group" all *Max. Flow VAV-Box* values are aggregated as a summary automatically:

IAQ Control Output = *Current Supply Air Flow Demand* / ∑ *Max. Flow VAV-Box * 100*

Please note: *Max Flow VAV-Box = Max. Flow Cool*.

The "Slaves" receive the *IAQ Control Output* from the "Master" and calculate their individual *IAQ Supply Air Demand VAV-Box* value relating to the individual *Max. Flow Cool* value:

IAQ Supply Air Demand VAV-Box = *IAQ Control Output * Max. Flow VAV-Box*

This individual *IAQ Supply Air Demand VAV-Box* value is also calculated in the “Master” device internally relating to the individual *Max. Flow VAV-Box* value.

The calculation function of the *IAQ Control Output* can be watched on the *IAQ Controller* page of the *VAVstatus* visualization project as shown in Figure 270. Please note that this function is only available in the “Master” device of a “VAV Group”. It is also available if the “Master” is the only device in the “VAV Group”.

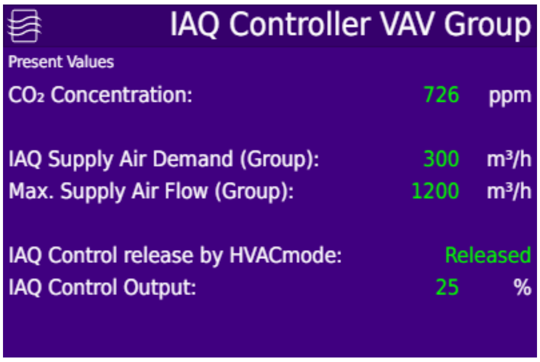

Figure 270: IAQ Controller VAV Group

Table 74 shows the present values of the IAQ controller.

Path: User Registers.VAVcontrol.IAQ_CO2_SA. CO2control_SA

Name on tile	**Data point name**	**Description**
CO_2 Concentration	CO2concentration(damped)	Present value of CO2 sensor (damped)
IAQ Supply Air Demand (Group)	IAQsumSupplyAirFlowDemand	Present value of the summary supply air flow demand of the room (curve output)
Max. Supply Air Flow (Group)	IAQsumSupplyMaxAirFlow	Present value of the summary aggregated maximum supply air flow of all VAV Boxes in the room
IAQ Control release by HVACmode	IAQcontrolHVACrelease	Indicates if IAQ control is released by HVAC mode
IAQ Control Output	IAQcontrolOutput	Control output of the “Master” sent to the “Slaves”

Table 74: Present values IAQ Controller

CO_2 Concentration:

This shows the damped value of the CO_2 sensor. It is equal to *CO_2 damped*. The linear curve function of the IAQ control operates this as the control value.

IAQ Supply Air Demand (Group):

This shows the result of the linear curve function and displays the current supply air flow demand of the room depending on the actual CO_2 concentration. It is equal to *Current Supply Air Demand*. If there are multiple VAV Boxes in a room this value is the summary *Current Supply Air Flow Demand* setpoint of all boxes in the “VAV Group”.

Max. Supply Air Flow (Group):

This shows the result of the automatic summary aggregation of all *Max. Flow Cool* values of the “Master” and all “Slave” devices in the “VAV Group”. This value is needed to calculate the *IAQ Control output* as a percentage value.

IAQ Control release by HVACmode:

This shows if the IAQ control is released by the current HVAC mode coming from the AHU. It is released in the HVAC modes AUTO, HEAT or COOL. If the IAQ control is not released, the *Current Supply Air Demand* is set to “Zero” and so the resulting *IAQ Control Output* is also “Zero”.

IAQ Control Output:

This is the *IAQ Control Output* as a percentage value of the *Max. Supply Air Flow (Group)* that is sent from the “Master” to the “Slaves” in a “VAV Group”. Based on this value every member of the “VAV Group” calculates its individual *IAQ Supply Air Demand VAV-Box*.

<u>Individual IAQ control:</u>

Every individual VAV Box of the “VAV Group” receives the *IAQ Control Output* as a percentage value from the “Master”. Based on this *IAQ Control Output* and the *Max. Flow VAV Box* the *IAQ Supply Air Demand VAV-Box* is calculated individually in every VAV Box.

The individual calculation function of the IAQ Control in every VAV Box can be watched on the *IAQ Control Box* page of the *VAVstatu*s visualization project as shown in Figure 271.

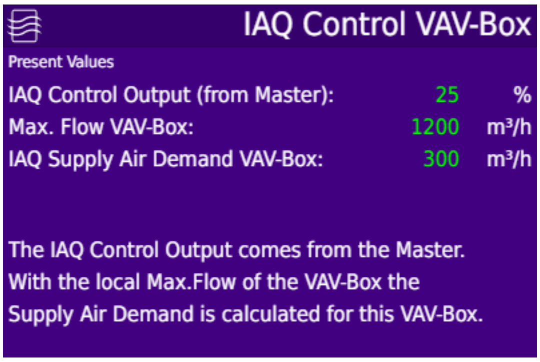

Figure 271: IAQ Control VAV-Box

Table 75 shows the present values of the IAQ Control in every VAV Box.

Path: User Registers.VAVcontrol.Core.IAQcontrol

Name on tile	Data point name	Description
IAQ Control Output (from Master)	IAQcontrolOutput	Present value IAQ control output received from the "Master"
Max. Flow VAV-Box	IAQlocalMaxFlow	Present value maximum air flow of the local VAV Box
IAQ Supply Air Demand VAV-Box	IAQsetpointLocalSupplyAirFlow	Resulting IAQ supply air setpoint of the local VAV Box

Table 75: Present values IAQ Control VAV-Box

IAQ Control Output (from Master):

The "Master" sends out the *IAQ Control Output* as a percentage value to all members of the "VAV Group". The *IAQ Control Output (from Master)* is the value that is received from the "Master".

Max. Flow VAV-Box:

This is the maximum supply air flow of the individual VAV Box that is to be parameterized on *Max. Flow Cool*.

IAQ Supply Air Demand VAV-Box:

This is the result of the individual calculation function of the IAQ Control in every VAV Box. This value is forwarded to the *Air Flow Setpoint Selection* of the Flow Control. Please refer to chapter 7.5.5.3 for more information.

<u>Functions in the AHU control:</u>

The following functions are requested to be realized in the AHU control to support the proper function of the method 1 if IAQ control in the VAV Boxes.

The AUH has to be equipped with an economizer, it mixes the outdoor air with recirculated air. So the multiple rooms and zones are supplied with a mixture of air.

As described above the AHU controller receives the maximum aggregated CO_2 concentration of all VAV Boxes from the manager.

Usually the outdoor air damper of the economizer is controlled by the sequence of the supply temperature control of the AHU control.

To maintain the IAQ function, the max CO_2 concentration of all VAV Boxes is used as the control value also with a separate CO_2 control function, which is realized as a linear curve (or P controller). Therefore, if the maximum CO_2 concentration of the rooms is increasing the outside air damper position is increasing also and vice versa.

Therefore, the maximum control output of the Temperature Control and of the CO_2control is put to the mixing damper actuators of the economizer.

An alternative way to detect the need of air quality in the AHU control could be the direct control of the CO_2 concentration in the supply air flow of the AHU. To realize that a CO_2 sensor is need to be mounted in the supply air duct. The CO2 controller in the AHU could maintain a constant setpoint of e.g. 600 ppm.

To become more accurate the AHU supply air CO_2 setpoint also could be calculated by a linear curve depending on the max CO_2 concentration of all VAV Boxes as shown in Figure 272. This curve has to be set up by the balancer.

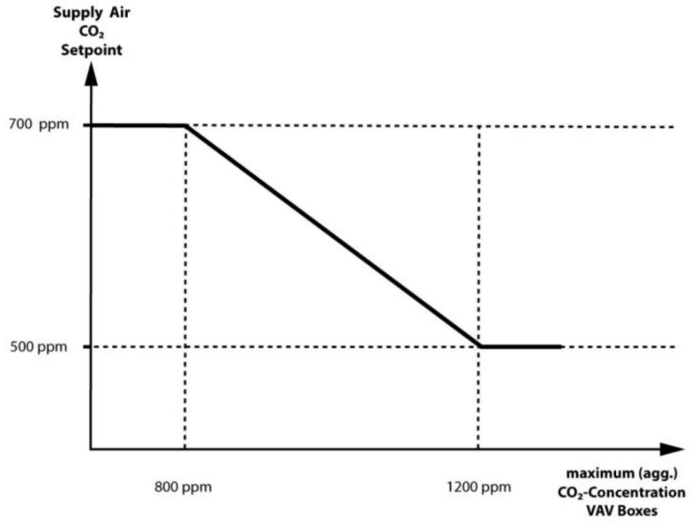

Figure 272: AHU supply air CO_2 setpoint curve

Therefore, if the maximum CO_2 concentration of the zones is increasing, the setpoint of the supply air CO2 concentration is decreasing. Of course this curve must be parmeterized with care but it allows to save more thermal energy.

The maximum control output of the temperature control and the CO_2control has to be put to the mixing damper actuator of the economizer.

7.5.9.3 IAQ Setpoint & Control (Method 2)

General Function (Outdoor Air Flow Demand):

In this method, there is a measurement of the outdoor air intake flow existing in the AHU. The IAQ-Control of the VAV controller in the room detects the air quality with CO2 sensors or VOC sensors or people counters or depending on the effective occupancy. The control function calculates the demand of outdoor air. This outdoor air demand is summary aggregated and communicated to the AHU. In the AHU-control, the outdoor air intake is measured and controlled to maintain the summary demand of the rooms. The current outdoor air fraction is communicated from the AHU to the VAV controllers. Therefore, the IAQ-Control in the room “know” how much outdoor air is included in the actual supply air flow. The IAQ-Control in the room calculates the supply air flow setpoint based on a linear curve function considering the actual outdoor air fraction to serve the room with the required outdoor air flow.

The IAQ Control is only enabled in the HVAC modes: AUTO, HEAT, and COOL.

Detailed Function:

The principle of the IAQ control is shown as an example in Figure 273 (in the red box).

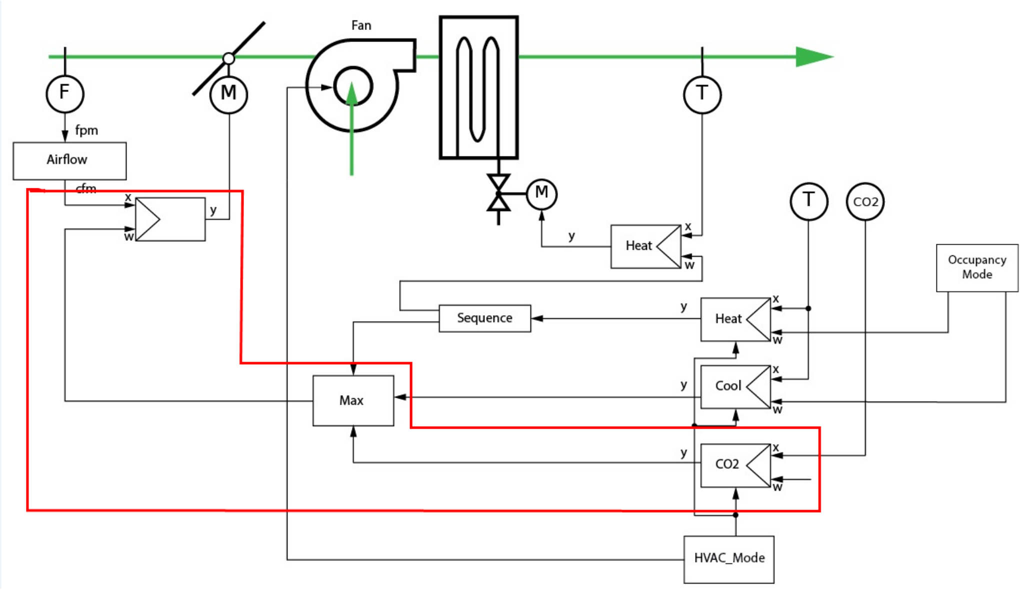

Figure 273: Example VAV-box IAQ control scheme
(multiple sensor types possible instead of CO_2)

From the air condition system design for every room, the following values are defined: “Minimum and Maximum Air Flow for Cooling, Heating and Unit Heat”.

However, this is only the supply air flow, which is needed to supply the heating or cooling energy to the room. There is no information which outdoor air rate is included.

Based on the area and the population of the room the demand of outdoor air flow is defined by design also: “Minimum and Maximum Outdoor Air Flow”

The Minimum Outdoor Air Flow is needed if no person occupies the room.
The Maximum Outdoor Air Flow is needed if the room is populated by the designed maximum of persons.

The more people populate the room the air quality is decreasing and the demand of outdoor air flow is rising.

In this method the information of current outdoor air flow from the AHU is available in the VAV controller.in this method. This is because the AHU control is measuring and controlling the outside air intake.

CO_2-Sensors, VOC sensors, People Counters or the effective occupancy are supported as IAQ sensor types in this method. The multiple sensor types can be mixed in the VAV controls of the multiple rooms belonging to one AHU system. However, in a dedicated room there must be the IAQ sensors of the same type.

The IAQ control function in the room is a linear curve, which calculates the outdoor air flow demand depending on the measured IAQ in the room. The min. and max. outdoor air flow demand have to be parameterized dedicated for every room by the system integrator according to the individual system design values of the room.

If the Effective Occupancy is used as the sensor type, the outdoor air flow demand is realized as a 2-point calculation depending on the current effective occupancy state.

See Figure 274, the linear curve calculation of the outdoor air flow demand depending on the CO2 concentration of the room.

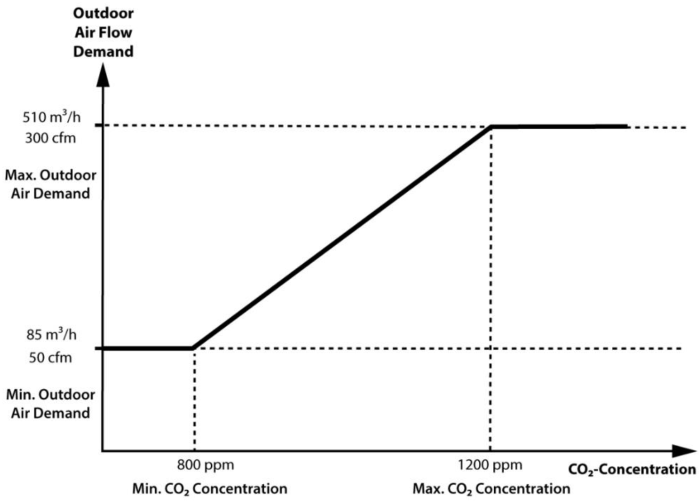

Figure 274: IAQ Control, CO_2 sensor, Outdoor Air Flow Demand Curve

See Figure 275, the linear curve calculation of the outdoor air flow demand depending on the VOC concentration of the room.

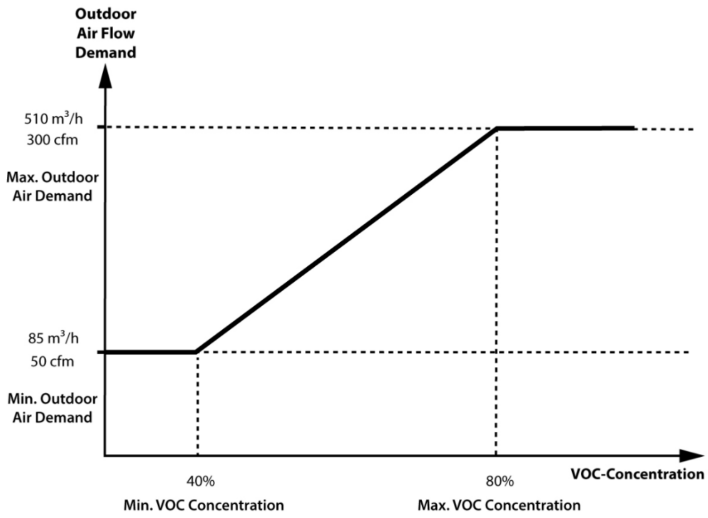

Figure 275: IAQ Control, VOC sensor, Outdoor Air Flow Demand Curve

See Figure 276, the linear curve calculation of the outdoor air flow demand depending on the number of people in the room (if such a sensor type is available in the market).

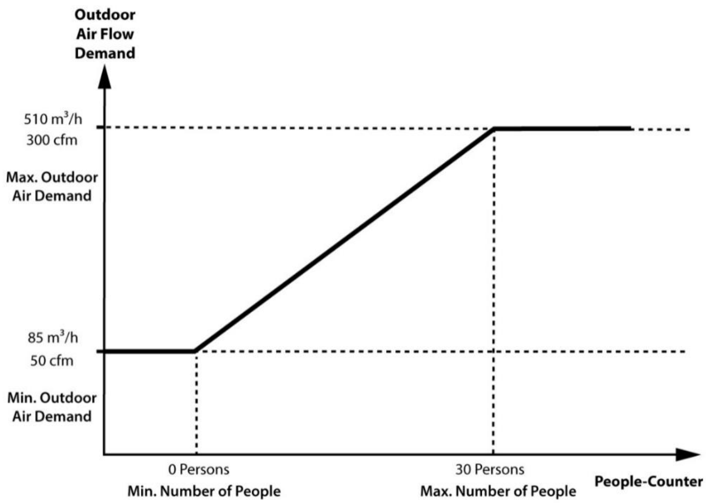

Figure 276: IAQ Control, People Counter, Outdoor Air Flow Demand Curve

See Figure 277, the 2 point calculation of the outdoor air flow demand depending on the effective occupancy of the room. No extra sensor needed, it uses the integrated occupancy function of the VAV control.

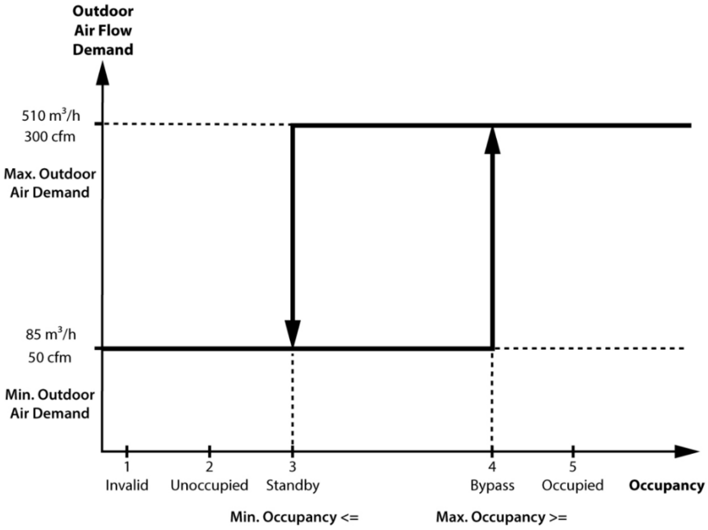

Figure 277: IAQ Control, Effective Occupancy, Outdoor Air Flow Demand

<u>CO_2 Sensor Function:</u>

The CO_2 sensor has a PT1 damping function. The damping affects the speed of the measurement and the IAQ control function. The IAQ control is using the damped CO_2 value as the control value. Higher PT1 Time values will increase the damping and slow down the speed of value changes. This will slow down the speed of the IAQ control output value changes also.

The CO_2 sensor with the PT1 damping function can be watched and parameterized completely on the *IAQ Sensor Configuration* page of the *VAVstatu*s visualization project as shown in Figure 278.

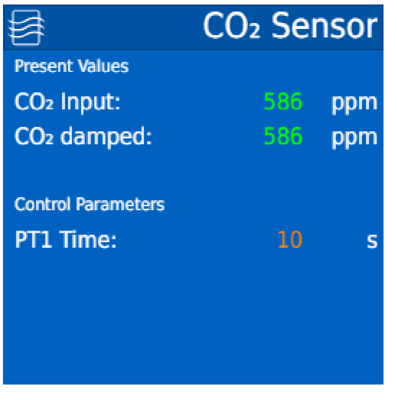

Figure 278: CO_2 Sensor damping

Table 76 shows the present values of the CO_2 sensor configuration.

Path: User Registers.VAVcontrol.IAQ_Sensors_OA

Name on tile	Data point name	Description
CO_2 Input	CO2concentration	Present value of CO2 sensor (not damped)
CO_2 damped	CO2concentration(damped)	Present value of CO2 sensor (damped)

Table 76: Present values of CO_2 sensor configuration

CO_2 Input:

This shows the not damped value of the CO_2 sensor. The IAQ control does not operate with this value.

CO_2 damped:

This shows the damped value of the CO2 sensor. The IAQ control operates this as the control value.

Table 77 shows the IAQ sensor configuration parameters.

Path: User Registers.VAVcontrol.IAQ_Sensors_OA

Name on tile	Data point name	Default	Description
PT1 Time	TimeConstantCO2VOC	10s	PT1 time constant for CO2 sensor damping

Table 77: CO_2 sensor configuration parameters

PT1 Time:

This defines PT1 time constant for the CO_2 sensor damping function. With increasing values, the damping will be increased and slow down the response of the damped resulting value. The *CO2 Input* is the input to the PT1 function. The result is the *CO2 damped* value.

<u>VOC Sensor Function:</u>

The VOC sensor has a PT1 damping function. The damping affects the speed of the measurement and the IAQ control function. The IAQ control is using the damped VOC value as the control value. Higher PT1 Time values will increase the damping and slow down the speed of value changes. This will slow down the speed of the IAQ control output value changes also.

The VOC sensor with the PT1 damping function can be watched and parameterized completely on the *IAQ Sensor Configuration* page of the *VAVstatus* visualization project as shown in Figure 279.

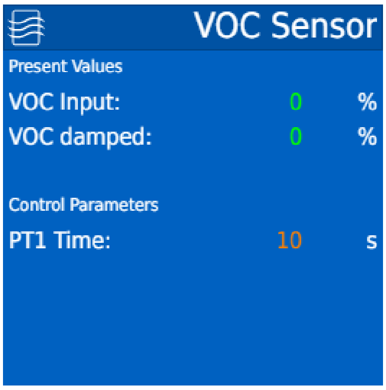

Figure 279: VOC Sensor damping

Table 78 shows the present values of the VOC sensor configuration.

Path: User Registers.VAVcontrol.IAQ_Sensors_OA

Name on tile	Data point name	Description
VOC Input	VOCconcentration	Present value of VOC sensor (not damped)
VOC damped	VOCconcentration(damped)	Present value of VOC sensor (damped)

Table 78: Present values of VOC sensor configuration

VOC Input:

This shows the not damped value of the VOC sensor. The IAQ control does not operate with this value.

VOC damped:

This shows the damped value of the VOC sensor. The IAQ control operates this as the control value.

Table 79 shows the IAQ sensor configuration parameters.

Path: User Registers.VAVcontrol.IAQ_Sensors_OA

Name on tile	Data point name	Default	Description
PT1 Time	TimeConstantCO2VOC	10s	PT1 time constant for VOC sensor damping

Table 79: VOC sensor configuration parameters

PT1 Time:

This defines PT1 time constant for the VOC sensor damping function. With increasing values, the damping will be increased and slow down the response of the damped resulting value. The *VOC Input* is the input to the PT1 function. The result is the *VOC damped* value.

People Counter Sensor Function:

The People Counter sensor has a PT1 damping function. The damping affects the speed of the measurement and the IAQ control function. The IAQ control is using the damped People Counter value as the control value. Higher PT1 Time values will increase the damping and slow down the speed of value changes. This will slow down the speed of the IAQ control output value changes also.

The People Counter sensor with the PT1 damping function can be watched and parameterized completely on the *IAQ Sensor Configuration* page of the *VAVstatu*s visualization project as shown in Figure 280.

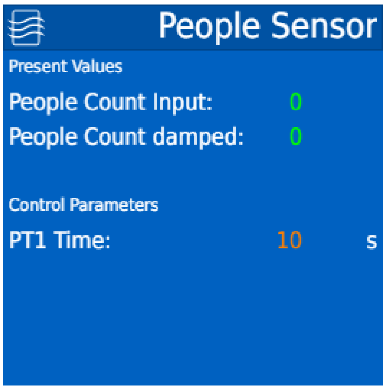

Figure 280: People Counter Sensor damping

Table 80 shows the present values of the VOC sensor configuration.

Path: User Registers.VAVcontrol.IAQ_Sensors_OA

Name on tile	**Data point name**	**Description**
People Count Input	PeopleCounter	Present value of People Counter sensor (not damped)
People Count damped	PeopleCounter(damped)	Present value of People Counter sensor (damped)

Table 80: Present values of People Counter sensor configuration

People Count Input:

This shows the not damped value of the People Counter sensor. The IAQ control does not operate with this value.

People Count damped:

This shows the damped value of the People Counter sensor. The IAQ control operates this as the control value.

Table 81 shows the People Counter sensor configuration parameters.

Path: User Registers.VAVcontrol.IAQ_Sensors_OA

Name on tile	**Data point name**	**Default**	**Description**
PT1 Time	TimeConstantCO2VOC	10s	PT1 time constant for People Counter sensor damping

Table 81: People Counter sensor configuration parameters

PT1 Time:

This defines PT1 time constant for the People Counter sensor damping function. With increasing values, the damping will be increased and slow down the response of the damped resulting value. The *People Count Input* is the input to the PT1 function. The result is the *People Count damped* value.

<u>Effective Occupancy Sensor Function:</u>

Because the IAQ control this is using the internal occupancy function of the VAV control in this cases there is no additional damping here. See chapter 7.5.12 for more information.

Calculation of Outdoor Air Demand with CO_2 Sensor:

The *CO_2 damped* value is the input of the linear curve, which calculates the outdoor air flow demand of the room. This linear curve function can be watched and parameterized on the *IAQ Controller* page of the *VAVstatus* visualization project as shown in Figure 281. Please note that this function is only available in the “Master” device of a “VAV Group”.

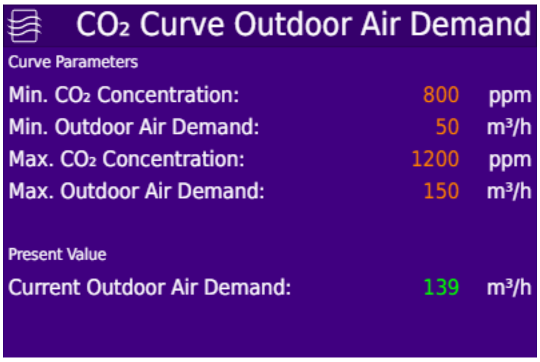

Figure 281: CO_2 curve outdoor air demand

Table 82 shows the CO_2 curve outdoor air demand parameters.

Path: User Registers.VAVcontrol.IAQ_Sensors_OA.IAQcontrol_OA

Name on tile	Data point name	Default	Description
Min. CO_2 Concentration	CO2MinConcentrMinOA	800ppm	Minimum CO_2 concentration of minimum outdoor air demand
Min. Outdoor Air Demand	IAQMinOutdoorAirFlow	$50m^3/h$ 29cfm	Minimum outdoor air flow demand (curve)
Max. CO_2 Concentration	CO2MaxConcentrMaxOA	1200ppm	Maximum CO_2 concentration of maximum outdoor air demand
Max. Outdoor Air Demand	IAQMaxOutdoorAirFlow	$150m^3/h$ 88cfm	Maximum supply air flow demand (curve)

Table 82: CO_2 curve outdoor air demand parameters

Min. CO_2 Concentration:

This defines the CO_2 concentration in the room that causes the linear curve function to calculate the *Min. Outdoor Air Demand* as the output value, see Figure 274. The *Min. CO2 Concentration* is a value for a good air quality. This is the concentration that is measured if no person occupies the room.

Min. Outdoor Air Demand:

This defines minimum outdoor air demand of the room that is needed by design if no person occupies the room. This outdoor air demand has to be taken from the system design values. If there are multiple VAV Boxes in a room this value has to be the summary *Min. Outdoor Air Flow Demand* of all boxes in the “VAV Group”.

Max. CO_2 Concentration:

This defines the CO_2 concentration in the room that causes the linear curve function to calculate the *Max. Outdoor Air Demand* as the output value, see Figure 274. The *Max. CO2 Concentration* is a value for a just good enough air quality. This is the concentration that is measured if the maximum number of persons is occupying the room.

Max. Outdoor Air Demand:

This defines maximum outdoor air demand of the room that is needed by if the maximum number of persons is occupying the room. This outdoor air demand has to be taken from the system design values. If there are multiple VAV Boxes in a room this value has to be the summary *Max. Supply Air Flow Demand* of all boxes in the "VAV Group".

Table 83 shows the present values of the IAQ sensor configuration.

Path: User Registers.VAVcontrol.IAQ_Sensors_OA.IAQcontrol_OA

Name on tile	Data point name	Description
Current Outdoor Air Demand	IAQsumOutdoorAirFlowDemand	Present value of the summary outdoor air flow demand of the room (curve output)

Table 83: Present value of CO_2 curve outdoor air demand

Current Outdoor Air Flow Demand:

This shows the result of the linear curve function and displays the Current Outdoor Air flow demand of the room depending on the actual CO_2 concentration. If there are multiple VAV Boxes in a room this value is the summary *Current Outdoor Air Flow Demand* setpoint of all boxes in the "VAV Group".

Calculation of Outdoor Air Demand with VOC Sensor:

The *VOC damped* value is the input of the linear curve, which calculates the outdoor air flow demand of the room. This linear curve function can be watched and parameterized on the *IAQ Controller* page of the *VAVstatu*s visualization project as shown in Figure 282. Please note that this function is only available in the "Master" device of a "VAV Group".

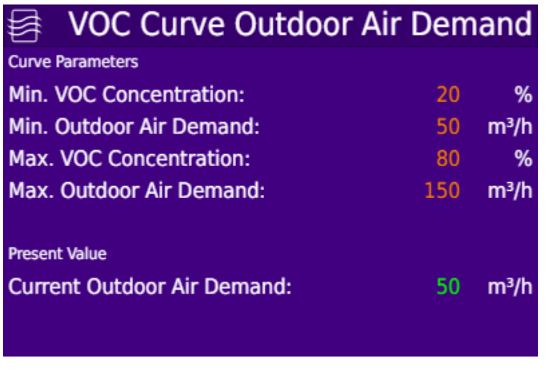

Figure 282: VOC curve outdoor air demand

Table 84 shows the VOC curve outdoor air demand parameters.

Path: User Registers.VAVcontrol.IAQ_Sensors_OA.IAQcontrol_OA

Name on tile	Data point name	Default	Description
Min. VOC Concentration	VOCminConcentrMinOA	20%	Minimum VOC concentration of minimum outdoor air demand
Min. Outdoor Air Demand	IAQMinOutdoorAirFlow	50m^3/h 29cfm	Minimum outdoor air flow demand (curve)
Max. VOC Concentration	VOCmaxConcentrMaxOA	80%	Maximum VOC concentration of maximum outdoor air demand
Max. Outdoor Air Demand	IAQMaxOutdoorAirFlow	150m^3/h 88cfm	Maximum supply air flow demand (curve)

Table 84: VOC curve outdoor air demand parameters

Min. VOC Concentration:

This defines the VOC concentration in the room that causes the linear curve function to calculate the *Min. Outdoor Air Demand* as the output value, see Figure 275. The *Min. VOC Concentration* is a value for a good air quality. This is the concentration that is measured if no person occupies the room.

Min. Outdoor Air Demand:

This defines minimum outdoor air demand of the room that is needed by design if no person occupies the room. This outdoor air demand has to be taken from the system design values. If there are multiple VAV Boxes in a room this value has to be the summary *Min. Outdoor Air Flow Demand* of all boxes in the “VAV Group”.

Max. VOC Concentration:

This defines the VOC concentration in the room that causes the linear curve function to calculate the *Max. Outdoor Air Demand* as the output value, see Figure 275. The *Max. VOC Concentration* is a value for a just good enough air quality. This is the concentration that is measured if the maximum number of persons is occupying the room.

Max. Outdoor Air Demand:

This defines maximum outdoor air demand of the room that is needed by if the maximum number of persons is occupying the room. This outdoor air demand has to be taken from the system design values. If there are multiple VAV Boxes in a room this value has to be the summary *Max. Supply Air Flow Demand* of all boxes in the “VAV Group”.

Table 85 shows the present values of the IAQ sensor configuration.

Path: User Registers.VAVcontrol.IAQ_Sensors_OA.IAQcontrol_OA

Name on tile	Data point name	Description
Current Outdoor Air Demand	IAQsumOutdoorAirFlowDemand	Present value of the summary outdoor air flow demand of the room (curve output)

Table 85: Present value of VOC curve outdoor air demand

Current Outdoor Air Flow Demand:

This shows the result of the linear curve function and displays the Current Outdoor Air flow demand of the room depending on the actual VOC concentration. If there are multiple VAV Boxes in a room this value is the summary *Current Outdoor Air Flow Demand* setpoint of all boxes in the "VAV Group".

Calculation of Outdoor Air Demand with People Counter Sensor:

The *People Count damped* value is the input of the linear curve, which calculates the outdoor air flow demand of the room. This linear curve function can be watched and parameterized on the *IAQ Controller* page of the *VAVstatu*s visualization project as shown in Figure 283. Please note that this function is only available in the "Master" device of a "VAV Group".

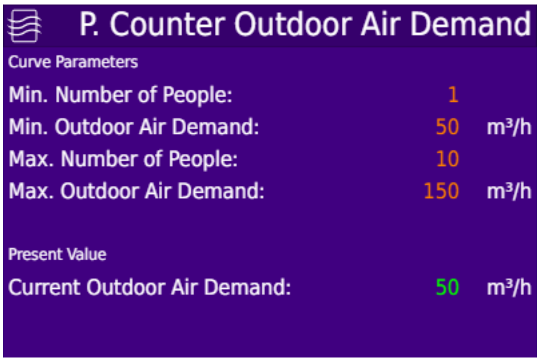

Figure 283: People Counter curve outdoor air demand

Table 86 shows the VOC curve outdoor air demand parameters.

Path: User Registers.VAVcontrol.IAQ_Sensors_OA.IAQcontrol_OA

Name on tile	Data point name	Default	Description
Min. Number of People	MinPeopleMinOA	1	Minimum count of people of minimum outdoor air demand
Min. Outdoor Air Demand	IAQMinOutdoorAirFlow	$50m^3/h$ 29cfm	Minimum outdoor air flow demand (curve)
Max. Number of People	MaxPeopleMaxOA	10	Maximum count of people of minimum outdoor air demand
Max. Outdoor Air Demand	IAQMaxOutdoorAirFlow	$150m^3/h$ 88cfm	Maximum supply air flow demand (curve)

Table 86: People Counter curve outdoor air demand parameters

Min. Number of People:

This defines the number of people in the room that causes the linear curve function to calculate the *Min. Outdoor Air Demand* as the output value, see Figure 276. The *Min. Number of People* is a value for a good air quality.

Min. Outdoor Air Demand:

This defines minimum outdoor air demand of the room that is needed by design if no person occupies the room. This outdoor air demand has to be taken from the system design values. If there are multiple VAV Boxes in a room this value has to be the summary *Min. Outdoor Air Flow Demand* of all boxes in the "VAV Group".

Max. Number of People:

This defines the number of people in the room that causes the linear curve function to calculate the *Max. Outdoor Air Demand* as the output value, see Figure 276. The *Max. Number of People* is a value for a just good enough air quality.

Max. Outdoor Air Demand:

This defines maximum outdoor air demand of the room that is needed by if the maximum number of persons is occupying the room. This outdoor air demand has to be taken from the system design values. If there are multiple VAV Boxes in a room this value has to be the summary *Max. Supply Air Flow Demand* of all boxes in the "VAV Group".

Table 85 shows the present values of the IAQ sensor configuration.

Path: User Registers.VAVcontrol.IAQ_Sensors_OA.IAQcontrol_OA

Name on tile	Data point name	Description
Current Outdoor Air Demand	IAQsumOutdoorAirFlowDemand	Present value of the summary outdoor air flow demand of the room (curve output)

Table 87: Present value of People Counter curve outdoor air demand

Current Outdoor Air Flow Demand:

This shows the result of the linear curve function and displays the Current Outdoor Air flow demand of the room depending on the actual number of people in the room. If there are multiple VAV Boxes in a room this value is the summary *Current Outdoor Air Flow Demand* setpoint of all boxes in the “VAV Group”.

Calculation of Outdoor Air Demand with Effective Occupancy:

This can be used if none of the sensors mentioned above is available. The *Effective Occupancy* can be scheduled, can have an Occupancy Sensor and can have the Occupancy Override. See chapter 7.5.12 for more information. The main purpose of the *Effective Occupancy* is to shift the space temperature setpoints but it also can be used to indicate that the room is occupied and so it needs a higher rate of outdoor air flow.

The *Effective Occupancy* value is the input of a 2-point function, which calculates the outdoor air flow demand of the room. This 2 point function can be watched and parameterized on the *IAQ Controller* page of the *VAVstatus* visualization project as shown in Figure 284. Please note that this function is only available in the “Master” device of a “VAV Group”.

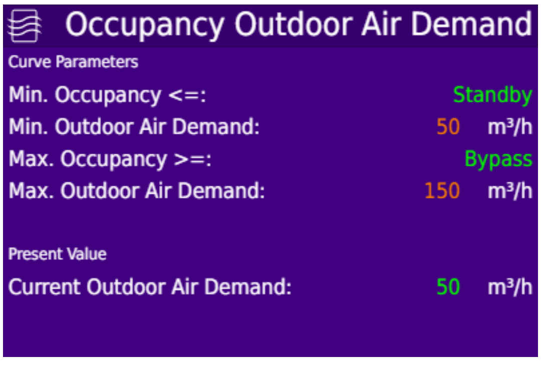

Figure 284: Effective Occupancy 2 point outdoor air demand

The *Effective Occupancy* has the following states:

1 = Invalid, 2 = Unoccupied, 3 = Standby, 4 = Bypass, 5 = Occupied.

Table 88 shows the Effective Occupancy 2 point outdoor air demand parameters.

Path: User Registers.VAVcontrol.IAQ_Sensors_OA.IAQcontrol_OA

Name on tile	**Data point name**	**Default**	**Description**
Min. Outdoor Air Demand	IAQMinOutdoorAirFlow	50m^3/h 29cfm	Minimum outdoor air flow demand (curve)
Max. Outdoor Air Demand	IAQMaxOutdoorAirFlow	150m^3/h 88cfm	Maximum supply air flow demand (curve)

Table 88: Effective Occupancy 2 point outdoor air demand parameters

Min. Outdoor Air Demand:

This defines minimum outdoor air demand of the room that is needed by design if no person occupies the room. This outdoor air demand has to be taken from the system design values. If there are multiple VAV Boxes in a room this value has to be the summary *Min. Outdoor Air Flow Demand* of all boxes in the “VAV Group”.

Max. Outdoor Air Demand:

This defines maximum outdoor air demand of the room that is needed if one or more persons are occupying the room. This outdoor air demand has to be taken from the system design values. If there are multiple VAV Boxes in a room this value has to be the summary *Max. Supply Air Flow Demand* of all boxes in the “VAV Group”.

Table 89 shows the present values of the IAQ sensor configuration.

Path: User Registers.VAVcontrol.IAQ_Sensors_OA.IAQcontrol_OA

Name on tile	**Data point name**	**Description**
Min. Occupancy <=	No data point, only fixed display !	Display of min Effective Occupancy state limit that sets the min. Outdoor Air demand
Max. Occupancy >=	No data point, only fixed display !	Display of max Effective Occupancy state limit that sets the max. Outdoor Air demand
Current Outdoor Air Demand	IAQsumOutdoorAirFlowDemand	Present value of the summary outdoor air flow demand of the room (curve output)

Table 89: Present values of Effective Occupancy 2 point outdoor air demand

Min. Occupancy <=:

This is no data point but only a fixed display value and cannot be modified. It defines the minimum state of *Effective Occupancy* that causes the 2 point function to calculate the *Min. Outdoor Air Demand* as the output value, see Figure 277. This means if the Effective Occupancy state is <= Standby (3) then the *Current Outdoor Air Flow Demand is* set to the *Min. Outdoor Air Demand* value.

Max. Occupancy >=:

This is no data point but only a fixed display value and cannot be modified. It defines the maximum state of *Effective Occupancy* that causes the 2 point function to calculate the *Max. Outdoor Air Demand* as the output value, see Figure 277. This means if the Effective Occupancy state is >= Bypass (4) then the *Current Outdoor Air Flow Demand is* set to the *Max. Outdoor Air Demand* value.

Current Outdoor Air Flow Demand:

This shows the result of the linear curve function and displays the Current Outdoor Air flow demand of the room depending on the actual number of people in the room. If there are multiple VAV Boxes in a room this value is the summary *Current Outdoor Air Flow Demand* setpoint of all boxes in the “VAV Group”.

<u>IAQ Controller Group and AHU Functions:</u>

If there are multiple LIOB-AIR devices in a room, they have to be parameterized as a “VAV Group” to be able to operate a proper room control. One device in the group has to be set as the “Master”. This “Master” device only is executing the IAQ control function with calculating the summary outdoor air flow demand of the room for all air supplying VAV Boxes. Therefore, the *Min. Outdoor Air Flow Demand* and the *Max. Outdoor Air Flow Demand* parameters have to be the summary of all these values of the “Master” and all “Slave” VAV Boxes in the “VAV Group”.

As described in the chapters before, this calculation of the summary outdoor air flow demand of the room is executed using either CO2 sensors, or VOC sensors, or People Counters or the Effective Occupancy as sensor types. Please note that in a dedicated room only the same type of sensors must be used. It is not allowed to mix multiple sensor types in a room.

The outdoor air flow demands of all rooms are summary aggregated and communicated to the AHU by the manager automatically. The air handling unit (AHU) has to maintain the summary outdoor air flow demand of all VAV Boxes with a dedicated control function. It measures the outdoor air flow intake with a dedicated outdoor air flow station and uses the economizer damper as the control output.

The current supply air flow of all VAV Boxes is also summary aggregated and communicated to the AHU by the manager automatically. Therefore, the AHU doesn´t need a dedicated supply air flow station.

The AHU control has to calculate the current outdoor air fraction using these values and has to communicate this to the manager. The manager is communicating the current outdoor air fraction value to all VAV Boxes automatically. See chapter 7.6 for details.

outdoor air fraction = outdoor air flow (measured) / supply air flow (aggregated) * 100

The “Master” of a “VAV Group” receives the *Outdoor Air Fraction (from AHU)* from the master and with the summary outdoor air flow demand of the room *Outdoor Air Demand (Group)* it calculates the summary supply air flow demand *IAQ Supply Air Demand (Group)* of the room.

IAQ Supply Air Demand = *Outdoor Air Demand / Outdoor Air Fraction* * 100

Because the VAV Boxes in a “VAV Group” can have different sizes, the *Current Supply Air Flow Demand* is calculated as a percentage *IAQ Control Output* that is communicated from the “Master” to the “Slaves”. In the “VAV Group” all *Max. Flow VAV-Box* values are aggregated as a summary automatically:

IAQ Control Output = *Current Supply Air Flow Demand* / ∑ *Max. Flow VAV-Box * 100*

<u>Please note: *Max Flow VAV-Box* = *Max. Flow Cool*</u>.

The “Slaves” receive the *IAQ Control Output* from the “Master” and calculate their <u>individual</u> *IAQ Supply Air Demand VAV-Box* value relating to the individual *Max. Flow Cool* value:

IAQ Supply Air Demand VAV-Box = *IAQ Control Output * Max. Flow VAV-Box*

This individual *IAQ Supply Air Demand VAV-Box* value is also calculated in the “Master” device internally relating to the individual *Max. Flow VAV-Box* value.

The calculation function of the *IAQ Control Output* can be watched on the *IAQ Controller* page of the *VAVstatus* visualization project as shown in Figure 285. Please note that this function is only available in the “Master” device of a “VAV Group”. It is also available if the “Master” is the only device in the “VAV Group”.

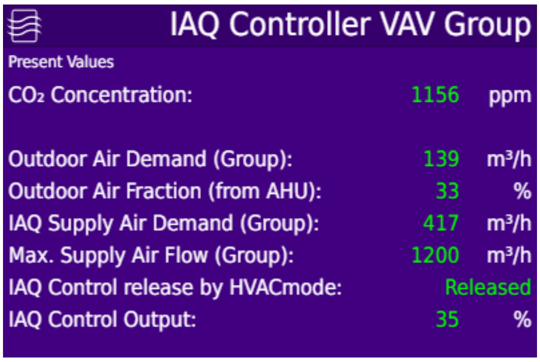

Figure 285: IAQ Controller VAV Group (here with CO_2 sensor)

Table 90 shows the present values of the IAQ controller.

Path: User Registers.VAVcontrol.IAQ_Sensors_OA. CO2control_OA

***)** Display is depending on which sensor is selected

Name on tile	**Data point name**	**Description**
CO_2 Concentration ***)**	CO2concentration(damped)	Present value of CO_2 sensor (damped)
VOC Concentration ***)**	VOCconcentration(damped)	Present value of VOC sensor (damped)
Number of People ***)**	PeopleCounter(damped)	Present value of people counter (damped)
Effective Occupancy ***)**	EffectiveOccupancy	Present value of Effective Occupancy
Outdoor Air Demand (Group)	IAQsumOutdoorAirFlowDemand	Present value of the summary outdoor air flow demand of the room (curve output)
Outdoor Air Fraction (from AHU)	AHUoutdoorAirFraction	Present value of the outdoor air fraction calculated and sent from the AHU
IAQ Supply Air Demand (Group)	IAQsumSupplyAirFlowDemand	Present value of the summary supply air flow demand of the room depending on the outdoor air fraction
Max. Supply Air Flow (Group)	IAQsumSupplyMaxAirFlow	Present value of the summary aggregated maximum supply air flow of all VAV Boxes in the room
IAQ Control release by HVACmode	IAQcontrolHVACrelease	Indicates if IAQ control is released by HVAC mode

Name on tile	Data point name	Description
IAQ Control Output	IAQcontrolOutput	Control output of the “Master” sent to the “Slaves”

Table 90: Present values IAQ Controller

CO_2 Concentration:

This shows the damped value of the CO_2 sensor. It is equal to *CO_2 damped*. The linear curve function of the IAQ control operates this as the control value. This is only shown is the CO_2 sensor is selected in the *IAQ Sensor Selection* dialog.

VOC Concentration:

This shows the damped value of the VOC sensor. It is equal to *VOC damped*. The linear curve function of the IAQ control operates this as the control value. This is only shown is the VOC sensor is selected in the *IAQ Sensor Selection* dialog.

Number of People:

This shows the damped value of the People Counter. It is equal to *People Count damped*. The linear curve function of the IAQ control operates this as the control value. This is only shown is the People Counter is selected in the *IAQ Sensor Selection* dialog.

Effective Occupancy:

This shows the current state of the *Effective Occupancy*. This is coming from the effective occupancy control. The 2-point function of the IAQ control operates this as the control value. This is only shown is the *Effective Occupancy* is selected in the *IAQ Sensor Selection* dialog.

Outdoor Air Demand (Group):

This shows the result of the linear curve function and displays the current outdoor air flow demand of the room depending on the actual IAQ sensor value. It is equal to *Current Outdoor Air Demand*. If there are multiple VAV Boxes in a room this value is the summary *Current Outdoor Air Flow Demand* setpoint of all boxes in the “VAV Group”.

Outdoor Air Fraction (from AHU):

This shows current outdoor air fraction that is calculated by the AHU control and is communicated by the master to the VAV Boxes. This value is used to calculate the *IAQ Supply Air Flow Demand*.

IAQ Supply Air Flow Demand:

This shows the result of the calculation based on the *Outdoor Air Demand (Group)* and the *Outdoor Air Fraction (from AHU).* If there are multiple VAV Boxes in a room this value is the summary *Current Supply Air Flow Demand* setpoint of all boxes in the “VAV Group”.

Max. Supply Air Flow (Group):

This shows the result of the automatic summary aggregation of all *Max. Flow Cool* values of the “Master” and all “Slave” devices in the “VAV Group”. This value is needed to calculate the *IAQ Control output* as a percentage value.

IAQ Control release by HVACmode:

This shows if the IAQ control is released by the current HVAC mode coming from the AHU. It is released in the HVAC modes AUTO, HEAT or COOL. If the IAQ control is not released, the *Current Supply Air Demand* is set to “Zero” and so the resulting *IAQ Control Output* is also “Zero”.

IAQ Control Output:

This is the *IAQ Control Output* as a percentage value of the *Max. Supply Air Flow (Group)* that is sent from the “Master” to the “Slaves” in a “VAV Group”. Based on this value every member of the “VAV Group” calculates its individual *IAQ Supply Air Demand VAV-Box*.

Individual IAQ Control:

Every individual VAV Box of the “VAV Group” receives the *IAQ Control Output* as a percentage value from the “Master”. Based on this *IAQ Control Output* and the *Max. Flow VAV Box* the *IAQ Supply Air Demand VAV-Box* is calculated individually in every VAV Box.

The individual calculation function of the IAQ Control in every VAV Box can be watched on the *IAQ Control Box* page of the *VAVstatus* visualization project as shown in Figure 286.

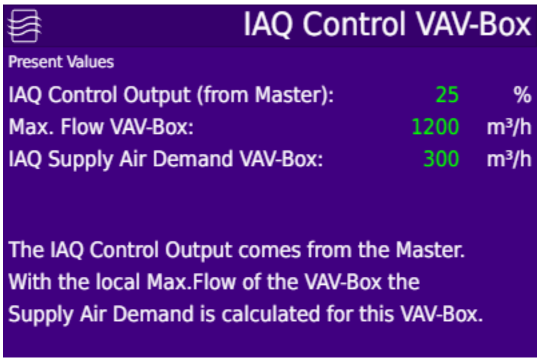

Figure 286: IAQ Control VAV-Box

Table 91 shows the present values of the IAQ Control in every VAV Box.

Path: User Registers.VAVcontrol.Core.IAQcontrol

Name on tile	Data point name	Description
IAQ Control Output (from Master)	IAQcontrolOutput	Present value IAQ control output received from the “Master”
Max. Flow VAV-Box	IAQlocalMaxFlow	Present value maximum air flow of the local VAV Box
IAQ Supply Air Demand VAV-Box	IAQsetpointLocalSupplyAirFlow	Resulting IAQ supply air setpoint of the local VAV Box

Table 91: Present values IAQ Control VAV-Box

IAQ Control Output (from Master):

The “Master” sends out the *IAQ Control Output* as a percentage value to all members of the “VAV Group”. The *IAQ Control Output (from Master)* is the value that is received from the “Master”.

Max. Flow VAV-Box:

This is the maximum supply air flow of the individual VAV Box that is to be parameterized on *Max. Flow Cool*.

IAQ Supply Air Demand VAV-Box:

This is the result of the individual calculation function of the IAQ Control in every VAV Box. This value is forwarded to the *Air Flow Setpoint Selection* of the Flow Control. Please refer to chapter 7.5.5.3 for more information.

<u>Functions in the AHU control:</u>

The following functions are requested to be realized in the AHU control to support the proper function of the method 2 if IAQ control in the VAV Boxes.

The AUH has to be equipped with an economizer, it mixes the outdoor air with recirculated air. So the multiple rooms and zones are supplied with a mixture of air.

As described above the AHU controller receives the summary aggregated outdoor air flow demand of all VAV Boxes from the manager.

Usually the outdoor air damper of the economizer is controlled by the sequence of the supply temperature control of the AHU control.

To maintain the outdoor air flow demand of all VAV Boxes the outdoor air flow intake has to be measured and controlled with a dedicated control function also. The measurement of the current outdoor air flow has to be operated by a flow station.

Therefore, the maximum control output of the Temperature Control and of the CO_2control is put to the mixing damper actuators of the economizer.

The summary aggregated current supply air flow of all VAV Boxes is communicated to the manger to be used by the AHU-Control for details see chapter 7.7. Therefore, the AHU doesn´t need an extra flow station to measure the primary supply air flow.

For a proper function of the IAQ control in the VAV Boxes the AHU control has to calculate the actual outdoor air fraction:

outdoor air fraction = outdoor air flow (measured) / supply air flow (aggregated) * 100

This outdoor air fraction is communicated to the VAV Boxes and so these devices “know” how much outdoor air is included in the actual supply air flow (see previous chapter).

7.5.9.4 CO_2 Max. Alarm (Method1)

General Function:

The current CO_2 concentration is monitored permanently to watch the room condition. If the CO_2 concentration is increasing above an adjustable maximum limit, a maximum Alarm is triggered with a time delay. The alarm function is enabled permanently.

Detailed Function:

The maximum CO_2 concentration alarm limit can be adjusted. If an alarm is triggered it can reset self-sufficiently in case CO_2 concentration returns to below the limits. The alarm can also be reset by the user.

Please note that the maximum CO_2 concentration alarm is triggered by this function and only this is described in this chapter. In the device, these alarms are operated as "generic" alarms that are reported to BACnet alarm servers in parallel. The complete alarming with alarm servers, alarm lists, alarm status, acknowledgement, alarm notification and further things are standard LOYTEC data point functions of the LIOB-AIR operating system.

The principle of the maximum CO_2 concentration alarm is displayed in Figure 287.

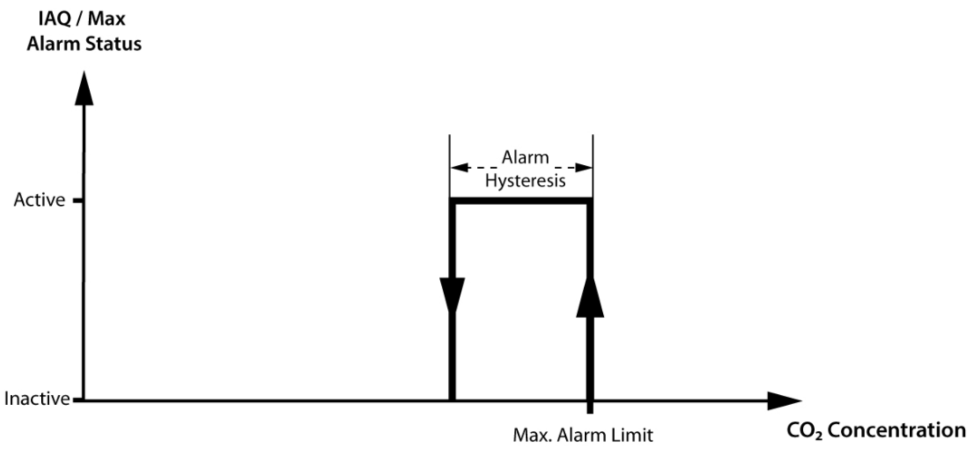

Figure 287: Principle of maximum CO_2 concentration alarm

The maximum CO_2 concentration alarm can be watched and parameterized on the *IAQ Alarm* page of the *VAVstatu*s visualization project as shown in Figure 288.

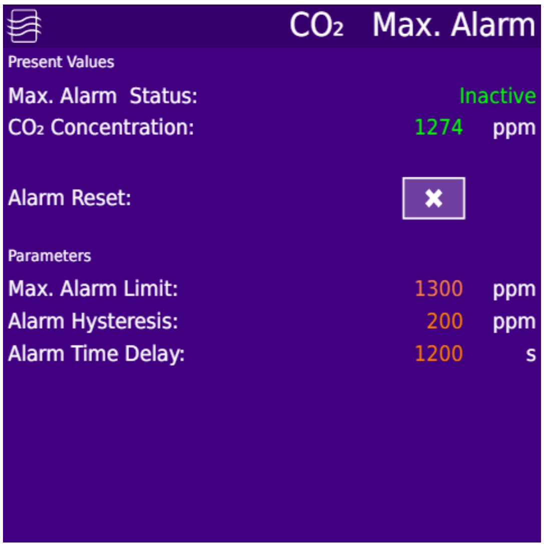

Figure 288: CO_2 concentration Max. Alarm configuration

Table 92 shows the maximum CO_2 concentration Alarm present values.

Path: User Registers.VAVcontrol.IAQ_CO2_SA.CO2maxAlarm

Name on tile	**Data point name**	**Description**
Max.Alarm Status	CO2MaximumAlarm	Present value CO_2 maximum alarm
CO2 Concentration	CO2concentration(damped)	Present value of damped CO_2 concentration

Table 92: CO_2 concentration Max. Alarm present values

Max.Alarm Status:

This displays the actual state of the maximum CO_2 concentration alarm trigger. It becomes active if the *CO_2 Concentration* is greater than the current *Max.Alarm Limit* delayed with the *Alarm Time Delay*. It becomes inactive if *CO_2 Concentration* is lower than the (*Max.Alarm Limit - Alarm Hysteresis)* without any delay or the alarm is reset by the user, see Figure 287.

CO2 Concentration:

Here the present value of the *CO_2 Concentration* is displayed. It is monitored by the maximum CO_2 concentration alarm function.

Table 93 shows the maximum CO_2 concentration Alarm parameters.

Path: User Registers.VAVcontrol.IAQ_CO2_SA.CO2maxAlarm

Name on tile	**Data point name**	**Default**	**Description**
Max. Alarm Limit	CO2MaximumAlarmLimit	1300ppm	Maximum CO_2 concentration alarm limit
AlarmHysteresis	CO2MaximumAlarmHys	200ppm	Hysteresis to reset the Space CO_2 concentration Max Alarm
Alarm Time Delay	CO2AlarmDelayTime	1200s	Time delay to trigger a CO_2 Max Alarm
Alarm Reset	CO2MaxAlarmReset	FALSE	Button to reset an active CO_2 Max Alarm

Table 93: CO_2 concentration Max. Alarm parameters

Max. Alarm Limit:

This defines the maximum CO_2 concentration alarm limit.

Alarm Hysteresis:

This defines the hysteresis the current *CO_2 Concentration* must be lower than the *Max.Alarm Limit* to reset the maximum CO_2 concentration alarm self-sufficiently without any time delay, see Figure 287.

Alarm Time Delay:

If the current *CO_2 Concentration* is above the limit, the max alarm is triggered with this time delay. The reset of the maximum CO_2 concentration alarm is operated without any time delay.

Alarm Reset:

A triggered maximum CO_2 concentration alarm can be reset by the user pressing this button. However, if the current *CO_2 Concentration* is still above the limit the maximum CO_2 concentration alarm will be retriggered again after the *Alarm Time Delay* has elapsed. Pressing this button will set the *Alarm Reset* to TRUE and releasing the button will set the *Alarm Reset* to FALSE (function of the visualization).

7.5.9.5 IAQ Max. Alarm (Method2)

General Function:

The IAQ Max. Alarm function is relating to the sensor that is selected in Method 2, see Figure 261. It supports the CO_2 sensor, VOC sensor and People Counter.

The current IAQ concentration is monitored permanently to watch the room condition. If the IAQ concentration is increasing above an adjustable maximum limit, a maximum Alarm is triggered with a time delay. The alarm function is enabled permanently.

Detailed Function:

The maximum IAQ concentration alarm limit can be adjusted. If an alarm is triggered it can reset self-sufficiently in case IAQ concentration returns to below the limits. The alarm can also be reset by the user.

Please note that the maximum IAQ concentration alarm is triggered by this function and only this is described in this chapter. In the device, these alarms are operated as “generic” alarms that are reported to BACnet alarm server in parallel. The complete alarming with alarm servers, alarm lists, alarm status, acknowledgement, alarm notification and further things are standard LOYTEC data point functions of the LIOB-AIR operating system.

The principle of the maximum IAQ concentration alarm is displayed in Figure 289.

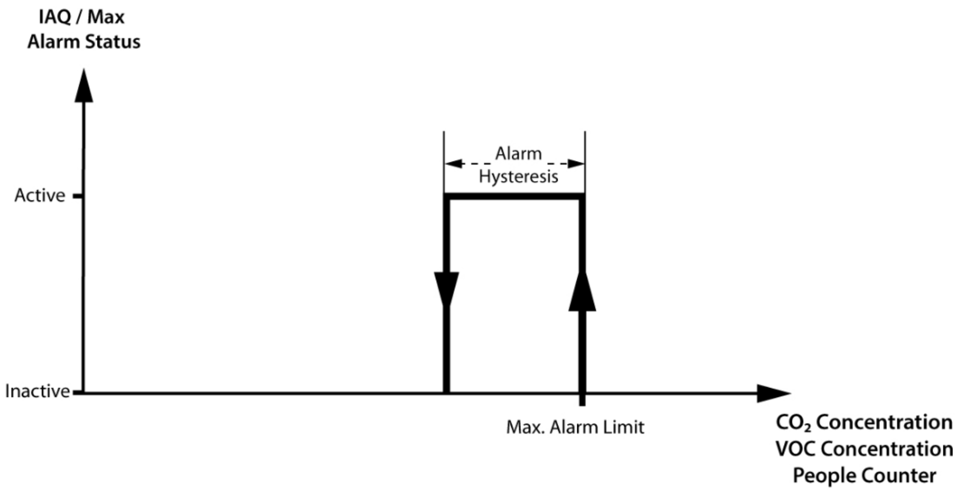

Figure 289: Principle of maximum IAQ concentration alarm

CO_2 Sensor:

The maximum CO_2 concentration alarm can be watched and parameterized on the *IAQ Alarm* page of the *VAVstatu*s visualization project as shown in Figure 290.

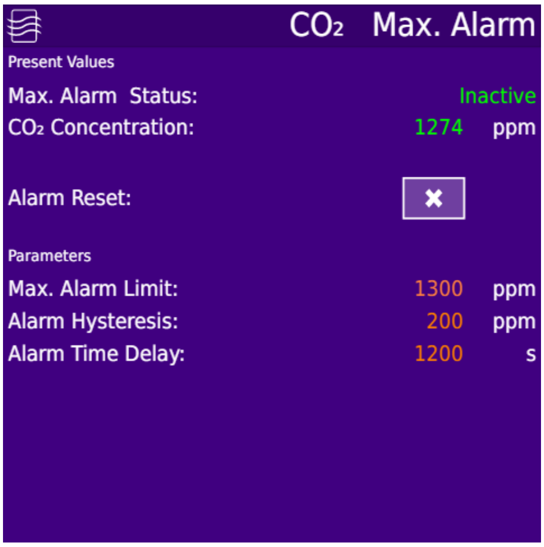

Figure 290: CO_2 concentration Max. Alarm configuration

Table 94 shows the maximum CO_2 concentration Alarm present values.

Path: User Registers.VAVcontrol.IAQ_Sensors_OA.CO2maxAlarm

Name on tile	**Data point name**	**Description**
Max.Alarm Status	CO2maximumAlarm	Present value CO_2 maximum alarm
CO_2 Concentration	CO2concentration(damped)	Present value of damped CO_2concentration

Table 94: CO_2 concentration Max. Alarm present values

Max.Alarm Status:

This displays the actual state of the maximum CO_2 concentration alarm trigger. It becomes active if the *CO_2Concentration* is greater than the current *Max.Alarm Limit* delayed with the *Alarm Time Delay*. It becomes inactive if *CO_2Concentration* is lower than the (*Max.Alarm Limit - Alarm Hysteresis)* without any delay or the alarm is reset by the user, see Figure 289.

CO_2 Concentration:

Here the present value of the *CO_2Concentration* is displayed. It is monitored by the maximum CO_2 concentration alarm function.

Table 95 shows the maximum CO_2 concentration Alarm parameters.

Path: User Registers.VAVcontrol.IAQ_Sensors_OA.CO2maxAlarm

Name on tile	Data point name	Default	Description
Max. Alarm Limit	CO2maximumAlarmLimit	1300ppm	Maximum CO_2 concentration alarm limit
AlarmHysteresis	CO2MaximumAlarmHys	200ppm	Hysteresis to reset the Space CO_2 concentration Max Alarm
Alarm Time Delay	CO2AlarmDelayTime	1200s	Time delay to trigger a CO_2 Max Alarm
Alarm Reset	CO2MaxAlarmReset	FALSE	Button to reset an active CO_2 Max Alarm

Table 95: CO_2 concentration Max. Alarm parameters

Max. Alarm Limit:

This defines the maximum CO_2 concentration alarm limit.

Alarm Hysteresis:

This defines the hysteresis the current *CO_2 Concentration* must be lower than the *Max.Alarm Limit* to reset the maximum CO_2 concentration alarm self-sufficiently without any time delay, see Figure 289.

Alarm Time Delay:

If the current *CO_2 Concentration* is above the limit, the max alarm is triggered with this time delay. The reset of the maximum CO_2 concentration alarm is operated without any time delay.

Alarm Reset:

A triggered maximum CO_2 concentration alarm can be reset by the user pressing this button. However, if the current *CO_2 Concentration* is still above the limit the maximum CO_2 concentration alarm will be retriggered again after the *Alarm Time Delay* has elapsed. Pressing this button will set the *Alarm Reset* to TRUE and releasing the button will set the *Alarm Reset* to FALSE (function of the visualization).

VOC Sensor:

The maximum VOC concentration alarm can be watched and parameterized on the *IAQ Alarm* page of the *VAVstatu*s visualization project as shown in Figure 291.

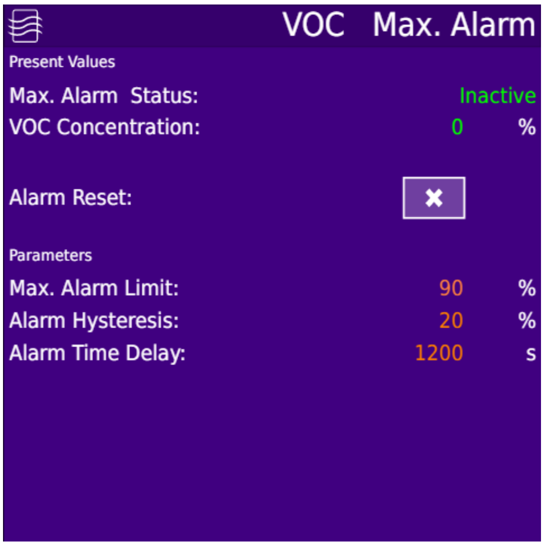

Figure 291: VOC concentration Max. Alarm configuration

Table 96 shows the maximum VOC concentration Alarm present values.

Path: User Registers.VAVcontrol.IAQ_Sensors_OA.VOCmaxAlarm

Name on tile	**Data point name**	**Description**
Max.Alarm Status	VOCmaximumAlarm	Present value VOC maximum alarm
VOC Concentration	VOCconcentration(damped)	Present value of damped VOC concentration

Table 96: VOC concentration Max. Alarm present values

Max.Alarm Status:

This displays the actual state of the maximum VOC concentration alarm trigger. It becomes active if the *VOC Concentration* is greater than the current *Max.Alarm Limit* delayed with the *Alarm Time Delay*. It becomes inactive if *VOC Concentration* is lower than the (*Max.Alarm Limit - Alarm Hysteresis)* without any delay or the alarm is reset by the user, see Figure 289.

VOC Concentration:

Here the present value of the *VOC Concentration* is displayed. It is monitored by the maximum VOC concentration alarm function.

Table 97 shows the maximum VOC concentration Alarm parameters.

Path: User Registers.VAVcontrol.IAQ_Sensors_OA.VOCmaxAlarm

Name on tile	Data point name	Default	Description
Max. Alarm Limit	VOCMaximumAlarmLimit	1300ppm	Maximum VOC concentration alarm limit
AlarmHysteresis	VOCMaximumAlarmHys	200ppm	Hysteresis to reset the Space VOC concentration Max Alarm
Alarm Time Delay	VOCAlarmDelayTime	1200s	Time delay to trigger a VOC Max Alarm
Alarm Reset	VOCMaxAlarmReset	FALSE	Button to reset an active VOC Max Alarm

Table 97: VOC concentration Max. Alarm parameters

Max. Alarm Limit:

This defines the maximum VOC concentration alarm limit.

Alarm Hysteresis:

This defines the hysteresis the current *VOC Concentration* must be lower than the *Max.Alarm Limit* to reset the maximum VOC concentration alarm self-sufficiently without any time delay, see Figure 289.

Alarm Time Delay:

If the current *VOC Concentration* is above the limit, the max alarm is triggered with this time delay. The reset of the maximum VOC concentration alarm is operated without any time delay.

Alarm Reset:

A triggered maximum VOC concentration alarm can be reset by the user pressing this button. However, if the current *VOC Concentration* is still above the limit the maximum VOC concentration alarm will be retriggered again after the *Alarm Time Delay* has elapsed. Pressing this button will set the *Alarm Reset* to TRUE and releasing the button will set the *Alarm Reset* to FALSE (function of the visualization).

People Counter:

The maximum People Counter alarm can be watched and parameterized on the *IAQ Alarm* page of the *VAVstatu*s visualization project as shown in Figure 292.

Figure 292: People Counter Max. Alarm configuration

Table 98 shows the maximum People Counter Alarm present values.

Path: User Registers.VAVcontrol.IAQ_Sensors_OA.PeopleMaxAlarm

Name on tile	Data point name	Description
Max.Alarm Status	PeopleMaximumAlarm	Present value People Counter maximum alarm
People Counter	PeopleCounter(damped)	Present value of damped People Counter

Table 98: People Counter Max. Alarm present values

Max.Alarm Status:

This displays the actual state of the maximum People Counter alarm trigger. It becomes active if the *PeopleCounter* is greater than the current *Max.Alarm Limit* delayed with the *Alarm Time Delay*. It becomes inactive if *PeopleCounter* is lower than the (*Max.Alarm Limit - Alarm Hysteresis)* without any delay or the alarm is reset by the user, see Figure 289.

VOC Concentration:

Here the present value of the *PeopleCounter* is displayed. It is monitored by the maximum People Counter alarm function.

Table 99 shows the maximum People Counter Alarm parameters.

Path: User Registers.VAVcontrol.IAQ_Sensors_OA.PeopleMaxAlarm

Name on tile	**Data point name**	**Default**	**Description**
Max. Alarm Limit	PeopleMaximumAlarmLimit	1300ppm	Maximum People Counter alarm limit
AlarmHysteresis	PeoplemaximumAlarmHys	200ppm	Hysteresis to reset the People Counter Max Alarm
Alarm Time Delay	PeopleAlarmDelayTime	1200s	Time delay to trigger a People Counter Max Alarm
Alarm Reset	PeopleMaxAlarmReset	FALSE	Button to reset an active People Counter Max Alarm

Table 99: People Counter Max. Alarm parameters

Max. Alarm Limit:

This defines the maximum People Counter alarm limit.

Alarm Hysteresis:

This defines the hysteresis the current *PeopleCounter* must be lower than the *Max.Alarm Limit* to reset the maximum People Counter alarm self-sufficiently without any time delay, see Figure 289.

Alarm Time Delay:

If the current *PeopleCounter* is above the limit, the max alarm is triggered with this time delay. The reset of the maximum People Counter alarm is operated without any time delay.

Alarm Reset:

A triggered maximum People Counter alarm can be reset by the user pressing this button. However, if the current *PeopleCounter* is still above the limit the maximum People Counter alarm will be retriggered again after the *Alarm Time Delay* has elapsed. Pressing this button will set the *Alarm Reset* to TRUE and releasing the button will set the *Alarm Reset* to FALSE (function of the visualization).

7.5.10 Relative Humidity Control

General Function:

According to chapter *7.3.1 Application Structure* the rel. Humidity control is a sensor function. If the VAV relative humidity sensor function is connected to the core, the relative humidity control function is enabled in the core application. It consists of the parts rel. humidity control and rel. humidity alarm.

7.5.10.1 rel. Humidity Measurement

General Function:

The rel. humidity is measured by a rel. humidity sensor connected to the local input of the LIOB-AIR device.

The rel. humidity display is shown on the *Status Overview* page of the *VAVstatus* visualization project as shown in Figure 293. This is the value the rel. humidity controller is using as the control value.

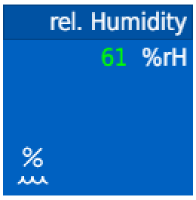

Figure 293: rel. humidity tile in Status Overview

Inputs:

In the LIOB-AIR I/O Standard configuration, the rel. humidity is located on the universal input UI9. For more information see chapter *7.3.2 Device Configuration*.

Favorites:

The Favorite of rel. humidity is shown in Table 100: rel. Humidity Favorite.

Path: Favorites.VAVcontrol.DischargeTemp

Favorite name	**Description**
inRelHumidity	Present value of rel. humidity

Table 100: rel. Humidity Favorite

inRelHumidity:

The rel. humidity measurement function has this one Favorite. To this Favorite, the Local I/O *UI9* is connected (see I/O Standard configuration).

If an L-STAT network thermostat is connected, it can be configured to operate with the integrated sensor as the rel. humidity or to display the current rel. humidity the controller is operating with.

If there are multiple LIOB-AIR devices in a room, they have to be parameterized as a “VAV Group” to be able to operate a proper room control. Either a device can have hard-wired sensors or L-STATs connected (not both at the same time) or no sensor connected. The rel. humidity is calculated as the average value of all sensors and L-STATs in the VAV Group automatically and used as the control value.

7.5.10.2 rel. Humidity Control

General Function:

The rel. humidity is controlled by dedicated humidification and dehumidification controllers. The humidification controller calculates the humidification demand and the dehumidification controller calculates the dehumidification demand. This calculation is enabled only if the effective occupancy state is occupied or bypass. The rel. humidity control does not have any effect to the VAV control functions. However, the humidification and dehumidification demands of all rooms are aggregated and communicated to the AHU. The AHU control is operating its supply humidity control depending on the aggregated humidification and dehumidification demands.

Detailed Function:

The principle of the rel. humidity control is shown in Figure 294.

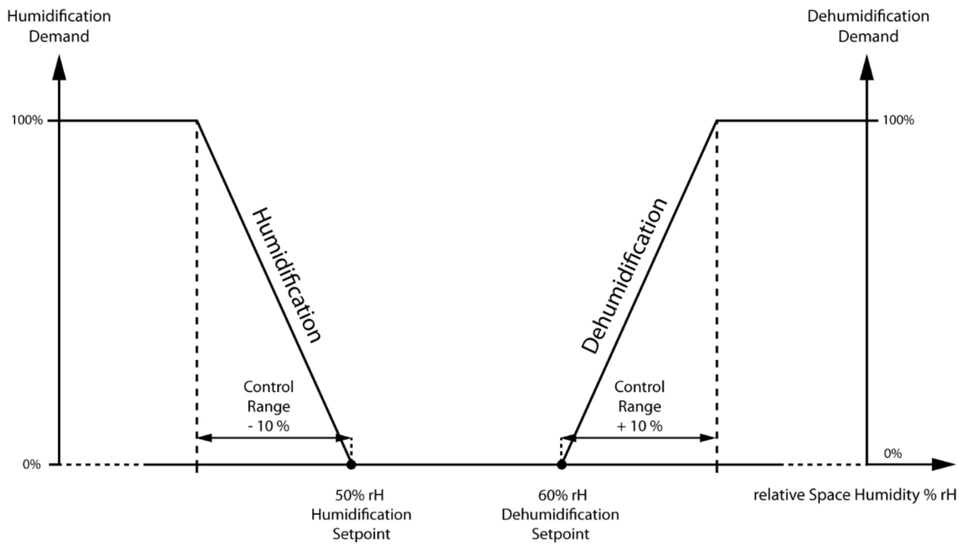

Figure 294: Principle of rel. Humidity Control

The humidification and dehumidification controllers are two dedicated linear curves (similar as P controllers) that calculate the humidification and dehumidification demands depending on the current rel. humidity in the space. There are two dedicated adjustable setpoints for humidification and dehumidification. The ranges of the linear demand calculations are defined by two dedicated adjustable control range parameters.

If the current rel. humidity value is between the humidification and dehumidification, setpoints there is a zero humidity demand calculated.

If the rel. humidity decreases below the adjustable humidification setpoint, a proportional humidification demand is calculated. The adjustable humidification control range parameter defines the range of the humidification demand curve, see Figure 294.

If the rel. humidity increases above the adjustable dehumidification setpoint, a proportional dehumidification demand is calculated. The adjustable dehumidification control range parameter defines the range of the dehumidification demand curve, see Figure 294.

Additionally, the humidification and dehumidification status is displayed with dedicated Boolean type signals that indicate if humidification or dehumidification is in operation.

In case only one function (humidification or dehumidification) is needed in a system the not needed function can be disabled by setting a setpoint value at the edge of the range. If no humidification function is needed the *Humidification Setpoint* value can be set to 0%rH. If no dehumidification function is needed the *Dehumidification Setpoint* value can be set to 100%rH.

The humidity control is enabled only if the *Effective Occupancy* is on “Occupied” or “Bypass” state, see also chapter 7.5.12. In all other states, the humidity control is disabled and there is a zero humidity demand calculated.

If there are multiple LIOB-AIR devices in a room, they have to be parameterized as a “VAV Group” to be able to operate a proper room control. One device in the group has to be set as the “Master”. This “Master” device only is executing the rel. humidity control function with humidification and dehumidification. The “Slaves” do not perform a rel. humidity control. If there are rel. humidity sensors or L-STATs connected to the “Slaves” the average value of all devices is calculated by the “Master” automatically and this is used as the control value. Please refer to chapter 7.6.2 for more information.

The humidification and dehumidification demands of the rel. humidity control do not have any effect to the other VAV control function and do not affect any actuator. However, the demands are aggregated using the internal serial communication. The aggregated humidification and dehumidification demands are communicated to the AHU control by the manager. See chapters 7.6.1.3 and 7.7 for more details.

The AHU control is operating the supply humidity control depending on the aggregated humidification and dehumidification demands of all rooms.

Humidification Controller (overview)

The first Overview of the humidification controller is shown on the *rel. Humidity Controller* page of the *VAVstatus* visualization project as shown in Figure 295. Only the most important present values are shown here without settings.

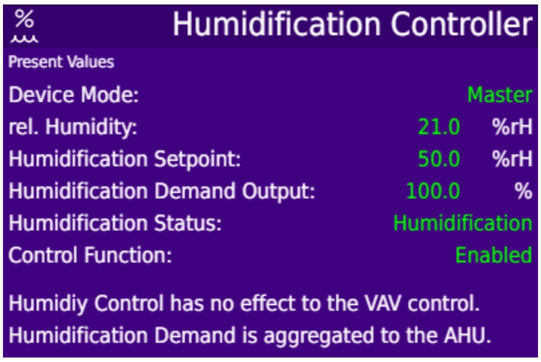

Figure 295: Humidification Controller (overview)

These present values are also shown on the complete humidification controller view as well and are described there.

Humidification Controller (complete view)

The humidification controller can be watched and parameterized completely on the *rel. Humidity Controller Parameter* page of the *VAVstatus* visualization project as shown in Figure 296.

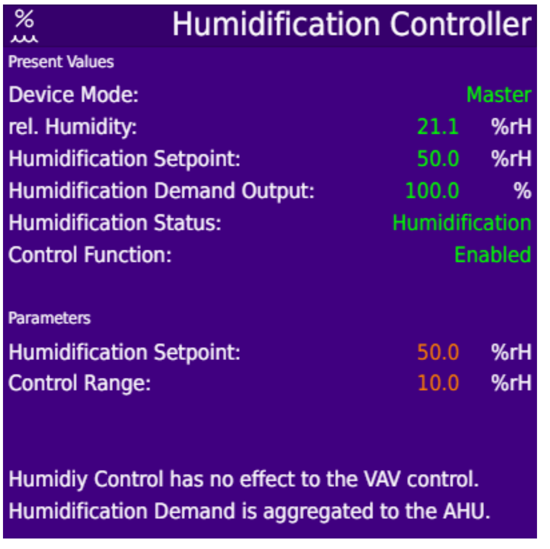

Figure 296: Humidification Controller (complete)

Table 101 shows the present values of the humidification controller.

Path: User Registers.VAVcontrol.RelHumidity.Control

Name on tile	Data point name	Description
Device Mode	VAVgroupDeviceMode	Indicates if the device is Master or Slave in a VAV Group
rel. Humidity	Rel.Humidity	Present value of rel. humidity
Humidification Setpoint	SetpointHumidification	Present value of the humidification setpoint
Humidification Demand Output	ControOutputHumidification	Present value of the humidification demand control output
Humidification Status	HumidificationStatus	Present value of the humidification status
Control Function	ControlFunction	Indicates if humidity control is enabled or not

Table 101: Present values of humidification controller

Device Mode:

Indicates if the device is set as the “Master” or as a “Slave” in the “VAV-Group”. Only the Master is executing the rel. humidity control. The “Slaves” do not execute any rel. humidity control. If there are humidity sensors available to the “Slaves”, the average humidity is calculated and used as the control value by the “Master”.

rel. Humidity:

Here the present value of the *rel. Humidity* is displayed. It is used by the humidification controller as the control value.

Humidification Setpoint:

This displays the current *Humidification Setpoint* of the humidification controller.

Humidification Demand Output:

This displays the current *Humidification Demand Output* of the humidification controller. This output value is aggregated from all VAV controllers and is communicated to the AHU controller by the manager, see chapters 7.6.1.3 and 7.7. The value range is 0…100%.

Humidification Status:

This displays the *Humidification Status* of the humidification controller. It indicates if humidification is requested or not (the humidification controller is calculating a demand greater than 2%).

Control Function:

This displays if the humidity control is enabled or not. It is enabled if the Effective Occupancy state is “Occupied” or Bypass”. If disabled, the *Humidification Demand Output* is set to a zero value.

Table 102 shows the parameter values of the humidification controller.

Path: User Registers.VAVcontrol.RelHumidity.Control

Name on tile	**Data point name**	**Default**	**Description**
Humidification Setpoint	SetpointHumidification	40 %rH	Setpoint of Humidification controller
Control Range	ControlRangeHumidification	10 %rH	Control Range of humidification controller

Table 102: Parameters of humidification controller

Humidification Setpoint:

This is the setpoint of the humidification controller. If the rel. humidity value is greater than this setpoint, the humidification controller will not calculate a *Humidification Demand Output* (0%). If the rel. humidity value is decreasing below this setpoint, the humidification controller will calculate a proportional *Humidification Demand Output*. The maximum value (100%) of *Humidification Demand Output* is calculated if the rel. humidity value reaches the limit of *Humidification Setpoint – Control Range*. See details in Figure 294.

Control Range:

This defines the control range of the humidification controller to calculate the Humidification Demand Output proportionally.

<u>Dehumidification Controller (overview)</u>

The first Overview of the dehumidification controller is shown on the *rel. Humidity Controller* page of the *VAVstatus* visualization project as shown in Figure 297. Only the most important present values are shown here without settings.

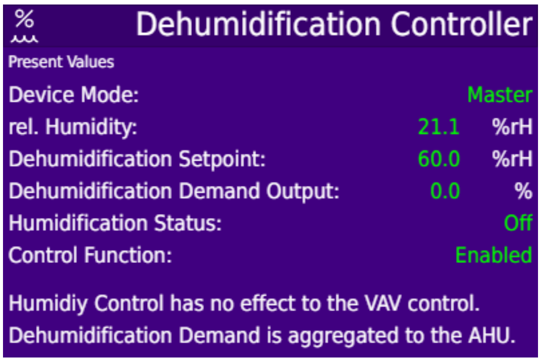

Figure 297: Dehumidification Controller (overview)

These present values are also shown on the complete dehumidification controller view as well and are described there.

<u>Dehumidification Controller (complete view)</u>

The dehumidification controller can be watched and parameterized completely on the *rel. Humidity Controller Parameter* page of the *VAVstatu*s visualization project as shown in Figure 298.

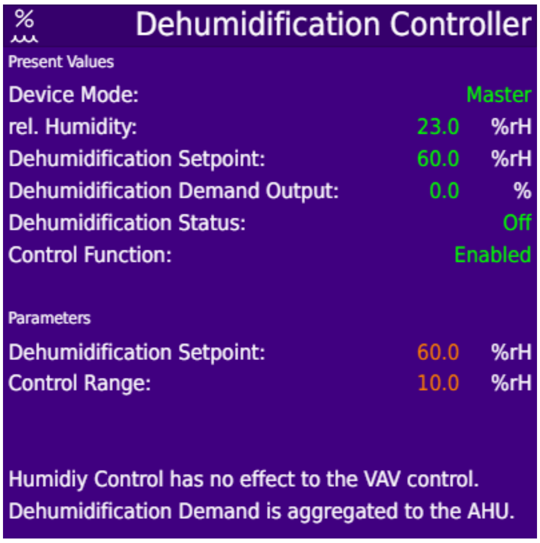

Figure 298: Dehumidification Controller (complete)

Table 103 shows the present values of the dehumidification controller.

Path: User Registers.VAVcontrol.RelHumidity.Control

Name on tile	Data point name	Description
Device Mode	VAVgroupDeviceMode	Indicates if the device is Master or Slave in a VAV Group
rel. Humidity	Rel.Humidity	Present value of rel. humidity
Dehumidification Setpoint	SetpointDehumidification	Present value of the dehumidification setpoint
Dehumidification Demand Output	ControOutputDehumidification	Present value of the dehumidification demand control output
Dehumidification Status	DehumidificationStatus	Present value of the dehumidification status
Control Function	ControlFunction	Indicates if humidity control is enabled or not

Table 103: Present values of dehumidification controller

Device Mode:

Indicates if the device is set as the “Master” or as a “Slave” in the “VAV-Group”. Only the Master is executing the rel. humidity control. The “Slaves” do not execute any rel. humidity control. If there are humidity sensors available to the “Slaves”, the average humidity is calculated and used as the control value by the “Master”.

rel. Humidity:

Here the present value of the *rel. Humidity* is displayed. It is used by the dehumidification controller as the control value.

Dehumidification Setpoint:

This displays the current *Dehumidification Setpoint* of the dehumidification controller.

Dehumidification Demand Output:

This displays the current *Dehumidification Demand Output* of the dehumidification controller. This output value is aggregated from all VAV controllers and is communicated to the AHU controller by the manager, see chapters 7.6.1.3 and 7.7. The value range is 0…100%.

Dehumidification Status:

This displays the *Dehumidification Status* of the dehumidification controller. It indicates if dehumidification is requested or not (the dehumidification controller is calculating a demand greater than 2%).

Control Function:

This displays if the humidity control is enabled or not. It is enabled if the Effective Occupancy state is “Occupied” or Bypass”. If disabled, the *Dehumidification Demand Output* is set to a zero value.

Table 104 shows the parameter values of the dehumidification controller.

Path: User Registers.VAVcontrol.RelHumidity.Control

Name on tile	Data point name	Default	Description
Dehumidification Setpoint	SetpointDehumidification	60 %rH	Setpoint of Dehumidification controller
Control Range	ControlRangeDehumidification	10 %rH	Control Range of dehumidification controller

Table 104: Parameters of dehumidification controller

Dehumidification Setpoint:

This is the setpoint of the dehumidification controller. If the rel. humidity value is lower than this setpoint the dehumidification controller will not calculate a *Dehumidification Demand Output* (0%). If the rel. humidity value is increasing above this setpoint, the dehumidification controller will calculate a proportional *Dehumidification Demand Output*. The maximum value (100%) of *Dehumidification Demand Output* is calculated if the rel. humidity value reaches the limit of *Dehumidification Setpoint* + *Control Range*. See details in Figure 294.

Control Range:

This defines the control range of the dehumidification controller to calculate the Dehumidification Demand Output proportionally.

7.5.10.3 rel. Humidity Alarms

General Function:

The current rel. humidity is monitored to watch the humidity condition in the room. If the rel. humidity is leaving a defined range according to the current humidification and dehumidification setpoints a minimum or maximum Alarm is triggered with a time delay. The range can be defined individually for the minimum and maximum alarms. The alarm function is enabled only if the effective occupancy state is occupied or bypass.

Detailed Function:

There is a minimum alarm function, which is relating to the current *Humidification Setpoint*. There is also a maximum alarm function, which is relating to the current *Dehumidification Setpoint*. The alarm limits are calculated using offset parameters to the current humidification and dehumidification setpoints. These offset parameters can be set dedicated for the minimum and maximum alarm function. If an alarm is triggered it can reset self-sufficiently in case rel. humidity returns to inside the limits. The alarm can also be reset by the user.

The humidity alarming is enabled only if the *Effective Occupancy* is on “Occupied” or “Bypass” state, see also chapter 7.5.12. In all other states, the humidity alarming is disabled and the humidity alarms are reset.

Please note that the rel. humidity alarms are triggered by this function and only this is described in this chapter. In the device, these alarms are operated as “generic” alarms that are reported to BACnet alarm server in parallel. The complete alarming with alarm servers, alarm lists, alarm status, acknowledgement, alarm notification and further things are standard LOYTEC data point functions of the LIOB-AIR operating system.

If there are multiple LIOB-AIR devices in a room, they have to be parameterized as a “VAV Group” to be able to operate a proper room control. One device in the group has to be set as the “Master”. This “Master” device only is executing the rel. humidity alarm function. The “Slaves” do not perform a rel. humidity alarming. Please refer to chapter 7.6.2 for more information.

The principle of the rel. Humidity Alarms is displayed in Figure 299.

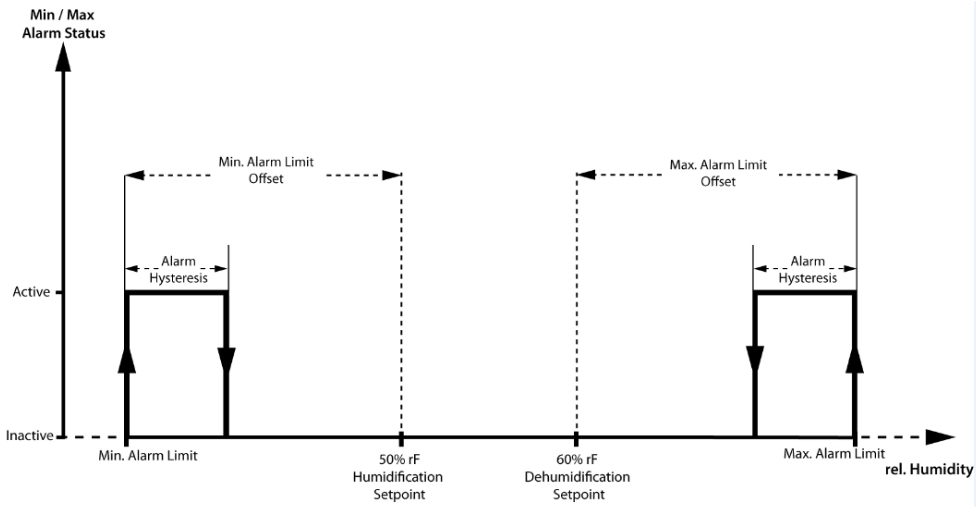

Figure 299: Principle of rel. Humidity Min. and Max. Alarms

Rel. Humidity Min. Alarm

The rel. Humidity Min Alarm can be watched and parameterized on the *rel. Humidity Alarm Parameters* page of the *VAVstatus* visualization project as shown in Figure 300.

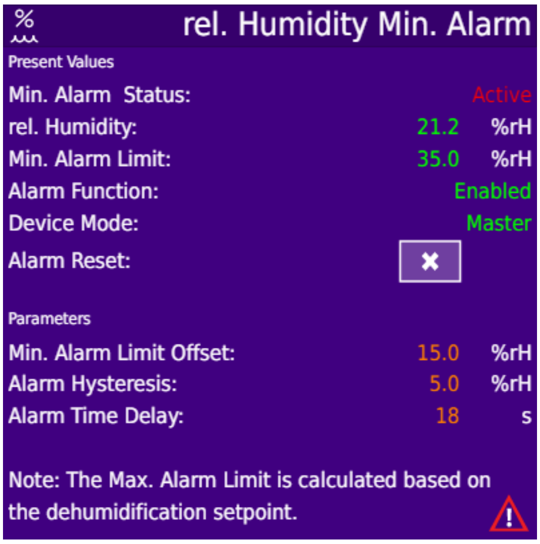

Figure 300: rel. Humidity Min. Alarm configuration

Table 105 shows the rel. Humidity Min.Alarm present values.

Path: User Registers.VAVcontrol.RelHumidity.Alarm

Name on tile	**Data point name**	**Description**
Min. Alarm Status	RelHumidityMinAlarm	Present value rel. humidity minimum alarm
Rel. Humidity	RelHumidity	Present value of rel. humidity
Min. Alarm Limit	RelHumidityMinAlarmLimit	Present value of rel. humidity minimum alarm limit
Alarm Function	AlarmFunction	Indicates if humidity alarming is enabled or not
Device Mode	VAVgroupDeviceMode	Indicates if the device is Master or Slave in a VAV Group

Table 105: rel. Humidity Min. Alarm present values

Min. Alarm Status:

This displays the actual state of the minimum rel. humidity alarm trigger. It becomes active if the *rel. Humidity* is lower than the current *Min.Alarm Limit* delayed with the *Alarm Time Delay*. It becomes inactive if *rel. Humidity* is greater than the (*Min.Alarm Limit + Alarm Hysteresis)* without any delay or the alarm is reset by the user, see Figure 299.

rel. Humidity:

Here the present value of the *rel. Humidity* is displayed. It is monitored by the rel. humidity min. alarm function.

Min. Alarm Limit:

This is the current minimum limit depending on the *Humidification Setpoint* of rel. humidity and resulting from the following calculation:

Min.Alarm Limit = Humidification Setpoint - Min.Alarm Limit Offset

Alarm Function:

This indicates if the humidity alarming is enabled or not. It is enabled if the *Effective Occupancy* state is “Occupied” or Bypass”. If disabled, the humidity alarms are reset.

Device Mode:

Indicates if the device is set as the “Master” or as a “Slave” in the “VAV-Group”. The alarm function is operated only in the “Master” device.

Table 106 shows the rel. Humidity Min. Alarm parameters.

Path: User Registers.VAVcontrol.RelHumidity.Alarm

Name on tile	**Data point name**	**Default**	**Description**
Min. Alarm Limit Offset	RelHumidityMinAlarmLimit Offset	15 %rH	Maximum Alarm Offset to the current humidification setpoint
AlarmHysteresis	RelHumidityAlarmHysteresis	5 %rH	Hysteresis to reset the rel. humidity Min or Max Alarm
Alarm Time Delay	RelHumidityAlarmDelayTime	1800s	Time delay to trigger a rel. humidity Min or Max Alarm
Alarm Reset	RelHumidityAlarmReset	FALSE	Button to reset an active rel. humidity Min or Max Alarm

Table 106: rel. Humidity Min. Alarm parameters

Min. Alarm Limit Offset:

This defines the offset to the current *Humidification Setpoint* of rel. humidity to calculate the *Min. Alarm Limit*. For details, see *Min. Alarm Limit.*

Alarm Hysteresis:

This is valid for the maximum and the minimum rel. humidity alarm function. It defines the hysteresis the current rel. humidity to be lower than the *Max.Alarm Limit* or greater than the *Min. Alarm Limit* to reset the rel. humidity max or min alarm self-sufficiently without any time delay, see Figure 299.

Alarm Time Delay:

This is valid for the maximum and the minimum rel. humidity alarm function. If the current *rel. Humidity* is outside of the limits, the min or max alarm is triggered with this time delay. The reset of the rel. humidity min or max alarm is operated without any time delay.

Alarm Reset:

A triggered rel. humidity maximum or minimum alarm can be reset by the user pressing this button. However, if the current *rel. Humidity* is still outside of the limits the discharge temperature maximum or minimum alarm will be retriggered again after the *Alarm Time Delay* has elapsed. Pressing this button will set the *Alarm Reset* to TRUE and releasing the button will set the *Alarm Reset* to FALSE (function of the visualization).

Rel. Humidity Max. Alarm

The rel. Humidity Max. Alarm can be watched and parameterized on the *rel. Humidity Alarm Parameters* page of the *VAVstatus* visualization project as shown in Figure 301.

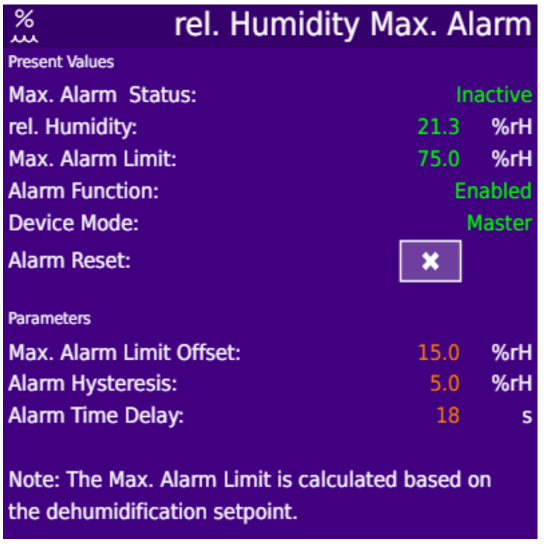

Figure 301: rel. Humidity Max. Alarm configuration

Table 107 shows the rel. Humidity Max.Alarm present values.

Path: User Registers.VAVcontrol.RelHumidity.Alarm

Name on tile	Data point name	Description
Max. Alarm Status	RelHumidityMaxAlarm	Present value rel. humidity maximum alarm
Rel. Humidity	RelHumidity	Present value of rel. humidity
Max. Alarm Limit	RelHumidityMaxAlarmLimit	Present value of rel. humidity maximum alarm limit
Alarm Function	AlarmFunction	Indicates if humidity alarming is enabled or not
Device Mode	VAVgroupDeviceMode	Indicates if the device is Master or Slave in a VAV Group

Table 107: rel. Humidity Max. Alarm present values

Max. Alarm Status:

This displays the actual state of the maximum rel. humidity alarm trigger. It becomes active if the *rel. Humidity* is greater than the current *Max.Alarm Limit* delayed with the *Alarm Time Delay*. It becomes inactive if *rel. Humidity* is lower than the (*Max.Alarm Limit - Alarm Hysteresis)* without any delay or the alarm is reset by the user, see Figure 299.

rel. Humidity:

Here the present value of the *rel. Humidity* is displayed. It is monitored by the rel. humidity max. alarm function.

Max. Alarm Limit:

This is the current maximum limit depending on the *Humidification Setpoint* of rel. humidity and resulting from the following calculation:

Max.Alarm Limit = Dehumidification Setpoint + Max.Alarm Limit Offset

Alarm Function:

This indicates if the humidity alarming is enabled or not. It is enabled if the *Effective Occupancy* state is “Occupied” or Bypass”. If disabled, the humidity alarms are reset.

Device Mode:

Indicates if the device is set as the “Master” or as a “Slave” in the “VAV-Group”. The alarm function is operated only in the “Master” device.

Table 108 shows the rel. Humidity Max. Alarm parameters.

Path: User Registers.VAVcontrol.RelHumidity.Alarm

Name on tile	**Data point name**	**Default**	**Description**
Min. Alarm Limit Offset	RelHumidityMinAlarmLimit Offset	15 %rH	Maximum Alarm Offset to the current humidification setpoint
AlarmHysteresis	RelHumidityAlarmHysteresis	5 %rH	Hysteresis to reset the rel. humidity Min or Max Alarm
Alarm Time Delay	RelHumidityAlarmDelayTime	1800s	Time delay to trigger a rel. humidity Min or Max Alarm
Alarm Reset	RelHumidityAlarmReset	FALSE	Button to reset an active rel. humidity Min or Max Alarm

Table 108: rel. Humidity Max. Alarm parameters

Max. Alarm Limit Offset:

This defines the offset to the current *Dehumidification Setpoint* of rel. humidity to calculate the *Max. Alarm Limit*. For details, see *Max. Alarm Limit.*

Alarm Hysteresis:

This is valid for the maximum and the minimum rel. humidity alarm function. It defines the hysteresis the current rel. humidity to be lower than the *Max.Alarm Limit* or greater than the *Min. Alarm Limit* to reset the rel. humidity max or min alarm self-sufficiently without any time delay, see Figure 299.

Alarm Time Delay:

This is valid for the maximum and the minimum rel. humidity alarm function. If the current *rel. Humidity* is outside of the limits, the min or max alarm is triggered with this time delay. The reset of the rel. humidity min or max alarm is operated without any time delay.

Alarm Reset:

A triggered rel. humidity maximum or minimum alarm can be reset by the user pressing this button. However, if the current *rel. Humidity* is still outside of the limits the discharge temperature maximum or minimum alarm will be retriggered again after the *Alarm Time Delay* has elapsed. Pressing this button will set the *Alarm Reset* to TRUE and releasing the button will set the *Alarm Reset* to FALSE (function of the visualization).

7.5.11 HVAC Modes in the VAV control

General Function:

According to chapter *7.3.1Application Structure* the HVAC Mode function is a core function. It is always part of the application and it cannot be deleted.

The HVAC Mode indicates the current operation mode of the air handling unit AHU to the VAV control, if it is in e.g. “Cooling” or “Heating” mode or if it is switched “Off”. The VAV control is reacting according to the HVAC mode by enabling or disabling dedicated control functions. As an example, Cooling will be disabled in the VAV control if the AHU is in “Heating” mode.

This ensures a proper and energy saving function of the entire VAV system according to the current operation of the AHU.

The current state of the *HVAC Mode in VAV* display is shown on the *Status Overview* page of the *VAVstatus* visualization project as shown in Figure 303. This is the state the VAV controller is operating with.

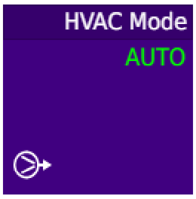

Figure 302: HVAC Mode tile in Status Overview

7.5.11.1 HVAC Mode Control Status

Usually the AHU control has to communicate the current operation mode of the air handling unit AHU to the manager, see chapter 7.7 for more details. This is defined as the HVAC Mode. The manager is communicating the HVAC Mode to all the VAV Boxes automatically.

The AHU can provide the information to the manager in two alternative ways:

Communicating the HVAC Mode from AHU

Using BACnet communication the data point *HvacModeFromAhu* in the manager can be written by the AHU controller. The manager is communicating this information to all VAV controllers automatically. This should be the “normal” procedure because this supports all the functions needed in the VAV control.

The following HVAC Modes are supported:

0 = HVAC_AUTO

1 = HVAC_HEAT

2 = HVAC_MRNG_WRMUP

3 = HVAC_COOL

4 = HVAC_NIGHT_PURGE

5 = HVAC_PRE_COOL

6 = HVAC_OFF

The VAV controls expect the following modes:

If the AHU is normal operating with cold supply air it sends HVAC_AUTO.

If the AHU is cooling and heating is forbidden in the VAVs it sends HVAC_COOL.

If the AHU is heating it sends HVAC_AUTO.

If the AHU is fan only and operating with cold supply air it sends HVAC_AUTO.

If the AHU is in morning warmup it sends HVAC_MRNG_WRMUP.

If the AHU is in night purge it sends HVAC_NIGHT_PURGE

If the AHU is pre cooling it sends HVAC_PRE_COOL.

If the AHU is switched off it sends HVAC_OFF.

<u>Communicating the Contacts from AHU</u>

If the AHU control does not have the ability to communicate with BACnet to the manager, it can use dry contacts that can be connected to the local I/O of the manager device. The manager is communicating this contact information to all VAV controllers automatically.

The following contacts are supported:

AHU Operation (On/Off), AHU Heating, AHU Cooling, AHU Fan only

Depending on the contact status, the VAV control sets the internal HVAC Mode as follows:

The *HVAC Mode in VAV* is set HVAC_AUTO if the contacts AHU Operation or AHU Cooling or AHU Fan only are active.

It is set to HVAC HEAT if the contact AHU Heating is active.

It is HVAC_OFF if the contacts AHU Operation and AHU Cooling and AHU Heating and AHU Fan only are not active.

<u>HVAC Mode Settings</u>

The settings for a proper HVAC Mode function can be done on the *HVAC Mode Control Status* tile on the *HVAC Mode Control Status* page of the *VAVstatu*s visualization project as shown in Figure 303. The present values of the HVAC Mode from the AHU, the AHU contacts and the resulting HVAC Mode in the VAV can be watched also.

It can be selected on *HVAC Mode from AHU Selection* which procedure is used to get the HVAC Mode from the AHU. This has to be set in every dedicated VAV controller according to the used procedure. All VAV controllers of an AHU must use the same procedure.

It also can be selected if the local heat (reheat) is released for operation or not if the AHU is performing a morning warmup or a night cycle (HVAV_MRNG_WRMUP). This is selected on *Local Heat Control in WARMUP*.

For testing, commissioning or maintenance purposes it is possible to override the HVAC Mode in the VAV manually using *HVAC Mode in VAV*.

If there are multiple LIOB-AIR devices in a room, they have to be parameterized as a “VAV Group” to be able to operate a proper room control. One device in the group has to be set as the “Master”. This “Master” device only is executing the HVAC Mode control function and it communicates the *HVAC Mode in VAV* to all the “Slaves” in the room. The “Slaves” do not perform an HVAC Mode control but they only follow the *HVAC Mode in VAV* of the “Master”. In addition, the *Local Heat control in Warmup* is communicated to the “Slaves”. Please refer to chapter 7.6.2 for more information.

In case of a reheat actuator type “No Reheat” is configured, there is no reheat unit existing in the VAV-Box but the space temperature heat control is operating with warm primary air. In this case, the *HVAC Mode in VAV* will never become the status AUTO, because in this mode the VAV control is allowed to use the cooling or heating control while the AHU is providing cold air. However, all other HVAC Modes are allowed with this reheat actuator type.

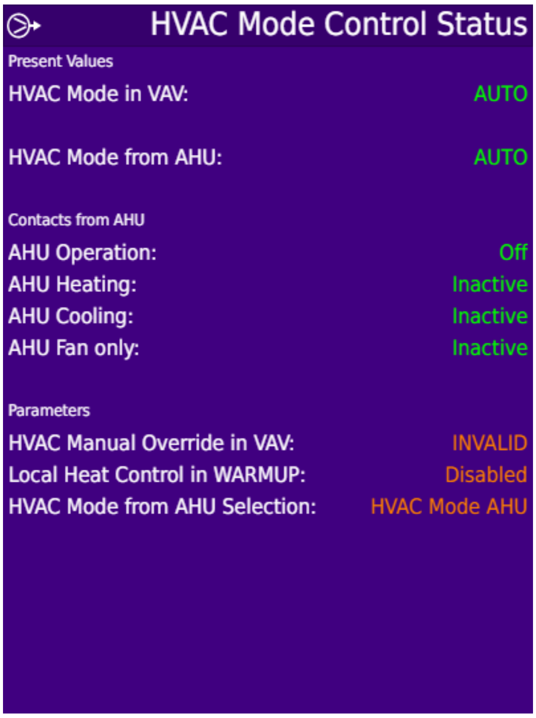

Figure 303: HVAC Mode Control Status

Table 109 shows the present values of the VOC sensor configuration.

Path: User Registers.VAVcontrol.Core.HVACmode

Name on tile	Data point name	Description
HVAC Mode in VAV	HVACmodeVAV	Present value of the resulting HVAC Mode the VAV control is operating with
HVAC Mode from AHU	HVACmodeFromAHU	Present value of HVAC Mode received from the manager
AHU Operation	OnOffFromAHU	Present value of the contact AHU Operation from the

Name on tile	Data point name	Description
		manager
AHU Heating	HeatingFromAHU	Present value of the contact AHU Heating received from the manager
AHU Cooling	CoolingFromAHU	Present value of the contact AHU Cooling received from the manager
AHU Fan only	FanOnlyFromAHU	Present value of the contact AHU Fan only received from the manager

Table 109: Present values of HVAC Mode Control Status

HVAC Mode in VAV:

This shows the current HVAC Mode the VAV control is operating with. This is resulting from the received HVAC Mode from AHU or from the received contacts from AHU depending on the setting of *HVAC Mode from AHU Selection*. It can be overridden manually by the *HVAC Manual Override in VAV*. This mode value is communicated from The “Master” to the “Slaves” if a VAV Group is configured.

HVAC Mode from AHU:

This shows the current HVAC Mode of the AHU that is received from the manager. If the *HVAC Mode from AHU Selection* is set to “HVAC Mode AHU”, the *HVAC Mode in VAV* is set to this received value.

AHU Operation:

This shows the state of the contact *AHU Operation* that is received from the manager. It indicates if the AHU is in operation or not (On/Off). If the *HVAC Mode from AHU Selection* is set to “Contacts from AHU,” the *HVAC Mode in VAV* is set to a HVAC Mode depending on the states of all the contacts from AHU.

AHU Heating

This shows the state of the contact *AHU Operation* that is received from the manager. It indicates if the AHU is in heating mode and supplying warm air. If the *HVAC Mode from AHU Selection* is set to “Contacts from AHU,” the *HVAC Mode in VAV* is set to a HVAC Mode depending on the states of all the contacts from AHU.

AHU Cooling

This shows the state of the contact *AHU Operation* that is received from the manager. It indicates if the AHU is in cooling mode and supplying cold air. If the *HVAC Mode from AHU Selection* is set to “Contacts from AHU,” the *HVAC Mode in VAV* is set to a HVAC Mode depending on the states of all the contacts from AHU.

AHU Fan Only

This shows the state of the contact *AHU Operation* that is received from the manager. It indicates if the AHU is neither heating nor cooling but supplying cold air. If the *HVAC Mode from AHU Selection* is set to “Contacts from AHU,” the *HVAC Mode in VAV* is set to a HVAC Mode depending on the states of all the contacts from AHU.

Table 110 shows the IAQ sensor configuration parameters.

Path: User Registers.VAVcontrol.Core.HVACmode

Name on tile	**Data point name**	**Default**	**Description**
HVAC Manual Override in VAV	HVACmodeManualValue	Invalid	HVAC Mode in VAV can be manually overridden here
Local Heat Control in WARMUP	WarmupHeatControl	Disabled	Setting if local heat is released in HVAC_MRNG_WRMUP
HVAC Mode from AHU Selection	HVACmodeAHUselection	HVAC Mode AHU	Setting if local heat is released in HVAC_MRNG_WRMUP

Table 110: HVAC Mode Control Status parameters

HVAC Manual Override in VAV:

This allows a manual override of the *HVAC Mode in AHU* for testing, commissioning or maintenance purposes. If it is set to "INVALID" then the *HVAC Mode in AHU* is defined automatically and that is the normal setting. If it is set to "AUTO" or "HEAT" or "MRNG_WRMUP" or "COOL" or "NIGHT_PURGE" or "PRE_COOL" or "OFF" the *HVAC Mode in AHU* is set accordingly. A Manual Alarm will be triggered and a manual indicator is shown in the *VAVstatu*s visualization project.

Local Heat Control in WARMUP:

This defines if the local heat (reheat, peripheral heat, discharge air temp control) is released for operation if the AHU is performing a morning warmup or a night cycle (HVAC_MRNG_WRMUP). This parameter value is communicated from The "Master" to the "Slaves" if a VAV Group is configured.

7.5.11.2 Functions of the HCAC Mode

Depending on the state of the *HVAC Mode in VAV*, dedicated functions in the VAV control are enabled or disabled to gain a proper and energy saving VAV function. As an overview, the most important functions are described in the dedicated HVAC Modes.

<u>HVAC_AUTO:</u>

- This is the "normal" VAV control function with no restrictions.
- Space temperature control with cooling and heating, setpoints are selected by occupancy status
- Flow control with cooling and heating sequence
- Discharge temperature control is enabled, if space temp heating controller is active
- Reheat and peripheral heat are requested by the heating control
- Series fan on if not Unoccupied, or requested by heating or cooling controller
- Parallel fan requested by heat controller
- Flow Alarm function is released
- Demand controlled ventilation by IAQ control is enabled.

<u>HVAC_HEAT:</u>

- Only heating operation is allowed in the VAV control
- Space temperature control with heating only, setpoints are selected by occupancy status
- Flow control with heating sequence only, it uses *Min. Flow Unit Heat* and *Max. Flow Unit Heat* limits
- Discharge temperature control is enabled
- Reheat and peripheral heat are requested by the heating control
- Series fan on or
- Parallel fan requested by heating controller
- Flow Alarm function is released
- Demand controlled ventilation by IAQ control is enabled.

<u>HVAC_MRNG_WRMUP:</u>

- Only heating operation is allowed in the VAV control
- Space temperature control with heating only, Standby mode setpoint value is selected
- Flow control with heating sequence only, it uses *Min. Flow Unit Heat* and *Max. Flow Unit Heat* limits
- Discharge temperature control is enabled, if *Local Heat Control in WRMUP* is enabled
- Reheat and peripheral heat are requested by the heating control, if *Local Heat Control in WRMUP* is enabled
- Series fan on or
- Parallel fan off (prevents to mix in cold plenum air)
- Flow Alarm function is released
- Demand controlled ventilation by IAQ control is disabled.

<u>HVAC_COOL:</u>

- Only cooling operation is allowed in the VAV control
- Space temperature control with cooling only, setpoints are selected by occupancy status
- Flow control with cooling sequence only
- Discharge temperature control is disabled
- Reheat and peripheral heat are disabled
- Series fan on if not Unoccupied, or requested by cooling controller
- Parallel fan off
- Flow Alarm function is released
- Demand controlled ventilation by IAQ control is enabled.

<u>HVAC_NIGHT_PURGE:</u>

- No temperature control is allowed in the VAV control
- Space temperature control disabled
- Flow control with *Max. Flow Cool* value as setpoint
- Discharge temperature control is disabled
- Reheat and peripheral heat are disabled
- Series fan on or
- Parallel fan off
- Flow Alarm function is released
- Demand controlled ventilation by IAQ control is disabled.

HVAC_PRE_COOL:

- Only cooling operation is allowed in the VAV control
- Space temperature control with cooling only, Occupied mode setpoint value is selected
- Flow control with cooling sequence only
- Discharge temperature control is disabled
- Reheat and peripheral heat are disabled
- Series fan on or
- Parallel fan off
- Flow Alarm function is released
- Demand controlled ventilation by IAQ control is disabled.

HVAC_OFF:

- This is also the “normal” VAV control function with no restrictions.
- Space temperature control with cooling and heating, setpoints are selected by occupancy status
- Flow control with cooling and heating sequence, but because there is no primary air flow the control will open the damper to 100%
- Discharge temperature control is enabled, if space temp heating controller is active
- Reheat and peripheral heat are requested by the heating control
- Series fan is requested by heat controller or
- Parallel fan requested by heat controller
- Flow Alarm function is blocked
- Demand controlled ventilation by IAQ control is disabled.
- External Flow Setpoint% is set to 0% (see chapter 7.5.17)

7.5.12 Effective Occupancy in the VAV control

General Function:

According to chapter *7.3.1Application Structure* the Effective Occupancy function is a core function. It is always part of the application and it cannot be deleted. It consists of the parts occupancy scheduler, occupancy sensor, occupancy override by bypass button and occupancy override from AHU.

The *Effective Occupancy* indicates the current occupancy state of the room. The space temperature cooling and heating control setpoints are selected by the Effective Occupancy, see chapter 7.5.6.2 . Therefore, this is a very important part of the VAV control to save energy.

If an external flow setpoint sensor function is configured, the *Effective Occupancy* selects the regarding external flow setpoint for an "Occupied" or "Not Occupied" state, see chapter 7.5.17.

The *Effective Occupancy* states of all rooms are maximum aggregated by the manager and communicated to the AHU control. Therefore, the AHU control can decide to start or to stop the unit depending on the received occupancy state, see chapter 7.6.1.3.

Basically, the *Effective Occupancy* is controlled by a dedicated scheduler in every VAV controller. Optionally the function can be enhanced by connecting an occupancy sensor function and / or an occupancy override function to the core.

It is also possible to override the *Effective Occupancy* of dedicated rooms by the AHU control to ensure sufficient airflow through the ductwork if needed.

The resulting state of the *Effective Occupancy* display is shown on the *Status Overview* page of the *VAVstatus* visualization project as shown in Figure 304. This is the state the VAV controller is operating with.

Figure 304: Effective Occupancy tile in Status Overview

The multiple states of the *Effective Occupancy* are defined as follows:

1 = Invalid:

This is an undefined state. It happens if there is no event entry in the scheduler. In this case, the "Unoccupied" cooling and heating setpoints are selected for the space temperature control.

2 = Unoccupied:

In this state, the room is not occupied by persons. It is the typical state during the nighttime. The "Unoccupied" cooling and heating setpoints are selected for the space temperature control to save heating and cooling energy. It would need a considerable amount of time to reach the comfort ("Occupied") space temperature setpoints.

3 = Standby:

In this state, the room is not occupied by persons but it will be ready to reach the requested comfort (“Occupied”) space temperature setpoints in a reasonable amount of time. The “Standby” cooling and heating setpoints are selected for the space temperature control.

4 = Bypass:

This state is resulting if the Occupancy is overridden. This can happen if the Occupancy Override function is triggered by pressing the bypass button or if the *Occupancy Override from AHU* is active. It is overriding the scheduled occupancy and also the occupancy sensor function. The “Occupied” (comfort) cooling and heating setpoints are selected for the space temperature control.

5 = Occupied:

This is the normal comfort state when the room is occupied by persons. The “Occupied” (comfort) cooling and heating setpoints are selected for the space temperature control.

There is also the Optimum Start function included in the Effective Occupancy section. It cares for an optimal start time depending on the occupancy scheduler, the current space temperature and the setpoint of the next scheduled occupancy state. It requests the HVAC Modes MRNG_WRMUP or PRE_COOL to the AHU in order to provide the space temperature matching the setpoint at the scheduled time. For more information, please refer to chapter 7.5.12.4.

7.5.12.1 Effective Occupancy Control and Scheduler

The Effective Occupancy function is part of the core function of the VAV control. It is available in every configuration independent of which sensor and actuator functions are connected to the core.

Scheduler:

The central element is a scheduler that is able to schedule the available occupancy states. Please refer to the LINX Configurator User Manual [2] for more information about scheduler functions.

If there are multiple LIOB-AIR devices in a room, they have to be parameterized as a “VAV Group” to be able to operate a proper room control. One device in the group has to be set as the “Master”. This “Master” device only is executing the Occupancy control function and it communicates the *Effective Occupancy* to all the “Slaves” in the room. The “Slaves” do not perform an Occupancy control. They do not need this information because the setpoint selection and the space temperature control are only performed in the “Master” device. Please refer to chapter 7.6.2 for more information.

The scheduler events can be edited on the *Occupancy Schedule* tile on the *Occupancy Control Mode Schedule* page of the *VAVstatu*s visualization project as shown in Figure 305.

Please refer to the L-VIS User Manual [5] for more information of editing schedulers.

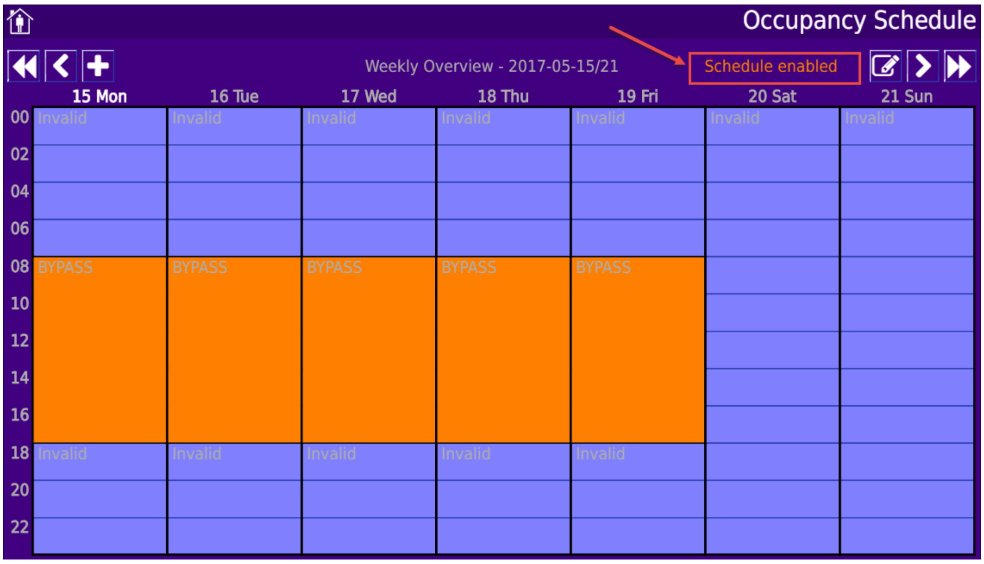

Figure 305: Occupancy Schedule

Multiple occupancy states can be scheduled by the scheduler events that have to be parameterized by the user. The result of the scheduler is the *Scheduled Occupancy* and the logic of the Occupancy Control calculates the result as Effective Occupancy considering further functions as occupancy sensor and occupancy override. The scheduler is only operating in case of "Schedule enabled" (default), see headline of scheduler table in Figure 305. If "Schedule disabled" is set by the user, the scheduler remains on its last scheduled state.

The available states of the *Scheduled Occupancy* are:

1 = Invalid / Null:

If "Null" is scheduled the resulting *Effective Occupancy* will be Invalid. This equals the situation as if no event is scheduled. A connected occupancy sensor will not affect the *Effective Occupancy* state. An override of the *Effective Occupancy* to "Bypass" caused by a bypass button or by override from AHU is possible.

2 = Unoccupied:

If "Unoccupied" is scheduled the resulting *Effective Occupancy* will be "Unoccupied" also. A connected occupancy sensor will not affect the *Effective Occupancy* state. An override of the *Effective Occupancy* to "Bypass" caused by a bypass button or by override from AHU is possible.

3 = Standby:

If "Standby" is scheduled the resulting *Effective Occupancy* will be "Standby" also. A connected occupancy sensor will not affect the *Effective Occupancy* state. An override of the *Effective Occupancy* to "Bypass" caused by a bypass button or by override from AHU is possible.

4 = Bypass:

If "Bypass" is scheduled, the resulting *Effective Occupancy* will be "Standby" but a connected occupancy sensor will change the *Effective Occupancy* state to "Occupied". This is the only case when the occupancy sensor will affect the *Effective Occupancy*. An override of the *Effective Occupancy* to "Bypass" caused by a bypass button or by override from AHU is possible.

5 = Occupied

If “Occupied” is scheduled the resulting *Effective Occupancy* will be “Occupied” also. A connected occupancy sensor will not affect the *Effective Occupancy* state. An override of the *Effective Occupancy* to “Bypass” caused by a bypass button or by override from AHU is possible.

Special Case: *Scheduled Occupancy* is written from outside via BACnet

It is also possible to use a common scheduler e.g. on a BACnet OWS. This can write on the *Scheduled Occupan*cy data point, see chapter 8.1.8.1. Multiple rooms can be operated by the same central scheduler in this case. Using this function, it is very important in this case to disable the local scheduler. There must be no events parameterized in the local scheduler in the LIOB-AIR device. Further, the scheduler must be set to “Schedule disabled” to prevent any action of the local scheduler. This has to be done at the headline of the scheduler table, see Figure 305.

Please note, if you are using the LOYTEC LWEB-900 building management system the function “Master Scheduler” operates central schedulers for multiple rooms much easier. In this case, there is no need to disable the local scheduler in the LIOB-AIR device.

Occupancy Control Status:

As mentioned above the scheduler is the basic occupancy function and there are additional optional functions that can affect the *Effective Occupancy*. These are the occupancy sensor, occupancy override by bypass button or occupancy override from AHU. The Occupancy Status control can be watched on the *Occupancy Control Status* tile on the *Occupancy Control Status* page of the *VAVstatus* visualization project as shown in Figure 306.

On this tile, it is also possible to override the *Effective Occupancy* manually using the Manual Override. However, this is only meant for testing, commissioning and maintenance purposes.

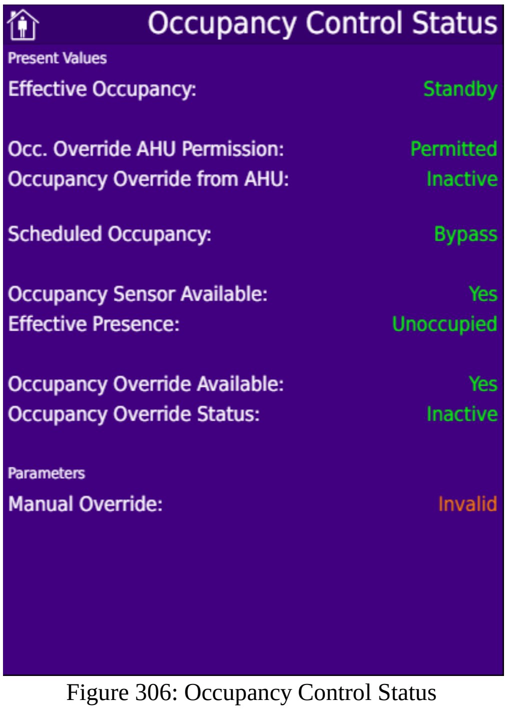

Figure 306: Occupancy Control Status

Table 111 shows the present values of the occupancy control status.

Path: User Registers.VAVcontrol.Core.Occup

Name on tile	**Data point name**	**Description**
Effective Occupancy	EffectiveOccupancy	Present value of the resulting Effective Occupancy state the VAV control is operating with
Occ.Override AHU Permission	AHUoccupOverridePermit	Indicates if an Occupancy Override would be permitted for this dedicated VAV control
Occup Override from AHU	AHUoccupOverride	Indicates if the Occup Override from AHU is active or not actually
Scheduled Occupancy	ScheduledOccupancy	Present value of the Occupancy operated by the scheduler
Occupancy Sensor Available	OccSensorAvailable	Indicates if the Occ Sensor Function is available (connected to the Core)
Effective Presence	EffectivePresence	Indicates the effective presence of the connected Occ Sensor function
Occupancy Override Available	OccOverrideAvailable	Indicates if the Occ Override Sensor Function is available (connected to the Core)
Occupancy Override Status	OccOverrideStatus	Indicates the status of the connected Occ Override Sensor function

Table 111: Present values of Occupancy Control Status

Effective Occupancy:

This shows the current *Effective Occupancy* state as the result of the occupancy control function. The VAV control is operating with this state. This value is communicated from the “Master” to the “Slaves”. This is needed in the “Slaves” e.g. to control the series fan.

Occ. Override AHU Permission:

This indicates if the AHU control is allowed to override the occupancy state to “Bypass” to ensure sufficient airflow through the ductwork if needed. The setting of this permission has to be done in the VAV Group Settings, see chapter 7.6.2.1 for more information. If the override from AHU is prohibited, then there is no influence of the AHU to the local *Effective Occupancy* in this dedicated VAV controller.

Occupancy Override from AHU:

This information is only shown on the tile if the *Occ. Override AHU Permission* is permitted. It indicates if the override from the AHU control is currently active or inactive. If it is active, the *Effective Occupancy* will become “Bypass” no matter of the scheduler or occupancy sensor or bypass button. It has to be reset to inactive by the AHU control to release the functions of the scheduler or occupancy sensor or bypass button. The *Occ. Override AHU Permission* can be set in the VAV Group configuration, see chapter 7.6.2.1.

Scheduled Occupancy:

The result of the occupancy state caused by the scheduler events is shown here. See the definitions of the available states of the *Scheduled Occupancy* described above.

Occupancy Sensor Available:

This indicates if an occupancy sensor function is available in the VAV control. By connecting the VAVoccupancy function to the core, the occupancy sensor function is enabled in the core application. See chapter 7.3.1 for more information. If the Occupancy Sensor function is available, it will affect the *Effective Occupancy*.

Effective Presence:

This information is only shown on the tile if an occupancy sensor function is available in the VAV control. It indicates the result of the occupancy sensor function including the *Off Time Delay*. As described above the occupancy sensor function only affects the Effective Occupancy if the *Scheduled Occupancy* state is on “Bypass”.

Occupancy Override Available:

This indicates if an occupancy override function is available in the VAV control. By connecting the VAVoccOverride function to the core, the occupancy override function is enabled in the core application. See chapter 7.3.1 for more information. If the occupancy override function is available, it will affect the *Effective Occupancy*.

Occupancy Override Status:

This information is only shown on the tile if an occupancy override function is available in the VAV control. It indicates the result of the occupancy override function including t*he Bypass Button* and the *Bypass Time Duration*. As described above if the *Occupancy Override Status* is active the *Effective Occupancy* will become “Bypass” no matter of the scheduler or occupancy sensor.

Table 112 shows the Occupancy Control Status parameters.

Path: User Registers.VAVcontrol.Core.Occup

Name on tile	**Data point name**	**Default**	**Description**
Manual Override	OccupAutoMan	Invalid	Effective Occupancy can be manually overridden here

Table 112: Occupancy Control Status parameters

Manual Override:

This allows a manual override of the *Effective Occupancy* for testing, commissioning or maintenance purposes. If it is set to “Invalid” then the *Effective Occupancy* is defined automatically and that is the normal setting. If it is set to “Unoccupied” or “Standby” or “Bypass” or “Occupied” the *Effective Occupancy* is set accordingly. A Manual Alarm will be triggered and a manual indicator is shown in the *VAVstatu*s visualization project.

7.5.12.2 Occupancy Sensor

The occupancy of the room is detected by an occupancy sensor connected to the local input of the LIOB-AIR device. It also can be detected by an L-STAT network thermostat or any other network thermostat that is connected to the LIOB-AIR device as well.

The occupancy sensor display is shown on the *Status Overview* page of the *VAVstatus* visualization project as shown in Figure 307. This is the *Effective Presence* value the Effective Occupancy Control is using.

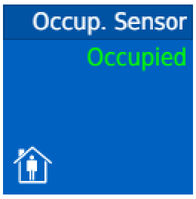

Figure 307: Occupancy Sensor tile in Status Overview

<u>Inputs:</u>

In the LIOB-AIR I/O Standard configuration, the occupancy sensor is located on the universal input UI3. For more information see chapter *7.3.2 Device Configuration*.

If an L-STAT network thermostat is connected, it can be configured to operate with the integrated sensor as the occupancy sensor or to display the current *Effective Presence* the controller is operating with.

If there are multiple LIOB-AIR devices in a room, they have to be parameterized as a “VAV Group” to be able to operate a proper room control. Either a device can have hard-wired sensors or L-STATs connected (not both at the same time) or no sensor connected. The resulting occupancy sensor state is calculated as the maximum value of all sensors and L-STATs in the VAV Group automatically and used as the control value to detect the *Effective Presence*.

<u>Favorites:</u>

The Favorite of occupancy sensor is shown in Table 113.

Path: Favorites.VAVcontrol.Occupancy

Favorite name	**Description**
inOccupancy	Present value of occupancy sensor

Table 113: Occupancy Sensor Favorite

inOccupancy:

The occupancy detection function has this one Favorite. To this Favorite, the Local I/O *UI3* is connected (see I/O Standard configuration). In case of using a third party network thermostat, the data point of the occupancy sensor coming from this device can be connected to the Favorite.

Effective Presence Function:

The occupancy sensor as described above detects if one or more people are occupying the room. This shall set the *Effective Presence* to "Occupied" immediately. With the *Off Time Delay*, the *Effective Presence* stays "Occupied" after the occupancy sensor dropped to "Unoccupied" state.

As described above the *Effective Presence* sets the *Effective Occupancy* to "Occupied" only if the *Scheduled Occupancy* is in "Bypass" state. In all other states of the *Scheduled Occupancy*, the *Effective Presence* does not affect the *Effective Occupancy*.

The occupancy sensor function can be watched and parameterized completely on the *Occupancy Sensor Configuration* page of the *VAVstatus* visualization project as shown in Figure 308.

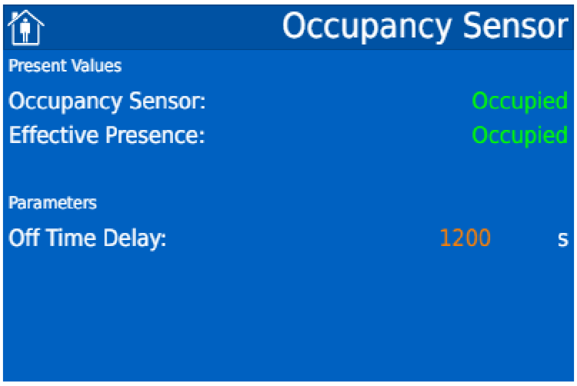

Figure 308: Occupancy Sensor Configuration tile

Table 114 shows the present values of the occupancy sensor configuration.

Path: User Registers.VAVcontrol.Occupancy

Name on tile	Data point name	Description
Occupancy Sensor	Occupancy	Present value of the occupancy sensor
Effective Presence	EffectivePresence	Present value of the effective Presence including the off time delay

Table 114: Present values of Occupancy Sensor Configuration

Occupancy Sensor:

This shows state of the occupancy sensor. This value comes from the local wired hardware input UI3 linked to the inOccupancy Favorite (see standard I/O configuration, chapter *7.3.2 Device Configuration*) or from a connected L-STAT automatically. It is also possible to connect a supported network sensor of any vendor to the inOccupancy Favorite. If there are multiple LIOB-AIR devices in a room building a "VAV-Group" (chapter 7.6.2) which have any sensors or stats connected, the occupancy is calculated as the maximum value in the master device automatically. Please note that a dedicated device only supports either a sensor connected to the Favorite or an L-STAT, but not both at the same time.

Effective Presence:

This indicates the state of the *Effective Presence* that is calculated with the *Off Time Delay*. The Effective Occupancy Control is using this state to calculate the *Effective Occupancy*.

Table 115 shows the Occupancy Sensor Configuration parameters.

Path: User Registers.VAVcontrol.Occupancy

Name on tile	Data point name	Default	Description
Off Time Delay	OccupancyOffDelay	1200s	Defines the off time delay of the effective presence

Table 115: Occupancy Sensor Configuration parameters

Off Time Delay:

This defines off time delay the *Effective Presence* stays “Occupied” after the occupancy sensor dropped to “Unoccupied” state.

7.5.12.3 Occupancy Override

The occupancy override in the room is detected by a bypass button connected to the local input of the LIOB-AIR device. It also can be triggered by an L-STAT network thermostat or any other network thermostat that is connected to the LIOB-AIR device as well.

The occupancy override display is shown on the *Status Overview* page of the *VAVstatus* visualization project as shown in Figure 309. This is the *Occ Override Status* value the Effective Occupancy Control is using.

Figure 309: Occupancy Override tile in Status Overview

Inputs:

In the LIOB-AIR I/O Standard configuration, the occupancy sensor is located on the universal input UI4. For more information see chapter *7.3.2 Device Configuration*.

If an L-STAT network thermostat is connected, it can be configured to operate with the integrated touch button as the occupancy override sensor.

If there are multiple LIOB-AIR devices in a room, they have to be parameterized as a “VAV Group” to be able to operate a proper room control. Either a device can have hard-wired sensors or L-STATs connected (not both at the same time) or no sensor connected. The resulting occupancy override sensor state is calculated as the maximum value of all sensors and L-STATs in the VAV Group automatically and used as the control value to detect the *Occ Override Status*.

Favorites:

The Favorite of occupancy override is shown in Table 116.

Path: Favorites.VAVcontrol.OccOverride

Favorite name	**Description**
inBypassButton	Present value of Bypass Button

Table 116: Occupancy Override Sensor Favorite

inOccupancy:

The occupancy override detection function has this one Favorite. To this Favorite, the Local I/O *UI4* is connected (see I/O Standard configuration). In case of using a third party network thermostat, the data point of the occupancy override sensor coming from this device can be connected to the Favorite.

<u>Occupancy Override Function:</u>

If the room occupant needs the comfort room conditions ("Occupancy") longer than the scheduled time, he has to trigger the bypass button in the room. This pulse signal will set *Occ Override Status* to active and it will stay active for the parameterized *Bypass Time Duration*. The active *Occ Override Status* affects the Effective Occupancy Control and overrides *Effective Occupancy* to "Bypass".

As described above the *Occ Override Status* will override the *Effective Occupancy* no matter of the *Effective Presence* or the *Scheduled Occupancy* states.

The occupancy override sensor function can be watched and parameterized completely on the *Occupancy Override Configuration* page of the *VAVstatus* visualization project as shown in Figure 310.

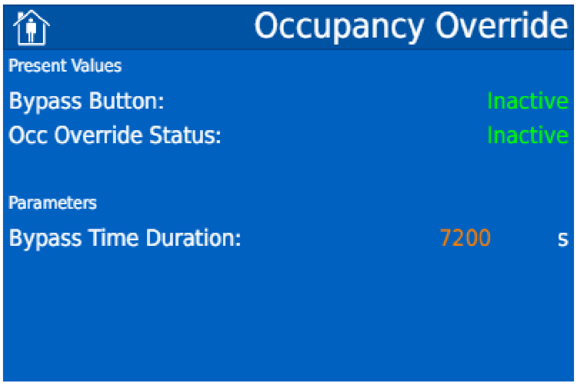

Figure 310: Occupancy Override Configuration tile

Table 117 shows the present values of the occupancy override configuration.

Path: User Registers.VAVcontrol.OccOverride

Name on tile	**Data point name**	**Description**
Bypass Button	BypassButton	Present value of the bypass button
Occ Override Status	OccOverrideStatus	Present value of the override status including the bypass time duration

Table 117: Present values of Occupancy Override Configuration

Bypass Button:

This shows state of the bypass button. This value comes from the local wired hardware input UI4 linked to the inBypassButton Favorite (see standard I/O configuration, chapter *7.3.2 Device Configuration*) or from a connected L-STAT automatically. It is also possible to connect a supported network sensor of any vendor to the inBypassButton Favorite. If there are multiple LIOB-AIR devices in a room building a "VAV-Group" (chapter 7.6.2) which have any buttons or stats connected, the occupancy override is calculated as the maximum value in the master device automatically. Please note that a dedicated device only supports either a sensor connected to the Favorite or an L-STAT, but not both at the same time.

Occ Override Status:

This indicates the state of the *Occ Override Status* that is calculated with the *Bypass Time Duration*. The Effective Occupancy Control is using this state to override the *Effective Occupancy*.

Table 118 shows the Occupancy Override Configuration parameters.

Path: User Registers.VAVcontrol.VAVcontrol.OccOverride

Name on tile	**Data point name**	**Default**	**Description**
Bypass Time Duration	BypassTimeDuration	7200s	Defines the time duration of a triggered occupancy override

Table 118: Occupancy Override Configuration parameters

Bypass Time Duration:

This defines time duration the *Occ Override Status* stays active since the bypass button was triggered.

7.5.12.4 Optimum Start

General Function:

The Optimum Start function ensures that the space temperature has reached the setpoint of the next occupancy status at the scheduled time. It operates an earlier start time and requests WARMUP or PRE_COOL to the AHU. Therefore, the room has the time to heat up or cool down to reach the space temperature setpoint at the scheduled time. It increases the occupants comfort because the room has reached its scheduled setpoint at the scheduled time. Without running Optimum Start, the room will only start heating or cooling at the scheduled time and the room will reach the setpoint later.

During operation the Optimum Start measures the time the room needs to heat up or to cool down for a temperature difference and it calculates a cool factor and a heat factor and saves it for the next operation cycle. Based on these last cycle factors and the current space temperature the next Optimum Start cycle is calculating the time the room needs to reach the next scheduled setpoint. This leads to an optimal calculation to start heating or cooling as late as possible to reach the scheduled setpoint in time.

In VAV systems, the AHU performs a centralized WARMUP or PRE_COOL function. On WARMUP, the AHU provides warm primary air to heat up all the zones. The AHU control communicates the HVAC Mode WARMUP to the VAV controllers. In this case, all the VAV controllers activate a WARMUP operation. On PRE_COOL, the AHU provides cold primary air to cool down the zones. The AHU control communicates the HVAC Mode PRE_COOL to the VAV controllers. In this case, all the VAV controllers activate a PRE_COOL operation. This happens according to the sequence in the next paragraph.

The Optimum Start functions in the VAV controllers do not directly perform a local WARMUP or a PRE_COOL function. The “Master” of every room operates an individual Optimum Start function and requests the HVAC Mode WARMUP or PRE_COOL to the AHU. The AHU communication is aggregating all these HVAC Mode requests to the Multi Master device, see chapter 7.6.1.4 and 7.7.1.4. The Multi Manager is communicating with the AHU control. The AHU control receives the number of WARMUP or PRE_COOL requests and decides to perform WARMUP or PRE_COOL by an individual algorithm. The current HVAC Mode is communicated to the Multi Manager. The Multi Manager is broadcasting the current AHU HVAC Mode to the VAV controllers using the AHU communication. The “Master” devices in the rooms now perform the local WARMUP or PRE_COOL function accordingly. See chapter 7.5.11.2 for the details of the HVAC Modes. The rooms are now heating up or cooling down. If the next occupancy state temperature setpoint is reached in a room the Optimum Start function resets the WARMUP or PRE_COOL request that is also aggregated and communicated to the AHU control. However, the room still performs the local WARMUP or PRE_COOL function according to the HVAC Mode sent by the AHU control. The individual algorithm in the AHU control decides to stop the WARMUP or PRE_COOL performance depending on the decreasing number of requests from the VAV controllers. The AHU control terminates the WARMUP or PRE_COOL operation enters a usual HVAC Mode as e.g. AUTO and communicates it to the VAV controllers. The VAV controller then also terminate the WARMUP or PRE_COOL operation continue the individual control according to the received HVAC Mode from the AHU.

The Optimum Start function is performed only if the VAV controller is the “Master” of a VAV Group.

The Optimum Start function can be enabled or disabled for dedicated rooms.

If EnergyHoldOff is triggered by an open window, the Optimum Start function is terminated for this dedicated room.

Because the Optimum Start operation is mostly depending on the occupancy scheduler, you will find the regarding pages in the Effective Occupancy area of the *VAVstatus* visualization project.

If the Optimum Start function is currently active, this is displayed additionally on the Effective Occupancy tile shown on the *Status Overview* page of the *VAVstatus* visualization project as shown in Figure 311. If the optimum Start function is inactive, it is not displayed on the tile.

Figure 311: Optimum Start displayed on Effective Occupancy tile

Detailed Function:

The Optimum Start function is internally operating as a state machine as displayed in Figure 312.

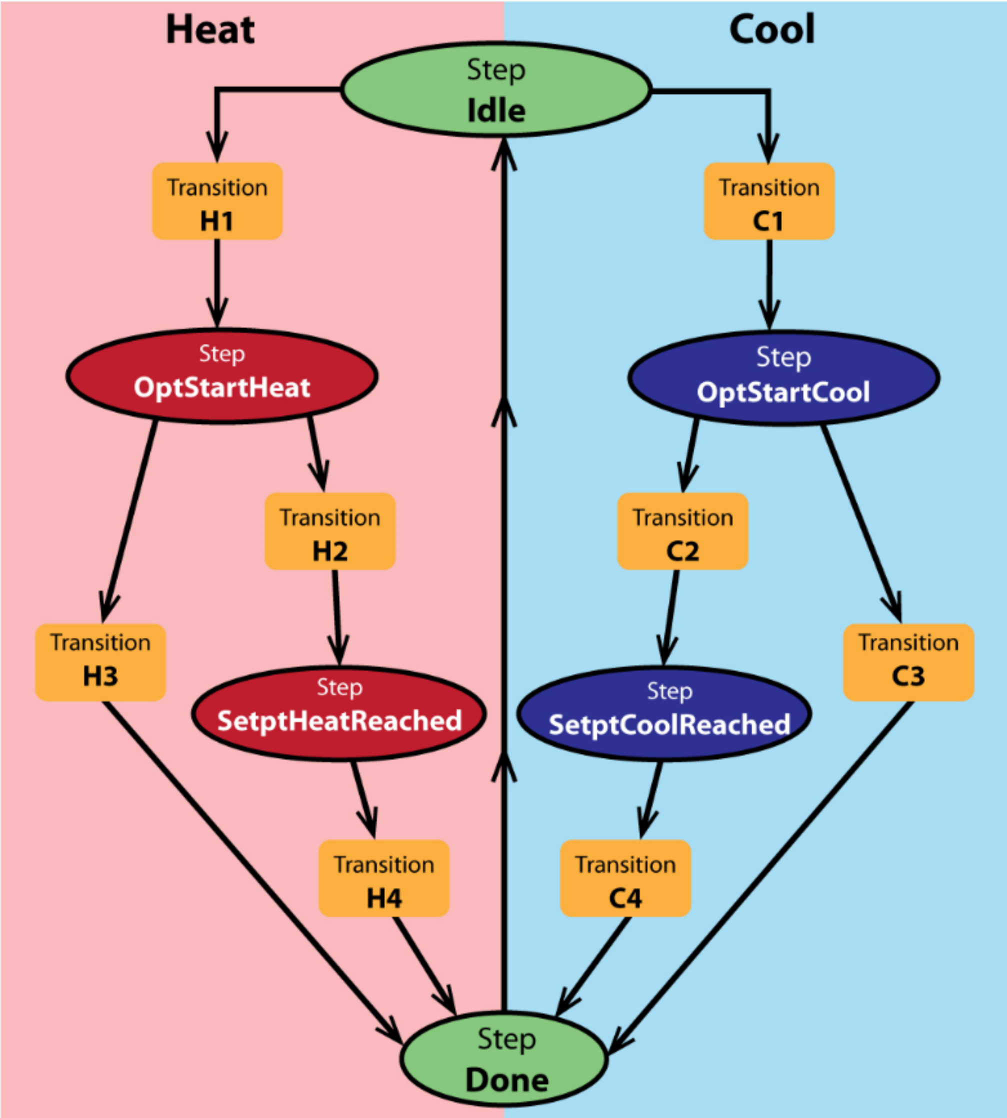

Figure 312: Optimum Start as sequential function chart control

There are the multiple steps that define the actions that are operated by the Optimum Start functions. Between the steps, there are the transitions, which define the different conditions to move to the next step. A step is active as long as the conditions of the next transition become true. Then the state machine activates the following step and executing the defined operations of this step.

In the following paragraphs, the steps and transitions are described relating to Figure 312. Please note that the used data points are explained later also.

Step “Idle”:

This step is active by default in the normal control mode. It is waiting to activate the Optimum Start depending on multiple conditions.

It is watching the *Time to next scheduled state* provided by the *Occupancy Schedule*. It watches the *Temp. difference to next state* provided by the space temperature setpoints logic. That means the difference of the current space temperature and the setpoint of the next scheduled occupancy state. Using the values of the *Last Heat Factor* and *Last Cool Factor* (calculated in the next steps in previous cycles) it calculates the estimated times to reach the next state setpoint *Est.time to reach next Heat setp*t and *Est.time to reach next Cool setpt*. It also stores the current *Space Temperature* as the internal start temperature for the next Optimum Start cycle. It further stores the current system time as the internal start time for the next Optimum Start cycle.

Procedure of an Optimum Start Heat cycle:

Transition H1:

This triggers to leave the step “Idle” and to activate the step “OptHeat”.

This can happen basically only if the *Optimum Start function* is enabled and the *HVAC Mode in VAV (from AHU)* is AUTO or HEAT or WARMUP and the *EnergyHoldOff state* is inactive. The *Next scheduled Occupancy* must be greater than the *Current scheduled Occupancy* (e.g. Standby > Unoccupied). The *Effective Occupancy* must be lower than the *Next scheduled Occupancy*. The *Temp. difference to next state* must be lower than the *Min. Temp. diff. limit to Heat*. The *Est.time to reach next Heat setp*t must be greater or equal the *Time to next scheduled state.*

Step “OptHeat”:

In this step, the optimum start Heat function is activated.

The *Optimum Start action* is set to “Active” and the *HVAC Mode requested (to AHU)* is set to WARMUP. This request is aggregated by the AHU communication and is sent to the AHU control. If the AHU control is activating the HVAC Mode WARMUP and the AHU is providing warm primary air, the room will start getting warmer.

Transition H2:

This triggers to leave the step “OptHeat” and to activate the step “SetptHeatReached”.

This happens in the normal cases if the *Temp. difference to next state* is greater or equal to zero. That means that room is warmed up so the *Space Temperature* has reached the next scheduled Heat setpoint.

Transition H3:

This triggers to leave the step “OptHeat” and to activate the step “Done”. This means a termination of the Optimum Start Heat cycle without reaching the next scheduled Heat setpoint.

This happens if the *HVAC Mode in VAV (from AHU)* becomes Not (AUTO or HEAT or WARMUP) or the *Optimum Start function* becomes disabled or the *EnergyHoldOff state* becomes active. Further conditions are the *Next scheduled Occupancy* becomes smaller or equal than the *Current scheduled Occupancy* (e.g. Unoccupied < Standby) or the *Effective Occupancy* becomes greater or equal than the *Next scheduled Occupancy or* the *Est.time to reach next Heat setp*t becomes smaller than the *Time to next scheduled state.*

Step “SetptHeatReached”:

In this step, the room is warmed up and the *Space Temperature* has reached the next scheduled Heat setpoint. The room does not need further WARMUP mode.

The *HVAC Mode requested (to AHU)* is set to HEAT. This request is aggregated by the AHU communication and is sent to the AHU control. The AHU control can decide to terminate the HVAC Mode WARMUP and activate a normal HVAC Mode e.g. AUTO by its individual algorithm depending on the decreasing number of WARMUP requests.

Using the time span and the space temperature difference from the step “OptHeat” to the step “SetptHeatReached” the *Last Heat Factor* is calculated and stored to be used in the next cycle of the Optimum Start Heat function.

Transition H4:

This triggers to leave the step “SetptHeatReached” and to activate the step “Done”. This means a usual termination of the Optimum Start Heat cycle after reaching the next scheduled Heat setpoint and the AHU control has switched back to a normal HVAC Mode e.g. AUTO.

This happens if the *HVAC Mode in VAV (from AHU)* becomes Not WARMUP or the *Optimum Start function* becomes disabled or the *EnergyHoldOff state* becomes active. Further conditions are the *Next scheduled Occupancy* becomes smaller than the *Current scheduled Occupancy* (e.g. Unoccupied < Standby) or the *Effective Occupancy* becomes greater or equal than the *Next scheduled Occupancy or* the *Est.time to reach next Heat setp*t becomes smaller than the *Time to next scheduled state.*

Step “Done”:

In this step, the end of the Optimum Start Heat cycle is defined.

The *HVAC Mode requested (to AHU)* is set to AUTO. The *Optimum Start action* is set to “Inactive”.

Without any transition, the step “Idle” is activated.

Procedure of an Optimum Start Cool cycle:

Transition C1:

This triggers to leave the step “Idle” and to activate the step “OptCool”.

This can happen basically only if the *Optimum Start function* is enabled and the *HVAC Mode in VAV (from AHU)* is AUTO or COOL or PRE_COOL and the *EnergyHoldOff state* is inactive. The *Next scheduled Occupancy* must be greater than the *Current scheduled Occupancy* (e.g. Standby > Unoccupied). The *Effective Occupancy* must be lower than the *Next scheduled Occupancy*. The *Temp. difference to next state* must be greater than the *Max. Temp. diff. limit to Cool*. The *Est.time to reach next Cool setp*t must be greater or equal the *Time to next scheduled state*.

Step “OptCool”:

In this step, the optimum start Cool function is activated.

The *Optimum Start action* is set to “Active” and the *HVAC Mode requested (to AHU)* is set to PRE_COOL. This request is aggregated by the AHU communication and is sent to the AHU control. If the AHU control is activating the HVAC Mode PRE_COOL and the AHU is providing cold primary air, the room will start getting colder.

Transition C2:

This triggers to leave the step “OptCool” and to activate the step “SetptCoolReached”.

This happens in the normal cases if the *Temp. difference to next state* is smaller or equal to zero. That means that room is cooled down so the *Space Temperature* has reached the next scheduled Cool setpoint.

Transition C3:

This triggers to leave the step “OptCool” and to activate the step “Done”. This means a termination of the Optimum Start Cool cycle without reaching the next scheduled Cool setpoint.

This happens if the *HVAC Mode in VAV (from AHU)* becomes Not (AUTO or COOL or PRE_COOL) or the *Optimum Start function* becomes disabled or the *EnergyHoldOff state* becomes active. Further conditions are the *Next scheduled Occupancy* becomes smaller or equal than the *Current scheduled Occupancy* (e.g. Unoccupied < Standby) or the *Effective Occupancy* becomes greater or equal than the *Next scheduled Occupancy or* the *Est.time to reach next Cool setp*t becomes smaller than the *Time to next scheduled state*.

Step “SetptCoolReached”:

In this step, the room is cooled down and the *Space Temperature* has reached the next scheduled Cool setpoint. The room does not need further PRE_COOL mode.

The *HVAC Mode requested (to AHU)* is set to COOL. This request is aggregated by the AHU communication and is sent to the AHU control. The AHU control can decide to terminate the HVAC Mode PRE_COOL and activate a normal HVAC Mode e.g. AUTO by its individual algorithm depending on the decreasing number of PRE_COOL requests.

Using the time span and the space temperature difference from the step “OptCool” to the step “SetptCoolReached” the *Last Cool Factor* is calculated and stored to be used in the next cycle of the Optimum Start Cool function.

<u>Transition C4:</u>

This triggers to leave the step “SetptCoolReached” and to activate the step “Done”. This means a usual termination of the Optimum Start Cool cycle after reaching the next scheduled Cool setpoint and the AHU control has switched back to a normal HVAC Mode e.g. AUTO.

This happens if the *HVAC Mode in VAV (from AHU)* becomes Not PRE_COOL or the *Optimum Start function* becomes disabled or the *EnergyHoldOff state* becomes active. Further conditions are the *Next scheduled Occupancy* becomes smaller than the *Current scheduled Occupancy* (e.g. Unoccupied < Standby) or the *Effective Occupancy* becomes greater or equal than the *Next scheduled Occupancy or* the *Est.time to reach next Cool setp*t becomes smaller than the *Time to next scheduled state.*

<u>Step “Done”:</u>

In this step, the end of the Optimum Start Cool cycle is defined.

The *HVAC Mode requested (to AHU)* is set to AUTO. The *Optimum Start action* is set to “Inactive”

Without any transition, the step “Idle” is activated.

<u>Optimum Start Overview:</u>

The first Overview of the Optimum Start function is shown on the *Optimum Start Status* page of the *VAVstatus* visualization project as shown in Figure 217.

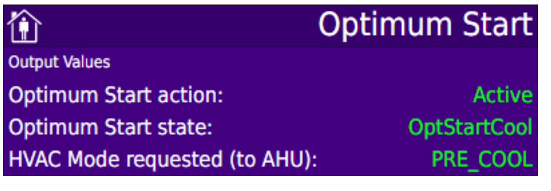

Figure 313: Output values of Optimum Start

Table 119 shows the output values of the Optimum Start function.

Path: User Registers.VAVcontrol.Core.Occup.OptimumStart

Name on tile	**Data point name**	**Description**
Optimum Start action	OsActive	Indicator is Optimum Start is currently active or inactive
Optimum Start state	OsState	Displays the current step of the internal Optimum Start state machine
HVAC Mode requested (to AHU)	HvacModeOsReq	Indicator of the HVAC mode the Optimum start requests to the AHU

Table 119: Output values of Optimum Start

Optimum Start action:

This indicates if the Optimum Start is currently active or not. It is set “Active” in the steps “OptHeat” or “OptCool” and it is reset to “Inactive in the step “Done”.

Optimum Start state:

This displays the current active step of the Optimum Start function. The multiple steps and transitions are described in the paragraphs before. The Steps that are displayed are: “Idle, OptHeat, OptCool, SetptHeatReached, SetptCoolReached”. Because Step “Done” directly followed by step “Idle” without any transition condition it is active only a very short time and will not be displayed here.

HVAC Mode requested (to AHU):

This indicates the HVAC Mode the Optimum Start function is currently requesting to the AHU. In step “Idle” AUTO is requested. In Step “OptHeat” WARMUP is requested. In Step “OptCool” PRE_COOL is requested. In Step “SetptHeatReached” HEAT is requested. In Step “SetptCoolReached” COOL is requested. The HVAC Modes requested by all the rooms are aggregated by the AHU communication as the number of WARMUP and PRE_COOL requests. The AHU control decides with an individual algorithm to operate WARMUP or PRE_COOL mode depending on the number of WARMUP and PRE_COOL requests.

Optimum Start Details:

Usually the Optimum Start function doesn´t need any user operation. It is operating automatically and is adapting the *Last Heat factor* and *Last Cool factor* to the dynamic of the room.

However, for testing, commissioning and maintenance purposes the Optimum Start details provide more transparence to the user to understand the function and the current state of the Optimum Start function.

The Optimum Start Details can be watched and operated on the *Optimum Start Details* tile on the *Optimum Start Details* page of the *VAVstatus* visualization project as shown in Figure 314.

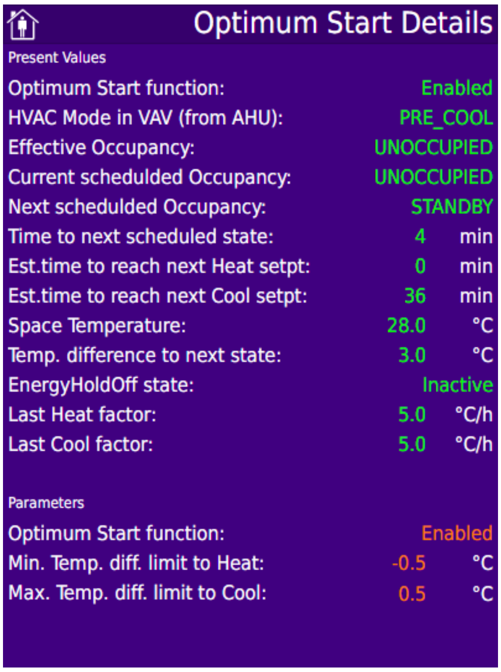

Figure 314: Optimum Start Details

Table 120 shows the present values of the Optimum Start Details.

Path: User Registers.VAVcontrol.Core.Occup.OptimumStart

Name on tile	**Data point name**	**Description**
Optimum Start function	OsEnable	Indicates if the Optimum Start function is enabled for operation
HVAC Mode in VAV (from AHU)	HvacModeVAV	Present value of the HVAC Mode the AHU is currently operating
Effective Occupancy	EffectiveOccupancy	Present value of the Effective Occupancy in the room
Current scheduled Occupancy	ScheduledOccupancy	Present value of the current occupancy operated by the scheduler
Next scheduled Occupancy	NextSchedOccupancy	Present value of the next occupancy that will be operated by the scheduler

Name on tile	Data point name	Description
Time to next scheduled state	TimeToNextSchedState	Present value of the time to the next scheduled occupancy state
Est.time to reach next Heat setpt	EstHeatTime	Estimated time to reach the space temperature Heat setpoint of the next scheduled occupancy state
Est.time to reach next Cool setpt	EstCoolTime	Estimated time to reach the space temperature Cool setpoint of the next scheduled occupancy state
Space Temperature	SpaceTemp	Present value of the current space temperature
Temp. difference to next state	TempDiffToNextSetpt	Difference of the next scheduled setpoint to the current space temperature
EnergyHoldOff state	EnergyHoldOffState	Present value of the EnergyHoldOff state
Last Heat factor	OsLastHeatFactor	Resulting Heat factor (°C/h or °F/h) of the last Optimum Start Heat cycle
Last Cool factor	OsLastCoolFactor	Resulting Cool factor (°C/h or °F/h) of the last Optimum Start Heat cycle

Table 120: Present values of Occupancy Control Status

Optimum Start function:

This indicates if the Optimum Start function is enabled or disabled by the user. If disabled, the Optimum Start permanently does not operate in this device. The HVAC Mode requested (to AHU) will remain on AUTO.

HVAC Mode in VAV (from AHU):

This is the present value of the HVAC Mode the AHU is currently operating and that is broadcasted by the Multi Manager to the VAV controllers using the AHU communication. The Optimum Start requests the *HVAC Mode requested (to AHU)* and this is aggregated and communicated to the AHU control. The AHU control is using an individual algorithm to decide to operate the requested HVAC Mode.

Effective Occupancy:

This is the present value of the *Effective Occupancy* of the room resulting from the Occupancy Control status, see chapter 7.5.12.1. If the *Optimum Start action* is active and the *Effective Occupancy* of the room becomes greater or equal the *Next Scheduled Occupancy* (e.g. Occupied > Standby, because a person occupies the room) the Optimum Start will be terminated and the step “Idle” becomes active.

Current scheduled Occupancy:

This is the present value of the occupancy state that is currently scheduled by the scheduler of the Occupancy Control status, see chapter 7.5.12.1. It is compared by the Optimum Start with the *Next scheduled Occupancy*. Optimum Start can only be activated if the *Next scheduled Occupancy* is greater than the *Current scheduled Occupancy* (e.g. Standby > Unoccupied). Optimum Start will be terminated if the *Next scheduled Occupancy* becomes smaller or equal than the *Current scheduled Occupancy* (e.g. Unoccupied < Standby).

Current scheduled Occupancy:

This is the present value of the occupancy state that will be scheduled next by the scheduler of the Occupancy Control status, see chapter 7.5.12.1. It is compared by the Optimum Start with the *Current scheduled Occupancy*. Optimum Start can only be activated if the *Next scheduled Occupancy* is greater than the *Current scheduled Occupancy* (e.g. Standby > Unoccupied). Optimum Start will be terminated if the *Next scheduled Occupancy* becomes smaller or equal than the *Current scheduled Occupancy* (e.g. Unoccupied < Standby).

Time to next scheduled state:

This is the present value of the time to the next occupancy state that will be scheduled next by the scheduler of the Occupancy Control status, see chapter 7.5.12.1. This is used to activate the steps “OptHeat” or “OptCool” in case the *Est.time to reach next Heat setpt* or *Est.time to reach next Cool setpt* is greater or equal to the *Time to next scheduled state*. Optimum Start will be terminated if the *Est.time to reach next Heat setpt* or *Est.time to reach next Cool setpt* becomes smaller than the *Time to next scheduled state*.

Est.time to reach next Heat setpt:

This is the estimated time to reach the Heat setpoint of the next scheduled occupancy state. It is calculated internally by the step “Idle” using the values of the *Last Heat factor* and the *Temp. difference to next state*. This estimation is recalculated with every update of the *Temp. difference to next state* but it remains on its last value if the step “Idle” is left. This value is used to activate the steps “OptHeat” in case the *Est.time to reach next Heat setpt* is greater or equal to the *Time to next scheduled state*. Optimum Start will be terminated if the *Est.time to reach next Heat setpt* becomes smaller than the *Time to next scheduled state*.

Est.time to reach next Cool setpt:

This is the estimated time to reach the Cool setpoint of the next scheduled occupancy state. It is calculated internally by the step “Idle” using the values of the *Last Cool factor* and the *Temp. difference to next state*. This estimation is recalculated with every update of the *Temp. difference to next state* but it remains on its last value if the step “Idle” is left. This value is used to activate the steps “OptCool” in case the *Est.time to reach next Cool setpt* is greater or equal to the *Time to next scheduled state*. Optimum Start will be terminated if the *Est.time to reach next Cool setpt* becomes smaller than the *Time to next scheduled state*.

Space Temperature:

This is the present value of the current space temperature. In the step “Idle”, it is stored as the internal start temperature for the next Optimum Start cycle. In the steps “SetptHeatReached” and “SetptCoolReached” the difference of the stored internal start temperature and the current space temperature is used to calculate the values of the *Last Heat factor* and *Last Cool factor*.

Temp. difference to next state:

This is the temperature difference of the current space temperature to the Heat or Cool setpoint of the next scheduled occupancy state. This value is provided by the space temperature setpoints logic, see chapter 7.5.6.2. It is set to a zero value if the current *Space Temperature* is inside the dead band between the next scheduled Heat setpoint and the next scheduled Cool setpoint. It results a negative value if the current *Space Temperature* is lower than the next scheduled Heat setpoint. It results a positive value if the current *Space Temperature* is greater than the next scheduled Heat setpoint. The *Temp. difference to next state* is used to calculate the values of the *Est.time to reach next Heat setpt* and *Est.time to reach next Cool setpt.*

EnergyHoldOff state:

This is the current *EnergyHoldOff state* that is triggered if a window is opened in the room, see chapter 7.5.7. The Optimum Start operation will not be activated or it will be terminated in case the *EnergyHoldOff state* becomes active.

Last Heat factor:

This is the temperature gradient of the last Optimum Start Heat cycle. It is calculated in the Step “SetptHeatReached”. An internal time span is calculated using the start time from the step “Idle” and the current system time. An internal temperature difference is calculated using the start temperature from the step “Idle” and the current *Space Temperature*. With the internal time span and the internal temperature difference, the *Last Heat factor* is calculated. The absolute value of the *Last Heat factor* is fix limited between 0,5 °C/h (1,0°F/h) and 5,0°C/h (10,0°F/h). The *Last Heat factor* is used to calculate the *Est.time to reach next Heat setpt* value.

Last Cool factor:

This is the temperature gradient of the last Optimum Start Cool cycle. It is calculated in the Step “SetptCoolReached”. An internal time span is calculated using the start time from the step “Idle” and the current system time. An internal temperature difference is calculated using the start temperature from the step “Idle” and the current *Space Temperature*. With the internal time span and the internal temperature difference, the *Last Cool factor* is calculated. The absolute value of the *Last Cool factor* is fix limited between 0,5 °C/h (1,0°F/h) and 5,0°C/h (10,0°F/h). The *Last Cool factor* is used to calculate the *Est.time to reach next Cool setpt* value.

Table 121 shows the Optimum Start Details parameters.

Path: User Registers.VAVcontrol.Core.Occup.OptimumStart

Name on tile	Data point name	Default	Description
Optimum Start function	OsEnable	Enabled	Enables the Optimum Start function for operation
Min. Temp. diff. limit to Heat	tempDiffMinHeat	-0.5°C -0.9°F	Minimum temperature difference limit to activate step OptHeat
Max. Temp. diff. limit to Cool	tempDiffMaxCool	0.5°C 0.9°F	Maximum temperature difference limit to activate step OptCool

Table 121: Optimum Start Details parameters

Optimum Start function:

This enables ore disables the Optimum Start function. If disabled, the Optimum Start permanently does not operate in this device. The HVAC Mode requested (to AHU) will remain on AUTO. If disabled during an active Optimum Start cycle it is terminated immediately.

Min. Temp. diff. limit to Heat:

This defines the minimum limit value the *Temp. difference to next state* must fall below to allow the activation of the step “OptHeat”, see transition H1. To ensure a proper function of the Optimum Start the value is internally fix maximum limited to -0.2 °C (-0.2°F).

Max. Temp. diff. limit to Cool:

This defines the maximum limit value the *Temp. difference to next state* must rise above to allow the activation of the step “OptCool”, see transition C1. To ensure a proper function of the Optimum Start the value is internally fix minimum limited to 0.2 °C (0.2°F).

7.5.13 Damper Actuators

According to chapter *7.3.1 Application Structure* the damper control is an actuator function. There are three different types of damper actuator functions available: MP-Bus damper VAVdamperMP, modulating damper VAVdamperMod, floating damper VAVdamperFloat. If one of the damper actuator functions is connected to the core, the damper actuator function is enabled in the core application. Depending on the used damper actuator device, type the according damper actuator function has to be selected and connected to the core to gain a proper control function.

The damper actuator function usually gets the damper position setpoint from the Air Flow controller. This position setpoint is put to the damper actuator device that drives the damper to the requested position.

In case of a pressure sensor failure, see chapter 7.5.5.1, the flow control is not able to operate properly. Then the damper position setpoint is set to a predefined position depending if the space temperature controller is cooling or heating.

For commissioning and maintenance purposes, the damper actuator function allows a manual mode to override the damper position setpoint manually.

Independent of the damper actuator function type there is a Damper Release function implemented. This locks the damper to the close position or releases the damper for the control operation.

7.5.13.1 Damper Release

General Function:

There are some defined cases when the damper is closed independent of the flow control output. These cases to lock the damper are:

1.Close the damper in Unoccupied mode (can be enabled/disabled).

2.Close the damper if series or parallel fan is switched on in HVAC_OFF mode.

3.Close the damper if the fan requests an anti-backward rotation start.

If one of these cases is active, the damper becomes locked and damper control output is set to 0%. The flow setpoint is set to a zero value, see chapter 7.5.5.3. If none of these cases is active, the damper is released for normal operation and the normal flow setpoint selection is operating.

The damper release function is valid for all damper actuator types.

Detailed function:

1.Close the damper in Unoccupied mode:

This function can be enabled or disabled by the system integrator on *Damper Close Unocc*. The enabled function is useful if multiple tenants use rooms that are supplied by the same AHU. If the tenants have different room occupancy schedules the unoccupied rooms can be cut off from the primary air flow and do not cause any energy consumption even if the AHU is in operation.

The *Damper Release* will be “Locked” and damper will be closed if *Eff.Occupancy* is in Unoccupied mode if the *Damper Close Unocc* is set to “Enabled”. However, this will not happen if the *HVAC Mode in VAV* is MRNG_WARMUP or NIGHT_PURGE or PRE_COOL or OFF because the damper must not be closed in these cases. In OFF the damper is not locked and not closed, because there is no air flow in the complete duct system and there is no real need to separate rooms from the ventilation system. However, this gains a better next start of the AHU, because the ductwork is opened.

Please note that the default setting of *Damper Close Unocc* is “Disabled”. To leave the damper open if the room is unoccupied is the usual way to operate. In this case, the unoccupied space temperature setpoints are maintained by the heating and cooling controllers and the resulting air flow setpoint is maintained by the flow controller. If the AHU is switched off e.g. in the evening the flow controller in the VAV will open the damper. When the AHU is switched on e.g. in the morning it will start with a fully opened ductwork which is the best way of operation.

Unoccupied Cool Request:

Even if the primary air damper is closed in Unoccupied mode, the space temperature control function is still in operation using the unoccupied space temperature setpoints. If the space temperature increases above the *Unoccupied Cool Setpoint*, the cool controller becomes active. The *Unocc Cool Request* is set to “Active”. The *Damper Release* will become “Released” and the *Flow Setpoint* is set to the *Max. Flow Cool* value. This causes a maximum cooling of the room until the space temperature decreases below the *Unoccupied Cool Setpoint* value. Then the *Damper Release* becomes “Locked” again and the *Damper Output* is set to 0% and the *Flow Setpoint* is set to a zero value. The *Unocc Cool Request* is reset to “Inactive”.

If the heating controller becomes active on heating request and the damper is closed in unoccupied mode, it is only operating the reheat and the fan units without using primary air. Therefore, a heating request does not change the *Damper Release* status in this case.

If the *Damper Close Unocc* is set to “Disabled” the damper will not be closed in Unoccupied mode and the damper is released for normal operation and the normal flow setpoint selection is operating e.g. using the flow setpoint coming from the space temperature controllers.

2.Close the damper if series or parallel fan is switched on in HVAC_OFF mode.

If the *HVAC Mode in VAV* is OFF there is no primary air flow in the VAV box.

If the series fan is switched on (*Fan Status* = “On”) caused e.g. by a heating request (see chapter 7.5.14.1), the *Damper Release* becomes “Locked” and the *Damper Output* is set to 0% and the *Flow Setpoint* is set to a zero value. This prevents that the series fan sucks in cold air from the primary air duct and mixes it to the warmer plenum air. Since the damper is closed, the series fan only gets the warm plenum air and the heating function becomes more energy efficient.

If the parallel fan is switched on (*Fan Status* = “On”) caused e.g. by a heating request (see chapter 7.5.14.2), the *Damper Release* becomes “Locked” and the *Damper Output* is set to 0% and the *Flow Setpoint* is set to a zero value. This prevents that the parallel fan blows warm plenum air into the open primary duct, which would cause a loss of heating energy. Since the damper is closed, the parallel fan blows the sucked in warm plenum air to the discharge air and the heating function becomes more energy efficient.

If the series or parallel fan is switched off in HVAC_OFF mode, the damper is released for normal operation and the normal flow setpoint selection is operating e.g. using the flow setpoint coming from the space temperature controllers.

3.Close the damper if the fan requests an anti-backward rotation start.

To prevent the fan starting with a backward rotation caused by primary air flow the anti-backward rotation start function sets the *Damper Release* to “Locked” and the *Damper Output* is set to 0% and the *Flow Setpoint* is set to a zero value before the fan is switched on. See chapter 7.5.14.3 for more details. The *Fan Status* is “Starting” during this time period.

If the fan is switched on after the anti-backward rotation start is finished, the damper is released for normal operation and the normal flow setpoint selection is operating e.g. using the flow setpoint coming from the space temperature controllers.

The *Damper Release* can be watched, operated and parameterized on the *Damper Configuration* page of the *VAVstatus* visualization project as shown in Figure 315.

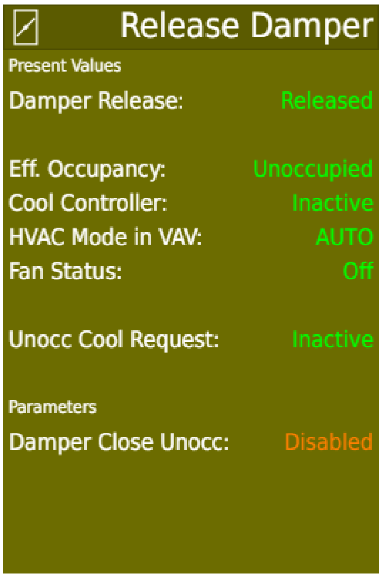

Figure 315: Release Damper configuration

Table 122 shows the Release Damper present values.

Path: User Registers.VAVcontrol.DamperMP.DamperRelease*)

Name on tile	Data point name	Description
Damper Release	DamperRelease	Displays the current state of the damper, released or locked
Eff. Occupancy	EffectiveOccupancy	Displays the current effective occupancy of the room
Cool Controller	CoolControlEnabled	Displays if the space temperature cooling controller is active or inactive
HVAC Mode in VAV	HvacModeVAV	Displays the current HVAC mode in the VAV box
Fan Status	FanStatus	Displays the current status of the fan, off, starting or on
Unocc Cool Request	UnoccCoolRequest	Displays if the damper should be locked and closed in Unoccupied mode but there is a cooling request that releases the damper

Table 122: Release Damper present values

*): Please note that the data point path for heating is depending on the connected damper actuator using different folder names:

Damper MP-Bus folder name: DamperMP

Damper modulating folder name: DamperMod

Damper floating folder name: DamperFloat

Damper Release:

Displays if the damper is “Locked” or “Released” for operation. If “Locked”, the *Damper Output* is set to 0% and the *Flow Setpoint* is set to a zero value. If “Released”, the *Damper Output* is released for normal operation and the normal flow setpoint selection is operating. The “Locked” status is shown in red letters to get more user attention.

Effective Occupancy:

Displays the current occupancy status of the room. If the room is “Unoccupied” and the *Cool Controller* is “Active” and the *HVAC Mode in VAV* is Not (MRNG_WARMUP or NIGHT_PURGE or PRE_COOL or OFF) and the *Damper Close Unocc* is “Enabled” the *Damper Release* becomes “Locked”. In this case, the *Eff. Occupancy* status is displayed in red flashing letters to indicate this damper lock reason.

Cool Controller:

This displays if the space temperature cooling controller indicates is “Inactive” or “Active”. If the *Eff. Occupancy* is “Unoccupied” and the *Cool Controller* is “Active” and the *HVAC Mode in VAV* is Not (MRNG_WARMUP or NIGHT_PURGE or PRE_COOL or OFF) and the *Damper Close Unocc* is “Enabled” the *Damper Release* becomes “Locked”. In this case, the *Cool Controller* status is displayed in red flashing letters to indicate this damper lock reason.

HVAC Mode in VAV:

This displays the current HVAC mode in the VAV box. If the *HVAC Mode in VAV* is “OFF” and the *Fan Status* is “ON” the *Damper Release* becomes “Locked”. In this case, the *HVAC Mode in VAV* status is displayed in red flashing letters to indicate this damper lock reason.

Fan Status:

This displays the current *Fan Status* “Off”, Starting” or “On”. If the *HVAC Mode in VAV* is “OFF” and the *Fan Status* is “ON” the *Damper Release* becomes “Locked”. Or if the fan is “Starting” (anti-backward rotation start), the *Damper Release* becomes “Locked”. In these cases, the *Fan Status* is displayed in red flashing letters to indicate this damper lock reason.

Table 123 shows the Release Damper parameters.

Path: User Registers.VAVcontrol.DamperMP.DamperRelease*)

Name on tile	**Data point name**	**Default**	**Description**
Damper Close Unocc	EnableDamperCloseUnocc	Disabled	Defines if the damper shall be closed in unoccupied mode

Table 123: Release Damper parameters

*): Please note that the data point path for heating is depending on the connected damper actuator using different folder names:

Damper MP-Bus	folder name: DamperMP
Damper modulating	folder name: DamperMod
Damper floating	folder name: DamperFloat

Damper Close Unocc:

If this is set to “Enabled”, the *Damper Release* will become “Locked” if the room is “Unoccupied” and the *Cool Controller* is “Active” and the *HVAC Mode in VAV* is <u>Not</u> (MRNG_WARMUP or NIGHT_PURGE or PRE_COOL or OFF). If this is set to “Disabled” the *Damper Release* will not be affected if the room becomes “Unoccupied”. Please note that this parameter value can be set on the “Master” device of a VAV group. It is communicated to the “Slave” devices automatically. This makes sure that all the fans in the VAV group have identical values in this parameter.

7.5.13.2 MP-Bus Damper Actuator

General Function:

The LIOB-AIR1 and LIOB-AIR2 devices are shipped with an integrated MP-Bus damper actuator. Therefore, this chapter is valid for the damper actuators of these types of VAV controllers.

The MP-Bus damper actuator device has to be connected to the “MP-BUS” port of the LIOB-AIR by the cable. The “MP-BUS” port is providing power supply and bus communication to the MP-Bus damper actuator. The MP-Bus damper actuator is commissioned by the LIOB-AIR device automatically on a power cycle of the LIOB-AIR.

The MP-Bus damper actuator is performing an automatic adaption of the rotation angle between the damper end positions every time the power is cycled. The adaption can also be triggered on the *MP Damper* tile on the *Damper Configuration* page of the *VAVstatus* visualization project. A further way to trigger the adaption is to press and release the clutch button on the MP-Bus damper actuator. The end stops of the open and close positions can be adjusted mechanically. After having adjusted one or both end stops mechanically, the adaption of the rotation angle must be performed.

If the adaption function is triggered the actuator rotates to the left direction until it reaches the left end position. Then it stops and drives to the right direction until it reaches the right end position. This rotation angle is now the new operation range 0…100% of the actuator. After that, it stops the adaption and drives to the current position setpoint. Once the adaption function is triggered, it cannot be terminated during the process.

For commissioning and maintenance purposes, the damper position can be set by hand mechanically as long as the clutch button on the local MP-Bus damper actuator is pressed.

The damper display is shown on the *Status Overview* page of the *VAVstatus* visualization project as shown in Figure 316. Here the *CurrentPosition* (position feedback) is displayed.

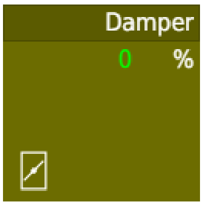

Figure 316: MP-Bus Damper tile in Status Overview

MP-Bus data points:

The communication MP-Bus damper actuator function is using the MP-Bus data points directly and it is not using Favorites.

The MP-Bus data points are used for the communication between the MP-Bus damper actuator and LIOB-AIR as shown in Table 124.

Please note that these MP-Bus data points are used for internal communication purposes only. There is no user access possible because it is not needed. This documentation of the MP-Bus data points is only for information purposes.

Path: MP-Bus.VAVcontrol.DamperMP.LMB24-MPL_OEM

Data point name	Description
CurrentPosition	Present value current actuator position (position feedback)
PosSetpoint	Output setpoint of the actuator position
State1b7	Indicates if the gear is disengaged and the position is set by hand mechanically on the actuator
State2b7	Indicates if the actuator motor has stopped, is not moving
State2b1	Indicates if the adaption is active
StartTest	Output to start the adaption

Table 124: MP-Bus data points

CurrentPosition:

This is the present value of the current damper actuator position. The position value is relating to the 0…100% range that was detected by the last adaption run.

PosSetpoint:

The VAV controller writes the requested damper actuator position on to this data point. The MP-Bus damper actuator is moving the damper to this position as long as the *CurrentPosition* (nearly) equals the *PosSetpoint*. The position value is relating to the 0…100% range that was detected by the last adaption run.

State1b7

This indicates if the gear is disengaged and the damper position is set by hand mechanically by pressing and holding the clutch button on the MP-Bus damper actuator.

State2b7

This indicates if actuator motor has stopped and the *CurrentPosition* has reached the *PosSetpoint*. The actuator is not moving and remains on the current position.

State2b1

This indicates if the adaption function is active.

StartTest

The VAV controller writes a command on to this data point to start the adaption. A running adaption process cannot be terminated.

Detailed Functions:

The MP-Bus damper actuator can be watched, operated and parameterized on the *Damper Configuration* page of the *VAVstatu*s visualization project as shown in Figure 317.

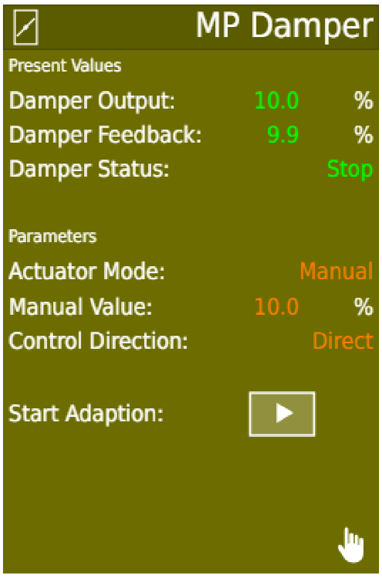

Figure 317: MP-Bus damper actuator configuration

Table 125 shows the MP-Bus damper actuator present values.

Path: User Registers.VAVcontrol.DamperMP

Name on tile	Data point name	Description
Damper Output	DamperOutput	Displays the current setpoint output of the damper position
Damper Feedback	DamperFeedback	Displays the current damper position feedback
Damper Status	DamperMotor	Displays if the damper runs or stops

Table 125: MP-Bus damper actuator present values

Damper Output:

Displays the current position setpoint that is communicated to the MP-Bus damper actuator. The MP-Bus damper actuator is moving the damper rotation angle to this position as long as the *Damper Feedback* (nearly) equals the *Damper Output*.

Damper Feedback:

Displays the current position feedback that is received from the MP-Bus damper actuator.

Damper Status:

This indicates if actuator motor has stopped and the *Damper Feedback* has reached the *Damper Output*. The actuator is not moving and remains on the current position. Or it is running if the *Damper Feedback* has not reached the *Damper Output*. It indicates also if the damper actuator executes the adaption function or if the clutch is disengaged.

Table 126 shows the MP-Bus damper actuator parameters.

Path: Path: User Registers.VAVcontrol.DamperMP

Name on tile	**Data point name**	**Default**	**Description**
Actuator Mode	AutoMan	Auto	Definition of the actuator mode Auto or Manual
Manual Value	ManualValue	0%	Definition of the manual damper position setpoint, (only displayed in Manuals mode)
Control Direction	ControlDirection	Direct	Definition control direction Direct or inverted
Start Adaption	StartTest	No Action	Button to start the adaption process in the damper actuator

Table 126: MP-Bus damper actuator parameters

Actuator Mode:

This defines if the damper actuator is controlled in “Auto” or “Manual” mode. In “Auto” mode, it gets the damper position setpoint *Damper Output* from the VAV control (air flow control, pressure sensor failure, emergency position). In “Manual” mode, the *Damper Output* is set to the *Manual Value*.

Manual Value:

This is only visible if the *Actuator Mode* is in “Manual” mode. A manual value can be entered here and is forwarded to the *Damper Output*. This is only meant for commissioning and maintenance purposes. A Manual Alarm will be triggered and a manual indicator is shown in the *VAVstatu*s visualization project.

Control Direction:

This defines the control direction. “Direct” means that the damper position is increasing by rotating the damper to the right direction. “Inverted” means that the damper position is increasing by rotating the damper to the left direction. This should be set only once during the commissioning phase, because a wrong control direction damages the complete VAV control function.

Start Adaption:

Pressing this button, the adaption process is triggered and stays active until the process has ended independently. The adaption process is also triggered by pressing and releasing the clutch button or by a power cycle of the MP-Bus damper actuator.

<u>Damper Feedback Alarm</u>

Because the MP-Bus damper actuator provides a position feedback *Damper Feedback* the MP-Bus damper actuator function includes a damper feedback alarm function. It watches the *Damper Command* and the *Damper Feedback* permanently, even if the *Actuator Mode* is “Manual”, except in case the adaption function is active.

If the *Damper Feedback* value does not match the *Damper Command* value for a longer time the damper feedback alarm is triggered. This can happen e.g. if the damper blade is blocked mechanically.

Please note that the Damper Feedback Alarm is triggered by this function and only this is described in this chapter. In the device, this alarm is operated as a “generic” alarm that is reported to BACnet alarm server in parallel. The complete alarming with alarm servers, alarm lists, alarm status, acknowledgement, alarm notification and further things are standard LOYTEC data point functions of the LIOB-AIR operating system.

The principle of the Damper Feedback Alarm is displayed in Figure 318.

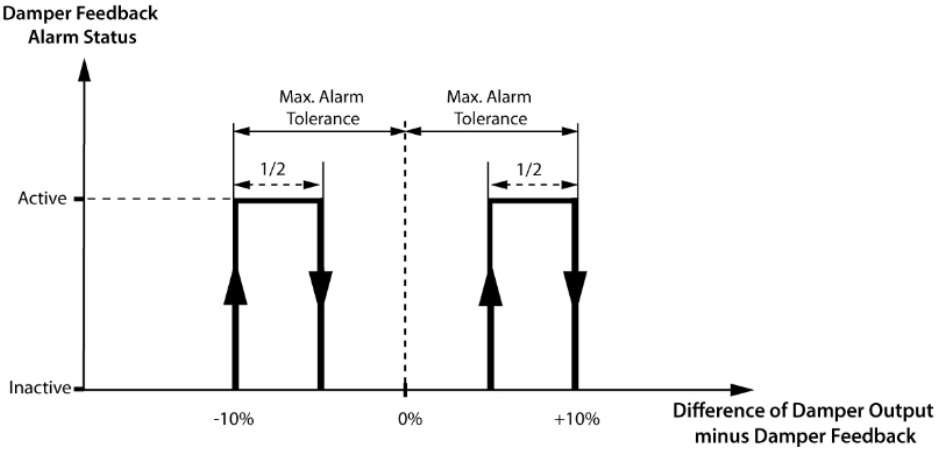

Figure 318: Principle of the Damper Feedback Alarm

The absolute difference of *Damper Command* and *Damper Feedback* is calculated. If this absolute difference value increases above the adjustable *Max. Alarm Tolerance* value, a Damper Feedback Alarm is triggered after the *Alarm Time Delay* has expired.

The alarm can be reset manually. However, it will be retriggered after the *Alarm Time Delay* if the absolute difference still remains. It resets automatically if the absolute difference decreases below the half *Max. Alarm Tolerance* value.

The Damper Feedback Alarm can be watched, operated and parameterized on the *Damper Feedback Alarm* page of the *VAVstatu*s visualization project as shown in Figure 319.

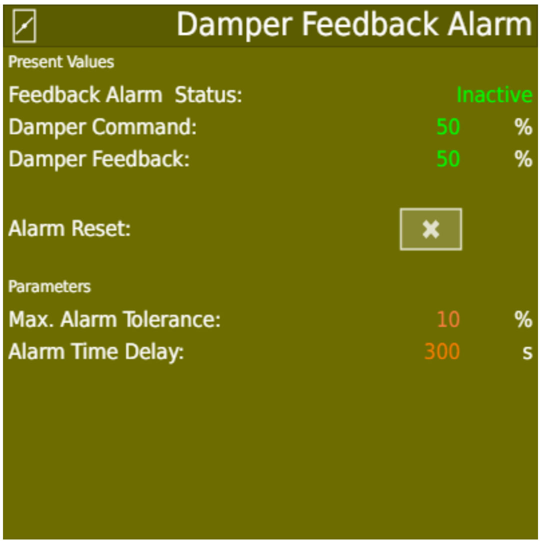

Figure 319: MP-Bus Damper Feedback Alarm configuration

Table 127 shows the MP-Bus damper actuator present values.

Path: User Registers.VAVcontrol.DamperMP.FeedbackAlarm

Name on tile	**Data point name**	**Description**
Feedback Alarm Status	FeedbackAlarm	Present value damper feedback alarm
Damper Command	DamperOutput	Displays the current setpoint output of the damper position
Damper Feedback	DamperFeedback	Displays the current damper position feedback

Table 127: MP-Bus Damper Feedback Alarm present values

Feedback Alarm Status:

This displays the actual state of the Damper Feedback alarm trigger. It becomes active if the absolute difference of *Damper Command* minus *Damper Feedback* is greater than the current *Max.Alarm Tolerance* delayed with the *Alarm Time Delay*. It becomes inactive if absolute difference is lower than the half of *Max.Alarm Tolerance* without any delay or the alarm is reset by the user, see Figure 318.

Damper Command:

Here the present value of the *Damper Command* (equal to *Damper Output*) is displayed as the current setpoint of the damper position. It is monitored by the Damper Feedback Alarm function.

Damper Feedback:

Here the present value if the Damper Feedback is displayed. It is monitored by the Damper Feedback Alarm function.

Table 128 shows the Discharge Temperature Max. Alarm parameters.

Path: User Registers.VAVcontrol.DamperMP.FeedbackAlarm

Name on tile	**Data point name**	**Default**	**Description**
Max. Alarm Tolerance	FeedbackAlarmTolerance	10%	Maximum Alarm tolerance between Damper Command and Damper Feedback
Alarm Time Delay	FeedbackAlarmDelayTime	300s	Time delay to trigger a Damper Feedback Alarm
Alarm Reset	FeedbackAlarmReset	FALSE	Button to reset an active Damper Feedback Alarm

Table 128: MP-Bus Damper Feedback Alarm parameters

Max Alarm Tolerance:

This defines the maximum absolute difference limit of *Damper Command* and *Damper Feedback*. If this limit value is exceeded, the Alarm is triggered with the *Alarm Time Delay*.

Alarm Time Delay:

If the current absolute difference limit of *Damper Command* and *Damper Feedback* is above of the limit, the alarm is triggered with this time delay. The reset of the Damper Feedback Alarm is operated without any time delay.

Alarm Reset:

A triggered Damper Feedback Alarm can be reset by the user pressing this button. However, if the current absolute difference of *Damper Command* and *Damper Feedback* is still above the limit the Damper Feedback Alarm will be retriggered again after the *Alarm Time Delay* has elapsed. Pressing this button will set the *FeedbackAlarmReset* to TRUE and releasing the button will set the *FeedbackAlarmReset* to FALSE (function of the visualization).

7.5.13.3 Modulating Damper Actuator

General Function:

The LIOB-AIR13 device is shipped without a damper actuator. Therefore, the user can connect an actuator type of his choice. This chapter describes the damper actuator function of a modulating damper.

The damper in the VAV Box is moved by a damper actuator. The damper actuator is led by an analog signal that is connected to a local output of the LIOB-AIR device. The damper blade is moved by the modulating damper actuator to the requested position by an internal position controller.

The modulating damper actuator function is not operating a damper position feedback. This can be connected to the Damper Feedback sensor function, see chapter 7.5.13.5

The damper display is shown on the *Status Overview* page of the *VAVstatus* visualization project as shown in Figure 320. Here the *Damper Output* (position setpoint) is displayed.

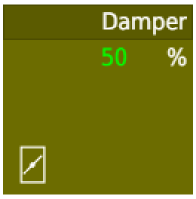

Figure 320: Modulating Damper tile in Status Overview

Output:

In the LIOB-AIR I/O Standard configuration, the modulating damper output is located on the analog output *AO2*. For more information see chapter *7.3.2 Device Configuration*.

The 0…10 VDC signal relates to a fixed physical rotation range 0…100% of the damper actuator device. However, the rotation angle of the damper is defined by the construction of the VAV Box. During the commissioning work, the physical rotation range and the open and closed end points of the damper have to be detected manually. By setting the MinValue (Voltage for 0% position setpoint) and the MaxValue (Voltage for 100% position setpoint) of the *AO2* analog output, the control output has to be adapted to the physical rotation range of the damper. This has to be done with the LINX-Configurator tool (L-IOB/Local I/O) in the VAV Device Type configuration.

If the damper actuator needs to operate in an inverse direction, it has to be set up on the damper actuator device. Please refer to the regarding manufacturer documentation.

Favorites:

The Favorite of a modulating damper is shown in Table 129.

Path: Favorites.VAVcontrol.DamperMod

Favorite name	**Description**
outDamperModulating	Output value of modulating damper position setpoint

Table 129: Modulating Damper Favorite

outDamperModulating:

The modulating damper function has this one Favorite. To this Favorite, the Local I/O *AO2* is connected (see I/O Standard configuration).

Detailed Functions:

The modulating damper actuator can be watched, operated and parameterized on the *Damper Configuration* page of the *VAVstatus* visualization project as shown in Figure 321.

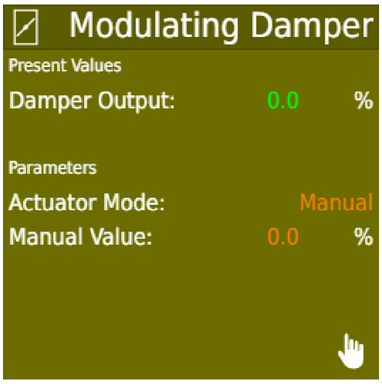

Figure 321: Modulating Damper Actuator configuration

Table 130 shows the modulating damper actuator present values.

Path: Favorites.VAVcontrol.DamperMod

Name on tile	Data point name	Description
Damper Output	outDamperModulating	Displays the current setpoint output of the damper position

Table 130: Modulating damper actuator present values

Damper Output:

Displays the current position setpoint that is put out damper actuator. The damper actuator is moving the damper rotation angle to this position by the internal position controller.

It is very important to set the MinValue (Voltage for 0% position setpoint) and the MaxValue (Voltage for 100% position setpoint) of the *AO2* analog output to adapt the control output to the physical rotation range of the damper.

Table 131 shows the modulating damper actuator parameters.

Path: Path: User Registers.VAVcontrol.DamperMod

Name on tile	Data point name	Default	Description
Actuator Mode	AutoMan	Auto	Definition of the actuator mode Auto or Manual
Manual Value	ManualValue	0%	Definition of the manual damper position setpoint, (only displayed in Manuals mode)

Table 131: Modulating damper actuator parameters

Actuator Mode:

This defines if the damper actuator is controlled in “Auto” or “Manual” mode. In “Auto” mode, it gets the damper position setpoint *Damper Output* from the VAV control (air flow control, pressure sensor failure, emergency position). In “Manual” mode, the *Damper Output* is set to the *Manual Value*.

Manual Value:

This is only visible if the *Actuator Mode* is in “Manual” mode. A manual value can be entered here and is forwarded to the *Damper Output*. This is only meant for commissioning and maintenance purposes. A Manual Alarm will be triggered and a manual indicator is shown in the *VAVstatu*s visualization project.

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7.5.13.4 Floating Damper Actuator

General Function:

The LIOB-AIR13 device is shipped without a damper actuator. Therefore, the user can connect an actuator type of his choice. This chapter describes the damper actuator function of a floating damper.

The damper in the VAV Box is moved by a damper actuator. The damper actuator is led by two binary signals (close and open) that are connected to two local digital outputs of the LIOB-AIR device. The damper blade is moved by the floating damper actuator.

The floating damper actuator function is not operating a damper position feedback. This can be connected to the Damper Feedback sensor function, see chapter 7.5.13.5

Because the floating damper actuator function does not operate a position feedback, it is calculating the current damper position internally, based on the parameterized runtime values. The floating position control operates the binary open and close commands depending on the calculated current damper position in a 3-point function “close / stop / open”. If the calculated position is below the position setpoint coming from the VAV control the floating position control triggers the “open” command. When the calculated position reaches the position setpoint, the “open” command is reset. If the calculated position is above the position setpoint coming from the VAV control the floating position control triggers the “close” command. When the calculated position reaches the position setpoint, the “close” command is reset. Therefore, when the calculated position matches the position setpoint both outputs “open” and “close” are reset and the actuator “stops” moving.

Therefore, the damper runtime values have to be detected and parameterized properly during the commissioning phase to allow a proper calculation of the damper position. Because some actuators are driving with different speed on the open and close directions there are dedicated parameters available.

Of course, the calculated damper position is only an approximation. For that reason, the floating damper actuator function performs synchronization every time the damper is driven to a 0% or 100% setpoint from the VAV control. It can be parameterized if the synchronization sets the “close” or “open” command permanently or for the double duration of the damper close or open runtime.

The damper display is shown on the *Status Overview* page of the *VAVstatus* visualization project as shown in Figure 322. Here the calculated damper position and the floating commands “close = ↓” and open = ↑” are displayed.

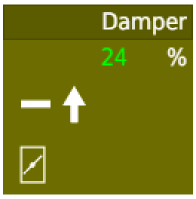

Figure 322: Floating Damper tile in Status Overview

Output:

In the LIOB-AIR I/O Standard configuration, the both floating damper outputs (close and open) are not located on digital outputs *DOx*, because floating dampers are not used very often. This has to be done with the LINX-Configurator tool (L-IOB/Local I/O) in the VAV Device Type configuration. For more information see chapter *7.3.2 Device Configuration*.

If the damper actuator needs to operate in an inverse direction, it has to be set up on the damper actuator device if possible. Please refer to the regarding manufacturer documentation.

Favorites:

The Favorites of a floating damper are shown in Table 129.

Path: Favorites.VAVcontrol.DamperFloat

Favorite name	**Description**
outDamperClose	Output value of floating damper command “close”
outDamperOpen	Output value of floating damper command “open”

Table 132: Floating Damper Favorites

outDamperClose:

This is the Favorite of the floating damper “close” command. To this Favorite, no Local I/O *DOx* is connected (see I/O Standard configuration). This has to be done individually with the LINX-Configurator tool (L-IOB/Local I/O) in the VAV Device Type configuration.

outDamperOpen:

This is the Favorite of the floating damper “open” command. To this Favorite, no Local I/O *DOx* is connected (see I/O Standard configuration). This has to be done individually with the LINX-Configurator tool (L-IOB/Local I/O) in the VAV Device Type configuration.

Detailed Functions:

The floating damper actuator can be watched, operated and parameterized on the *Damper Configuration* page of the *VAVstatus* visualization project as shown in Figure 323.

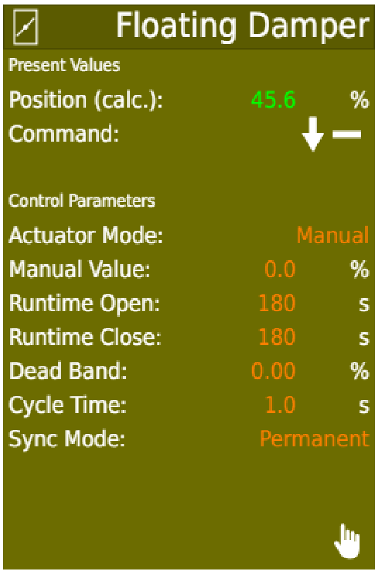

Figure 323: Floating Damper Actuator configuration

Table 133 shows the floating damper actuator present values.

Path: User Registers.VAVcontrol.DamperFloat

Name on tile	Data point name	Description
Position (calc.)	CalcPosition	Displays the current calculated damper position
Command	outDamperClose outDamperOpen	Displays the current state of the “close = ↓” and “open = ↑” commands, “stop = --“

Table 133: Floating damper actuator present values

Position (calc.):

Displays the current calculated damper position depending on the active duration of the “close” and “open” commands and the *Runtime Open* and *Runtime Close* parameter values.

Command:

Displays the current state of the floating damper commands. It indicates if the damper actuator is set to move the damper to the “close = ↓” or “open = ↑” direction or if it “stops = --“ moving.

Table 134 shows the floating damper actuator parameters.

Path: Path: User Registers.VAVcontrol.DamperFloat

Name on tile	Data point name	Default	Description
Actuator Mode	AutoMan	Auto	Definition of the actuator mode Auto or Manual
Manual Value	ManualValue	0%	Definition of the manual damper position setpoint, (only displayed in Manuals mode)
Runtime Open	RuntimeOpen	180s	Definition of the runtime the damper needs to open completely 100% starting from the close position 0%
Runtime Close	RuntimeClose	180s	Definition of the runtime the damper needs to close completely 0% starting from the open position 100%
Dead Band	DeadBand	0%	Definition of the dead band of the damper position controller
Cycle Time	CycleTime	1s	Definition of the cycle time of the damper position calculation
Sync Mode	PositionSynchrMode	Permanent	Definition of the synchronization mode of the damper position calculation

Table 134: Floating damper actuator parameters

Actuator Mode:

This defines if the damper actuator is controlled in “Auto” or “Manual” mode. In “Auto” mode, it gets the damper position setpoint from the VAV control (air flow control, pressure sensor failure, emergency position). In “Manual” mode, the damper position setpoint is set to the *Manual Value*.

Manual Value:

This is only visible if the *Actuator Mode* is in “Manual” mode. A manual value can be entered here and is forwarded to the damper position setpoint. This is only meant for commissioning and maintenance purposes. A Manual Alarm will be triggered and a manual indicator is shown in the *VAVstatu*s visualization project.

Runtime Open:

This defines the time duration the actuator drives from the close position (0%) to the full open position (100%) of the connected damper. This value has to be detected and parameterized during the system commissioning properly to gain a realistic calculation of the damper *Position (calc.)*. To support actuators with different open and close speed the *Runtime Open* and *Runtime Close* are available, but both parameters have to be set.

Runtime Close:

This defines the time duration the actuator drives from the full open position (100%) to the close position (0%) of the connected damper. This value has to be detected and parameterized during the system commissioning properly to gain a realistic calculation of the damper *Position (calc.)*. To support actuators with different open and close speed the *Runtime Open* and *Runtime Close* are available, but both parameters have to be set.

Dead Band:

The floating damper position controller is operating with a dead band. If the absolute difference between the *Position (calc.)* and the position setpoint is lower or equal the half *Dead Band* value, the position controller stops moving the damper. If it is, not the damper will be moved to the required direction. Usually this parameterized *Dead Band* default value is 0%. Then the position controller operates with the highest possible accuracy. If this does not work in special cases (fast moving actuators), the *Dead Band* can be set to higher values to stabilize the position control.

Cycle Time:

This is the cycle time to calculate the damper *Position (calc.)*. Because the cycle is fixed internally to 1 second this parameter has to have its default value of 1s and must not be changed.

Sync Mode:

The calculation of the damper *Position (calc.)* needs to be synchronized from time to time. This is always done when the damper position 0% or 100% is requested by the VAV control. The Sync Mode parameter defines how this synchronization is performed. There are two options “Permanent” or “2xRuntime” available:

Permanent:

If the 0% position is requested by the VAV control, the “close” command is set permanently. The damper will drive to the close position physically and the calculation of the damper position will result 0%. If the 100% position is requested by the VAV control, the “open” command is set permanently. The damper will drive to the open position physically and the calculation of the damper position will result 100%.

2xRuntime:

This is the same procedure as described above, but the commands “close” or “open” are set for the time duration of 2 times of the parameterized *Runtime Open* or *Runtime Close*. This Sync Mode has to be chosen if the damper actuator cannot stand permanent “open” or “close” commands.

7.5.13.5 Damper Feedback (mod, float)

The LIOB-AIR devices with integrated MP-Bus damper actuator have an integrated damper feedback display and functionality, see chapter 7.5.13.1. If the LIOB-AIR is operating with modulating or floating damper actuators, the damper feedback is a separate function because there are variations of actuators manufactured without having a feedback sensor.

Therefore, this chapter is only valid if modulation or floating damper actuators are configured.

According to chapter *7.3.1 Application Structure* the damper feedback is a sensor function. If the VAVdamperFeedback sensor function is connected to the core, the damper feedback function is enabled in the core application.

General Function:

Actually, this function is only displaying the damper feedback value. In one of the future releases, there will be additional functions available like feedback alarm or adaption of the operation range for modulating and floating damper actuators.

The damper position feedback is measured by a position sensor connected to the local input of the LIOB-AIR device.

The damper feedback display is shown on the *Status Overview* page of the *VAVstatus* visualization project as shown in Figure 324.

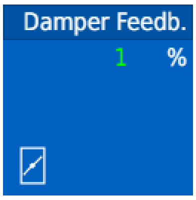

Figure 324: Damper Feedback tile in Status Overview

Inputs:

In the LIOB-AIR I/O Standard configuration, the damper feedback is located on the universal input UI7. For more information see chapter *7.3.2 Device Configuration*.

The 0…10 VDC feedback signal relates to a fixed physical rotation range 0…100% of the damper actuator device. However, the rotation angle of the damper is defined by the construction of the VAV Box. During the commissioning work, the physical rotation range and the open and closed end points of the damper have to be detected manually. By setting up a “Translation Table” (Voltage for 0% position, Voltage for 100% position) of the *UI7* universal input, the input has to be adapted to the physical rotation range of the damper. This has to be done with the LINX-Configurator tool (L-IOB/Local I/O) in the VAV Device Type configuration.

Favorites:

The Favorite of damper feedback is shown in Table 135.

Path: Favorites.VAVcontrol.DamperFeedback

Favorite name	Description
inDamperFeedback	Present value of damper Feedback

Table 135: Damper Feedback Favorite

inDamperFeedback:

The damper feedback measurement function has this one Favorite. To this Favorite, the Local I/O *UI7* is connected (see I/O Standard configuration).

7.5.14 Fan Actuators

According to chapter *7.3.1 Application Structure* the fan is an actuator function. There are two different types of fan actuator functions available: series fan VAVserFan and parallel fan VAVparFan. If one of the fan actuator functions is connected to the core, the fan actuator function is enabled in the core application. Depending on the used fan actuator device type, the according fan actuator function has to be selected and connected to the core to gain a proper control function.

The fan actuator function usually gets the request for operation from the HVAC Mode and the reheat request of the VAV control or a cooling request (series only) or a manual request of the reheat. For details, see the following chapters.

If the fan request is reset by the VAV heating control the fan is switched off with an adjustable delay time.

For commissioning and maintenance purposes, the fan actuator function allows a manual mode to switch the fan manually.

Fans equipped with an ECM motor are also supported by LIOB-Air. These ECM motors provide the best energy efficiency and that is the main reason why used in VAV Boxes. ECM motors also provide a variable fan speed. A minimum and maximum speed can be set that is useful for the balancing of the VAV Box. It is selectable if the fan performs a smooth start or a direct start. A series or parallel fan is usually operating with the maximum speed. The speed is not changed by the VAV control functions.

Both fan types are supported by an anti-backward rotation function. This shall avoid the fan start rotating backwards. This can happen sometimes if there is a primary air flow and the fan is not energized. In this case, the fan can rotate backward driven by the air flow. If the fan is energized in this situation, it can happen that the fan rotates backwards. To prevent this, the primary air damper is closed before the fan is energized. For more details, see chapter 7.5.14.3.

7.5.14.1 Series Fan

<u>General Function:</u>

The series fan is requested for operation in the following cases:

HVAC Mode in VAV is “AUTO” or “COOL” <u>and</u> *Effective Occupancy* is <u>not</u> “Unoccupied”.

It is also requested if the *HVAC Mode in VAV* is “HEAT”, or “MRNG_WRMUP”, or “NIGHT_PURGE”, or “PRE_COOL” independent of the *Effective Occupancy*.

The series fan is also requested if there is a heat request in the room from the space temperature heating controller. See *Fan Heat Sequence* in chapter 7.5.6.5 for more information. If there is no heat request the series fan is switched off with an adjustable time delay.

The series fan is also requested if there is a cool request in the room from the space temperature cooling controller, see *Cool Controller State* in chapter 7.5.6.4 for more information. If there is no cool request the series fan is switched off immediately.

The series fan is also requested, if the reheat actuator is requested in manual mode. If the reheat actuator is set back to auto mode, the series fan is switched off with an adjustable time delay.

If the series fan is requested by a condition described above (usually heating request) and the *HVAC Mode in VAV* is “OFF”, the primary air damper is locked and closed (see chapter 7.5.13.1 Damper Release for more details). This prevents that the fan sucks in cold air from the primary duct when the AHU is off. Since the damper is closed, the series fan only gets the warm plenum air and the heating function becomes more energy efficient.

The series fan display is shown on the *Status Overview* page of the *VAVstatus* visualization project as shown in Figure 325. Here the series fan command output is displayed.

Figure 325: Series fan tile in Status Overview

Output:

In the LIOB-AIR I/O Standard configuration the series fan output is located on the digital output *DO4* and the fan speed output is located on the analog output *AO3*. For more information see chapter *7.3.2 Device Configuration*.

Favorites:

The Favorite of the series fan is shown in Table 136.

Path: Favorites.VAVcontrol.SeriesFan

Favorite name	Description
outSeriesFanOnOff	Output value of the series fan to switch on or off
outSeriesFanSpeed	Output value of the series fan to modulate the fan speed

Table 136: Series fan Favorite

outSeriesFanOnOff:

This Favorite switches the series fan on and off. To this Favorite, the Local I/O *DO4* is connected (see I/O Standard configuration).

outSeriesFanSpeed:

This Favorite modulates the fan speed. To this Favorite, the Local I/O *AO3* is connected (see I/O Standard configuration).

Detailed Functions:

Depending on which fan speed type motor is equipped in the VAV Box (constant speed motor or ECM motor) the parameter *Fan Speed Type* has to be set. Depending on this setting, the according dialog is available on the *Fan Configuration* page of the *VAVstatus* visualization project.

Series fan with constant speed motor:

The series fan constant speed actuator can be watched, operated and parameterized on the *Fan Configuration* page of the *VAVstatus* visualization project as shown in Figure 326.

Figure 326: Series fan constant speed actuator configuration

Table 137 shows the series fan constant speed actuator present values.

Path: User Registers.VAVcontrol.SeriesFan.FanOffDelay

Name on tile	Data point name	Description
Fan Command	outSeriesFanOnOff	Displays the current output value to switch the fan on or off
HVAC Mode in VAV	HvacModeVAV	Displays the current HVAC mode of the VAV controller
Effective Occupancy	EffectiveOccupancy	Present value of the resulting Effective Occupancy state the VAV control is operating with
Heat Request Fan	HeatRequestFan	Displays the current heat request of the fan by the space temperature heating controller sequence
Cool Request Fan	CoolControlEnabled	Displays the current cool request of the fan by the space temperature cooling controller sequence
Manual Reheat Request	ReheatActiveMan	Displays if the reheat is in Manual Mode and active
Device Mode	VAVgroupDeviceMode	Indicates if the device is Master or Slave in a VAV Group

Table 137: Series fan constant speed actuator present values

Fan Command

Displays the command output that is put out to the fan actuator.

HVAC Mode in VAV:

The *HVAC Mode in VAV* coming from the AHU requests the series fan for operation:

AUTO:	series fan switched on, if *Effective Occupancy* not Unoccupied
HEAT:	series fan switched on
MRNG_WRMUP:	series fan switched on
COOL:	series fan switched on, if *Effective Occupancy* not Unoccupied
NIGHT_PURGE:	series fan switched on
PRE_COOL:	series fan switched on
OFF:	series fan switched on only if *Heat Request Fan* or *Cool Request Fan* is TRUE

Effective Occupancy:

In case the *HVAC Mode in VAV* is AUTO or Cool, the series fan will be switched off if the *Effective Occupancy* is Unoccupied. In all other cases of *HVAC Mode in VAV,* the Effective Occupancy has no effect to the series fan control.

Heat Request Fan:

This indicates if the fan is requested by the space temperature heating controller. If the space temperature heating controller output is greater than 1% the *Heat Request Fan* is set to TRUE. See *Fan Heat Sequence* in chapter 7.5.6.5 for more information. If the heating controller output decreases below 0,1% the *Heat Request Fan* is set to FALSE delayed with the *Off Delay Time*. This causes the delayed switching off the fan depending on the heating request. The *Heat Request Fan* switches on the series fan independent of the *HVAC Mode in VAV* or the *Effective Occupancy*.

Cool Request Fan:

This indicates if the fan is requested by the space temperature cooling controller. If the *Cool Controller State* is TRUE the *Cool Request Fan* also becomes TRUE 1:1. See chapter 7.5.6.4 for more details. The Cool Request Fan is not delayed by an on or off delay time. The *Cool Request Fan* switches on the series fan independent of the *HVAC Mode in VAV* or the *Effective Occupancy*.

Manual Reheat Request:

This indicates if the reheat actuator is switched on in manual mode for commissioning and maintenance purposes. In this case, the series fan is requested also to ensure the air flow to the reheat unit. If the reheat actuator is switched back to auto mode, the *Manual Reheat Request* is reset with the *Off Delay Time*. This causes a delayed switching off the fan.

Device Mode:

Indicates if the device is set as the “Master” or as a “Slave” in the “VAV-Group”. The fan control is operated locally in every device no matter if it is a “Master” or a “Slave”. However, to ensure the same behavior of all VAV Boxes in a “VAV-Group” the *Off Delay Time* is set on the “Master” and is sent to the “Slaves”. So all devices in the VAV-Group are operating with the same *Off Delay Time* value.

Table 138 shows the series fan constant speed actuator parameters.

Path: User Registers.VAVcontrol.SeriesFan

Name on tile	Data point name	Default	Description
Actuator Mode	AutoMan	Auto	Definition of the actuator mode Auto or Manual_Off or Manual_On
Fan Speed Type	FanSpeedType	Constant Speed	Definition of the motor type of the fan to be set during commissioning
Off Delay Time	OffDelayFan	300s	Definition of the time delay to switch off the fan in some cases

Table 138: Series fan constant speed actuator parameters

Actuator Mode:

This defines if the series actuator is controlled in “Auto” or “Manual_Off” or “Manual_On” mode. In “Auto” mode, the fan is requested by the HVAC Mode or by the controller heat request. In “Manual_Off”, the series fan is switched off permanently. In “Manual_On”, the series fan is switched on permanently. This is only meant for commissioning and maintenance purposes. A Manual Alarm will be triggered and a manual indicator is shown in the *VAVstatu*s visualization project.

Fan Speed Type:

This defines motor type of the fan. For constant speed motors, it has to be set to “Constant Speed”. For ECM motors, it has to be set to “Variable Speed”. The according fan controls functions are enabled internally. In case of “Variable Speed”, additional parameters are shown and adjustable on the tile. The setting of the *Fan Speed Type* has to be done once during commissioning and this is usually never changed later on. This parameter value is set individually in every device and it is not communicated in the VAV group.

Off Delay Time:

This defines the time delay the *Heat Request Fan* or the *Manual Reheat Request* is switched of and so a delayed switch off the series fan is realized in these cases. Please note that this parameter value can be set on the “Master” device of a VAV group. It is communicated to the “Slave” devices automatically. This makes sure that all the fans in the VAV group have identical off delay time values.

Series fan with variable speed motor (ECM):

The series fan variable speed actuator can be watched, operated and parameterized on the *Fan Configuration* page of the *VAVstatus* visualization project as shown in Figure 327.

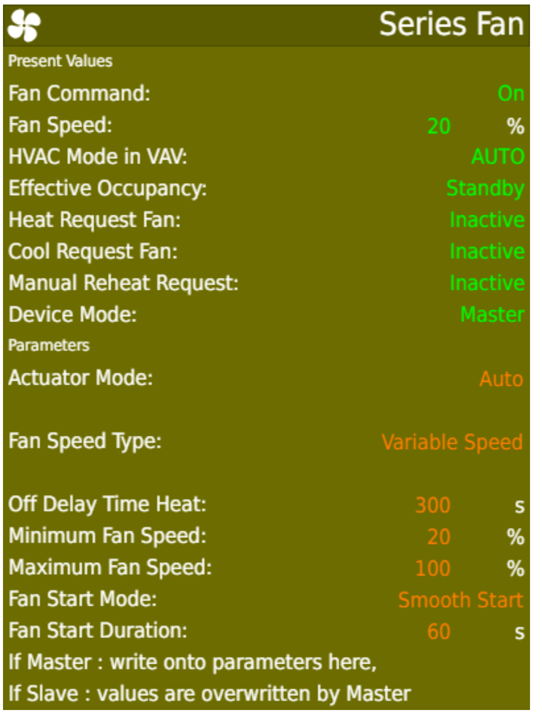

Figure 327: Series fan variable speed actuator configuration

Table 139 shows the series fan actuator present values.

Path: User Registers.VAVcontrol.SeriesFan.FanOffDelay

Name on tile	Data point name	Description
Fan Command	outSeriesFanOnOff	Displays the current output value to switch the fan on or off
Fan Speed	outSeriesFanSpeed	Displays the current output value to modulate the fan
HVAC Mode in VAV	HvacModeVAV	Displays the current HVAC mode of the VAV controller
Effective Occupancy	EffectiveOccupancy	Present value of the resulting Effective Occupancy state the VAV control is operating with
Heat Request Fan	HeatRequestFan	Displays the current heat request of the fan by the space temperature heating controller sequence
Cool Request Fan	CoolControlEnabled	Displays the current cool request of the fan by the space temperature cooling controller sequence

Name on tile	Data point name	Description
Manual Reheat Request	ReheatActiveMan	Displays if the reheat is in Manual Mode and active
Device Mode	VAVgroupDeviceMode	Indicates if the device is Master or Slave in a VAV Group

Table 139: Series fan variable speed actuator present values

Fan Command

Displays the digital command on off output that is put out to the fan actuator.

Fan Speed

Displays the analog command speed output that is put out to the fan actuator.

HVAC Mode in VAV:

The *HVAC Mode in VAV* coming from the AHU requests the series fan for operation:

AUTO: series fan switched on, if *Effective Occupancy* not Unoccupied

HEAT: series fan switched on

MRNG_WRMUP: series fan switched on

COOL: series fan switched on, if *Effective Occupancy* not Unoccupied

NIGHT_PURGE: series fan switched on

PRE_COOL: series fan switched on

OFF: series fan switched on only if *Heat Request Fan* or *Cool Request Fan* is TRUE

Effective Occupancy:

In case the *HVAC Mode in VAV* is AUTO or Cool, the series fan will be switched off if the *Effective Occupancy* is Unoccupied. In all other cases of *HVAC Mode in VAV,* the Effective Occupancy has no effect to the series fan control.

Heat Request Fan:

This indicates if the fan is requested by the space temperature heating controller. If the space temperature heating controller output is greater than 1% the *Heat Request Fan* is set to TRUE. See *Fan Heat Sequence* in chapter 7.5.6.5 for more information. If the heating controller output decreases below 0,1% the *Heat Request Fan* is set to FALSE delayed with the *Off Delay Time*. This causes the delayed switching off the fan depending on the heating request. The *Heat Request Fan* switches on the series fan independent of the *HVAC Mode in VAV* or the *Effective Occupancy*.

Cool Request Fan:

This indicates if the fan is requested by the space temperature cooling controller. If the *Cool Controller State* is TRUE, the *Cool Request Fan* also becomes TRUE 1:1. See chapter 7.5.6.4 for more details. The Cool Request Fan is not delayed by an on or off delay time. The *Cool Request Fan* switches on the series fan independent of the *HVAC Mode in VAV* or the *Effective Occupancy*.

Manual Reheat Request:

This indicates if the reheat actuator is switched on in manual mode for commissioning and maintenance purposes. In this case, the series fan is requested also to ensure the air flow to the reheat unit. If the reheat actuator is switched back to auto mode, the Manual Reheat Request is reset with the *Off Delay Time*. This causes a delayed switching off the fan.

Device Mode:

Indicates if the device is set as the “Master” or as a “Slave” in the “VAV-Group”. The fan control is operated locally in every device no matter if it is a “Master” or a “Slave”. But to ensure the same behavior of all VAV Boxes in a “VAV-Group” the parameter values e.g. *Off Delay Time* are set on the “Master” and are sent to the “Slaves”. So all devices in the VAV-Group are operating with the same parameter values.

Table 140 shows the series fan variable speed actuator parameters.

Path: User Registers.VAVcontrol.SeriesFan

Name on tile	Data point name	Default	Description
Actuator Mode	AutoMan	Auto	Definition of the actuator mode Auto or Manual_Off or Manual_Min or Manual_Max or Manual_Value
Manual Speed Value	ManualValue	0%	Definition of the manual fan speed setpoint, (only displayed in Manual_Value mode)
Fan Speed Type	FanSpeedType	Constant Speed	Definition of the motor type of the fan to be set during commissioning
Off Delay Time	OffDelayFan	300s	Definition of the time delay to switch off the fan in some cases
Minimum Fan Speed	MinFanSpeed	20%	Definition of the minimum fan speed if the fan is switched on
Maximum Fan Speed	MaxFanSpeed	100%	Definition of the maximum fan speed if the fan is switched on
Fan Start Mode	FanStartMode	Smooth Start	Definition of the start mode if the fan starts smoothly or directly
Fan Start Duration	StartDuration	60s	Definition of the start duration time if the fan starts smoothly

Table 140: Series fan variable speed actuator parameters

Actuator Mode:

This defines if the series actuator is controlled in “Auto” or “Manual_Off” or “Manual_Min” or “Manual_Max” or “Manual_Value” mode. In “Auto” mode, the fan is requested by the HVAC Mode or by the controller heat request. In “Manual_Off”, the *Fan Command* is switched off permanently and the *Fan Speed* is set to 0%. In “Manual_Min”, the *Fan Command* is switched on permanently and the *Fan Speed* is set to the *Minimum Fan Speed* value. In “Manual_Max”, the *Fan Command* is switched on permanently and the *Fan Speed* is set to the *Maximum Fan Speed* value. In “Manual_Value”, the *Fan Command* is switched on permanently and the *Fan Speed* is set to the *Manual Speed Value*. This is only meant for commissioning and maintenance purposes. A Manual Alarm will be triggered and a manual indicator is shown in the *VAVstatu*s visualization project.

Manual Speed Value:

This is only visible if the *Actuator Mode* is in “Manual_Value” mode. A manual value can be entered here and is forwarded to the *FanSpeed*. This is only meant for commissioning and maintenance purposes. A Manual Alarm will be triggered and a manual indicator is shown in the *VAVstatu*s visualization project.

Fan Speed Type:

This defines motor type of the fan. For constant speed motors, it has to be set to “Constant Speed”. For ECM motors, it has to be set to “Variable Speed”. The according fan controls functions are enabled internally. In case of “Variable Speed”, additional parameters are shown and adjustable on the tile. The setting of the *Fan Speed Type* has to be done once during commissioning and this is usually never changed later on. This parameter value is set individually in every device and it is not communicated in the VAV group.

Off Delay Time:

This defines the time delay the *Heat Request Fan* or the *Manual Reheat Request* are switched of and so a delayed switch off the series fan is realized in these cases. Please note that this parameter value can be set on the “Master” device of a VAV group. It is communicated to the “Slave” devices automatically. This makes sure that all the fans in the VAV group have identical off delay time values.

Minimum Fan Speed:

This defines the minimum speed the fan can operate. The Fan Speed will not decrease below this limit. If the *Fan Start Mode* is “Smooth Start”, the time ramp will start with this speed value. In case of a series fan speed modulation, maintaining supply air flow depending on the primary air flow this limit will also not be undershot. Please note that this parameter value can be set on the “Master” device of a VAV group. It is communicated to the “Slave” devices automatically. This makes sure that all the fans in the VAV group have identical values in this parameter.

Maximum Fan Speed:

This defines the maximum speed the fan can operate. The Fan Speed will not increase above this limit. Usually this is the speed the fan is operating all the time it is switched on. If the *Fan Start Mode* is “Smooth Start”, the time ramp will end with this speed value. In case of a series speed modulation maintaining supply air flow depending on the primary air flow, this limit will also not be exceeded. Please note that this parameter value can be set on the “Master” device of a VAV group. It is communicated to the “Slave” devices automatically. This makes sure that all the fans in the VAV group have identical values in this parameter.

Fan Start Mode:

This defines how the fan speed is operating when the *Fan Command* is switched on. On "Direct Start", the *Fan Speed* is set to the *Maximum Fan Speed* value immediately. On "Smooth Start" the *Fan Speed* is set to the *Minimum Fan Speed* value and the speed is increased smoothly to the *Maximum Fan Speed* value (or the speed value requested by a series fan speed control function) in the *Fan Start Duration* time interval. Please note that this parameter value can be set on the "Master" device of a VAV group. It is communicated to the "Slave" devices automatically. This makes sure that all the fans in the VAV group have identical values in this parameter.

Fan Start Duration:

This is only visible if the *Fan Start Mode* is in "Smooth Start" mode. This defines the time interval of the smooth start function. This is valid only if the *Fan Start Mode* is set to "Smooth Start". Please note that this parameter value can be set on the "Master" device of a VAV group. It is communicated to the "Slave" devices automatically. This makes sure that all the fans in the VAV group have identical values in this parameter.

7.5.14.2 Parallel Fan

General Function:

The parallel fan is requested for operation in the following cases:

In the HVAC Modes AUTO, or HEAT, or OFF the parallel fan is requested, if there is a heat request in the room from the space temperature heating controller. See *Fan Heat Sequence* in chapter 7.5.6.5 for more information. If there is no heat request the parallel fan is switched off with an adjustable time delay.

The parallel fan is also requested, if the reheat actuator is requested in manual mode. If the reheat actuator is set back to auto mode, the parallel fan is switched off with an adjustable time delay.

Note: The parallel Fan is not requested in the HVAC Mode MRNG_WRMUP to prevent mixing in cold plenum air to the warm discharge air.

If the parallel fan is requested by a condition described above (usually heating request) and the *HVAC Mode in VAV* is “OFF”, the primary air damper is locked and closed (see chapter 7.5.13.1 Damper Release for more details). This prevents that the fan blows plenum air into the primary duct when the AHU is off, which would cause a loss of heating energy.

The parallel fan display is shown on the *Status Overview* page of the *VAVstatus* visualization project as shown in Figure 328. Here the parallel fan command output is displayed.

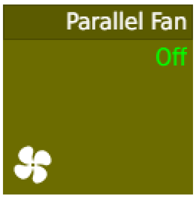

Figure 328: Parallel fan tile in Status Overview

Output:

In the LIOB-AIR I/O Standard configuration, the parallel fan output is located on the digital output *DO4* and the fan speed output is located on the analog output *AO3*. For more information see chapter *7.3.2 Device Configuration*.

Favorites:

The Favorite of the parallel fan is shown in Table 141.

Path: Favorites.VAVcontrol.ParallelFan

Favorite name	**Description**
outParallelFanOnOff	Output value of the parallel fan to switch on or off
outParallelFanSpeed	Output value of the parallel fan to modulate the fan speed

Table 141: Parallel fan Favorite

outParallelFanOnOff:

The parallel fan function has this one Favorite. To this Favorite, the Local I/O *DO4* is connected (see I/O Standard configuration).

outSeriesFanSpeed:

This Favorite modulates the fan speed. To this Favorite, the Local I/O *AO3* is connected (see I/O Standard configuration).

Detailed Functions:

Depending on which fan speed type motor is equipped in the VAV Box (constant speed motor or ECM motor) the parameter *Fan Speed Type* has to be set. Depending on this setting, the according dialog is available on the *Fan Configuration* page of the *VAVstatus* visualization project.

Parallel fan with constant speed motor:

The parallel fan constant speed actuator can be watched, operated and parameterized on the *Fan Configuration* page of the *VAVstatus* visualization project as shown in Figure 329.

Figure 329: Parallel fan constant speed actuator configuration

Table 142 shows the parallel fan constant speed actuator present values.

Path: User Registers.VAVcontrol.ParallelFan.FanOffDelay

Name on tile	Data point name	Description
Fan Command	outParallelFanOnOff	Displays the current output value to switch the fan on or off
HVAC Mode in VAV	HvacModeVAV	Displays the current HVAC mode of the VAV controller
Heat Request Fan	HeatRequestFan	Displays the current heat request of the fan by the space temperature heating controller sequence
Manual Reheat Request	ReheatActiveMan	Displays if the reheat is in Manual Mode and active
Device Mode	VAVgroupDeviceMode	Indicates if the device is Master or Slave in a VAV Group

Table 142: Parallel fan constant speed actuator present values

Fan Command

Displays the command output that is put out to the fan actuator.

HVAC Mode in VAV:

The *HVAC Mode in VAV* coming from the AHU requests the parallel fan for operation:

AUTO: parallel fan switched on only if *Heat Request Fan* is TRUE

HEAT: parallel fan switched on only if *Heat Request Fan* is TRUE

MRNG_WRMUP: parallel fan switched on

COOL: parallel fan switched off

NIGHT_PURGE: parallel fan switched off

PRE_COOL: parallel fan switched off

OFF: parallel fan switched on only if *Heat Request Fan* is TRUE

Heat Request Fan:

This indicates if the fan is requested by the space temperature heating controller. If the space temperature heating controller output is greater than 1% the *Heat Request Fan* is set to TRUE. See *Fan Heat Sequence* in chapter 7.5.6.5 for more information. This is only important in HVAC mode OFF. If the heating controller output decreases below 0,1% the *Heat Request Fan* is set to FALSE delayed with the *Off Delay Time*. This causes the delayed switching off the fan depending on the heating request.

Manual Reheat Request:

This indicates if the reheat actuator is switched on in manual mode for commissioning and maintenance purposes. In this case, the parallel fan is requested also to ensure the air flow to the reheat unit. If the reheat actuator is switched back to auto mode, the Manual Reheat Request is reset with the *Off Delay Time*. This causes a delayed switching off the fan.

Device Mode:

Indicates if the device is set as the “Master” or as a “Slave” in the “VAV-Group”. The fan control is operated locally in every device no matter if it is a „Master” or a “Slave”. However, to ensure the same behavior of all VAV Boxes in a “VAV-Group” the *Off Delay Time* is set on the “Master” and is sent to the “Slaves”. So all devices in the VAV-Group are operating with the same *Off Delay Time* value.

Table 143 shows the parallel fan constant speed actuator parameters.

Path: User Registers.VAVcontrol.ParallelFan.FanOffDelay

Name on tile	Data point name	Default	Description
Actuator Mode	AutoMan	Auto	Definition of the actuator mode Auto or Manual_Off or Manual_On
Fan Speed Type	FanSpeedType	Constant Speed	Definition of the motor type of the fan to be set during commissioning
Off Delay Time	OffDelayFan	300s	Definition of the time delay to switch off the fan in some cases

Table 143: Parallel fan constant speed actuator parameters

Actuator Mode:

This defines if the parallel actuator is controlled in “Auto” or “Manual_Off” or “Manual_On” mode. In “Auto” mode, the fan is requested by the HVAC Mode and by the controller heat request. In “Manual_Off”, the parallel fan is switched off permanently. In “Manual_On”, the parallel fan is switched on permanently. This is only meant for commissioning and maintenance purposes. A Manual Alarm will be triggered and a manual indicator is shown in the *VAVstatu*s visualization project.

Fan Speed Type:

This defines motor type of the fan. For constant speed motors, it has to be set to “Constant Speed”. For ECM motors, it has to be set to “Variable Speed”. The according fan controls functions are enabled internally. In case of “Variable Speed”, additional parameters are shown and adjustable on the tile. The setting of the *Fan Speed Type* has to be done once during commissioning and this is usually never changed later on. This parameter value is set individually in every device and it is not communicated in the VAV group.

Off Delay Time:

This defines the time delay the *Heat Request Fan* or the *Manual Reheat Request* are switched off and so a delayed switch off the parallel fan is realized in these cases. Please note that this parameter value can be set on the “Master” device of a VAV group. It is communicated to the “Slave” devices automatically. This makes sure that all the fans in the VAV group have identical off delay time values.

Parallel fan with variable speed motor:

The parallel fan variable speed actuator can be watched, operated and parameterized on the *Fan Configuration* page of the *VAVstatus* visualization project as shown in Figure 330.

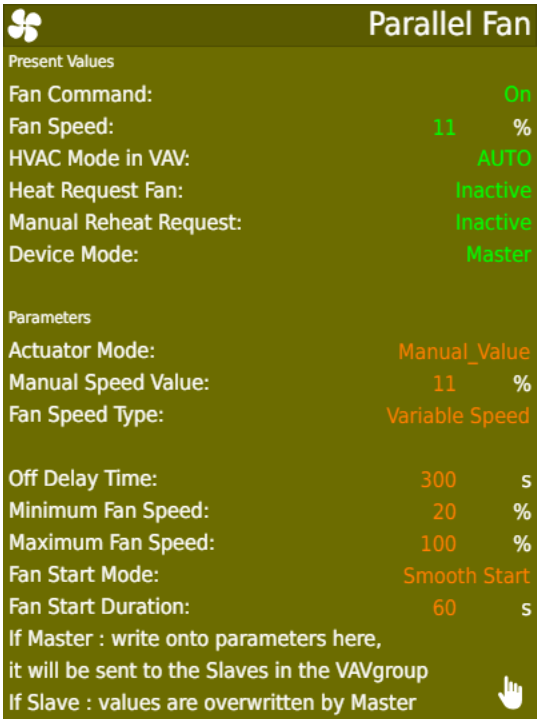

Figure 330: Parallel fan variable speed actuator configuration

Table 144 shows the parallel fan variable speed actuator present values.

Path: User Registers.VAVcontrol.ParallelFan.FanOffDelay

Name on tile	**Data point name**	**Description**
Fan Command	outParallelFanOnOff	Displays the current output value to switch the fan on or off
Fan Speed	outParallelFanSpeed	Displays the current output value to modulate the fan
HVAC Mode in VAV	HvacModeVAV	Displays the current HVAC mode of the VAV controller
Heat Request Fan	HeatRequestFan	Displays the current heat request of the fan by the space temperature heating controller sequence
Manual Reheat Request	ReheatActiveMan	Displays if the reheat is in Manual Mode and active
Device Mode	VAVgroupDeviceMode	Indicates if the device is Master or Slave in a VAV Group

Table 144: Parallel fan variable speed actuator present values

Fan Command

Displays the command output that is put out to the fan actuator.

Fan Speed

Displays the analog command speed output that is put out to the fan actuator.

HVAC Mode in VAV:

The *HVAC Mode in VAV* coming from the AHU requests the parallel fan for operation:

AUTO:	parallel fan switched on only if *Heat Request Fan* is TRUE
HEAT:	parallel fan switched on only if *Heat Request Fan* is TRUE
MRNG_WRMUP:	parallel fan switched on
COOL:	parallel fan switched off
NIGHT_PURGE:	parallel fan switched off
PRE_COOL:	parallel fan switched off
OFF:	parallel fan switched on only if *Heat Request Fan* is TRUE

Heat Request Fan:

This indicates if the fan is requested by the space temperature heating controller. If the space temperature heating controller output is greater than 1% the *Heat Request Fan* is set to TRUE. See *Fan Heat Sequence* in chapter 7.5.6.5 for more information. This is only important in HVAC mode OFF. If the heating controller output decreases below 0,1% the *Heat Request Fan* is set to FALSE delayed with the *Off Delay Time*. This causes the delayed switching off the fan depending on the heating request.

Manual Reheat Request:

This indicates if the reheat actuator is switched on in manual mode for commissioning and maintenance purposes. In this case, the parallel fan is requested also to ensure the air flow to the reheat unit. If the reheat actuator is switched back to auto mode, the Manual Reheat Request is reset with the *Off Delay Time*. This causes a delayed switching off the fan.

Device Mode:

Indicates if the device is set as the “Master” or as a “Slave” in the “VAV-Group”. The fan control is operated locally in every device no matter if it is a „Master” or a “Slave”. However, to ensure the same behavior of all VAV Boxes in a “VAV-Group” the *Off Delay Time* is set on the “Master” and is sent to the “Slaves”. So all devices in the VAV-Group are operating with the same *Off Delay Time* value.

Table 143 shows the parallel fan variable speed actuator parameters.

Path: User Registers.VAVcontrol.ParallelFan.FanOffDelay

Name on tile	**Data point name**	**Default**	**Description**
Actuator Mode	AutoMan	Auto	Definition of the actuator mode Auto or Manual_Off or Manual_On
Fan Speed Type	FanSpeedType	Constant Speed	Definition of the motor type of the fan to be set during commissioning
Fan Speed Type	FanSpeedType	Constant Speed	Definition of the motor type of the fan to be set during commissioning
Off Delay Time	OffDelayFan	300s	Definition of the time delay to switch off the fan in some cases
Minimum Fan Speed	MinFanSpeed	20%	Definition of the minimum fan speed if the fan is switched on
Maximum Fan Speed	MaxFanSpeed	100%	Definition of the maximum fan speed if the fan is switched on
Fan Start Mode	FanStartMode	Smooth Start	Definition of the start mode if the fan starts smoothly or directly
Fan Start Duration	StartDuration	60s	Definition of the start duration time if the fan starts smoothly

Table 145: Parallel fan variable speed actuator parameters

Actuator Mode:

This defines if the parallel actuator is controlled in “Auto” or “Manual_Off” or “Manual_Min” or “Manual_Max” or “Manual_Value” mode. In “Auto” mode, the fan is requested by the HVAC Mode or by the controller heat request. In “Manual_Off”, the *Fan Command* is switched off permanently and the *Fan Speed* is set to 0%. In “Manual_Min”, the *Fan Command* is switched on permanently and the *Fan Speed* is set to the *Minimum Fan Speed* value. In “Manual_Max”, the *Fan Command* is switched on permanently and the *Fan Speed* is set to the *Maximum Fan Speed* value. In “Manual_Value”, the *Fan Command* is switched on permanently and the *Fan Speed* is set to the *Manual Speed Value*. This is only meant for commissioning and maintenance purposes. A Manual Alarm will be triggered and a manual indicator is shown in the *VAVstatu*s visualization project.

Manual Speed Value:

This is only visible if the *Actuator Mode* is in “Manual_Value” mode. A manual value can be entered here and is forwarded to the *FanSpeed*. This is only meant for commissioning and maintenance purposes. A Manual Alarm will be triggered and a manual indicator is shown in the *VAVstatu*s visualization project.

Fan Speed Type:

This defines motor type of the fan. For constant speed motors, it has to be set to “Constant Speed”. For ECM motors, it has to be set to “Variable Speed”. The according fan controls functions are enabled internally. In case of “Variable Speed”, additional parameters are shown and adjustable on the tile. The setting of the *Fan Speed Type* has to be done once during commissioning and this is usually never changed later on. This parameter value is set individually in every device and it is not communicated in the VAV group.

Off Delay Time:

This defines the time delay the *Heat Request Fan* or the *Manual Reheat Request* are switched off and so a delayed switch off the parallel fan is realized in these cases. Please note that this parameter value can be set on the “Master” device of a VAV group. It is communicated to the “Slave” devices automatically. This makes sure that all the fans in the VAV group have identical off delay time values.

Minimum Fan Speed:

This defines the minimum speed the fan can operate. The Fan Speed will not decrease below this limit. If the *Fan Start Mode* is “Smooth Start”, the time ramp will start with this speed value. In case of a series fan speed modulation maintaining supply air flow depending on the primary air flow, this limit will also not be undershot. Please note that this parameter value can be set on the “Master” device of a VAV group. It is communicated to the “Slave” devices automatically. This makes sure that all the fans in the VAV group have identical values in this parameter.

Maximum Fan Speed:

This defines the maximum speed the fan can operate. The Fan Speed will not increase above this limit. Usually this is the speed the fan is operating all the time it is switched on. If the *Fan Start Mode* is “Smooth Start”, the time ramp will end with this speed value. Please note that this parameter value can be set on the “Master” device of a VAV group. It is communicated to the “Slave” devices automatically. This makes sure that all the fans in the VAV group have identical values in this parameter.

Fan Start Mode:

This defines how the fan speed is operating when the *Fan Command* is switched on. On “Direct Start”, the *Fan Speed* is set to the *Maximum Fan Speed* value immediately. On “Smooth Start” the *Fan Speed* is set to the *Minimum Fan Speed* value and the speed is increased smoothly to the *Maximum Fan Speed* value (or the speed value requested by a series fan speed control function) in the *Fan Start Duration* time interval. Please note that this parameter value can be set on the “Master” device of a VAV group. It is communicated to the “Slave” devices automatically. This makes sure that all the fans in the VAV group have identical values in this parameter.

Fan Start Duration:

This is only visible if the *Fan Start Mode* is in “Smooth Start” mode. This defines the time interval of the smooth start function. This is valid only if the *Fan Start Mode* is set to “Smooth Start”. Please note that this parameter value can be set on the “Master” device of a VAV group. It is communicated to the “Slave” devices automatically. This makes sure that all the fans in the VAV group have identical values in this parameter.

7.5.14.3 Anti-backward rotation start function

General Function:

The series fan and the parallel fan types are supported by an anti-backward rotation function. This shall avoid the fan start rotating backwards.

This can happen e.g. on series fans with forward curved blower if there is a primary air flow in the VAV Box and the fan is not energized. In this case, the fan can spin backward driven by the air flow. This also can happen e.g. on parallel fans if there is no backdraft damper covering the parallel fan port and there is primary air flow in the VAV Box. If the fan is energized in this situation, it can happen that the fan motor runs backwards.

To prevent this malfunction, the primary air damper is locked and closed (see chapter 7.5.13.1 Damper Release for more details) and the flow setpoint is set to a zero value before the fan is energized for an adjustable time. This cuts off the primary air flow in the VAV Box and the not energized fan stops spinning backward. The fan is energized and the damper is put to normal control after the time has expired. This causes the fan motor to rotate in the forward direction.

During the anti-backward rotation start function is currently active the fan is switched off and the damper is closed to 0%. This is indicated by a flashing "Starting" on the series or parallel fan display is shown on the *Status Overview* page of the *VAVstatus* visualization project as shown in Figure 331.

Figure 331: Fan tile shows "Starting" in Status Overview

The anti-backward rotation start function for series and parallel fan types can be watched, operated and parameterized on the *Fan Configuration* page of the *VAVstatus* visualization project as shown in Figure 332.

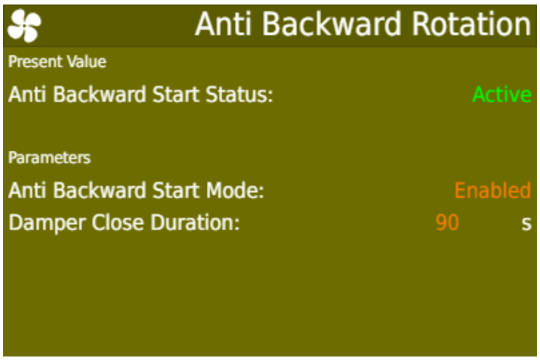

Figure 332: Anti-backward rotation start function configuration

Table 146 shows the anti-backward rotation start function present values.

Path: User Registers.VAVcontrol.SeriesFan***)**

Name on tile	**Data point name**	**Description**
Anti Backward Start Status	AntiBackwardStartStatus	Displays the current state of the anti-backward rotation start function

Table 146: Anti-backward rotation start function present values

***)**: Please note that the data point path is depending on the fan actuator type:

Series Fan Path: User Registers.VAVcontrol.SeriesFan

Parallel Fan Path: User Registers.VAVcontrol.ParallelFan

Anti Backward Start Status:

This displays the current state of the anti-backward rotation start function. If the function is currently “Active”, it is displayed flashing. The damper is closed to 0% and the fan stays switched off. If the function is currently “Inactive”, the damper is released for the normal control functions and the fan is switched on or off depending on the fan request.

Table 147 shows the anti-backward rotation start function parameters.

Path: User Registers.VAVcontrol.SeriesFan.FanAntiBackwardRotation***)**

Name on tile	**Data point name**	**Default**	**Description**
Anti Backward Start Mode	AntiBackRotation Mode	Disabled	Definition if the anti-backward rotation start mode is basically enabled or not
Damper Close Duration	DamperCloseDur ation	90s	Definition of the time duration the damper is closed if the anti-backward rotation start status is active

Table 147: Anti-backward rotation start function parameters

***)**: Please note that the data point path is depending on the fan actuator type:

Series Fan Path: *.SeriesFan.FanAntiBackwardRotation

Parallel Fan Path: *.ParallelFan.FanAntiBackwardRotation

Anti Backward Start Mode:

This defines if the anti-backward rotation start function is basically enabled or disabled. If enabled and the fan gets requested for operation the damper is closed to 0% and the flow setpoint is set to a zero value for the “*Damper Close Duration* time. When the time is expired, the damper is released for the normal control function and the flow setpoint is released to the normal value and the fan is switched on. If disabled and the fan gets requested for operation, the fan is switched on immediately and the damper continues with its normal control function. Please note that the Anti Backward Start Mode should be enabled only in case of the risk the fan could start rotating backward. This has to be decided in the commissioning phase of the project. If there are multiple VAV Boxes in a room, they can have different sizes or different fan actuators. For that reason, this parameter is not communicated in the VAV Group and can be set individually in every VAV box.

Damper Close Duration:

This defines the duration of the anti-backward rotation start function interval. This is the time the damper is set to close to 0%, the flow setpoint is set to a zero value and the fan stays switched off. If there are multiple VAV Boxes in a room, they can have different sizes or different fan actuators. For that reason, this parameter is not communicated in the VAV Group and can be set individually in every VAV box.

7.5.15 Reheat Actuators

According to chapter *7.3.1 Application Structure* the reheat is an actuator function. There are multiple types of reheat actuators available: Hot water modulating reheat (VAVreheatHwMod), Hot water floating reheat (VAVreheatHwFloat), electric modulating reheat (VAVreheatElMod), electric 3 stage reheat (VAVreheatEl3St), heat function with primary air without reheat (VAVnoReheat). If one of the reheat actuator functions is connected to the core, the reheat actuator function and the heat lockout function are enabled in the core application. Further, the space temperature heating control function is enabled in the core application additionally. It consists of the parts heating setpoints heating control, heat sequences and heat alarm. See chapters 7.5.6.4 and 7.5.6.5 for more information about space temperature control and the sequences.

The reheat actuator function gets the output signal from the space temperature heating sequence as the setpoint of valve position or as the setpoint for the electric heating power percentage. (In case of a discharge temperature sensor function is connected to the core this setpoint is coming from the discharge temperature controller output.) This setpoint is put out (analog output) to the reheat actuator that drives the reheat valve or the reheat power controller (e.g. thyristor). Or the setpoint is recalculated with an internal position controller to drive digital outputs for a floating valve actuator. In case of a 3 stage, electric reheat the setpoint is recalculated in a 3 stages control with digital and/or analog outputs.

To ensure that the heating energy is transmitted to the room and to protect the reheat from damage, the reheat function is released only if there is sufficient air flow detected in the VAV-Box. This minimum air flow detection and reheat flow release function is only implemented for the electric reheat types. In case of hot water reheat, there is no flow release function needed. If the current air flow is lower than the *Min.Alarm Limit* of the *Air Flow Alarm* function (see chapter 7.5.5.4) then the reheat is blocked for operation by the air flow. This block function uses a dedicated adjustable time delay. If the current air flow is greater than the *Min.Alarm Limit* of the *Air Flow Alarm* function, then the reheat is released for operation by the air flow. If a series or parallel fan is running actually, the reheat is released for operation, even if there is no or less primary air flow.

For commissioning and maintenance purposes, the reheat actuator function allows a manual mode to override the reheat setpoint manually. In case there is a manual request of the reheat, a series or parallel fan will be switched on to ensure a sufficient air flow to the reheat. However, the manual request is put out to the reheat actuator anyway.

The Heat Sequence function and the Heat Lockout function are implemented in all reheat actuator types (except VAVnoReheat) and are described in the following:

<u>Heat Sequence:</u>

As described in chapter 7.5.6.5 the control output of the space temperature heating controller is forwarded to multiple sequences. The Air Flow Heat Sequence calculates the *Setpoint Air Flow Heating*. The Reheat/Periph. Sequence calculates the control outputs for the reheat or the discharge air temp. setpoint and the control output for the peripheral heat. The Fan Heat Sequence calculates the fan request.

The parameterization of the Air Flow Heat Sequence and the Reheat/Periph. Sequence has to be done on the *Heat Sequence Parameters* page of the *VAVstatu*s visualization project as shown in Figure 333. Please note that this is the only place to modify these parameter values. On all other pages and tiles as shown in chapter 7.5.6.5 these parameter values only can be watched but not be modified.

These Heat Sequence parameters described below are valid for all types of reheat.

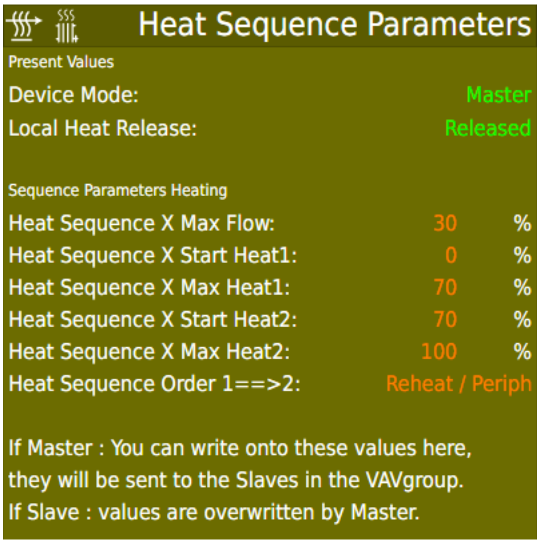

Figure 333: Heat sequence parameters

The Air Flow Heat Sequence calculates the *Setpoint Air Flow Heating*. This is described in chapter 7.5.6.5 and displayed in Figure 235 and Figure 236. Please refer to this chapter for detailed information. The important parameter for the Air Flow Heat Sequence is *Heat Sequence X Max Flow*.

All the other parameters are important for the *Reheat/ Periph. Sequence.*

The *Reheat/ Periph. Sequence* calculates the *Reheat Control Output* and the *Peripheral Heat Control Output* in case there is no discharge air temperature sensor function connected to the core, see Figure 237 in chapter 7.5.6.5.

The *Reheat/ Periph. Sequence* calculates the *Setpoint Discharge Temp.* and the *Peripheral Heat Control Output* in case there is a discharge air temperature sensor function connected to the core, see Figure 238 in chapter 7.5.6.5.

If there are multiple LIOB-AIR devices in a room, they have to be parameterized as a "VAV Group" to be able to operate a proper room control. One device in the group has to be set as the "Master". As described in chapter 7.5.6.5 the space temperature control is operated in a "Master" device. If devices are configured as "Slaves", they only perform the Air Flow Heat Sequence and the *Reheat/ Periph. Sequence.* The "Master" sends out the space temperature heat control output and the sequence parameters to the "Slaves" as well. This ensures that all the sequences of all VAV-Boxes in a room are operating with the same parameter values. Therefore, the parameterization of the *Heat Sequence Parameters* has only to be done on the "Master" device.

Table 148 shows the heat sequence actuator present values.

Path: User Registers.VAVcontrol.ReheatHwMod.HeatSequence***)**

Name on tile	**Data point name**	**Description**
Device Mode	VAVgroupDeviceMode	Indicates if the device is Master or Slave in a VAV Group
Local Heat Release	LocalHeatRelease	Indicates if local heat with reheat and periph. heat is released actually

Table 148: Heat sequence present values

***)**: Please note that the data point path for heating is depending on the connected reheat actuator using different folder names:

Hot Water Reheat, modulating	folder name: ReheatHwMod
Hot Water Reheat, floating	folder name: ReheatHwFloat
Electric Reheat, modulating	folder name: ReheatElMod
Electric Reheat, 3 stages	folder name: ReheatEl3St
No Reheat, but heat control	folder name: NoReheat

Device Mode:

Indicates if the device is set as the “Master” or as a “Slave” in the “VAV-Group”. Only the Master is executing the space temperature control and it sends the *Heat Control Output* to the “Slaves”. The “Slaves” do not execute any space temperature control but they receive the *Heat Control Output* from the “Master” and are operating the *Reheat/ Periph. Sequence* to calculate the *Reheat Control Output* or the *Setpoint Discharge Temp.* and the *Peripheral Heat Control Output*. The “Slaves” are operating the *Air Flow Heat Sequence* based the *Heat Control Output* from the “Master” as well to reset the air flow setpoint accordingly.

These sequence parameters are also sent from the “Master” to the “Slaves” and so they only have to be set in the “Master”: *Heat Sequence X Max Flow*, *Heat Sequence X Start Heat1*, *Heat Sequence X Max Heat1*, *Heat Sequence X Start Heat2*, *Heat Sequence X Max Heat2*, *Heat Sequence Order 1==>2*, *Min.Discharge Temp.Setpt.*, *Max.Discharge Temp.Setpt.* This ensures that all *Air Flow Heat Sequences Reheat/ Periph. Sequences* have the same values and are operating in parallel.

Local Heat Release:

This indicates if the local heat is released actually. If the local heat is released the current control output of the space temperature heating controller 0…100% is forwarded to the *Reheat/ Periph. Sequence*. If the local heat is prohibited a constant value of 0% is forwarded to the *Reheat/ Periph. Sequence*. This causes 0% of *Reheat Control Output* or deactivates the *Discharge Temp.* controller and causes 0% of *Peripheral Heat Control Output* as well. The *Local Heat Release* is important in the *HVAC Mode* MRNG_WRMUP only. It can be parameterized on *Local Heat Control in WARMUP* (*HVAC Mode Control Status*, see chapter 7.5.11) if local heat will be released during MRNG_WRMUP or not.

Table 149 shows the heat sequence parameters.

Path: User Registers.VAVcontrol.ReheatHwMod.HeatSequence***)**

Name on tile	**Data point name**	**Default**	**Description**
Heat Sequence X Max Flow	HeatSequenceXmaxFlow	30%	Definition of the HeatSequenceXmaxFlow
Heat Sequence X Start Heat1	HeatSequenceXstartHeat1	0%	Definition of the Heat Sequence X Max Heat1, first sequence
Heat Sequence X Max Heat1	HeatSequenceXmaxHeat1	70%	Definition of the Heat Sequence X Max Heat1, first sequence

Name on tile	Data point name	Default	Description
Heat Sequence X Start Heat2	HeatSequenceXstartHeat2	70%	Definition of the Heat Sequence X Max Heat2, second sequence
Heat Sequence X Max Heat2	HeatSequenceXmaxHeat2	100%	Definition of the Heat Sequence X Max Heat2, second sequence
Heat Sequence Order 1==>2	HeatSequenceOrder	Reheat/ Periph	Definition of the Heat Sequence Order 1==>2

Table 149: Heat sequence parameters

***)**: Please note that the data point path for heating is depending on the connected reheat actuator using different folder names:

Hot Water Reheat, modulating folder name: ReheatHwMod

Hot Water Reheat, floating folder name: ReheatHwFloat

Electric Reheat, modulating folder name: ReheatElMod

Electric Reheat, 3 stages folder name: ReheatEl3St

No Reheat, but heat control folder name: NoReheat

Heat Sequence X Max Flow:

This defines the current *Heat Sequence X Max Flow.* That is the value of the *Heat Controller Output* where the linear curve function of the *Air Flow Heat Sequence* reaches *Max. Air Flow Heat* for the *Setpoint Air Flow Heating* as the output. See Figure 235 in chapter 7.5.6.5 for more information.

Heat Sequence X Start Heat1:

This value defines on which value of the *Heat Control Output* the first heating sequence output starts increasing by the linear curve. What actuator (reheat/discharge or periph. heat) is applied to the first sequence is defined by the *Heat Sequence Order 1==>2.* See Figure 237 and Figure 238 in chapter 7.5.6.5 for more information.

Heat Sequence X Max Heat1:

This value defines on which value of the *Heat Control Output* the first heating sequence output reaches the maximum value by the linear curve. What actuator (reheat/discharge or periph. heat) is applied to the first sequence is defined by the *Heat Sequence Order 1==>2.* See Figure 237 and Figure 238 in chapter 7.5.6.5 for more information.

Heat Sequence X Start Heat2:

This value defines on which value of the *Heat Control Output* the first heating sequence output starts increasing by the linear curve. What actuator (reheat/discharge or periph. heat) is applied to the second sequence is defined by the *Heat Sequence Order 1==>2.* See Figure 237 and Figure 238 in chapter 7.5.6.5 for more information.

Heat Sequence X Max Heat2:

This value defines on which value of the *Heat Control Output* the first heating sequence output reaches the maximum value by the linear curve. What actuator (reheat/discharge or periph. heat) is applied to the second sequence is defined by the *Heat Sequence Order 1==>2*. See Figure 237 and Figure 238 in chapter 7.5.6.5 for more information.

Heat Sequence Order 1 ==>2:

This value defines which actuator (reheat/discharge or periph. heat) is applied to the first and the second sequence. See Figure 237 and Figure 238 in chapter 7.5.6.5 for more information.

Heat Lockout:

In summertime on higher outdoor temperatures, the heat lockout function locks the reheat and peripheral heat actuators and the space temperature heating controller, because there is usually no primary hot water heating energy available. This prevents the room from overcooling or it saves electrical energy.

If there are multiple LIOB-AIR devices in a room, they have to be parameterized as a “VAV Group” to be able to operate a proper room control. One device in the group has to be set as the “Master”. The heat lockout function is performed in every device, no matter if it is a “Master” or a “Slave”. The limit the outdoor temperature must exceed the *Reheat Lockout Outdoor Temp.>* limit to trigger the heat lockout function. This can be parameterized in the “Master” device and is transmitted to the “Slaves” automatically.

The heat lockout can be watched, operated and parameterized on the *Heat Lockout* page of the *VAVstatus* visualization project as shown in Figure 334.

Figure 334: Heat lockout configuration

Table 150 shows the het lockout present values.

Path: User Registers.VAVcontrol.ReheatHwMod.HeatSequence***)**

Name on tile	**Data point name**	**Description**
Device Mode	VAVgroupDeviceMode	Indicates if the device is Master or Slave in a VAV Group
Outdoor Temperature	OutdoorTemperature	Displays the current outdoor temperature
Heat Lockout State	HeatLockoutState	Displays the current heat lockout state

Table 150: Heat lockout present values

***)**: Please note that the data point path for heating is depending on the connected reheat actuator using different folder names:

Hot Water Reheat, modulating folder name: ReheatHwMod

Hot Water Reheat, floating folder name: ReheatHwFloat

Electric Reheat, modulating folder name: ReheatElMod

Electric Reheat, 3 stages folder name: ReheatEl3St

No Reheat, but heat control folder name: NoReheat

Device Mode:

Indicates if the device is set as the “Master” or as a “Slave” in the “VAV-Group”. All devices are executing the heat lockout function no matter if they are “Master” or “Slaves”. However, the parameter value *Reheat Lockout Outdoor Temp.*> has to be set in the “Master” only and is transmitted to the “Slaves” automatically. So all VAV-Boxes in a room are operating with the same heat lockout limit.

Outdoor Temperature:

This displays the current *Outdoor Temperature* the heat lockout function is using for operation. Usually this is communicated by the manager.

Heat Lockout State:

This displays the current heat lockout state. It is calculated as follows. The *Heat Lockout State* becomes “Active” if the *Outdoor Temperature* exceeds above *Reheat Outdoor Temp.*>. The *Heat Lockout State* is reset to “Inactive” if the *Outdoor Temperature* decreases below (*Reheat Outdoor Temp.*> - (*Reheat Outdoor Temp.*>* *0,05)*). So a fixed hysteresis of 5% is realized.

Table 151 shows the heat lockout parameters.

Path: User Registers.VAVcontrol.ReheatHwMod.HeatSequence***)**

Name on tile	**Data point name**	**Default**	**Description**
Reheat Lockout Outdoor Temp.>	HeatLockoutTempReheat	18°C 64,4°F	Definition of the outdoor temperature limit to trigger heat lockout

Table 151: heat lockout parameters

***)**: Please note that the data point path for heating is depending on the connected reheat actuator using different folder names:

Hot Water Reheat, modulating folder name: ReheatHwMod

Hot Water Reheat, floating folder name: ReheatHwFloat

Electric Reheat, modulating folder name: ReheatElMod

Electric Reheat, 3 stages folder name: ReheatEl3St

No Reheat, but heat control folder name: NoReheat

Reheat Lockout Outdoor Temp.>:

This defines the limit value the outdoor temperature must exceed to set the Heat Lockout State to “Active”. It is reset with a fixed 5% hysteresis value. This limit value is transmitted from the “Master” to the “Slaves” automatically.

7.5.15.1 Hot Water Modulating Reheat

General Function:

This reheat type is supplied with hot water heating energy. The actuator is a valve to control the hot water flow to the reheat coil. The modulating valve actuator is led by an analog signal that is connected to a local output of the LIOB-AIR device. The valve is moved by the modulating valve actuator to the requested position by an internal position controller.

The reheat display is shown on the *Status Overview* page of the *VAVstatus* visualization project as shown in Figure 335. Here the *Reheat Output* (position setpoint) is displayed.

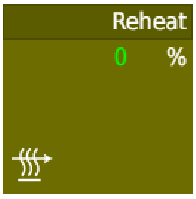

Figure 335: Hot water modulating reheat tile in Status Overview

Output:

In the LIOB-AIR I/O Standard configuration the hot water modulating reheat output is located on the analog output *AO1*. For more information see chapter *7.3.2 Device Configuration*.

Favorites:

The Favorite of a hot water modulating reheat is shown in Table 152.

Path: Favorites.VAVcontrol.ReheatHwMod

Favorite name	**Description**
outReheatHotWaterMod	Output value of modulating valve position setpoint

Table 152: Hot water modulating reheat Favorite

outReheatHwMod:

The hot water modulating reheat actuator function has this one Favorite. To this Favorite, the Local I/O *AO1* is connected (see I/O Standard configuration).

Detailed Functions:

The hot water modulating reheat actuator can be watched, operated and parameterized on the *Reheat Configuration* page of the *VAVstatus* visualization project as shown in Figure 336.

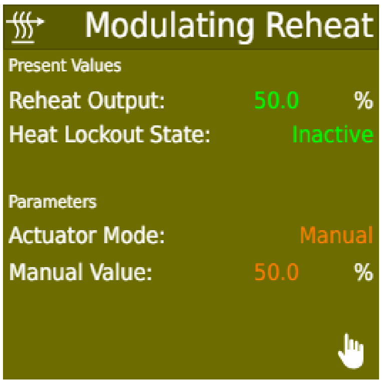

Figure 336: The hot water modulating reheat actuator configuration

Table 153 shows the hot water modulating reheat actuator present values.

Path: User Registers.VAVcontrol.ReheatHwMod

Name on tile	Data point name	Description
Reheat Output	outReheatHotWaterMod	Displays the current setpoint output of the valve position
Heat Lockout State	HeatLockoutState	Displays the current heat lockout state

Table 153: Hot water modulating reheat actuator present values

Reheat Output:

Displays the current position setpoint that is put out to the reheat actuator. The reheat actuator is moving the valve to this position by the internal position controller.

Heat Lockout State:

Displays the current state of the heat lockout function depending on the outdoor temperature, see description above in chapter 7.5.15. If the Heat Lockout state is “Inactive”, the reheat actuator function is released for operation. If the Heat Lockout state is “Active”, the reheat actuator function is not released for operation.

Table 154 shows the hot water modulating reheat actuator parameters.

Path: User Registers.VAVcontrol.ReheatHwMod

Name on tile	Data point name	Default	Description
Actuator Mode	AutoMan	Auto	Definition of the actuator mode Auto or Manual
Manual Value	ManualValue	0%	Definition of the manual valve position setpoint, (only displayed in Manual mode)

Table 154: Hot water modulating reheat actuator parameters

Actuator Mode:

This defines if the reheat actuator is controlled in “Auto” or “Manual” mode. In “Auto” mode, it gets the valve position setpoint *Reheat Output* from the space temperature heating sequence or the discharge temp. controller. In “Manual” mode, the *Reheat Output* is set to the *Manual Value*.

Manual Value:

This is only visible if the *Actuator Mode* is in “Manual” mode. A manual value can be entered here and is forwarded to the *ReheatOutput*. This is only meant for commissioning and maintenance purposes. A Manual Alarm will be triggered and a manual indicator is shown in the *VAVstatu*s visualization project.

7.5.15.2 Hot Water Floating Reheat

General Function:

This reheat type is supplied with hot water heating energy. The actuator is a valve to control the hot water flow to the reheat coil. The floating valve actuator lead by two binary signals (close and open) that are connected to two local digital outputs of the LIOB-AIR device. The valve is moved by the floating valve actuator.

Because the floating reheat actuator function does not operate a position feedback, it is calculating the current valve position internally, based on the parameterized runtime values. The floating position control operates the binary open and close commands depending on the calculated current valve position in a 3-point function “close / stop / open”. If the calculated position is below the position setpoint coming from the VAV control the floating position control triggers the “open” command. When the calculated position reaches the position setpoint, the “open” command is reset. If the calculated position is above the position setpoint coming from the VAV control the floating position control triggers the “close” command. When the calculated position reaches the position setpoint, the “close” command is reset. Therefore, when the calculated position matches the position setpoint both outputs “open” and “close” are reset and the actuator “stops” moving.

Therefore, the valve runtime values have to be detected and parameterized properly during the commissioning phase to allow a proper calculation of the valve position. Because some actuators are driving with different speed on the open and close directions there are dedicated parameters available.

Of course, the calculated valve position is only an approximation. For that reason, the floating reheat actuator function performs synchronization every time the valve is driven to a 0% or 100% setpoint from the VAV control. It can be parameterized if the synchronization sets the “close” or “open” command permanently or for the double duration of the valve close or open runtime.

The reheat display is shown on the *Status Overview* page of the *VAVstatus* visualization project as shown in Figure 337. Here the calculated reheat valve position and the floating commands “close = ↓” and open = ↑” are displayed.

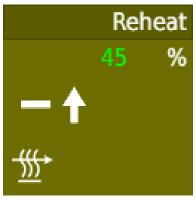

Figure 337: Hot water floating reheat tile in Status Overview

Output:

In the LIOB-AIR I/O Standard configuration the floating reheat output close is located on digital output *DO5* and open is located on digital output *DO6*. For more information see chapter *7.3.2 Device Configuration*.

If the valve actuator needs to operate in an inverse direction, it has to be set up on the valve actuator device if possible. Please refer to the regarding manufacturer documentation.

Favorites:

The Favorites of a floating reheat are shown in Table 155.

Path: Favorites.VAVcontrol.ReheatHwFloat

Favorite name	**Description**
outReheatHotWaterClose	Output value of floating reheat command “close”
outReheatHotWaterOpen	Output value of floating reheat command “open”

Table 155: Floating Reheat Favorites

outReheatHotWaterClose:

This is the Favorite of the floating reheat “close” command. To this Favorite, the Local I/O *DO5* is connected (see I/O Standard configuration).

outReheatHotWaterOpen:

This is the Favorite of the floating damper “open” command. To this Favorite, the Local I/O *DO6* is connected (see I/O Standard configuration).

Detailed Functions:

The hot water floating reheat actuator can be watched, operated and parameterized on the *Reheat Configuration* page of the *VAVstatus* visualization project as shown in Figure 338.

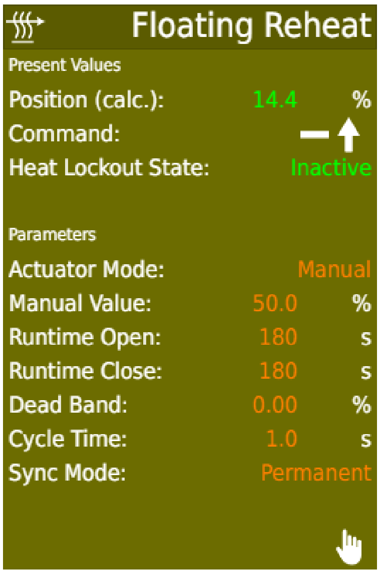

Figure 338: The hot water floating reheat actuator configuration

Path: User Registers.VAVcontrol.ReheatHwFloat

Name on tile	**Data point name**	**Description**
Position (calc.)	CalcPosition	Displays the current calculated valve position
Command	outReheatHotWaterClose outReheatHotWaterOpen	Displays the current state of the "close = ↓" and "open = ↑" commands, "stop = --"
Heat Lockout State	HeatLockoutState	Displays the current heat lockout state

Table 156: Hot water floating reheat actuator present values

Position (calc.):

Displays the current calculated reheat valve position depending on the active duration of the "close" and "open" commands and the *Runtime Open* and *Runtime Close* parameter values.

Command:

Displays the current state of the floating reheat commands. It indicates if the valve actuator is set to move the valve to the "close = ↓" or "open = ↑" direction or if it "stops = --" moving.

Heat Lockout State:

Displays the current state of the heat lockout function depending on the outdoor temperature, see description above in chapter 7.5.15. If the Heat Lockout state is "Inactive", the reheat actuator function is released for operation. If the Heat Lockout state is "Active", the reheat actuator function is <u>not</u> released for operation.

Table 157 shows the hot water floating reheat actuator parameters.

Path: User Registers.VAVcontrol.ReheatHwFloat

Name on tile	Data point name	Default	Description
Actuator Mode	AutoMan	Auto	Definition of the actuator mode Auto or Manual
Manual Value	ManualValue	0%	Definition of the manual valve position setpoint, (only displayed in Manual mode)
Runtime Open	RuntimeOpen	180s	Definition of the runtime the valve needs to open completely 100% starting from the close position 0%
Runtime Close	RuntimeClose	180s	Definition of the runtime the valve needs to close completely 0% starting from the open position 100%
Dead Band	DeadBand	0%	Definition of the dead band of the valve position controller
Cycle Time	CycleTime	1s	Definition of the cycle time of the valve position calculation
Sync Mode	PositionSynchrMode	Permanent	Definition of the synchronization mode of the valve position calculation

Table 157: Hot water floating reheat actuator parameters

Actuator Mode:

This defines if the reheat actuator is controlled in “Auto” or “Manual” mode. In “Auto” mode, it gets the valve position setpoint *Reheat Output* from the space temperature heating sequence or the discharge temp. controller. In “Manual” mode, the *Reheat Output* is set to the *Manual Value*.

Manual Value:

This is only visible if the *Actuator Mode* is in “Manual” mode. A manual value can be entered here and is forwarded to the *ReheatOutput*. This is only meant for commissioning and maintenance purposes. A Manual Alarm will be triggered and a manual indicator is shown in the *VAVstatu*s visualization project.

Runtime Open:

This defines the time duration the actuator drives from the close position (0%) to the full open position (100%) of the connected valve. This value has to be detected and parameterized during the system commissioning properly to gain a realistic calculation of the reheat valve *Position (calc.)*. To support actuators with different open and close speed the *Runtime Open* and *Runtime Close* are available, but both parameters have to be set.

Runtime Close:

This defines the time duration the actuator drives from the full open position (100%) to the close position (0%) of the connected reheat valve. This value has to be detected and parameterized during the system commissioning properly to gain a realistic calculation of the reheat valve *Position (calc.)*. To support actuators with different open and close speed the *Runtime Open* and *Runtime Close* are available, but both parameters have to be set.

Dead Band:

The floating reheat valve position controller is operating with a dead band. If the absolute difference between the *Position (calc.)* and the position setpoint is lower or equal the half *Dead Band* value, the position controller stops moving the valve. If it is not, the valve will be moved to the required direction. Usually this parameterized *Dead Band* default value is 0%. Then the position controller operates with the highest possible accuracy. If this does not work in special cases (fast moving actuators), the *Dead Band* can be set to higher values to stabilize the position control.

Cycle Time:

This is the cycle time to calculate the reheat valve *Position (calc.)*. Because the cycle is fixed internally to 1 second this parameter has to have its default value of 1s and must not be changed.

Sync Mode:

The calculation of the reheat valve Position *(calc.)* needs to be synchronized from time to time. This is always done when the reheat valve position 0% or 100% is requested by the VAV control. The Sync Mode parameter defines how this synchronization is performed. There are two options “Permanent” or “2xRuntime” available:

Permanent:

If the 0% position is requested by the VAV control, the “close” command is set permanently. The reheat valve will drive to the close position physically and the calculation of the valve position will result 0%. If the 100% position is requested by the VAV control, the “open” command is set permanently. The valve will drive to the open position physically and the calculation of the valve position will result 100%.

2xRuntime:

This is the same procedure as described above, but the commands “close” or “open” are set for the time duration of 2 times of the parameterized *Runtime Open* or *Runtime Close*. This Sync Mode has to be chosen if the valve actuator cannot stand permanent “open” or “close” commands.

7.5.15.3 Electric Modulating Reheat

General Function:

This reheat type is supplied with electric energy. The actuator is a power controller (e.g. a thyristor) to control the electrical current to the reheat coil. The power controller is led by an analog signal that is connected to a local output of the LIOB-AIR device. The power controller dispenses the electrical power to the reheat coil proportional to the analog signal form the LIOB-AIR device.

It is also possible to use a triac output (DO) of the LIOB-AIR device and do the power control in this way. In this case, the electric reheat coil does not need a power controller. The electrical power is directly running through the triac to the reheat coil. This can be used if the maximum current is less than 4 amperes. **Important: It has to be checked if this solution is compliant with the local electrical regulations !!**

The reheat display is shown on the *Status Overview* page of the *VAVstatus* visualization project as shown in Figure 339. Here the *Reheat Output* (power percentage) is displayed.

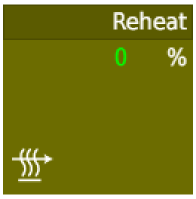

Figure 339: Electric modulating reheat tile in Status Overview

Output:

In the LIOB-AIR I/O Standard configuration, the electric modulating reheat output is located on the analog output *AO1*. However, this analog output is not connected to the Favorite. This has to be done with the LINX-Configurator tool (L-IOB/Local I/O) in the VAV Device Type configuration. For more information see chapter *7.3.2 Device Configuration*.

As an alternative for reheaters without an integrated power controller, the triac output for the electric modulating reheat is located on the digital output *DO9*. However, this digital output is not connected to the Favorite. This has to be done with the LINX-Configurator tool (L-IOB/Local I/O) in the VAV Device Type configuration. For more information see chapter *7.3.2 Device Configuration*. **Important: It has to be checked if this solution is compliant with the local electrical regulations !!**

Favorites:

The Favorite of an electric modulating reheat is shown in Table 158.

Path: Favorites.VAVcontrol.ReheatElMod

Favorite name	**Description**
outReheatElectricModulating	Output value of modulating reheat (power percentage)

Table 158: Electric modulating reheat Favorite

outReheatElectricModulating:

The electric modulating reheat actuator function has this one Favorite. To this Favorite the Local I/Os *AO1* (or *DO9*) can be connected (see I/O Standard configuration).

Detailed Functions:

The electric modulating reheat actuator can be watched, operated and parameterized on the *Reheat Configuration* page of the *VAVstatus* visualization project as shown in Figure 340.

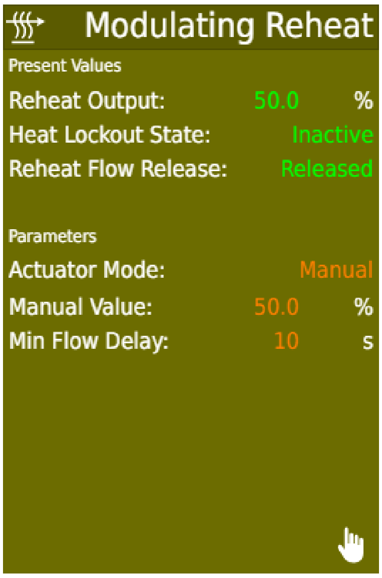

Figure 340: The electric modulating reheat actuator configuration

Table 159 shows the electric modulating reheat actuator present values.

Path: User Registers.VAVcontrol.ReheatElMod

Name on tile	Data point name	Description
Reheat Output	outReheatElectricModulating	Displays the current setpoint output of the power percentage
Heat Lockout State	HeatLockoutState	Displays the current heat lockout state
Reheat Flow Release	ReheatFlowRelease	Displays if the reheat is released by air flow

Table 159: Electric modulating reheat actuator present values

Reheat Output:

Displays the current power percentage setpoint that is put out to the reheat actuator. The reheat actuator is dispensing the power to this setpoint by the power controller.

Heat Lockout State:

Displays the current state of the heat lockout function depending on the outdoor temperature, see description above in chapter 7.5.15. If the Heat Lockout state is “Inactive”, the reheat actuator function is released for operation. If the Heat Lockout state is “Active”, the reheat actuator function is not released for operation.

Reheat Flow Release:

Displays if the reheat is released for operation by sufficient air flow. If the current air flow is lower than the *Min.Alarm Limit* of the *Air Flow Alarm* function (see chapter 7.5.5.4) then the reheat is blocked for operation by the air flow. This block function uses the *Min Flow Delay* time. If the current air flow is greater than the *Min.Alarm Limit* of the *Air Flow Alarm* function, then the reheat is released for operation by the air flow. If a series or parallel fan is running actually, the reheat is released for operation, even if there is no or less primary air flow.

Table 160 shows the electric modulating reheat actuator parameters.

Path: User Registers.VAVcontrol.ReheatElMod

Name on tile	**Data point name**	**Default**	**Description**
Actuator Mode	AutoMan	Auto	Definition of the actuator mode Auto or Manual
Manual Value	ManualValue	0%	Definition of the manual power percentage setpoint, (only displayed in Manual mode)
Min Flow Delay	ReheatMinFlowDelay	10s	Definition of the time delay to block the reheat on low air flow

Table 160: Electric modulating reheat actuator parameters

Actuator Mode:

This defines if the reheat actuator is controlled in “Auto” or “Manual” mode. In “Auto” mode, it gets the power percentage setpoint *Reheat Output* from the space temperature heating sequence or the discharge temp. controller. In “Manual” mode, the *Reheat Output* is set to the *Manual Value*.

Manual Value:

This is only visible if the *Actuator Mode* is in “Manual” mode. A manual value can be entered here and is forwarded to the *ReheatOutput*. This is only meant for commissioning and maintenance purposes. A Manual Alarm will be triggered and a manual indicator is shown in the *VAVstatu*s visualization project.

Min Flow Delay:

This defines the time delay the *Reheat Flow Release* is blocked on low air flow. Please refer to the common description of reheat actuators for the details.

7.5.15.4 Electric 3 Stage Reheat

General Function:

This reheat type is supplied with electric energy. The reheat unit consists of up to 3 coils that are switched on or off separately as stages. The actuator is a unit that switches the electric power of the up to 3 stages. If a stage is switched on, it operates with the full power of this coil. Therefore, this actuator allows a 3 stage control of the electric reheat.

There are also electric staged reheat units provided in the market that have up to 3 steady stages. Every coil has a dedicated power controller a power controller (e.g. a thyristor) to control the electrical current to the reheat coil. These up to 3 power controllers are led by 3 an analog signals that are connected to 3 local outputs of the LIOB-AIR device. The power controllers dispense the electrical power to each reheat coil proportional to the analog signals form the LIOB-AIR device.

Further there are electric staged reheat units found in the market that have a mix of switched and steady stages, e.g. Stage1 switched Stage2+3 steady or something else.

All these variations are supported by the electric 3 stage actuator function of the LIOB-AIR. The 3 switched stages strategy and the 3 steady stages strategy are internally operating in parallel and can be mixed connecting the regarding Favorites to the LIOB-AIR I/Os.

The control principle of a 3 stage reheat with up to 3 switched stages is shown in Figure 341. As described above in chapter 7.5.15 the reheat is requested by a power setpoint coming from the space temperature heating sequence or from the discharge temperature controller output (depending on the application structure, see chapter 7.3.1). This power setpoint is recalculated into 3 resulting stages, which are switched on in the order 1,2,3 if the adjustable stage limit percentage is exceeded. This happens with adjustable time delays. The 3 stages are switched off in the order 3,2,1 if the stage limits are undershot using adjustable hysteresis values. It is also adjustable how much stages (1or 2 or 3) are used by the staged reheat actuator function.

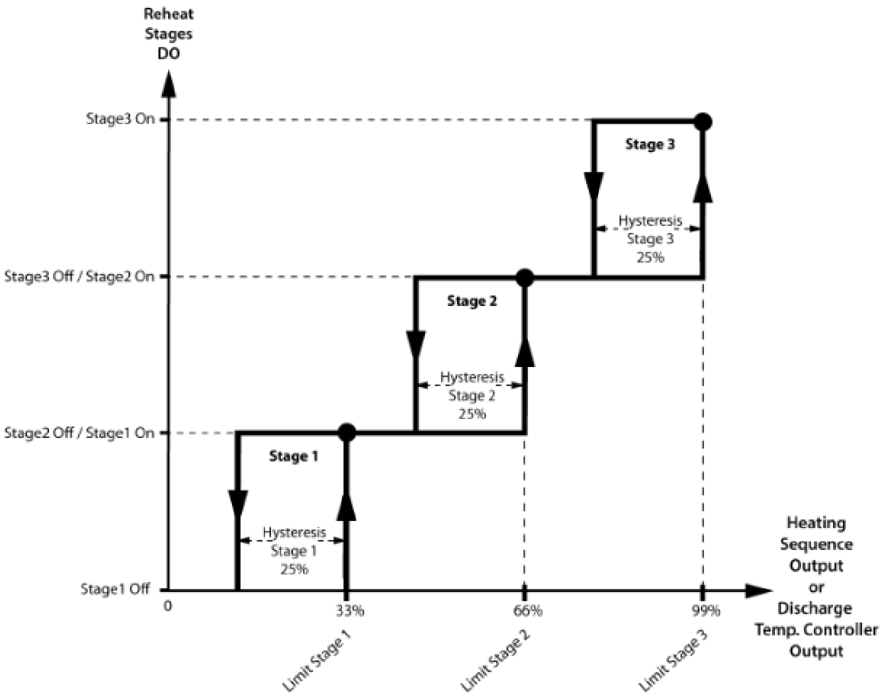

Figure 341: Electric 3 stage reheat with 3 switched stages

The control principle of a 3 stage reheat with up to 3 steady stages is shown in Figure 342. The power setpoint is recalculated into 3 steady 0…100% stages in the order 1,2,3 using the same adjustable stage limit values as the switched stages. It is also possible to start with adjustable minimum outputs on the dedicated stages.

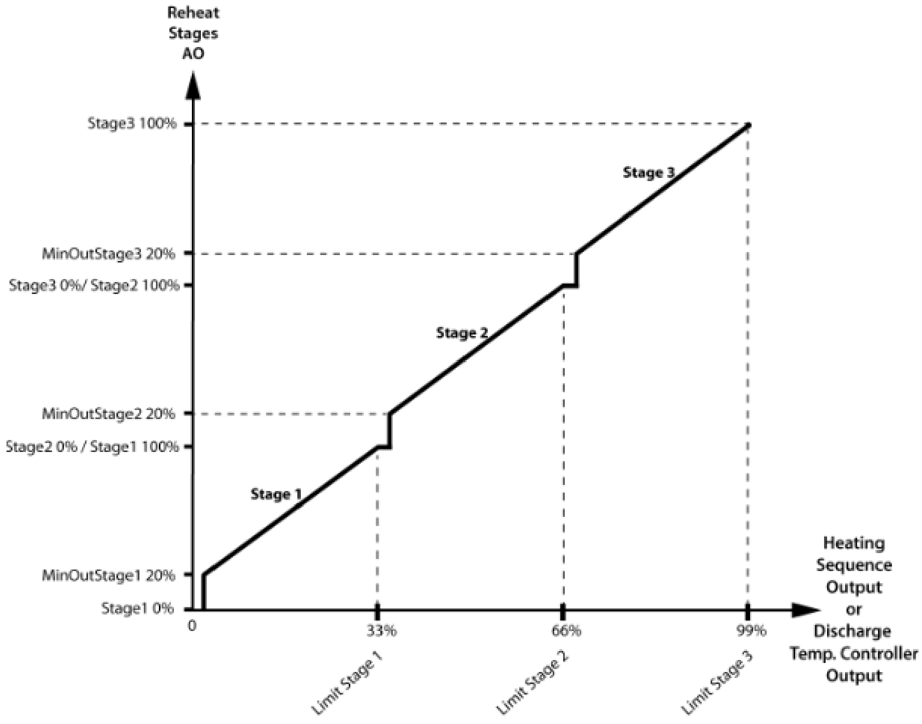

Figure 342: Electric 3 stage reheat with 3 steady stages

As mentioned above it is also possible to mix the switched and steady stages. Both strategies are operated internally in parallel and the switched and steady stages outputs are writing on dedicated Favorites. The LIOB-AIR I/O configuration (VAV Device Type) has to be set up and connected to the Favorites according to the real actuator stages configuration.

The reheat display is shown on the *Status Overview* page of the *VAVstatus* visualization project as shown in Figure 343. Here the *Reheat Output* (stage) is displayed.

Figure 343: Electric 3 stage reheat tile in Status Overview

<u>Output:</u>

In the LIOB-AIR I/O Standard configuration the electric 3 stage reheat switching outputs are located on the 3 digital outputs *DO1* (Stage1), *DO2* (Stage2), *DO3* (Stage3). The 3 steady outputs are <u>not</u> located on any analog outputs *AOx*. This has to be done with the LINX-Configurator tool (L-IOB/Local I/O) in the VAV Device Type configuration. For more information see chapter *7.3.2 Device Configuration*.

Favorites:

The Favorites of an electric 3 stages reheat is shown in Table 161

Path: Favorites.VAVcontrol.ReheatEl3St

Favorite name	**Description**
outReheatStage1	Output of switching reheat Stage 1
outReheatStage2	Output of switching reheat Stage 2
outReheatStage3	Output of switching reheat Stage 3
outReheatStage1analog	Output value of steady reheat Stage 1(power percentage)
outReheatStage2analog	Output value of steady reheat Stage 2(power percentage)
outReheatStage3analog	Output value of steady reheat Stage 3(power percentage)

Table 161: Electric 3 stage reheat Favorites

outReheatStage1:

This is the Favorite of the switching Stage 1 output. To this Favorite, the Local I/O *DO1* is connected (see I/O Standard configuration). It is switched on if Stage1 or Stage2 or Stage3 are requested by the *Controller Output*.

outReheatStage2:

This is the Favorite of the switching Stage 2 output. To this Favorite, the Local I/O *DO2* is connected (see I/O Standard configuration). It is switched on if Stage2 or Stage3 are requested by the *Controller Output*.

outReheatStage3:

This is the Favorite of the switching Stage 3 output. To this Favorite, the Local I/O *DO3* is connected (see I/O Standard configuration). It is switched on if Stage3 is requested by the *Controller Output*.

outReheatStage1analog:

This is the Favorite of the steady Stage 1 output. To this Favorite no Local I/O *AOx* is connected. (see I/O Standard configuration). This has to be done individually with the LINX-Configurator tool (L-IOB/Local I/O) in the VAV Device Type configuration if the reheat has a steady function on this stage.

outReheatStage2analog:

This is the Favorite of the steady Stage 2 output. To this Favorite no Local I/O *AOx* is connected. (see I/O Standard configuration). This has to be done individually with the LINX-Configurator tool (L-IOB/Local I/O) in the VAV Device Type configuration if the reheat has a steady function on this stage.

outReheatStage3analog:

This is the Favorite of the steady Stage 3 output. To this Favorite no Local I/O *AOx* is connected. (see I/O Standard configuration). This has to be done individually with the LINX-Configurator tool (L-IOB/Local I/O) in the VAV Device Type configuration if the reheat has a steady function on this stage.

Detailed Functions:

The electric 3 stage reheat actuator can be watched, operated and parameterized on the *Reheat Configuration* page of the *VAVstatus* visualization project as shown in Figure 344.

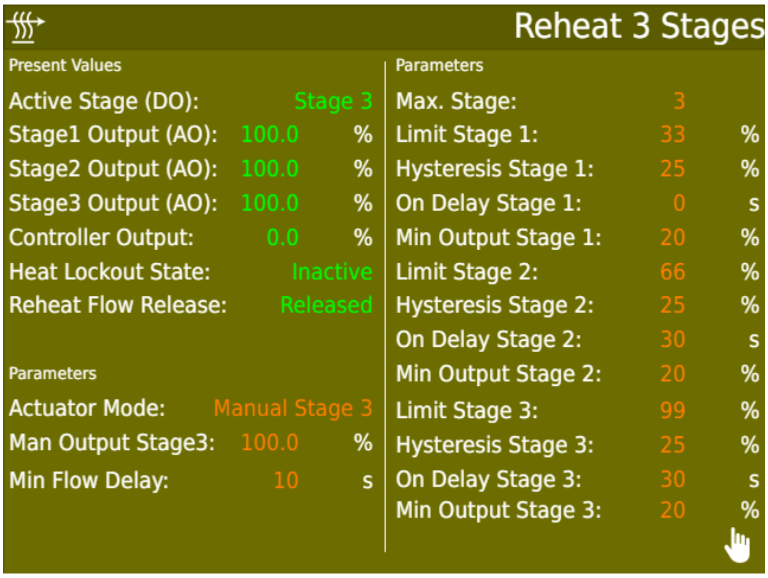

Figure 344: The electric 3 stage reheat actuator configuration

Table 162 shows the electric 3 stage reheat actuator present values.

Path: User Registers.VAVcontrol.ReheatEl3St

Name on tile	**Data point name**	**Description**
Active Stage (DO)	ReheatStageFb	Displays the current output of the switched reheat stage
Stage1 Output (AO)	outReheatStage1analog	Displays the current output of the steady reheat stage1
Stage2 Output (AO)	outReheatStage2analog	Displays the current output of the steady reheat stage2
Stage3 Output (AO)	outReheatStage3analog	Displays the current output of the steady reheat stage3
Controller Output	ControlOutputReheat	Displays the current control output to control the reheat stages
Heat Lockout State	HeatLockoutState	Displays the current heat lockout state
Reheat Flow Release	ReheatFlowRelease	Displays if the reheat is released by air flow

Table 162: Electric modulating reheat actuator present values

Active Stage (DO):

This displays the current output of the switched reheat stage. The Favorites *outReheatStage1, outReheatStage2, outReheatStage3,* are set accordingly. The switched stages are operating in parallel to the steady stages.

Stage1 Output (AO):

This displays the current output of the steady reheat stage1. This is operating from 0…100% if the *Controller Outpu*t is in the range between 0% and *LimitStage1*, see Figure 342.

Stage2 Output (AO):

This displays the current output of the steady reheat stage2. This is operating from 0…100% if the *Controller Output* is in the range between *LimitStage1* and *LimitStage2*, see Figure 342.

Stage1 Output (AO):

This displays the current output of the steady reheat stage1. This is operating from 0…100% if the *Controller Output* is in the range between *LimitStage2* and *LimitStage3*, see Figure 342.

Controller output:

This displays the power setpoint coming from the space temperature heating sequence or the discharge temp. controller. The switching stage outputs and the steady stage outputs are calculated based on this value if the *Actuator Mode* is in “Auto” mode.

Heat Lockout State:

Displays the current state of the heat lockout function depending on the outdoor temperature, see description above in chapter 7.5.15. If the Heat Lockout state is “Inactive”, the reheat actuator function is released for operation. If the Heat Lockout state is “Active”, the reheat actuator function is not released for operation.

Reheat Flow Release:

Displays if the reheat is released for operation by sufficient air flow. If the current air flow is lower than the *Min.Alarm Limit* of the *Air Flow Alarm* function (see chapter 7.5.5.4) then the reheat is blocked for operation by the air flow. This block function uses the *Min Flow Delay* time. If the current air flow is greater than the *Min.Alarm Limit* of the *Air Flow Alarm* function, then the reheat is released for operation by the air flow. If a series or parallel fan is running actually, the reheat is released for operation, even if there is no or less primary air flow.

Table 163 shows the electric 3 stage reheat actuator parameters part 1 on the left side of the Tile.

Path: User Registers.VAVcontrol.ReheatEl3St

Name on tile	Data point name	Default	Description
Actuator Mode	AutoMan	Auto	Definition of the actuator mode Auto or Manual Off, Manual Stage1, Manual Stage2, Manual Stage3
Manual Output Stage1	ManualValue	0%	Definition of the manual percentage setpoint of stage 1, (only displayed in Manual Stage1 mode)
Manual Output Stage2	ManualValue	0%	Definition of the manual percentage setpoint of stage 2, (only displayed in Manual Stage2 mode)
Manual Output Stage3	ManualValue	0%	Definition of the manual percentage setpoint of stage 3, (only displayed in Manual Stage3 mode)
Min Flow Delay	ReheatMinFlowDelay	10s	Definition of the time delay to block the reheat on low air flow

Table 163: Electric modulating reheat actuator parameters, part 1

Actuator Mode:

This defines if the reheat actuator is controlled in “Auto” or “Manual Off” or “Manual Stage1” or “Manual Stage2” or “Manual Stage3” mode. In “Auto” mode, it gets the power setpoint *Controller Output* from the space temperature heating sequence or the discharge temp. controller. In “Manual xxxx” mode, the *Active Stage (DO)* is set to the requested *Actuator Mode*. In “Manual xxxx” mode, the switching stages and the steady stages are set as displayed in Table 164.

	Manual Off	**Manual Stage1**	**Manual Stage2**	**Manual Stage3**
Active Stage (DO)	Off	Stage 1	Stage 2	Stage 3
Stage1 Output (AO)	0%	Man Output Stage1	0%	0%
Stage2 Output (AO)	0%	100%	Man Output Stage2	0%
Stage3 Output (AO)	0%	100%	100%	Man Output Stage3

Table 164: Manual modes of the electric 3 stage reheat

Manual Output Stage1:

This is only visible if the *Actuator Mode* is in “Manual Stage1” mode. A manual value can be entered here and is forwarded to the *Stage1 Output (AO)*. This is only meant for commissioning and maintenance purposes. A Manual Alarm will be triggered and a manual indicator is shown in the *VAVstatu*s visualization project.

Manual Output Stage2:

This is only visible if the *Actuator Mode* is in “Manual Stage2” mode. A manual value can be entered here and is forwarded to the *Stage2 Output (AO)*. This is only meant for commissioning and maintenance purposes. A Manual Alarm will be triggered and a manual indicator is shown in the *VAVstatu*s visualization project.

Manual Output Stage3:

This is only visible if the *Actuator Mode* is in “Manual Stage3” mode. A manual value can be entered here and is forwarded to the *Stage3 Output (AO)*. This is only meant for commissioning and maintenance purposes. A Manual Alarm will be triggered and a manual indicator is shown in the *VAVstatu*s visualization project.

Min Flow Delay:

This defines the time delay the *Reheat Flow Release* is blocked on low air flow. Please refer to the common description of reheat actuators for the details.

Table 165 shows the electric 3 stage reheat actuator parameters part 2 on the right side of the Tile.

Path: User Registers.VAVcontrol.ReheatEl3St

Name on tile	Data point name	Default	Description
Max.Stage	ReheatMaxStage	3	Definition of the number of stages of the reheat actuator
Limit Stage1	LimitActiveReheatStage1	33%	Definition of the limit of the Controller Output to switch on stage 1 and to put out 100% on the steady stage 1
Hysteresis Stage1	HysOffReheatStage1	25%	Definition of the hysteresis of the Controller Output to switch off stage1
On Delay Stage1	OnDelayReheatStage1	0s	Definition of the delay time the stage 1 is switched on
Min Output Stage1	MinOutputStage1	20%	Definition of the minimum steady output of stage 1 if it is active
Limit Stage2	LimitActiveReheatStage2	66%	Definition of the limit of the Controller Output to switch on stage 2 and to put out 100% on the steady stage 2
Hysteresis Stage2	HysOffReheatStage2	25%	Definition of the hysteresis of the Controller Output to switch off stage2
On Delay Stage2	OnDelayReheatStage2	30s	Definition of the delay time the stage 2 is switched on
Min Output Stage2	MinOutputStage2	20%	Definition of the minimum steady output of stage 2 if it is active
Limit Stage3	LimitActiveReheatStage3	99%	Definition of the limit of the Controller Output to switch on stage 3 and to put out 100% on the steady stage 3
Hysteresis Stage3	HysOffReheatStage3	25%	Definition of the hysteresis of the Controller Output to switch off stage3
On Delay Stage3	OnDelayReheatStage3	30s	Definition of the delay time the stage 3 is switched on
Min Output Stage3	MinOutputStage3	20%	Definition of the minimum steady output of stage 3 if it is active

Table 165: Electric modulating reheat actuator parameters, part 2

Max.Stage:

This defines the number of stages (valid numbers: 1,2,3) the reheat actuator is operating with. The reheat actuator function will not request a stage greater than the *Max. Stage* value, even if the *Actuator Mode* is on “Manual xxxx”. The parameters of the higher stages will not be visible on the tile.

Limit Stage1:

This defines the limit the *Controller Output* must exceed to set the *Active Stage (DO)* to “Stage 1” with the *On Delay Stage 1* and to request the switched stage 1 of the reheat, see Figure 341. The steady stage 1 output *Stage1 Output (AO)* is driven by a linear curve based on the *Controller Output* starting on 0% (or *Min Output Stage 1*) to 100% when the *Limit Stage1* value is reached, see Figure 342.

Hysteresis Stage1:

This defines the hysteresis the *Controller Output* must fall below to set the *Active Stage (DO)* down to “Off” and to switch off all stages of the reheat actuator, see Figure 341.

On Delay Stage 1:

This defines the delay time the *Active Stage (DO)* is set to “Stage 1” if the *Controller Output* exceeds the *Limit Stage 1* value.

Min Output Stage 1:

This defines the minimum output of the linear curve function to drive the steady stage 1 output *Stage1 Output (AO)* if the stage 1 becomes active, see Figure 342. This prevents this steady output starting from a zero value. (This function is needed in some special reheat types.)

Limit Stage2:

This defines the limit the *Controller Output* must exceed to set the *Active Stage (DO)* to “Stage 2” with the *On Delay Stage 2* and to request the switched stages 1 and 2 of the reheat, see Figure 341. The steady stage 2 output *Stage2 Output (AO)* is driven by a linear curve based on the *Controller Output* starting on 0% (or *Min Output Stage 2*)when the *Limit Stage1* value is reached and ending on 100% when the *Limit Stage2* value is reached, see Figure 342.

Hysteresis Stage2:

This defines the hysteresis the *Controller Output* must fall below to set the *Active Stage (DO)* down to “Stage 1” and to switch off the stage 2 of the reheat actuator, see Figure 341.

On Delay Stage 2:

This defines the delay time the *Active Stage (DO)* is set to “Stage 2” if the *Controller Output* exceeds the *Limit Stage 2* value.

Min Output Stage 2:

This defines the minimum output of the linear curve function to drive the steady stage 2 output *Stage2 Output (AO)* if the stage 2 becomes active, see Figure 342. This prevents this steady output starting from a zero value. (This function is needed in some special reheat types.)

Limit Stage3:

This defines the limit the *Controller Output* must exceed to set the *Active Stage (DO)* to "Stage 3" with the *On Delay Stage 3* and to request the switched stages 1 and 2 and 3 of the reheat, see Figure 341. The steady stage 3 output *Stage3 Output (AO)* is driven by a linear curve based on the *Controller Output* starting on 0% (or *Min Output Stage 3*)when the *Limit Stage2* value is reached and ending on 100% when the *Limit Stage3* value is reached, see Figure 342.

Hysteresis Stage3:

This defines the hysteresis the *Controller Output* must fall below to set the *Active Stage (DO)* down to "Stage 2" and to switch off the stage 3 of the reheat actuator, see Figure 341.

On Delay Stage 3:

This defines the delay time the *Active Stage (DO)* is set to "Stage 2" if the *Controller Output* exceeds the *Limit Stage 2* value.

Min Output Stage 3:

This defines the minimum output of the linear curve function to drive the steady stage 3 output *Stage3 Output (AO)* if the stage 3 becomes active, see Figure 342. This prevents this steady output starting from a zero value. (This function is needed in some special reheat types.)

7.5.15.5 No Reheat

General Function:

This reheat actuator function type has to be configured if there is no reheat unit existing in the VAV-Box but the space temperature heat control function is needed to supply the room with warm primary air. This type is needed to enable the space temperature heat control functions and parameters basically.

In case there is no heat function needed in the VAV control, because the AHU never provides warm primary air, then the “No Reheat” actuator function is not needed to be connected to the core. Then only the space temperature cool controller will be available in the VAV control configuration.

The space temperature heat controller is released for operation by the *HVAC Mode in VAV* as described in chapters 7.5.6.4 and 7.5.11. If the *HVAC Mode in VAV* is AUTO, the AHU is providing cool primary air and the space temperature control can decide to use the cool or heat controller based on the load of the room. However, because there is no reheat unit available in the VAV-Box this will not work in HVAC Mode AUTO. For that reason, the *HVAC Mode in VAV* will never become AUTO if a “No Reheat” actuator function is configured. If the AHU *HVAC Mode from AHU* is sending AUTO this will set the *HVAC Mode in* VAV to COOL automatically in this special case.

The space temperature heat controller is permitted for operation if the *HVAC Mode in VAV* is on HEAT or MRNG_WRMUP or OFF.

Because there is no reheat unit available in the VAV-Box, the *Reheat/ Periph. Sequence* or the discharge temperature controller does not have any effect on a reheat actuator. However, the *Air Flow Heat Sequence* will calculate the *Setpoint Air Flow Heating* as the setpoint for the air flow control based on the *Heat Control Output* of the space temperature heating controller. This is the only function that is gained configuring a no reheat actuator.

Please refer to chapter 7.5.6.5 for more details of space temperature control sequences, or to chapter 7.5.8.2 for discharge temperature control.

The “no reheat” display is shown on the *Status Overview* page of the *VAVstatus* visualization project as shown in Figure 345. Here a “virtual” *Reheat Output* (position setpoint) is displayed. Virtual means that this would be the valve position setpoint if a modulating reheat would be connected. Thus, this virtual signal has no real meaning! It is only displayed to support the same philosophy of all the other actuator types.

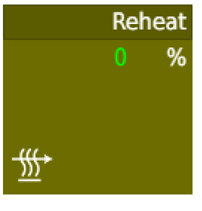

Figure 345: No reheat tile in Status Overview

Output:

Of course, in the LIOB-AIR I/O Standard configuration the no reheat output is not located on any analog output *AOx*.

Favorites:

The Favorite of a no reheat is shown in Table 166.

Path: Favorites.VAVcontrol.NoReheat

Favorite name	Description
outNoReheat	Virtual output value of no reheat position setpoint

Table 166: No reheat Favorite

outNoReheat:

The no reheat actuator function has this one Favorite. To this Favorite no Local I/O *AOx* is connected. This is only a virtual signal because no reheat actuator is existing. This is only to support the same philosophy as the other actuator types.

Detailed Functions:

The hot water modulating reheat actuator can be watched on the *Reheat Configuration* page of the *VAVstatus* visualization project as shown in Figure 346.

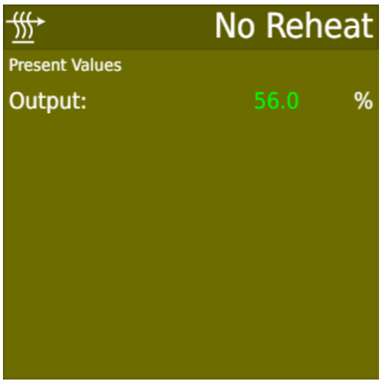

Figure 346: The no reheat actuator configuration

Table 167 shows the hot water modulating reheat actuator present values.

Path: User Registers.VAVcontrol.NoReheat

Name on tile	Data point name	Description
Output	outNoReheat	Displays the current virtual setpoint output of the reheat position

Table 167: No reheat actuator present values

Output:

Displays the current virtual position setpoint of the reheat actuator. This is only to support the same philosophy as the other actuator types.

7.5.16 Periph. Heat Actuators

According to chapter *7.3.1 Application Structure* the peripheral heat is an actuator function. There are multiple types of peripheral heat actuators available: Modulating peripheral heat (VAVperiphHeatMod), Floating peripheral heat (VAVperiphHeatFloat) and On/Off peripheral heat (VAVperiphHeatOnOff). If one of the peripheral heat actuator functions is connected to the core, the peripheral heat actuator function and the Winter Minimum Position function are enabled in the core application.

The peripheral heat units supply additional heating energy to the peripheral zones of the building. It can be realized as radiators or convectors using hot water or electrical energy.

Please note that the peripheral heat function always operates as an additional sequence function to the reheat function. Because the reheat function enables the space temperature heating control function in the core application, the peripheral heat function is only an enhancement and does not work without the reheat function.

The peripheral heat actuator function gets the output signal from the space temperature heating sequence as the setpoint of valve position. This setpoint is put out (analog output) to the peripheral heat actuator that drives the peripheral heat valve or the peripheral heat power controller (e.g. thyristor). Or the setpoint is recalculated with an internal position controller to drive digital outputs for a floating valve actuator. In case of an On/Off peripheral heat, the setpoint is recalculated in a control cycle based On/Off interval control with an digital output.

For commissioning and maintenance purposes, the peripheral heat actuator function allows a manual mode to override the peripheral heat valve position setpoint manually.

As the reheat, the peripheral heat is also blocked and released by the Heat Lockout function. Please refer to the description of the Heat Lockout function of the reheat in chapter 7.5.15.

The Heat Sequence function and the Heat Lockout function are implemented in all reheat actuator types (except VAVnoReheat) and are described in chapter 7.5.15.

The Winter Minimum Position function is part of all peripheral heat actuator types and is described in the following:

<u>Winter Minimum Position:</u>

To prevent “cold feet” or condensation effects in peripheral zones with large glass facades in wintertime, the Winter Minimum position function can help. If the current outdoor temperature decreases below an adjustable limit the Winter Min Position function becomes “Active” and the preheater valve is set to an adjustable minimum position, even if the space temperature control sequence does not request the preheater valve. The peripheral heat valve is set to this minimum position and provides a minimum heat energy in the peripheral zone if the request from the space temperature heat sequence is lower than this position. If the request from the space temperature heat sequence is greater than this position the peripheral heat valve is following this control request to satisfy the heat demand of the zone. If the outdoor temperature increases above the adjustable limit (plus 1°C hysteresis) the Winter Min Position function becomes “Inactive”.

The Winter Minimum Position can only become active if the space temperature heating controller is active. That means there is some heating demand in the zone and the space temperature heating controller is operating the heat sequence.

As default, the Winter Minimum Position function does not have any influence to the control function. It can be parameterized by the user if there is a need.

The principle of the Winter Minimum Position is shown in Figure 347.

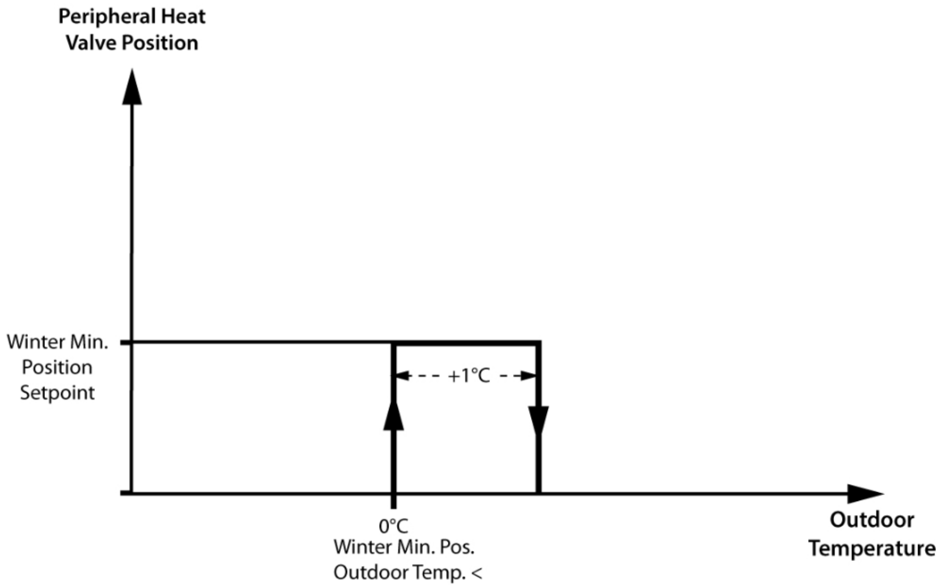

Figure 347: Principle of the Winter Minimum Position

The parameterization of the Winter Minimum Position has to be done on the *Peripheral Heat Winter Min. Position* page of the *VAVstatus* visualization project as shown in Figure 348.

The Winter Minimum Position configuration described below is valid for all types of peripheral heat.

Figure 348: Winter Minimum Position Configuration

If there are multiple LIOB-AIR devices in a room, they have to be parameterized as a “VAV Group” to be able to operate a proper room control. One device in the group has to be set as the “Master”. The parameters of the Winter Minimum Position only have to be set in the “Master” and are communicated to the “Slaves” automatically. Settings in the “Slaves” are overwritten by the “Master” cyclically. This ensures that all the Winter Minimum Positions of all VAV-Boxes in a room are operating with the same parameter values. Therefore, the parameterization has only to be done on the “Master” device.

Table 168 shows the Winter Minimum Position present values.

Path: User Registers.VAVcontrol.PeripheralHeatMod.WinterMinPos***)**

Name on tile	**Data point name**	**Description**
Device Mode	VAVgroupDeviceMode	Indicates if the device is Master or Slave in a VAV Group
Outdoor Temperature	OutdoorTemperature	Displays the current outdoo temperature of winter min position
Heat Controller State	HeatControl Enabled	Indicates if the space temperature heat controller is active
Winter Min Position State	WinterMinPositionStatus	Indicates if the winter min position function is currently active

Table 168: Winter Minimum Position present values

***)**: Please note that the data point path is depending on the connected peripheral heat actuator using different folder names:

Peripheral Heat, modulating folder name: PeripheralHeatMod

Peripheral Heat, floating folder name: PeripheralHeatFloat

Peripheral Heat, On/Off folder name: PeripheralHeatOnOff

Device Mode:

Indicates if the device is set as the “Master” or as a “Slave” in the “VAV-Group”. Only the Master is executing the space temperature control and it sends the *Heat Control Output* to the “Slaves”. The “Slaves” do not execute any space temperature control but they receive the *Heat Control Output* from the “Master” and are operating the *Reheat/ Periph. Sequence* to calculate the *Reheat Control Output* or the *Setpoint Discharge Temp.* and the *Peripheral Heat Control Output*. The “Slaves” are operating the *Winter Min. Position* by themselves based on the parameters sent from the “Master”.

These parameters are sent from the “Master” to the “Slaves” and so they only have to be set in the “Master”: *Winter Min. Pos. Outdoor Temp. <, Winter Min. Position Setpoint.* This ensures that all *Winter Min. Position functions* have the same values and are operating in parallel.

Outdoor Temperature:

This displays the current *Outdoor Temperature* (see chapter 7.6.3) the *Winter Min. Position* function is operating with.

Heat Controller State:

This indicates the current status of the space temperature heating controller, see chapter 7.5.6.4. The Winter Min. Position function can only become active if the *Heat Controller State* is “Active”.

Winter Min. Position State:

This indicates the current status of the Winter Min. Position function. It becomes active if the current *Outdoor Temperature* is lower than *Winter Min.Pos. Outdoor Temp.* < value and the *Heat Controller State* is "Active".

Table 169 shows the winter minimum position parameters.

Path: User Registers.VAVcontrol.PeriphHeatMod.WinterMinPos***)**

Name on tile	Data point name	Default	Description
Winter Min. Pos. Outdoor Temp. <	ODTlimitWinterMinPos	0°C 32°F	Definition of the minimum ODT limit the winter min. pos. can become active
Winter Min. Position Setpoint	WinterMinPosition	0%	Definition of the control output of the active winter min. position function

Table 169: Winter Minimum Position parameters

***)**: Please note that the data point path is depending on the connected peripheral heat actuator using different folder names:

Peripheral Heat, modulating folder name: PeripheralHeatMod

Peripheral Heat, floating folder name: PeripheralHeatFloat

Peripheral Heat, On/Off folder name: PeripheralHeatOnOff

Winter Min. Pos. Outdoor Temp. <:

This defines the current minimum outdoor temperature limit to activate the *Winter Min. Position* function, if the *Heat Controller State* is "Active". If the Outdoor Temperature increases above that limit (plus 1°C hysteresis), or the *Heat Controller State* becomes "Inactive", the Winter Min. Position becomes "Inactive". This limit value is sent from the "Master" to the "Slaves" automatically and overwrites the values in the "Slaves".

Winter Min. Position Setpoint:

This defines the minimum position setpoint that is set to the peripheral heat valve if the *Winter Min. Position State* becomes "Active". This opens the peripheral heat valve for this percentage. If the *Peripheral Heat Control Output* coming from the *Reheat/ Periph. Sequence* (see chapter 7.5.6.5) is lower than the *Winter Min. Position Setpoint* the peripheral heat valve will remain in this position and provide a minimum heat. If the *Peripheral Heat Control Output* coming from the *Reheat/ Periph* becomes greater than the *Winter Min. Position Setpoint* the peripheral heat valve will open according to the control output signal. This *Winter Min. Position Setpoint* is sent from the "Master" to the "Slaves" automatically and overwrites the values in the "Slaves". The default value is 0% and so the Winter Min Position has no effect even if it is active.

Heat Lockout:

This locks in parallel the reheat and the peripheral heat and the heating controller in summertime. Please refer to chapter 7.5.15 for the details.

7.5.16.1 Modulating Peripheral Heat

General Function:

This reheat type is supplied with hot water or electrical heating energy. The actuator is a valve to control the hot water flow, or a thyristor to control the electric energy to the heating radiator or convector. The modulating valve actuator is led by an analog signal that is connected to a local output of the LIOB-AIR device. The valve is modified by the modulating actuator to the requested position by an internal position controller or the thyristor is controlling the electric energy accordingly.

The peripheral display is shown on the *Status Overview* page of the *VAVstatus* visualization project as shown in Figure 349. Here the *Peripheral Heat Output* (position setpoint) is displayed.

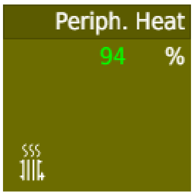

Figure 349: Modulating Peripheral Heat tile in Status Overview

Output:

In the LIOB-AIR I/O Standard configuration, the modulating peripheral heat output is not connected to an analog output *AOx*. If this type of actuator is needed the Standard I/O configuration has to be modified. For more information see chapter *7.3.2 Device Configuration*.

Favorites:

The Favorite of a hot water modulating reheat is shown in Table 152.

Path: Favorites.VAVcontrol.ReheatHwMod

Favorite name	**Description**
outPeriphHeatMod	Output value of modulating valve position setpoint

Table 170: Modulating peripheral heat Favorite

outPeriphHeatMod:

The modulating peripheral heat actuator function has this one Favorite. To this Favorite, no Local I/O *AOx* is connected (see I/O Standard configuration). If this type of actuator is needed, the I/O Standard configuration has to be modified and the according *AOx* has to be connected to that Favorite.

<u>Detailed Functions:</u>

The modulating peripheral heat actuator can be watched, operated and parameterized on the *Peripheral Heat Configuration* page of the *VAVstatu*s visualization project as shown in Figure 350.

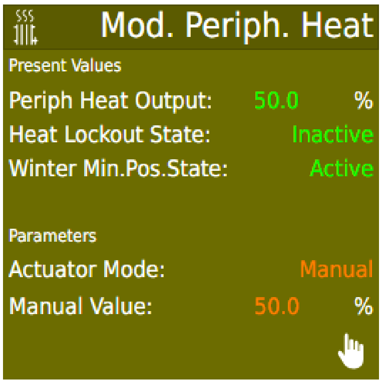

Figure 350: The modulating peripheral heat actuator configuration

Table 171 shows the modulating peripheral heat actuator present values.

Path: User Registers.VAVcontrol.PeriphHeatModMod

Name on tile	Data point name	Description
Peripheral Heat Output	outPeriphHeatMod	Displays the current setpoint output of the valve position
Heat Lockout State	HeatLockoutState	Displays the current heat lockout state
Winter Min.Pos.State	WinterMinPositionStatus	Displays the current heat winter min position status

Table 171: Modulating peripheral heat actuator present values

Peripheral Heat Output:

Displays the current position setpoint that is put out to the peripheral heat actuator. The peripheral heat actuator is moving the valve to this position by the internal position controller.

Heat Lockout State:

Displays the current state of the heat lockout function depending on the outdoor temperature, see description in chapter 7.5.15. If the Heat Lockout state is “Inactive”, the peripheral heat actuator function is released for operation. If the Heat Lockout state is “Active”, the peripheral heat actuator function is <u>not</u> released for operation.

Winter Min Position State:

Displays the current state of the *Winter Minimum Position* function depending on the outdoor temperature and the Heat Controller State, see description in chapter 7.5.16.

Table 172 shows the hot water modulating reheat actuator parameters.

Path: User Registers.VAVcontrol.PeriphHeatModMod

Name on tile	Data point name	Default	Description
Actuator Mode	AutoMan	Auto	Definition of the actuator mode Auto or Manual
Manual Value	ManualValue	0%	Definition of the manual valve position setpoint, (only displayed in Manual mode)

Table 172: Modulating peripheral heat actuator parameters

Actuator Mode:

This defines if the peripheral heat actuator is controlled in “Auto” or “Manual” mode. In “Auto” mode, it gets the valve position setpoint *Periph Heat Output* from the space temperature heating sequence or Winter Minimum Position function. In “Manual” mode, the *Periph Heat Output* is set to the *Manual Value*.

Manual Value:

This is only visible if the *Actuator Mode* is in “Manual” mode. A manual value can be entered here and is forwarded to the *Periph Heat Output*. This is only meant for commissioning and maintenance purposes. A Manual Alarm will be triggered and a manual indicator is shown in the *VAVstatu*s visualization project.

7.5.16.2 Floating Peripheral Heat

General Function:

This peripheral heat type is supplied with hot water heating energy. The actuator is a valve to control the hot water flow to the peripheral heat radiator or convector. The floating valve actuator lead by two binary signals (close and open) that are connected to two local digital outputs of the LIOB-AIR device. The valve is moved by the floating valve actuator.

Because the floating peripheral heat actuator function does not operate a position feedback, it is calculating the current valve position internally, based on the parameterized runtime values. The floating position control operates the binary open and close commands depending on the calculated current valve position in a 3-point function “close / stop / open”. If the calculated position is below the position setpoint coming from the VAV control the floating position control triggers the “open” command. When the calculated position reaches the position setpoint, the “open” command is reset. If the calculated position is above the position setpoint coming from the VAV control the floating position control triggers the “close” command. When the calculated position reaches the position setpoint, the “close” command is reset. Therefore, when the calculated position matches the position setpoint both outputs “open” and “close” are reset and the actuator “stops” moving.

Therefore, the valve runtime values have to be detected and parameterized properly during the commissioning phase to allow a proper calculation of the valve position. Because some actuators are driving with different speed on the open and close directions there are dedicated parameters available.

Of course, the calculated valve position is only an approximation. For that reason, the floating reheat actuator function performs synchronization every time the valve is driven to a 0% or 100% setpoint from the VAV control. It can be parameterized if the synchronization sets the “close” or “open” command permanently or for the double duration of the valve close or open runtime.

The peripheral heat display is shown on the *Status Overview* page of the *VAVstatus* visualization project as shown in Figure 351. Here the calculated peripheral heat valve position and the floating commands “close = ↓” and open = ↑” are displayed.

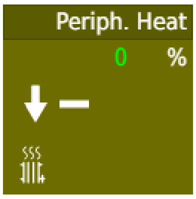

Figure 351: Floating peripheral heat tile in Status Overview

Output:

In the LIOB-AIR I/O Standard configuration, the floating peripheral heat outputs close and open are not located on digital outputs *DOx*. If this type of actuator is needed the Standard I/O configuration has to be modified. For more information see chapter *7.3.2 Device Configuration*.

If the valve actuator needs to operate in an inverse direction, it has to be set up on the valve actuator device if possible. Please refer to the regarding manufacturer documentation.

Favorites:

The Favorites of a floating peripheral heat are shown in Table 173.

Path: Favorites.VAVcontrol.PeripheralHeatFloat

Favorite name	Description
outPeripheralHeatClose	Output value of floating peripheral heat command “close”
outPeripheralHeatOpen	Output value of floating peripheral heat command “open”

Table 173: Floating peripheral heat Favorites

outPeripheralHeatClose:

This is the Favorite of the floating peripheral heat “close” command. To this Favorite, no Local I/O *DOx* is connected (see I/O Standard configuration). If this type of actuator is needed, the I/O Standard configuration has to be modified and the according *DOx* has to be connected to that Favorite.

outPeripheralHeatOpen:

This is the Favorite of the floating peripheral heat “open” command. To this Favorite, no Local I/O *DOx* is connected (see I/O Standard configuration). If this type of actuator is needed, the I/O Standard configuration has to be modified and the according *DOx* has to be connected to that Favorite.

Detailed Functions:

The floating peripheral heat actuator can be watched, operated and parameterized on the *Peripheral Heat Configuration* page of the *VAVstatus* visualization project as shown in Figure 352.

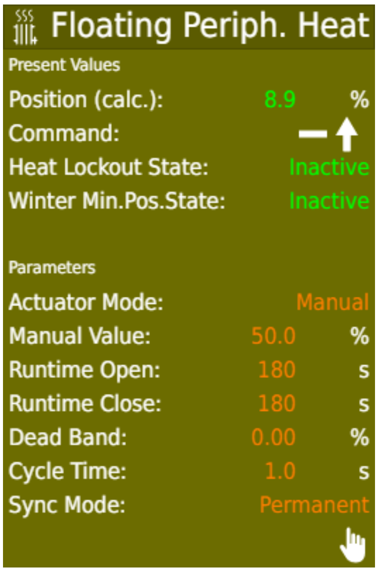

Figure 352: The floating peripheral heat actuator configuration

Path: User Registers.VAVcontrol.PeripheralHeatFloat

Name on tile	**Data point name**	**Description**
Position (calc.)	CalcPosition	Displays the current calculated valve position
Command	outPeripheralHeatClose outPeripheralHeatOpen	Displays the current state of the “close = ↓” and “open = ↑” commands, “stop = --“
Heat Lockout State	HeatLockoutState	Displays the current heat lockout state
Winter Min.Pos.State	WinterMinPositionStatus	Displays the current heat winter min position status

Table 174: Floating peripheral heat actuator present values

Position (calc.):

Displays the current calculated peripheral heat valve position depending on the active duration of the “close” and “open” commands and the *Runtime Open* and *Runtime Close* parameter values.

Command:

Displays the current state of the floating peripheral heat commands. It indicates if the valve actuator is set to move the valve to the “close = ↓” or “open = ↑” direction or if it “stops = --“ moving.

Heat Lockout State:

Displays the current state of the heat lockout function depending on the outdoor temperature, see description above in chapter 7.5.15. If the Heat Lockout state is “Inactive”, the peripheral heat actuator function is released for operation. If the Heat Lockout state is “Active”, the peripheral heat actuator function is not released for operation.

Winter Min Position State:

Displays the current state of the *Winter Minimum Position* function depending on the outdoor temperature and the Heat Controller State, see description in chapter 7.5.16.

Table 175 shows the floating peripheral heat actuator parameters.

Path: User Registers.VAVcontrol.PeripheralHeatHwFloat

Name on tile	**Data point name**	**Default**	**Description**
Actuator Mode	AutoMan	Auto	Definition of the actuator mode Auto or Manual
Manual Value	ManualValue	0%	Definition of the manual valve position setpoint, (only displayed in Manual mode)
Runtime Open	RuntimeOpen	180s	Definition of the runtime the valve needs to open completely 100% starting from the close position 0%
Runtime Close	RuntimeClose	180s	Definition of the runtime the valve needs to close completely 0% starting from the open position 100%
Dead Band	DeadBand	0%	Definition of the dead band of the valve position controller
Cycle Time	CycleTime	1s	Definition of the cycle time of the valve position calculation
Sync Mode	PositionSynchrMode	Permanent	Definition of the synchronization mode of the valve position calculation

Table 175: Floating peripheral heat actuator parameters

Actuator Mode:

This defines if the peripheral heat actuator is controlled in “Auto” or “Manual” mode. In “Auto” mode, it gets the valve position setpoint *Peripheral Heat Output* from the space temperature heating sequence. In “Manual” mode, the *Peripheral Heat Output* is set to the *Manual Value*.

Manual Value:

This is only visible if the *Actuator Mode* is in “Manual” mode. A manual value can be entered here and is forwarded to the *Peripheral Heat Output*. This is only meant for commissioning and maintenance purposes. A Manual Alarm will be triggered and a manual indicator is shown in the *VAVstatu*s visualization project.

Runtime Open:

This defines the time duration the actuator drives from the close position (0%) to the full open position (100%) of the connected valve. This value has to be detected and parameterized during the system commissioning properly to gain a realistic calculation of the reheat valve *Position (calc.)*. To support actuators with different open and close speed the *Runtime Open* and *Runtime Close* are available, but both parameters have to be set.

Runtime Close:

This defines the time duration the actuator drives from the full open position (100%) to the close position (0%) of the connected reheat valve. This value has to be detected and parameterized during the system commissioning properly to gain a realistic calculation of the reheat valve *Position (calc.)*. To support actuators with different open and close speed the *Runtime Open* and *Runtime Close* are available, but both parameters have to be set.

Dead Band:

The floating peripheral heat valve position controller is operating with a dead band. If the absolute difference between the *Position (calc.)* and the position setpoint is lower or equal the half *Dead Band* value, the position controller stops moving the valve. If it is not, the valve will be moved to the required direction. Usually this parameterized *Dead Band* default value is 0%. Then the position controller operates with the highest possible accuracy. If this does not work in special cases (fast moving actuators), the *Dead Band* can be set to higher values to stabilize the position control.

Cycle Time:

This is the cycle time to calculate the peripheral heat valve *Position (calc.)*. Because the cycle is fixed internally to 1 second this parameter has to have its default value of 1s and must not be changed.

Sync Mode:

The calculation of the peripheral heat valve Position *(calc.)* needs to be synchronized from time to time. This is always done when the reheat valve position 0% or 100% is requested by the VAV control. The Sync Mode parameter defines how this synchronization is performed. There are two options “Permanent” or “2xRuntime” available:

Permanent:

If the 0% position is requested by the VAV control, the “close” command is set permanently. The peripheral heat valve will drive to the close position physically and the calculation of the valve position will result 0%. If the 100% position is requested by the VAV control, the “open” command is set permanently. The valve will drive to the open position physically and the calculation of the valve position will result 100%.

2xRuntime:

This is the same procedure as described above, but the commands “close” or “open” are set for the time duration of 2 times of the parameterized *Runtime Open* or *Runtime Close*. This Sync Mode has to be chosen if the valve actuator cannot stand permanent “open” or “close” commands.

7.5.16.3 Peripheral Heat On Off

General Function:

This reheat type is supplied with hot water or electrical heating energy. The actuator is a valve to control the hot water flow, or a relay to control the electric energy to the heating radiator or convector. The On Off actuator is led by a digital signal that is connected to a local output of the LIOB-AIR device.

The valve or the relay of this actuator type are only able to release the full power of the peripheral heat unit or not. To provide a better control characteristic the digital output is controlled by a control cycle interval. This is a time interval that is defined by the *Cycles per hour* parameter. In this time interval, the digital output is switched on for a percentage of the time interval proportionally according to the *Control Output* requested by the *Peripheral Heat Control Output* of the space temperature heating sequence.

Example: The actuator is parameterized to operate e.g. 6 *Cycles per hour*. This means a complete cycle time of 600 seconds. If the current *Control Output* is 30% the digital output (*Command*) is switched On for 180 seconds (*Curr. On Cycle*) and is switched off for 420 seconds (*Curr. Off Cycle*). Then a new cycle begins. The *Curr. On Cycle* and *Curr. Off Cycle* are recalculated and updated according to the current *Control Output* every second. Therefore, the On Off actuator is operating and updated every second according to the current *Control Output*.

The principle of the On Off actuator is shown in Figure 353.

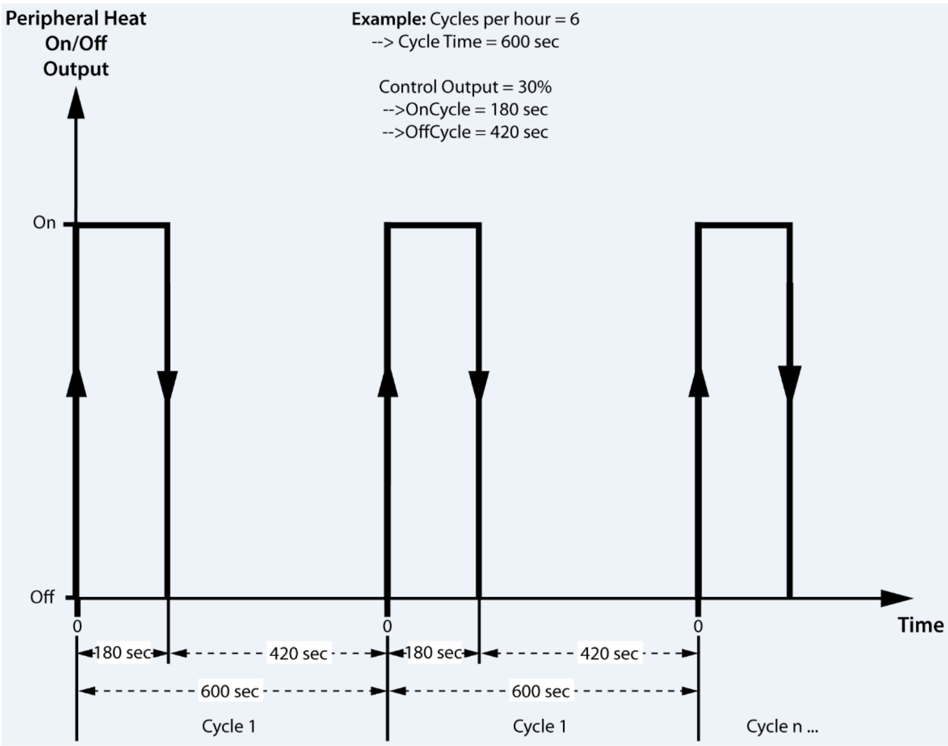

Figure 353: Principle of the On Off actuator

The peripheral heat display is shown on the *Status Overview* page of the *VAVstatus* visualization project as shown in Figure 354. Here the *Control Output* and the digital output *Command* are displayed.

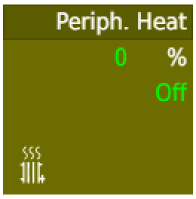

Figure 354: Peripheral heat On Off tile in Status Overview

Output:

In the LIOB-AIR I/O Standard configuration, the On Off peripheral heat output is located on digital output *DO8*. For more information see chapter *7.3.2 Device Configuration*.

If the valve actuator needs to operate in an inverse direction, it has to be set up on the valve actuator device if possible. Please refer to the regarding manufacturer documentation.

Favorites:

The Favorites of an On Off peripheral heat are shown in Table 176.

Path: Favorites.VAVcontrol.PeripheralHeatOnOff

Favorite name	**Description**
outPeripheralHeat	Output value On Off of peripheral heat command

Table 176: On Off peripheral heat Favorites

outPeripheralHeat:

This is the Favorite of the floating peripheral heat “close” command. To this Favorite, the Local I/O *DO8* is connected (see I/O Standard configuration).

Detailed Functions:

The On Off peripheral heat actuator can be watched, operated and parameterized on the *Peripheral Heat Configuration* page of the *VAVstatus* visualization project as shown in Figure 355.

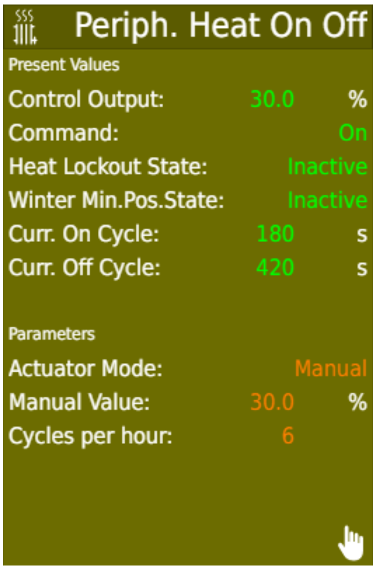

Figure 355: The On Off peripheral heat actuator configuration

Path: User Registers.VAVcontrol.PeripheralHeatOnOff

Name on tile	**Data point name**	**Description**
Control Output	Control Output	Displays the current control output as 0…100%
Command	outPeripheralHeat	Displays the current state of the digital output
Heat Lockout State	HeatLockoutState	Displays the current heat lockout state
Winter Min.Pos.State	WinterMinPositionStatus	Displays the current heat winter min position status
Curr. On Cycle	CurrCycleOnTime	Displays the current cycle time to switch on the actuator
Curr. Off Cycle	CurrCycleOffTime	Displays the current cycle time to switch off the actuator

Table 177: On Off peripheral heat actuator present values

Control Output:

Displays the current “virtual” value of an analog control output. The calculation of the *Curr. On Cycle* and *Curr. Off Cycle* is executed proportionally according to this value.

Command:

Displays the current state of the On Off peripheral heat command. It indicates if the actuator is currently switched on or off.

Heat Lockout State:

Displays the current state of the heat lockout function depending on the outdoor temperature, see description above in chapter 7.5.15. If the Heat Lockout state is “Inactive”, the peripheral heat actuator function is released for operation. If the Heat Lockout state is “Active”, the peripheral heat actuator function is not released for operation.

Winter Min Position State:

Displays the current state of the *Winter Minimum Position* function depending on the outdoor temperature and the Heat Controller State, see description in chapter 7.5.16.

Curr. On Cycle:

Displays the current time the *Command* is switched on. This value is recalculated every second proportionally according to the current *Control Output* and the *Cycles per hour*.

Curr. Off Cycle:

Displays the current time the *Command* is switched on. This value is recalculated every second proportionally according to the current *Control Output* and the *Cycles per hour*.

Table 178 shows the floating peripheral heat actuator parameters.

Path: User Registers.VAVcontrol.PeripheralHeatFloat

Name on tile	**Data point name**	**Default**	**Description**
Actuator Mode	AutoMan	Auto	Definition of the actuator mode Auto or Manual
Manual Value	ManualValue	0%	Definition of the manual valve position setpoint, (only displayed in Manual mode)
Cycles per hour	CyclesPerHour	6	Definition of the number of cycles per hour

Table 178: On Off peripheral heat actuator parameters

Actuator Mode:

This defines if the peripheral heat actuator is controlled in “Auto” or “Manual” mode. In “Auto” mode, it gets the valve position setpoint *Peripheral Heat Output* from the space temperature heating sequence. In “Manual” mode, the *Peripheral Heat Output* is set to the *Manual Value*.

Manual Value:

This is only visible if the *Actuator Mode* is in “Manual” mode. A manual value can be entered here and is forwarded to the *Peripheral Heat Output*. This is only meant for commissioning and maintenance purposes. A Manual Alarm will be triggered and a manual indicator is shown in the *VAVstatu*s visualization project.

Cycles per hour:

This defines the number of cycles per hour. In every cycle, the actuator is switched on and off only one time for the duration of *Curr. On Cycle* and *Curr. Off Cycle*.

7.5.17 External Flow Setpoint

General Function:

According to chapter *7.3.1 Application Structure* the external flow setpoint control is a sensor function. If the VAVflowSetptExternal sensor function is connected to the core, the external flow setpoint control function is enabled in the core application.

The external flow setpoint function gets an air flow setpoint from an external controller. This external controller (e.g. DDC) is processing any kind of individual logic and is calculating an air flow setpoint as a percentage value. This air flow setpoint is communicated or transmitted hard wired to the LIOB-AIR device. The external flow setpoint function in the LIOB-AIR device calculates an effective setpoint depending on the received external setpoint and the parameterized Min. and Max Flow values. See Figure 356 for the principle.

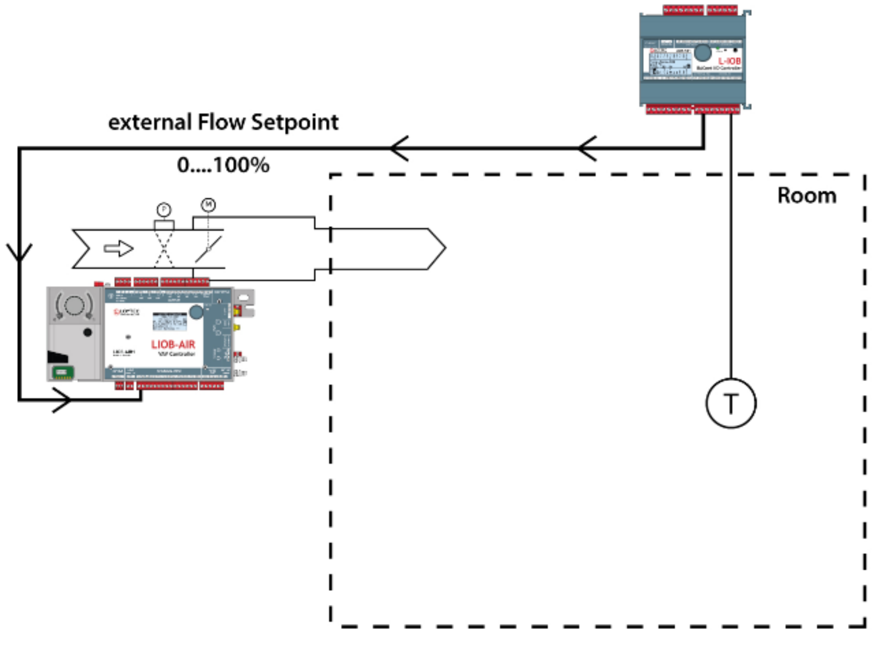

Figure 356: External Flow Setpoint from an external controller

Detailed Function:

If an external flow setpoint function is configured in the LIOB-AIR, there is no need for other sensor functions (in future versions probably there will be IAQ control available additionally). So the external flow setpoint function is operating exclusively if it is configured, no matter if other sensor or actuator functions are configured.

The LIOB-AIR device with a configured external flow setpoint function uses the air flow setpoint of the external controller *External Setpoint% effective* as the control setpoint for its air flow controller that is maintaining this setpoint and controlling the damper actuator.

It is possible to use the implemented *Effective Occupancy* function in the VAV application as described in chapter 7.5.12. Therefore, it is possible to have an external flow setpoint that is maintained in an “Occupied” state, and to have an external setpoint that is maintained in a “Not Occupied” state. This can be used in some special cases. See chapter 337 for *Effective Occupancy*.

If the Effective Occupancy is “4=Bypass” or “5=Occupied” or “1=Invalid”, then:

External Setpoint% effective = External Setpoint% occupied

If the Effective Occupancy is “2=Unoccupied” or “3=Standby, then:

External Setpoint% effective = External Setpoint% not occupied

The HVAC Mode in VAV is also used by the external flow setpoint function. In case of the AHU is shut down and sends HVAC_OFF a 0% value will be set to the *External Setpoint% effective*. All other HVAC Modes will not affect the *External Setpoint% effective*. See chapter 7.5.11 for more information regarding HVAC Modes. This is useful to cause the damper to close if the AHU is shut down.

The *External Setpoint% effective* is requested by the external controller as a percentage value. The resulting *Flow Setpoint* is calculated by a linear curve function that is relating to the parameterized *Air Flow Data* parameters *Min. Flow Cool* (Setpoint 0%) and *Max. Flow Cool* (Setpoint 100%). However, additionally it is possible using the *Min. Setpoint%* parameter to drive the *Flow Setpoint* to a zero value. If the Air Flow Controller gets a zero value Flow Setpoint, it will close the damper to 0%. Therefore, the flow setpoint can be driven and the damper can be closed also using the external flow Setpoint function. See Figure 357 for the details.

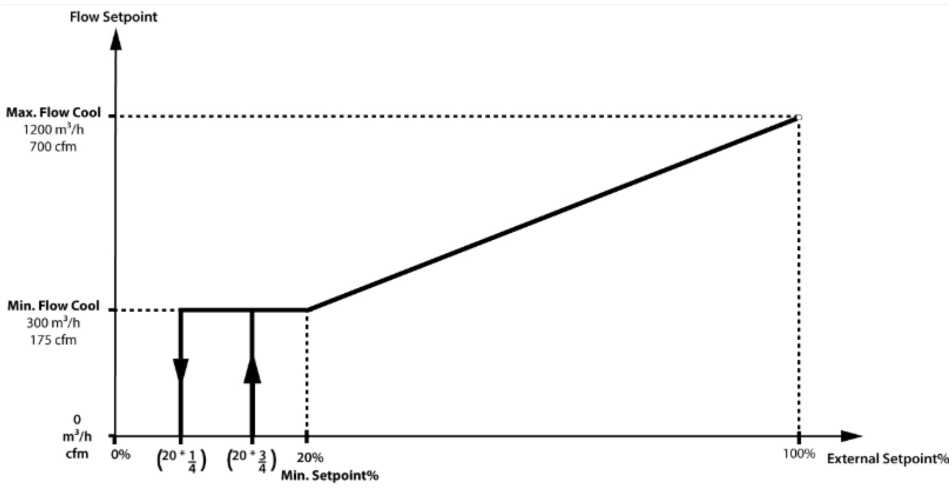

Figure 357: External Flow Setpoint curve

The linear curve function proceeds the following functions:

External Setpoint% =100% ➔

Flow Setpoint = Max.Flow Cool.

Min.Setpoint% < External Setpoint% <100% ➔

Flow Setpoint = linear curve between *Min.Flow Cool* and *Max.Flow Cool.*

External Setpoint% = Min.Setpoint% ➔

Flow Setpoint = Min.Flow Cool.

External Setpoint% < (*Min.Setpoint%* / 4) ➔

Flow Setpoint = 0 m³/h or CFM (Flow controller will close the damper).

External Setpoint% > (*Min.Setpoint%* * 3/4) ➔

Flow Setpoint = *Min.Flow Cool.*

If there are multiple LIOB-AIR devices in a room, they have to be parameterized as a "VAV Group" to be able to operate a proper room control. One device in the group has to be set as the "Master". This "Master" device only is executing the external flow setpoint control function and it communicates the *Supply Air Flow Setpoint%* to all the supply air "Slaves" in the room. The supply air "Slaves" do not perform the external flow setpoint control but they only follow the *Supply Air Flow Setpoint%* of the "Master". Please refer to chapter 7.6.2.2 for more information.

It is also possible to have exhaust air "Slaves" in the "VAV Group". In this case, the exhaust air flow setpoint is calculated by the "Master" using the *Exhaust Flow Rate* parameter. Please refer to chapter 7.6.2.3 to learn more about Exhaust Air Flow Setpoint calculation.

7.5.17.1 External Flow Setpoint Sensor

The external flow setpoint sensors *External Setpoint% occupied* and *External Setpoint% not occupied* can be connected to the local inputs of the LIOB-AIR device. It also can be connected as a network data point connected to the Favorites.

The external flow setpoint display is shown on the *Status Overview* page of the *VAVstatus* visualization project as shown in Figure 358. These are the *External Setpoint% effective* and the resulting *Flow Setpoint* value of the external flow setpoint function.

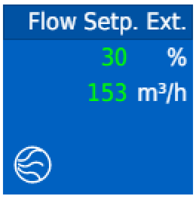

Figure 358: External Flow Setpoint tile in Status Overview

Inputs:

In the LIOB-AIR I/O Standard configuration, the external flow sensor is not located on Local I/O universal inputs UIx because this is a special case in the market. This has to be done with the LINX-Configurator tool (L-IOB/Local I/O) in the VAV Device Type configuration. For more information see chapter *7.3.2 Device Configuration*.

If there are multiple LIOB-AIR devices in a room, they have to be parameterized as a "VAV Group" to be able to operate a proper room control. A device can have either hard-wired sensors or no sensors connected. The resulting *External Setpoint% occupied* and *External Setpoint% not occupied* values are taken by the "Master" from the device in the "VAV Group" automatically where the last value change was detected. These values are used by the "Master" to detect the *External Setpoint%*.

Favorites:

The Favorites of the external flow setpoint are shown in Table 179.

Path: Favorites.VAVcontrol.FlowSetptExternal

Favorite name	Description
inFlowSetpointExternal%NotOcc	Input value of external flow setpoint for the “Not Occupied” state
inFlowSetpointExternal%Occ	Input value of external flow setpoint for the “Occupied” state

Table 179: External Flow Setpoint Favorites

inFlowSetpointExternal%NotOcc:

This is the Favorite of the external flow setpoint for the “Not Occupied” state. To this Favorite, no Local I/O *UIx* is connected (see I/O Standard configuration). This has to be done individually with the LINX-Configurator tool (L-IOB/Local I/O) in the VAV Device Type configuration.

inFlowSetpointExternal%Occ:

This is the Favorite of the external flow setpoint for the “Occupied” state. To this Favorite, no Local I/O *UIx* is connected (see I/O Standard configuration). This has to be done individually with the LINX-Configurator tool (L-IOB/Local I/O) in the VAV Device Type configuration.

7.5.17.2 External Flow Setpoint Configuration

The external flow setpoint function can be watched, operated and parameterized on the *External Flow Setpoint Configuration* page of the *VAVstatus* visualization project as shown in Figure 323.

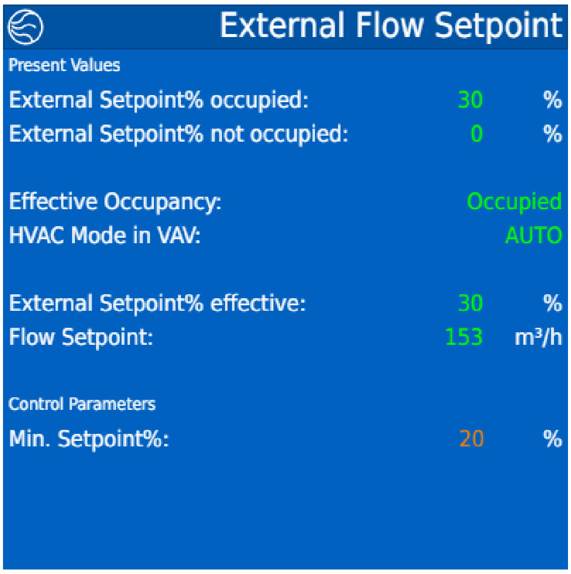

Figure 359: External Flow Setpoint configuration

Table 180 shows the external flow setpoint present values.

Path: User Registers.VAVcontrol.FlowSetptExternal

Name on tile	Data point name	Description
External Setpoint% occupied	FlowSetpointExternal%Occ	Displays the current external flow setpoint for the “Occupied” state as % value received from an external controller
External Setpoint% not occupied	FlowSetpointExternal%NotOcc	Displays the current external flow setpoint for the “Not Occupied” state as % value received from an external controller
Effective Occupancy	EffectiveOccupancy	Displays the current Effective Occupancy in the VAV controller
HVAC Mode in VAV	HvacModeVAV	Displays the current HVAC Mode in the VAV controller
External Setpoint% effective	FlowSetpointExternal%Eff	Displays the current resulting external flow setpoint as % value
Flow Setpoint	FlowSetpointExt	Displays the current resulting external flow setpoint as an absolute value relating to the parameterized Min and Max Flows

Table 180: External Flow Setpoint present values

External Setpoint% occupied:

This displays the external setpoint for an “Occupied” state of the VAV control as a percentage value that is received from an external controller.

External Setpoint% occupied:

This displays the external setpoint for a “Not Occupied” state of the VAV control as a percentage value that is received from an external controller.

Effective Occupancy:

This displays the current state of the *Effective Occupancy* in the VAV controller as described in chapter 7.5.12. It selects the *External Setpoint% occupied* or the *External Setpoint% not occupied* to the *External Setpoint% effective* as described above.

HVAC Mode in VAV:

This displays the current state of the *HVAC Mode in VAV* in the VAV controller as described in chapter 7.5.11. In case of HVAC_OFF, the *External Setpoint% effective* is set to 0%. All other HVAC Modes do not affect the external flow setpoint function.

External Setpoint% effective:

This is the resulting external flow setpoint received from an external controller selected by the *Effective Occupancy* and probably set by the *HVAC Mode in VAV*. This is a percentage value. If the device is the “Master” of the VAV Group, this value is sent to the supply air “Slaves” as the current flow setpoint.

Flow Setpoint:

This is the current *Flow Setpoint* as an absolute value that is calculated by the linear curve function depending on the current External Setpoint% effective value and on the individual *Min.Flow Cool* and *Max.Flow Cool* parameters. This linear curve function is calculated individually in every “Master” and the supply air “Slaves”. Please note that the exhaust air “Slaves” get their flow setpoints resulting from the Exhaust Air Flow Setpoint Calculation described in chapter 7.6.2.3.

Table 181 shows the external flow setpoint parameter.

Path: User Registers.VAVcontrol.FlowSetptExternal

Name on tile	**Data point name**	**Default**	**Description**
Min. Setpoint%	MinSetptPercentage	20%	Definition of the minimum percentage setpoint value of the linear curve function to set Min. Flow Cool as the Flow Setpoint absolute value

Table 181: External Flow Setpoint parameters

Actuator Mode:

This defines the *Min Setpoint%* parameter. If the *External Setpoint% effective* is lower or equal to this value, the linear curve function calculates the *Min. Flow Cool* value as the *Flow Setpoint*. This parameter is also used to set the Flow Setpoint to a zero value, as described above.

7.5.18 Energy

Energy metering functions are not supported in the actual version

7.5.19 VAV scheme

Additionally to the dedicated information on the tiles of the sensors, actuators and control functions, of the *VAVstatus* visualization project provides a graphical VAV scheme. This scheme displays the components of the VAV-Box together with the visualization of important current values of the sensors, actuators and controllers. The VAV scheme is for display purposes only. Adjustments of parameters or manual operations have to be done on the regarding tiles of the sensors, actuators or controller functions.

The VAV scheme is built automatically in the *VAVstatus* visualization project depending on the configured sensor and actuator functions of the VAV type.

An example of a VAV scheme is shown on the *VAV scheme* page of the *VAVstatus* visualization project as shown in Figure 361.

The *VAV scheme* page can be opened by click on the VAV scheme button in the navigation area on the *Status Overview* page of the *VAVstatus* visualization project.

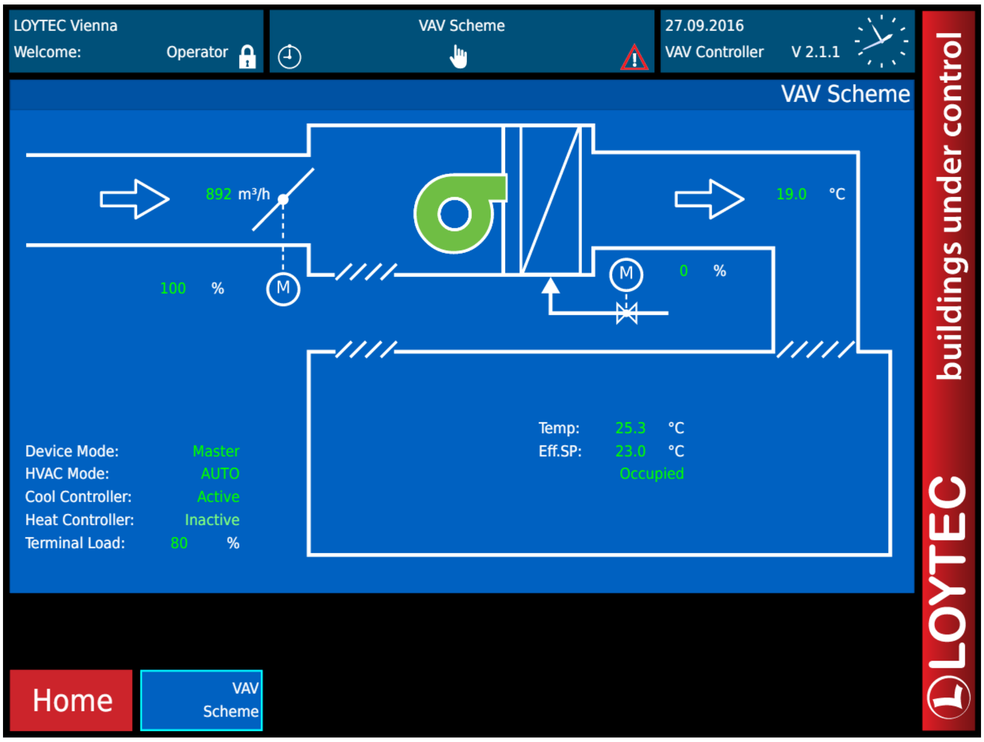

Figure 360: Example of a VAV scheme

7.6 VAV communication

The LIOB-AIR system is using an internal serial communication system. The VAV controllers are communicating to each other to aggregate values between the controllers. This is used for the AHU Communication and the VAV Groups Communication.

Using the manager functions, these aggregated values are provided to an AHU control. The manager function also receives information from the AHU control and communicates it to the VAV controllers. The communication between the manager and the VAV controllers is defined as the AHU communication.

If there are multiple VAV-Boxes in a room a VAV Group has to be configured with a “Master” and one or more “Slaves”. The “Master” is executing the main control functions and is leading the “Slaves”. This is defined as the VAV Groups communication.

According to chapter *7.3.1Application Structure* the AHU communication and the VAV Groups communication are core functions. They are always part of the application and they cannot be deleted.

7.6.1 AHU Communication in the VAV controllers

This chapter describes the part of the AHU communication in the VAV controllers. The manager functions are described in chapter 7.7.

The AHU communication basic information is described in chapter 7.5.2.

If the VAV controllers have to communicate for AHU purposes, the AHU communication has to be configured in the VAV controllers and in the manager.

7.6.1.1 Configuring an Air Supply Zone

To establish the AHU communication in the VAV controllers an Air Supply Zone has to be configured in every VAV controller. To establish the AHU communication in the manager the identical Air Supply Zone has to be configured in the manager, see chapter 7.7. The Air Supply Zone is configured very easy by setting the identical *AirSupplyZoneID* in the VAV controllers and in the manager.

The setting of the *AirSupplyZoneID* can be done during the runtime of the VAV controllers in the *VAVstatus* visualization project.

The main information of the Air Supply Zone configuration is shown on the *Status Overview* page of the *VAVstatus* visualization project as shown in Figure 361.

Figure 361: Air Supply Zone tile in Status Overview

At the first sight, the user can see that this VAV controller is member of the Air Supply Zone “AHU01” this is the *AirSupplyZoneID*.

In this example, the Alarm icon indicates if there is a communication problem to the manager. Every VAV controller executes a watchdog function if the manager is sending data or not, e.g. in case the manager and this VAV controller have a different *AirSupplyZoneID.*

The *AirSupplyZoneID* in the VAV controller can be configured on the *AHU Communication Configuration* page of the *VAVstatus* visualization project as shown in Figure 362.

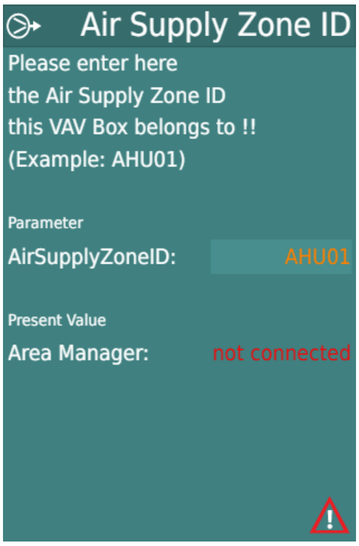

Figure 362: Air Supply Zone configuration

Table 182 shows the Air Supply Zone parameters.

Path: User Registers.VAVcontrol.Core.AHUcommunication

Name on tile	Data point name	Default	Description
AirSupplyZoneID	AirSupplyZoneID	AHU01	Definition of the Air Supply Zone ID

Table 182: Air Supply Zone parameters

AirSupplyZoneID:

This defines the name of the Air Supply Zone. All VAV controllers and the manager having the identical *AirSupplyZoneID* are communicating and aggregating values automatically.

Table 183 shows the Air Supply Zone present values.

Path: User Registers.VAVcontrol.Core.AHUcommunication

Name on tile	Data point name	Description
Area Manager	ManagerWatchdog	Displays if the communication to the manager is ok or not

Table 183: Air Supply Zone present values

Area Manager:

This displays if the communication to the manager is ok or not. If the manager and the VAV controller have the same *AirSupplyZoneID*, the VAV controller will receive data from the manager in a fixed time cycle. If this fails longer than a fixed tolerance time, a communication alarm is triggered.

Please note that the communication alarm is triggered by this function and only this is described in this chapter. In the device, this alarm is operated as a “generic” alarm that is reported to BACnet alarm server in parallel. The complete alarming with alarm servers, alarm lists, alarm status, acknowledgement, alarm notification and further things are standard LOYTEC data point functions of the LIOB-AIR operating system.

7.6.1.2 Enable / Disable Data Aggregation

For every device, it can be defined if the device data is aggregated or not. If there are small rooms or less important rooms or for maintenance purposes also, the data aggregation can be disabled for this device. If disabled, the device is still part of the serial communication chain, but the data is not aggregated to the other devices of the chain.

If there are multiple VAV Boxes in a room and the LIOB AIR device is part of a VAV Group, the data aggregation has to be enabled or disabled in the “Master” only. The Slaves are enabled or disabled automatically according to the setting of the “Master”.

The most data aggregation is relating on the room data coming from the “Master” device as e.g. Occupancy Mode, Terminal Load and Space Temperature and so on. However, the data individual to every VAV Box as e.g. Air Flow Supply and Damper Position Supply are aggregated individually from every device no matter if it is a “Master” or a “Slave” in a room. Therefore, the information if the device aggregation is enabled or not is communicated by the VAV Group communication, see chapter 7.6.2.2.

The *Aggregation* of the VAV controller can be configured on the *AHU Communication Configuration* page of the *VAVstatus* visualization project as shown in Figure 363.

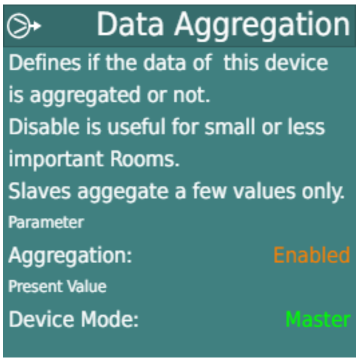

Figure 363: Data Aggregation configuration

Table 184 shows the Data Aggregation parameters.

Path: User Registers.VAVcontrol.Core.AHUcommunication

Name on tile	**Data point name**	**Default**	**Description**
Aggregation	EnableAggregation	Enabled	Definition if the data aggregation is enabled or not

Table 184: Data Aggregation parameters

Aggregation:

This defines if the data of this device or of all devices of the VAV Group are aggregated to the AHU or not.

Table 183 shows the Data Aggregation present values.

Path: User Registers.VAVcontrol.Core.AHUcommunication

Name on tile	Data point name	Description
Device Mode	VAVgroupDeviceMode	Indicates if the device is Master or Slave in a VAV Group

Table 185: Data Aggregation present values

Device Mode:

Indicates if the device is set as the “Master” or as a “Slave” in the “VAV-Group”. Only the Master is parameterized to enable or disable the data aggregation to all the devices of the VAV Group.

7.6.1.3 Weight Factor Data Aggregation

If the data aggregation is enabled a weight factor can be set by the user for every room. The weight factor is a multiplier for the data to be aggregated for this room. So e.g., Space Temperature is multiplied with this weight factor when it is aggregated. Also, the counted number of space temperature sensor functions is multiplied with the weight factor when it is aggregated. This leads to more weight of the data of this room when calculating the average space temperature. A weight factor of >1 can be useful for larger or more important rooms to put more impact of this room to the data aggregation.

The weight factor is a multiplier for the data aggregation of: damper position demand class, terminal load cool and heat demand classes, humidification and dehumidification demand classes, occupancy state count, summary of space temperatures, summary of rel. humidities, summary of effective setpoints and also the regarding number of sensor functions.

The weight factor can be set on the “Master” device of a VAV Group. It is communicated to the “Slaves” automatically. The most data is only aggregated in the “Master”, bit a few individual data as the damper position and the air flow is aggregated in the “Slaves” individually.

The *Weight Factor Room* of the VAV controller can be configured on the *AHU Communication Configuration* page of the *VAVstatus* visualization project as shown in Figure 364.

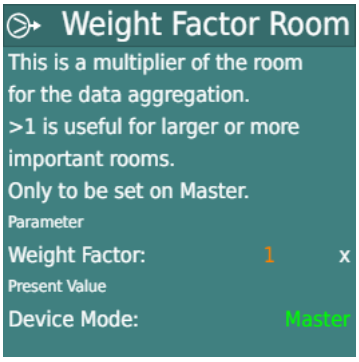

Figure 364: Weight Factor Room configuration

Table 186 shows the Weight Factor Room parameters.

Path: User Registers.VAVcontrol.Core.AHUcommunication

Name on tile	Data point name	Default	Description
Weight Factor Room	WeightFactorRoom	1	Definition if the weight factor this device or room is aggregated with

Table 186: Weight Factor Room parameters

Weight Factor Room:

This defines the weight factor as a multiplier of dedicated data of this device or room to be aggregated. To be adjusted on a “Master” device only.

Table 187 shows the Weight Factor Room present values.

Path: User Registers.VAVcontrol.Core.AHUcommunication

Name on tile	Data point name	Description
Device Mode	VAVgroupDeviceMode	Indicates if the device is Master or Slave in a VAV Group

Table 187: Weight Factor Room present values

Device Mode:

Indicates if the device is set as the “Master” or as a “Slave” in the “VAV-Group”. Only the Master is parameterized to set the weight factor to all the devices of the VAV Group.

7.6.1.4 Values communicated between Manager and VAV controllers

This chapter describes all the values that are communicated bidirectional between the manager and the VAV controllers. This happens here from the point of view from the VAV controller. The communication can be divided in two parts: Values to AHU and Values from AHU.

Values to AHU:

As described in chapter 7.5.2 the manager communicates to the AHU control using standard communication as BACnet or OPC. All the data the manager is sending to the AHU control results from aggregated values from the VAV controllers. This data aggregated between the VAV controllers to the manager are defined as “Values to AHU”. Therefore, every VAV controller is providing data to be aggregated to the manager.

Please note that only the “Master” device in a VAV Group is operating the data aggregation for most values. Because in a VAV Group the main sensors connected to the multiple devices are communicated and calculated automatically (see chapter 7.6.2.4), these resulting sensor values are aggregated only by the “Master”. These are e.g. occupancy mode, setback override, space temperature, rel. humidity and air quality. The “Master” is operating the main control functions. For that reason, the control outputs are also only aggregated by the “Master”. The individual data in the VAV Boxes of air flow and damper position values are aggregated from every device, no matter if it is a “Master” or a “Slave “device.

As described in chapter 7.6.1.2 the data aggregation can be disabled for e.g. small or less important rooms. The Values to AHU described below are only aggregated in case of the aggregation is enabled. If disabled, the device is still part of the serial communication chain, but the data is not aggregated to the other devices of the chain.

As described in chapter 7.6.1.3 a weight factor room can be set for large or more important rooms. This is a multiplier for the data of this room to be aggregated.

There are two methods of data aggregation operating the values to the AHU.

Method #1: Values are aggregated as minimum, maximum and summary and the number of aggregated values is counted. This allows the AHU control to calculate average values and to do a simple control based on the minimum, maximum and averaged values.

Method #2: (Class Aggregation) The most important values e.g., the damper position is also aggregated in classes. That means that e.g. the damper position is classified if it is actually operating in a predefined position range 0-25%, 25-50%, 50%-75%. 75-90%, >90%. The aggregation counts all the devices that have e.g. the damper position in the dedicated classes. The AHU control interprets the number of the devices with the classified damper positions as “calls” to e.g. adjust the static supply pressure setpoint of the AHU. There are several other values aggregated in classes also.

Values to AHU Method #1

The values that are communicated from a dedicated VAV controller to the next VAV controller in a chain to the manager can be watched on the *AHU Communication* page of the *VAVstatu*s visualization project as shown in Figure 365. These are the values that are aggregated with the method of minimum, maximum and summary and the number of aggregated values.

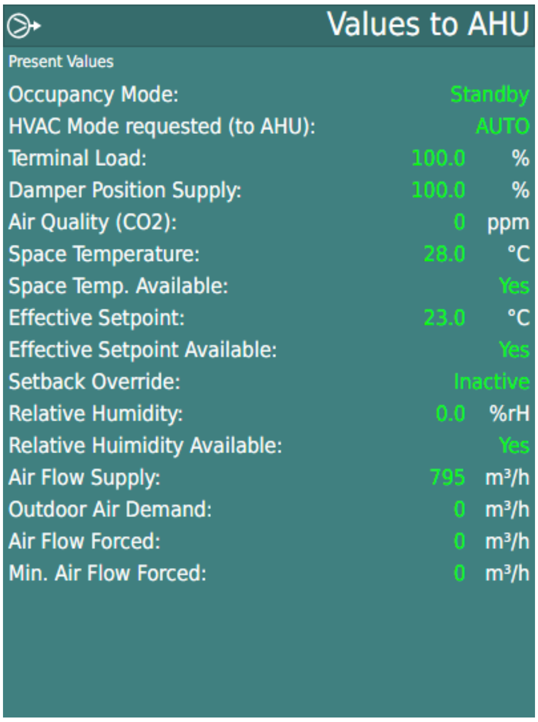

Figure 365: Values to AHU Method #1

Table 188 shows the Values to AHU Method #1 present values.

Path: User Registers.VAVcontrol.Core.AHUcommunication

Name on tile	**Data point name**	**Description**
Occupancy Mode	OccupiedModeToAHU	Displays the current Effective Occupancy of this VAV controller aggregated to the manager
HVAC Mode requested (to AHU)	HvacModeOsReqToAHU	Displays the current HVAC Mode requested by the Optimum Start function sent to the AHU
Terminal Load	TerminalLoadToAHU	Displays the current Terminal Load of this VAV controller aggregated to the manager
Damper Position Supply	SupplyDamperPositionToAHU	Displays the current supply damper position of this VAV controller aggregated to the manager
Damper Position Exhaust	ExhaustDamperPositionToAHU	Displays the current exhaust damper position of this VAV controller aggregated to the manager

Name on tile	Data point name	Description
Air Quality (CO2)	CO2ToAHU	Displays the current CO2 concentration of this VAV controller aggregated to the manager
Space Temperature	SpaceTempToAHU	Displays the current space temperature of this VAV controller aggregated to the manager
Space Temp. Available	SpaceTempAvailableToAHU	Displays if the space temp sensor function is configured in this VAV controller
Effective Setpoint	EffSetpointToAHU	Displays the current effective setpoint of this VAV controller aggregated to the manager
Effective Setpoint Available	EffSetpointAvailableToAHU	Displays if the space temp sensor function is configured in this VAV controller
Relative Humidity. Available	RelHumidityAvailableToAHU	Displays if the relative humidity sensor function is configured in this VAV controller
Air Flow Supply	SupplyAirFlowToAHU	Displays the current supply air flow of this VAV controller aggregated to the manager
Air Flow Exhaust	ExhaustAirFlowToAHU	Displays the current exhaust air flow of this VAV controller aggregated to the manager
Outdoor Air Demand	OutdoorAirFlowDemandToAHU	Displays the current outdoor air flow demand of this VAV controller aggregated to the manager
Air Flow Forced	AirFlowForcedToAHU	Not supported in the actual version
Min. Air Flow Forced	MinAirFlowForcedToAHU	Not supported in the actual version

Table 188: Values to AHU Method #1 present values

Occupancy Mode:

This displays the current *Effective Occupancy* state of this dedicated VAV controller (see chapter 7.5.12) or of the VAV Group “Master” (see chapter 7.6.2.4). This will be aggregated as the maximum occupancy (5= Occupied) of all VAV controllers (“Masters”) in the area chain to the manager by the AHU communication, if the data aggregation is enabled for this device, see chapter 7.6.1.2. The summary aggregation of rooms with dedicated occupancy states (Method #2) is also using the weight factor, see chapter 7.6.1.3. The result of the maximum aggregation of this manager area, that is communicated to the AHU can be watched on the regarding tile in the manager, see chapter 7.7. The AHU control can use this value e.g. as a request for operation.

HVAC Mode requested (to AHU):

This displays the current *HVAC Mode requested (to AHU)* of this dedicated VAV controller (see chapter 7.5.6.4) if it is set as the VAV Group “Master” (see chapter 7.6.2.4). This request is generated by the Optimum Start function, see chapter 7.5.12.4. This will be aggregated separately as the number of rooms requesting WARMUP and the number of rooms requesting PRE_COOL to the AHU (Method #2). (Here is no Method #1 aggregation operated.) This is operated for all VAV controllers (“Masters”) in the area chain to the manager by the AHU communication, if the data aggregation is enabled for this device, see chapter 7.6.1.2. The results of this number aggregation of this manager area, that are communicated to the AHU can be watched on the regarding tile in the manager, see chapter 7.7. The AHU control can use these values for an individual algorithm to perform the WARMUP or PRE_COOL mode.

Terminal Load:

This displays the current *Terminal Load* of this dedicated VAV controller (see chapter 7.5.6.4) if it is set as the VAV Group “Master” (see chapter 7.6.2.4). This will be aggregated as the maximum and the minimum terminal load of all VAV controllers (“Masters”) in the area chain to the manager by the AHU communication, if the data aggregation is enabled for this device, see chapter 7.6.1.2. The summary aggregation is also using the weight factor, see chapter 7.6.1.3. The aggregation of the values of this dedicated VAV controller will be performed only if the space temperature sensor function is configured and the device is the “Master” in a VAV Group. The results of this maximum and minimum aggregation of this manager area, that are communicated to the AHU can be watched on the regarding tile in the manager, see chapter 7.7. The AHU control can use these values for e.g. the supply air temperature setpoint reset.

Damper Position Supply:

This displays the current *Control Output* of the Air Flow Controller of this dedicated VAV controller, see chapter 7.5.5.3. It is displayed, if the *Air Function* of the VAV controller is “Supply Air” set in the VAV Group settings, see chapter 7.6.2.1. This value will be aggregated as the maximum supply damper position of all VAV controllers in the area chain to the manager by the AHU communication, if the data aggregation is enabled for this device, see chapter 7.6.1.2. The result of this maximum aggregation of this manager area, that is communicated to the AHU can be watched on the regarding tile in the manager, see chapter 7.7. The AHU control can use this value e.g. for the supply air static pressure setpoint reset.

Damper Position Exhaust:

This displays the current *Control Output* of the Air Flow Controller of this dedicated VAV controller, see chapter 7.5.5.3. It is displayed, if the *Air Function* of the VAV controller is “Exhaust Air” set in the VAV Group settings, see chapter 7.6.2.1. This value will be aggregated as the maximum exhaust damper position of all VAV controllers in the area chain to the manager by the AHU communication, if the data aggregation is enabled for this device, see chapter 7.6.1.2. The result of this maximum aggregation of this manager area, that is communicated to the AHU can be watched on the regarding tile in the manager, see chapter 7.7. The AHU control can use this value e.g. for the exhaust air static pressure setpoint reset.

Air Quality (CO2):

This displays the current *CO_2 damped* value of this dedicated VAV controller, see chapter 7.5.8.4. This will be aggregated as the maximum CO2 concentration of all VAV controllers in the area chain to the manager by the AHU communication, if the data aggregation is enabled for this device, see chapter 7.6.1.2. The result of this maximum aggregation of this manager area, that is communicated to the AHU can be watched on the regarding tile in the manager, see chapter 7.7. The AHU control can use this value e.g. for the outdoor air damper control.

Space Temperature:

This displays the current *Space Temperature* of this dedicated VAV controller (see chapter 7.5.6) if it is set as the VAV Group “Master” (see chapter 7.6.2.4). This will be aggregated as the minimum and maximum and the summary of the space temperatures of all VAV controllers (“Masters”) in the area chain to the manager by the AHU communication, if the data aggregation is enabled for this device, see chapter 7.6.1.2. The summary aggregation is also using the weight factor, see chapter 7.6.1.3. The aggregation of the values of this dedicated VAV controller will be performed only if the space temperature sensor function is configured and the device is the “Master” in a VAV Group. The results of this aggregation of this manager area, that is communicated to the AHU can be watched on the regarding tile in the manager, see chapter 7.7. The AHU control can use these values e.g. for the supply air temperature setpoint reset.

Space Temp. Available:

This displays if the space temperature sensor function is configured in this dedicated VAV controller or of the VAV Group “Master” (see chapter 7.6.2.4). If Yes, then the aggregation of the Space Temperature of this VAV controller to the values of the other VAV controllers in the chain is executed. If No, then the aggregation of the space temperature values is executed without the values of this dedicated VAV controller.

Effective Setpoint:

This displays the current *Effective Setpoint* (of space temp.) of this dedicated VAV controller (see chapter 7.5.6) if it is set as the VAV Group “Master” (see chapter 7.6.2.4). This will be aggregated as the minimum and maximum and the summary of the effective setpoints of all VAV controllers (“Masters”) in the area chain to the manager by the AHU communication, if the data aggregation is enabled for this device, see chapter 7.6.1.2. The summary aggregation is also using the weight factor, see chapter 7.6.1.3. The aggregation of the values of this dedicated VAV controller will be performed only if the space temperature function is configured and the device is the “Master” in a VAV Group. The results of this aggregation of this manager area, that is communicated to the AHU can be watched on the regarding tile in the manager, see chapter 7.7. The AHU control can use these values e.g. for the supply air temperature setpoint reset.

Effective Setpoint Available:

This displays if the space temperature sensor function is configured in this dedicated VAV controller or of the VAV Group “Master” (see chapter 7.6.2.4). If Yes, then the aggregation of the effective setpoint of this VAV controller to the values of the other VAV controllers in the chain is executed. If No, then the aggregation of the space temperature values is executed without the values of this dedicated VAV controller.

Setback Override:

This displays the current *Occ. Override Status* of this dedicated VAV controller, (see chapter 7.5.12) or of the VAV Group “Master” (see chapter 7.6.2.4). This will be aggregated as the maximum Override status (= Active) of all VAV controllers (“Masters”) in the area chain to the manager by the AHU communication, if the data aggregation is enabled for this device, see chapter 7.6.1.2. The result of this maximum aggregation of this manager area, that is communicated to the AHU can be watched on the regarding tile in the manager, see chapter 7.7. The AHU control can use this value e.g. as a request for operation.

Relative Humidity:

This displays the current *Relative Humidity* of this dedicated VAV controller (see chapter 7.5.9.4) or of the VAV Group “Master” (see chapter 7.6.2.4). This will be aggregated as the minimum and maximum and the summary of the humidities of all VAV controllers (“Masters”) in the area chain to the manager by the AHU communication, if the data aggregation is enabled for this device, see chapter 7.6.1.2. The summary aggregation is also using the weight factor, see chapter 7.6.1.3. The aggregation of the values of this dedicated VAV controller will be performed only if the relative humidity sensor function is configured. The results of this aggregation of this manager area, that is communicated to the AHU can be watched on the regarding tile in the manager, see chapter 7.7. The AHU control can use these values e.g. for the supply air humidity setpoint reset.

Relative Humidity Available:

This displays if the relative humidity sensor function is configured in this dedicated VAV controller or of the VAV Group “Master” (see chapter 7.6.2.4). If Yes, then the aggregation of the humidity of this VAV controller to the values of the other VAV controllers in the chain is executed. If No, then the aggregation of the humidity values is executed without the values of this dedicated VAV controller.

Air Flow Supply:

This displays the current *Air Flow* value of this dedicated VAV controller, see chapter 7.5.5.3. It is displayed, if the *Air Function* of the VAV controller is “Supply Air” set in the VAV Group settings, see chapter 7.6.2.1. This will be aggregated as the summary supply air flow of all VAV controllers in the area chain to the manager by the AHU communication, if the data aggregation is enabled for this device, see chapter 7.6.1.2. The result of this summary aggregation of this manager area, that is communicated to the AHU can be watched on the regarding tile in the manager, see chapter 7.7. The AHU control can use this value e.g. for the supply fan speed control.

Air Flow Exhaust:

This displays the current *Air Flow* value of this dedicated VAV controller, see chapter 7.5.5.3. It is displayed, if the *Air Function* of the VAV controller is “Exhaust Air” set in the VAV Group settings, see chapter 7.6.2.1. This will be aggregated as the summary exhaust air flow of all VAV controllers in the area chain to the manager by the AHU communication, if the data aggregation is enabled for this device, see chapter 7.6.1.2. The result of this summary aggregation of this manager area, that is communicated to the AHU control can be watched on the regarding tile in the manager, see chapter 7.7. The AHU can use this value e.g. for the exhaust fan speed control.

Outdoor Air Demand:

This displays the *Current Outdoor Air Demand* value of this dedicated VAV controller (see chapter 7.5.9.3) or of the VAV Group “Master” (see chapter 7.6.2.4). It is displayed, if the *Air Function* of the VAV controller is “Supply Air” and the Device Mode is “Master” set in the VAV Group settings, see chapter 7.6.2.1. This value is only valid in case of the IAQ control method 2 is configured. This will be aggregated as the summary outdoor air flow demand of all “Master” VAV controllers in the area chain to the manager by the AHU communication, if the data aggregation is enabled for this device, see chapter 7.6.1.2. The result of this summary aggregation of this manager area, that is communicated to the AHU can be watched on the regarding tile in the manager, see chapter 7.7. The AHU control can use this value e.g. for the outdoor air flow control.

Air Flow Forced:

This function is not supported in the actual version.

Min. Air Flow Forced:

This function is not supported in the actual version.

Values to AHU Method #2

The Values to AHU that are aggregated with the method of class aggregation can be watched on the *AHU Communication* page of the *VAVstatus* visualization project as shown in Figure 366.

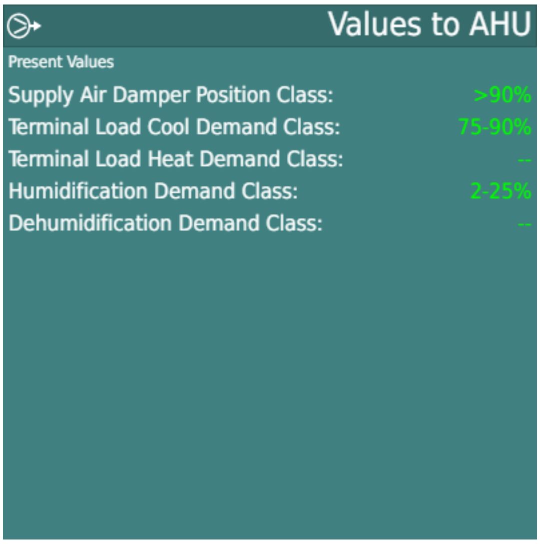

Figure 366: Values to AHU Method #2

Table 188 shows the Values to AHU Method #2 present values.

Path: User Registers.VAVcontrol.Core.AHUcommunication

Name on tile	**Data point name**	**Description**
Supply Air Damper Position Class	SupplyAirDamperPositionClass	Displays the position class of the currant supply air damper position of this VAV controller aggregated to the manager
Exhaust Air Damper Position Class	ExhaustAirDamperPositionClass	Displays the position class of the current exhaust air damper position of this VAV controller aggregated to the manager
Terminal Load Cool Demand Class	TerminalLoadCoolClass	Displays the demand class of the current terminal load cool of this VAV controller aggregated to the manager
Terminal Load Heat Demand Class	TerminalLoadHeatClass	Displays the demand class of the current terminal load heat of this VAV controller aggregated to the manager
Humidification Demand Class	HumidificationDemandClass	Displays the demand class of the current humidification Demand of this VAV controller

Name on tile	Data point name	Description
		aggregated to the manager
Dehumidification Demand Class	DehumidificationDemandClass	Displays the demand class of the current dehumidification Demand of this VAV controller aggregated to the manager

Table 189: Values to AHU Method #2 present values

Supply Air Damper Position Class:

This displays the position class (0-25%, 25-50%, 50-75%, 75-90%, >90%) of the current *Control Output* of the Air Flow Controller of this dedicated VAV controller, see chapter 7.5.5.3. It is displayed, if the *Air Function* of the VAV controller is “Supply Air” set in the VAV Group settings, see chapter 7.6.2.1. If the aggregation is enabled for this device (see chapter 7.6.1.2), this position class will be aggregated as the dedicated summary of all supply air position classes of all VAV controllers in the area chain to the manager by the AHU communication. The position class number is counted multiplied with the weight factor for this device, see chapter 7.6.1.3. The result of this position class count of this manager area, that is communicated to the AHU can be watched on the regarding tile in the manager, see chapter 7.7. The AHU control can use this value as a “call” e.g. for the supply air static pressure setpoint reset.

Exhaust Air Damper Position Class:

This displays the position class (0-25%, 25-50%, 50-75%, 75-90%, >90%) of the current *Control Output* of the Air Flow Controller of this dedicated VAV controller, see chapter 7.5.5.3. It is displayed, if the *Air Function* of the VAV controller is “Exhaust Air” set in the VAV Group settings, see chapter 7.6.2.1. If the aggregation is enabled for this device (see chapter 7.6.1.2), this position class will be aggregated as the dedicated summary of all exhaust air position classes of all VAV controllers in the area chain to the manager by the AHU communication. The position class number is counted multiplied with the weight factor for this device, see chapter 7.6.1.3. The result of this position class count of this manager area, that is communicated to the AHU can be watched on the regarding tile in the manager, see chapter 7.7. The AHU control can use this value as a “call” e.g. for the exhaust air static pressure setpoint reset.

Terminal Load Cool Demand Class:

This displays the demand class (2-25%, 25-50%, 50-75%, 75-90%, >90%) of the current *Terminal Load* of cooling of this dedicated VAV controller (see chapter 7.5.6.4) if it is set as the VAV Group “Master” (see chapter 7.6.2.4). If the aggregation is enabled for this device (see chapter 7.6.1.2), this demand class will be aggregated as the dedicated summary of all terminal load cool demand classes of all VAV Group “Masters” in the area chain to the manager by the AHU communication. The demand class number is counted multiplied with the weight factor for this device, see chapter 7.6.1.3. The result of this demand class count of this manager area, that is communicated to the AHU can be watched on the regarding tile in the manager, see chapter 7.7. The AHU control can use this value as a “call” e.g. for e.g. the supply air temperature setpoint reset.

Terminal Load Heat Demand Class:

This displays the demand class (2-25%, 25-50%, 50-75%, 75-90%, >90%) of the current *Terminal Load* of heating of this dedicated VAV controller (see chapter 7.5.6.4) if it is set as the VAV Group “Master” (see chapter 7.6.2.4). If the aggregation is enabled for this device (see chapter 7.6.1.2), this demand class will be aggregated as the dedicated summary of all terminal load heat demand classes of all VAV Group “Masters” in the area chain to the manager by the AHU communication. The demand class number is counted multiplied with the weight factor for this device, see chapter 7.6.1.3. The result of this demand class count of this manager area, that is communicated to the AHU can be watched on the regarding tile in the manager, see chapter 7.7. The AHU control can use this value as a “call” e.g. for e.g. the supply air temperature setpoint reset.

Humidification Demand Class:

This displays the demand class (2-25%, 25-50%, 50-75%, 75-90%, >90%) of the current *Humidification Demand Output* of this dedicated VAV controller (see chapter 7.5.10.2) if it is set as the VAV Group “Master” (see chapter 7.6.2.4). If the aggregation is enabled for this device (see chapter 7.6.1.2), this demand class will be aggregated as the dedicated summary of all humidification demand classes of all VAV Group “Masters” in the area chain to the manager by the AHU communication. The demand class number is counted multiplied with the weight factor for this device, see chapter 7.6.1.3. The result of this demand class count of this manager area, that is communicated to the AHU can be watched on the regarding tile in the manager, see chapter 7.7. The AHU control can use this value as a “call” e.g. for e.g. the supply air humidity setpoint reset.

Dehumidification Demand Class:

This displays the demand class (2-25%, 25-50%, 50-75%, 75-90%, >90%) of the current *Dehumidification Demand Output* of this dedicated VAV controller (see chapter 7.5.10.2) if it is set as the VAV Group “Master” (see chapter 7.6.2.4). If the aggregation is enabled for this device (see chapter 7.6.1.2), this demand class will be aggregated as the dedicated summary of all humidification demand classes of all VAV Group “Masters” in the area chain to the manager by the AHU communication. The demand class number is counted multiplied with the weight factor for this device, see chapter 7.6.1.3. The result of this demand class count of this manager area, that is communicated to the AHU can be watched on the regarding tile in the manager, see chapter 7.7. The AHU control can use this value as a “call” e.g. for e.g. the supply air humidity setpoint reset.

Values from AHU

As described in chapter 7.5.2 the manager communicates to the AHU control using standard communication as BACnet or OPC. All the data the manager is receiving from the AHU control, it sends out to the VAV controllers like a broadcast using the internal serial communication. The VAV controllers are operating their control functions regarding to the information received from the manager.

The values that are communicated from the manager and received by a dedicated VAV controller can be watched on the *AHU Communication* page of the *VAVstatu*s visualization project as shown in Figure 367.

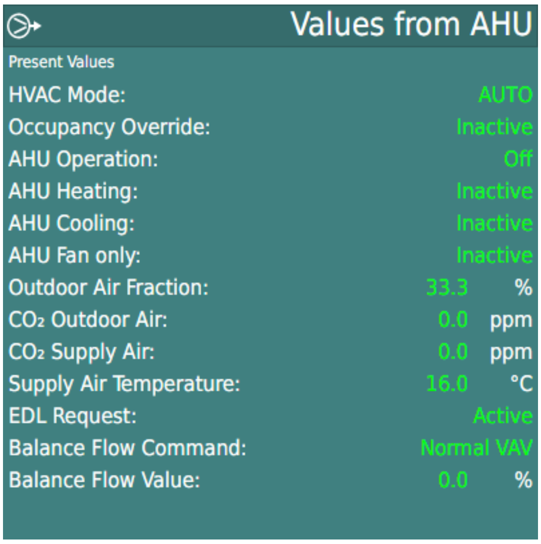

Figure 367: Values from AHU

Table 190 shows the Values from AHU present values.

Path: User Registers.VAVcontrol.Core.AHUcommunication

Name on tile	Data point name	Description
HVAC Mode	HvacModeFromAHU	Displays the HVAC Mode sent by the manager to the VAV controller
Occupancy Override	OccupOverrideFromAHU	Displays the Occupancy Override sent by the manager to the VAV controller
AHU Operation	OnOffFromAHU	Displays the AHU Operation contact sent by the manager to the VAV controller
AHU Heating	HeatingFromAHU	Displays the AHU Heating contact sent by the manager to the VAV controller
AHU Cooling	CoolingFromAHU	Displays the AHU Cooling contact sent by the manager to the VAV

Name on tile	Data point name	Description
		controller
AHU Fan only	FanOnlyFromAHU	Displays the AHU Fan only contact sent by the manager to the VAV controller
Outdoor Air Fraction	OutdoorAirFractionFromAHU	Displays the Outdoor Air Fraction sent by the manager to the VAV controller
CO_2 Outdoor Air	CO2outdoorAirFromAHU	Displays the CO_2 concentration of the outdoor air sent by the manager to the VAV controller
CO_2 Supply Air	CO2supplyAirFromAHU	Displays the CO_2 concentration of the supply air sent by the manager to the VAV controller
Supply Air Temperature	SupplyAirTempFromAHU	Displays the primary supply air temperature sent by the manager to the VAV controller
EDL Request	EnergyDemandLimitFromAHU	Displays the Energy Demand Limiting request sent by the manager to the VAV controller
Balance Flow Command	BalanceFlowCmdFromAHU	Displays the balance flow command sent by the manager to the VAV controller
Balance Flow Value	BalanceFlowValueFromAHU	Displays the balance flow value sent by the manager to the VAV controller

Table 190: Values from AHU present values

HVAC Mode:

This displays the *HVAC Mode* that is sent by the manager and received by the dedicated VAV controller. The VAV controller operates this information as *HVAC Mode from AHU* in the HVAC Mode Control, see chapter 7.5.11.1.

Occupancy Override:

This displays the *Occupancy Override* that is sent by the manager and received by the dedicated VAV controller. The VAV controller operates this information as *Occupancy Override from AHU* in the Effective Occupancy Control, see chapter 7.5.12.

AHU Operation:

This displays the contact *AHU Operation* that is sent by the manager and received by the dedicated VAV controller. It is a dry contact on the Local I/O of the manager, which is controlled by the AHU control. The VAV controller operates this information as *AHU Operation* in the HVAC Mode Control, contacts from AHU, see chapter 7.5.11.1.

AHU Heating:

This displays the contact *AHU Heating* that is sent by the manager and received by the dedicated VAV controller. It is a dry contact on the Local I/O of the manager that is controlled by the AHU control. The VAV controller operates this information as *AHU Heating* in the HVAC Mode Control, contacts from AHU, see chapter 7.5.11.1.

AHU Cooling:

This displays the contact *AHU Cooling* that is sent by the manager and received by the dedicated VAV controller. It is a dry contact on the Local I/O of the manager that is controlled by the AHU control. The VAV controller operates this information as *AHU Cooling* in the HVAC Mode Control, contacts from AHU, see chapter 7.5.11.1.

AHU Fan only:

This displays the contact *AHU Fan only* that is sent by the manager and received by the dedicated VAV controller. It is a dry contact on the Local I/O of the manager that is controlled by the AHU control. The VAV controller operates this information as *AHU Fan only* in the HVAC Mode Control, contacts from AHU, see chapter 7.5.11.1.

Outdoor Air Fraction:

This displays the *Outdoor Air Fraction* that is sent by the manager and received by the dedicated VAV controller. The VAV controller operates this information as *Outdoor Air Fraction (from AHU)* in the IAQ Control (Method 2), see chapter 7.5.9.3.

CO_2 Outdoor Air:

This displays the CO2 concentration of the outdoor air that is sent by the manager and received by the dedicated VAV controller. This information is not operated in the VAV controller actually. It is meant for future purposes probably in the in the IAQ Control, see chapter 7.5.8.4.

CO_2 Supply Air:

This displays the CO2 concentration of the supply air that is sent by the manager and received by the dedicated VAV controller. This information is not operated in the VAV controller actually. It is meant for future purposes probably in the in the IAQ Control, see chapter 7.5.8.4.

Supply Air Temperature:

This displays the primary supply air of the AHU that is sent by the manager and received by the dedicated VAV controller. The VAV controller operates this information in the plenum temperature function.

EDL Request:

This displays the Energy Demand Limiting request of the AHU that is sent by the manager and received by the dedicated VAV controller. The VAV controller operates this information to raise the cooling setpoint if this request is active.

Balance Flow Command:

This displays the *Balance Flow Command* that is sent by the manager and received by the dedicated VAV controller. The VAV controller operates this information for the flow setpoint selection in the air flow control. This is only for commissioning purposes, see chapter 7.5.5.3.

Balance Flow Value:

This displays the *Balance Flow Value* that is sent by the manager and received by the dedicated VAV controller. The VAV controller operates this information for the flow setpoint selection in the air flow control in case the Balance Flow Command is “Flow Value”. This is only for commissioning purposes, see chapter 7.5.5.3.

7.6.2 VAV Group Communication

The basic functions of the “VAV Groups” are described in chapter 7.5.3.

In the following chapter, the details of the group functions are described.

“VAV Groups” have to be configured if there are multiple VAV-Boxes in a room.

7.6.2.1 Configuring a VAV Group

A “VAV Group” can be configured very easily during the runtime of the VAV controllers. There are only a few parameters to be set in the *VAVstatus* visualization project. These are the *Room ID* (e.g. Room111), the *Device Mode* (Master or Slave) and the *Air Function* (Supply or Exhaust).

The main information of the VAV Group configuration is shown on the *Status Overview* page of the *VAVstatus* visualization project as shown in Figure 368.

Figure 368: VAV Group tile in Status Overview

At the first sight the user can see that this VAV controller is member of the “Room111” *Room ID*, in this room the *Zone ID* is “A”, this controller is the “Master” *Device Mode* of the group and the *Air Function* is of this controller is “Supply Air”.

<u>Setting the Room ID and the Zone ID:</u>

The VAV Group communication is part of the serial communication system of the LIOB-AIR system. These are the same communication mechanisms that are operating in the LOYTEC L-ROC room control system. In this philosophy, a VAV controller supports a segment. (An L-ROC controller supports up to 16 segments). To establish the basic communication between multiple VAV controllers the VAV Box Segment Data has to be set as described in chapter 7.5.4 Device Data. Please refer to this chapter for more information. **These settings have to be done anyway, no matter if the VAV-Box is part of a group or not!**

It is displayed in this chapter again for a better understanding.

The basic communication configuration can be done on the *VAV Box General Settings* page of the *VAVstatus* visualization project as shown in Figure 369.

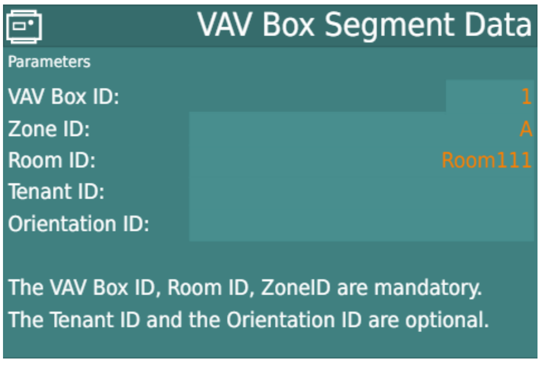

Figure 369: VAV Box segment data

Table 191 shows the VAV Box Segment Data parameters.

Path: User Registers.VAVcontrol.Core.SegmentCoupler.HmiLWeb

Name on tile	**Data point name**	**Default**	**Description**
VAV Box ID	idSeg idSegFb	--	Definition of the Segment ID Important: must have a valid number!
Zone ID	VAVgroupZoneId	A	Definition of the Zone ID Must be se same in a VAV Group
Room ID	idRoom idRoomFb	--	Definition of the Room ID. Controllers with the same Room ID build a VAV Group

Table 191: VAV Box segment data parameters

VAV Box ID:

This is the segment ID of the room in the serial communication system. In LIOB-AIR systems, every VAV controller supports one segment. This parameter is the most important one to be set to enable the serial communication system to work! Due to compatibility reasons to the L-ROC system, it does not have a default value. It can be set to any number but it must not be empty. The user can enter a unique number to every dedicated device for a good order and overview. However, it will also work for VAV only systems if every VAV controller gets the same segment ID e.g. “1”.

Zone ID:

This ID divides the room into multiple zones. This parameter exists because of compatibility reasons to the L-ROC system. In VAV systems, multiple zones in a room are not supported, because it is only useful to have one space temperature controller and one IAQ controller in a room. So the default value of the Zone ID is “A” and it should not be changed to gain a proper communication function.

Room ID:

This is the name of the room. This parameter needs to be entered if multiple VAV controllers have to collaborate in a VAV Group. The group communication is established automatically between all VAV controllers that have the same *Room ID*.

VAV Group Settings:

While the Room ID and the Zone ID have to be set on the *VAV Box General Settings* page, the other VAV Group Settings have to be done on the *VAV Group Configuration* page of the *VAVstatus* visualization project as shown in Figure 370.

These settings are only valid especially to the VAV Group Function. There are the *Device Mode*, which decides if the device is “Master” or “Slave” in a VAV Group and the *Air Function* that defines if the device is operating “Supply Air” or “Exhaust Air”. There are further settings in a “Master” device that are needed to calculate the air flow setpoints for existing exhaust “Slave” boxes. In addition, a setting defines in a “Master”, if the group will perform an Occupancy Override from AHU.

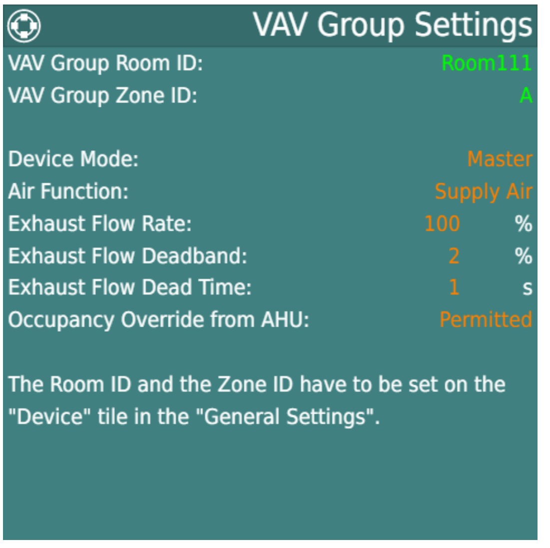

Figure 370: VAV Group Settings

Table 192 shows the VAV Group settings present values.

Path: User Registers.VAVcontrol.Core.Group

Name on tile	Data point name	Description
VAV Group Room ID	idRoomFb	Displays the current Room ID that was set in the VAV Box Segment Data
VAV Group Zone ID	VAVgroupZoneId	Displays the current Zone ID that was set in the VAV Box Segment Data

Table 192: VAV Group Settings present values

VAV Group Room ID:

This displays the current value of the *Room ID* that was set in the *VAV Box Segment Data*. This is the name of the room. The group communication is established automatically between all VAV controllers that have the same *Room ID*.

VAV Group Zone ID:

This displays the current value of the *Zone ID* that was set in the *VAV Box Segment Data*.

Table 193 shows the VAV Group settings parameters.

Path: User Registers.VAVcontrol.Core.Group

Name on tile	Data point name	Default	Description
Device Mode	VAVgroupDeviceMode	Master	Definition of the device mode Master or Slave
Air Function	VAVgroupAirFunction	Supply Air	Definition of the Air Function Supply Air or Exhaust Air
Exhaust Flow Rate	VAVgroupExhaustFlowRate	100%	Definition of the exhaust air flow rate in relation to the summary of the supply air flow.
Exhaust Flow Deadband	VAVgroupExhaustFlowDeltaSend	2%	Definition of the dead band a new exhaust air setpoint is sent to the slaves
Exhaust Flow Dead Time	VAVgroupExhaustFlowTimeSend	1s	Definition of the dead time a new exhaust air setpoint is sent to the slaves
Occupancy Override from AHU	VAVgroupOccupOverridePermit	Prohibited	Definition if Occupancy Override from AHU is permitted for the group or not.

Table 193: VAV Group Settings parameters

Device Mode:

This defines if the device is acting as a “Master” or a “Slave” device. See Table 8 in chapter 7.5.3 to see which functions are performed by a “Master” and a “Slave”. The main control functions are operated in the “Master” and the control outputs are communicated to the “Slaves” automatically. The Slaves are operating the sequences and the control of their local sensors and actuators based on the leading signals of the “Master”.

Air Function:

This defines if the device is acting as a “Supply Air” or an “Exhaust Air” box. Supply boxes do operate their configured equipment as reheats and fans and dampers depending on their sequences based on the leading signals of the “Master”. Exhaust boxes are performing the air flow control only depending on the air flow setpoints calculated by the “Master”. Please note that there is no need to create an extra VAV_Type for the exhaust boxes, see chapter 7.1.4. If a device is set as exhaust during the runtime it will only operate the own air flow control with the local pressure sensor and the local damper actuator.

Exhaust Flow Rate:

This parameter is only displayed if the *Device Mode* is “Master”. It is only important if there are exhaust boxes configured in the VAV Group. The master is aggregating the current air flow values of all supply boxes in the group. The *Exhaust Flow Rate* defines the rate how much air flow is needed in the exhaust boxes.

Exhaust Flow Rate = 100% means the current air exhaust flow setpoint is always equal to the summary of all current supply air flow values. Therefore, the room is operating with neutral pressure.

Exhaust Flow Rate < 100% means the current air exhaust flow setpoint is always less than the summary of all current supply air flow values. Therefore, the room is operating with over pressure.

Exhaust Flow Rate > 100% means the current air exhaust flow setpoint is always greater than the summary of all current supply air flow values. Therefore, the room is operating with under pressure.

Exhaust Flow Deadband:

This parameter is only displayed if the *Device Mode* is “Master”. It is only important if there are exhaust boxes configured in the VAV Group. The “Master” is sending a new exhaust air flow setpoint to the exhaust “Slaves”, if the setpoint change is bigger than the *Exhaust Flow Deadband*. Together with the *Exhaust Flow Dead Time*, it reduces the number of setpoint changes and it cares for a stable and proper exhaust air flow control.

Exhaust Flow Dead Time:

This parameter is only displayed if the *Device Mode* is “Master”. It is only important if there are exhaust boxes configured in the VAV Group. The “Master” is sending a new exhaust air flow setpoint to the exhaust “Slaves” not faster than the *Exhaust Flow Dead Time*. Together with the *Exhaust Flow Deadband*, it reduces the number of setpoint changes and it cares for a stable and proper exhaust air flow control.

Occupancy Override from AHU:

This parameter is only displayed if the *Device Mode* is “Master”. It defines, in case the AHU is requesting an occupancy override during unoccupied times, if the group is permitted to be occupancy overridden or not. To ensure a minimum air flow through the ductwork if the AHU is requested by an occupancy override in a room during unoccupied times, the AHU can trigger an *Occupancy Override from AHU* to all VAV Boxes.

7.6.2.2 Values communicated between Master and Slaves

To realize the control functions in a VAV Group lots of values have to be communicated between the “Master” and the “Slaves”. As described in chapter 7.5.3, the main control functions are operated in the “Master” and the control outputs are communicated to the “Slaves” automatically. The Slaves are operating the sequences and the control of their local sensors and actuators based on the leading signals of the “Master”, see Figure 371

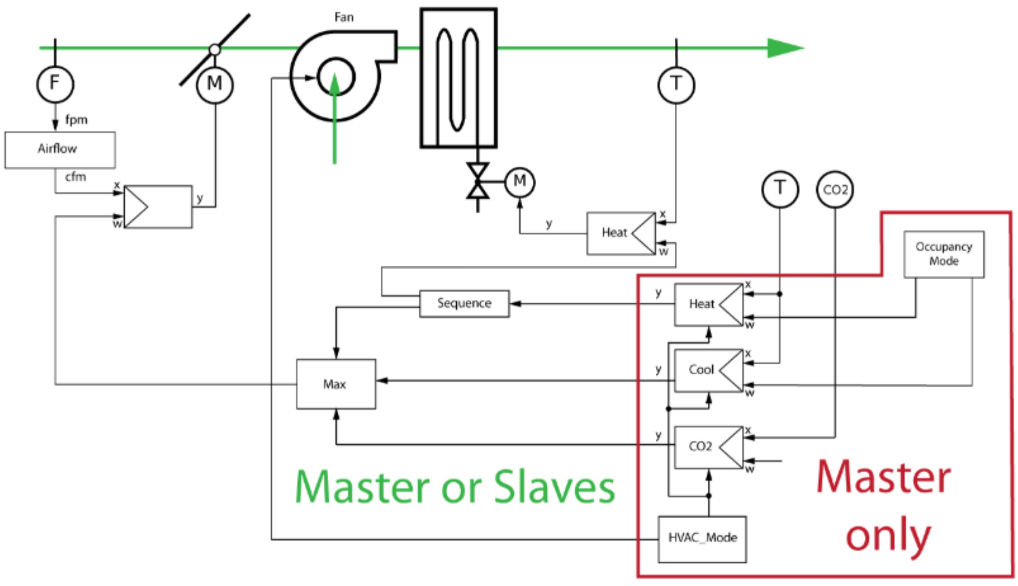

Figure 371: Functions in Master and Slave

The values that are communicated between the “Master” and the “Slaves” can be watched on the *VAV-Group-Slave Values* page of the *VAVstatus* visualization project on the “Master” and the “Slave” devices as shown in Figure 372. Because this tile can be watched in the “Master” and the “Slaves”, it got the name: *VAV-Group-Slave Values*. Please note that there are so much data points to be displayed that it needs two separate tiles *VAV-Group-Slave Values (1)* and *VAV-Group-Slave Values (2)* to present the information.

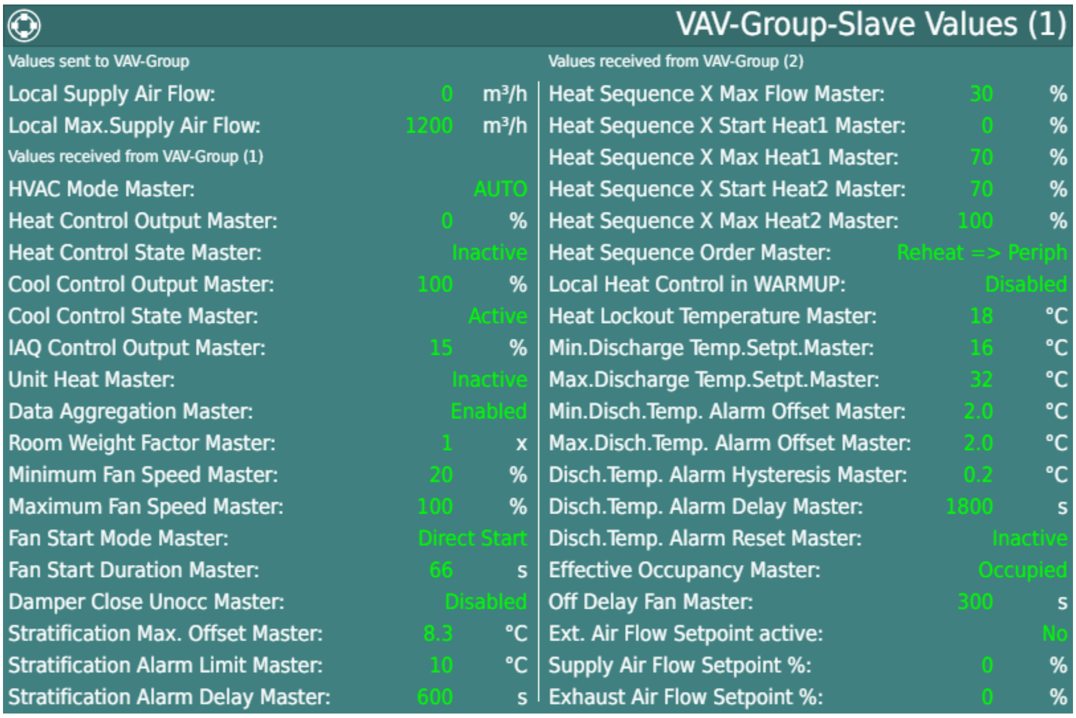

Figure 372: VAV-Group-Slave-Values (1)

Table 194 shows the VAV-Group-Slave-Values (1) present values (left side of the tile).

Path: User Registers.VAVcontrol.Core.Group

Name on tile	Data point name	Description
Local Supply Air Flow	SupplyAirFlowLocal	Displays the current supply air flow of this device that is sent to the Master
Local Exhaust Air Flow	ExhaustAirFlowLocal	Displays the current exhaust air flow of this device that is sent to the Master
Local Max.Supply Air Flow	MaxAirFlowCoolingLocal	Displays the maximum supply air flow of this device that is sent to the Master
Local Max.Exhaust Air Flow	MaxAirFlowCoolingLocal	Displays the maximum exhaust air flow of this device that is sent to the Master
HVAC Mode Master	HvacModeGroup	Displays the HVAC Mode that is sent from the Master to the Slaves

Name on tile	Data point name	Description
Heat Control Output Master	HeatControlMaster	Displays the space temp. heating controller output that is sent from the Master to the Slaves
Cool Control Output Master	CoolControlMaster	Displays the space temp. cooling controller output that is sent from the Master to the Slaves
IAQ Control Output Master	IAQcontrol	Displays the IAQ controller output that is sent from the Master to the Slaves
Unit Heat Master	UnitHeatActiveMaster	Displays the AHU is providing warm air, that is sent from the Master to the Slaves
Data Aggregation Master	EnableAggregation	Displays if the data aggregation is enabled
Room Weight Factor Master	WeightFactorRoom	Displays the weight factor of data aggregation data aggregation is enabled
Minimum Fan Speed Master	MinFanSpeed	Displays the minimum fan speed of the master
Maximum Fan Speed Master	MaxFanSpeed	Displays the maximum fan speed of the master
Fan Start Mode Master	FanStartMode	Displays the fan start mode of the master
Fan Start Duration Master	StartDuration	Displays the fan start duration of the master
Damper Close Unocc Master	DamperCloseUnocc	Displays if the function to close the damper in unocc mode is enabled in the master or not
Stratification Max. Offset Master	StratificationMaxOffset	Displays the maximum difference the discharge temperature can be warmer than the space in the master
Stratification Alarm Limit Master	StratificationAlarmLimit	Displays the current maximum limit of the *Discharge Over Temperature* in the master.
Stratification Alarm Delay Master	StratificationAlarmDelay	Displays the current time delay of the stratification alarm in the master.

Table 194: VAV-Group-Slave-Values (1) present values (left side of the tile)

Local Supply Air Flow:

This is only displayed if the *Air Function* is set to “Supply Air”. It shows the current supply air flow of this dedicated VAV-Box. All the current supply air flows are accumulated in the VAV-Group and sent to the “Master”. This accumulated value can be watched on *Summary Supply Air Flow* in the “Master” device on the *VAV-Group-Master Values* tile. This is used by the “Master” to calculate the *Exhaust Air Flow Setpoint.*

Local Exhaust Air Flow:

This is only displayed if the *Air Function* is set to “Exhaust Air”. It shows the current exhaust air flow of this dedicated VAV-Box. All the current exhaust air flows are accumulated in the VAV-Group and sent to the “Master”. This accumulated value can be watched on *Summary Exhaust Air Flow* in the “Master” device on the *VAV-Group-Master Values* tile. This is used by the “Master” for information purposes only.

Local Max.Supply Air Flow:

This is only displayed if the *Air Function* is set to “Supply Air”. It shows the maximum supply air flow of this dedicated VAV-Box (taken from *Max. Flow Cool*). All the maximum supply air flows are accumulated in the VAV-Group and sent to the “Master”. This accumulated value can be watched on *Summary Supply Max. Air Flow* in the “Master” device on the *VAV-Group-Master Values* tile. This is used by the “Master” to calculate the *Exhaust Air Flow Setpoint.*

Local Max.Exhaust Air Flow:

This is only displayed if the *Air Function* is set to “Exhaust Air”. It shows the maximum exhaust air flow of this dedicated VAV-Box (taken from *Max. Flow Cool*). All the maximum exhaust air flows are accumulated in the VAV-Group and sent to the “Master”. This accumulated value can be watched on *Summary Exhaust Max. Air Flow* in the “Master” device on the *VAV-Group-Master Values* tile. This is used by the “Master” for information purposes only.

HVAC Mode Master:

This displays the current HVAC Mode that is sent from the “Master” and received by the “Slaves”. The “Master” receives the *HVAC Mode from AHU* and performs the HVAC Mode Control Status as described in chapter 7.5.11.1. It sends the *HVAC Mode Master* to the “Slaves”, where the regarding functions are executed. See chapter 7.5.11.2 for details of the Functions of HVAC Mode. The Slaves do not receive the *HVAC Mode from AHU* and do not perform an HVAC Mode Control Status.

Heat Control Output Master:

This displays the current space temperature heating controller output that is sent from the “Master” and received by the “Slaves”. As described above, the “Master” device only executes the space temperature control function with cooling and heating. The “Slaves” do not perform a space temperature control. The control outputs of the cooling and heating controllers are communicated from the “Master” to all “Slaves” in the group. The sequence functions to reset the air flow setpoints, control reheat and peripheral heat valves or reset a discharge air temperature setpoint or request fan operations are operated in the “Slaves” according to the control outputs of the “Master”.

Cool Control Output Master:

This displays the current space temperature cooling controller output that is sent from the “Master” and received by the “Slaves”. More details see *Heat Control Output Master*.

IAQ Control Output Master:

This displays the current IAQ controller output that is sent from the “Master” and received by the “Slaves”. See chapter 7.5.8.4 for a detailed description of the group functions in the two methods of IAQ control. The “Slaves” do not perform an IAQ control but they only follow the control output of the “Master”.

Unit Heat Master:

The *Unit Heat Master* indicates if the AHU is in heating mode and is supplying warm air. This is recognized if the manager receives the HVAC_Modes HEAT or MRNG_WRMUP from the AHU control. This is only performed in the “Master” device and sent to the “Slave”. See chapter 7.5.6.5 for more details. This is used by the “Slaves” for information purposes only.

Data Aggregation Master:

This displays if the device is enabled for data aggregation. The most functions of data aggregation are operated by the “Master”. However, some individual functions like aggregation of damper positions or air flow values are aggregated is every device no matter if it is “Master” or “Slave”. For that purpose, this information if data aggregation is enabled is communicated to every device of the VAV Group. See chapter 7.6.1.2 for more details.

Room Weight Factor Master:

This displays the weight factor of the room used for data aggregation. The most functions of data aggregation are operated by the “Master”. However, some individual functions like aggregation of damper positions or air flow values are aggregated is every device no matter if it is “Master” or “Slave”. For that purpose, this weight factor is communicated to every device of the VAV Group. See chapter 7.6.1.3 for more details.

Minimum Fan Speed Master:

This displays the minimum fan speed that is parameterized on the “Master” device. This value is used only if an ECM variable speed fan is configured. The fan speed will not undershoot this limit. See chapter 7.5.14 for the details.

Maximum Fan Speed Master:

This displays the maximum fan speed that is parameterized on the “Master” device. This value is used only if an ECM variable speed fan is configured. The fan speed will not rise above this limit. See chapter 7.5.14 for the details.

Fan Start Mode Master:

This displays the fan start mode of the “Master” device. This value is used only if an ECM variable speed fan is configured. The fan will perform a “Direct Start” or a “Smooth Start”. See chapter 7.5.14 for the details.

Fan Start Duration Master:

This displays the fan start duration of the “Master” device. This value is used only if an ECM variable speed fan is configured and the *Fan Start Mode* is “Smoot Start”. It defines the time from min speed to max speed during a smooth fan start. See chapter 7.5.14 for the details.

Damper Close Unocc Master:

This displays if the function to close the damper in unoccupied mode is enabled in the master or not. See chapter 7.5.13.1 for the details.

Stratification Max. Offset:

This displays the maximum difference the discharge temperature can be warmer than the space temperature in the “Master” to prevent stratification of warm air in the room. See chapter 7.5.8.2 for the details.

Stratification Alarm Limit Master:

This displays the current maximum limit of the *Discharge Over Temperature* in the “Master”. See chapter 7.5.8.4 for the details.

Stratification Alarm Delay Master:

This displays the current time delay of the stratification alarm in the “Master”. See chapter 7.5.8.4 for the details.

Table 195 shows the VAV-Group-Slave-Values (1) present values (right side of the tile).

Path: User Registers.VAVcontrol.Core.Group

Name on tile	**Data point name**	**Description**
Heat Sequence X Max Flow Master	HeatSeqXmaxFlowMaster	Displays *Air Flow Heat Sequence* parameter sent from the Master to the Slaves
Heat Sequence X Start Heat1 Master	HeatSeqXstartHeat1Master	Displays *Reheat/ Periph. Sequence* parameter sent from the Master to the Slaves
Heat Sequence X Max Heat1 Master	HeatSeqXmaxHeat1Master	Displays *Reheat/ Periph. Sequence* parameter sent from the Master to the Slaves
Heat Sequence X Start Heat2 Master	HeatSeqXstartHeat2Master	Displays *Reheat/ Periph. Sequence* parameter sent from the Master to the Slaves
Heat Sequence X Max Heat2 Master	HeatSeqXmaxHeat2Master	Displays *Reheat/ Periph. Sequence* parameter sent from the Master to the Slaves
Heat Sequence Order Master	HeatSequenceOrder	Displays *Reheat/ Periph. Sequence* parameter sent from the Master to the Slaves
Local Heat Control in WARMUP	WarmupHeatControlGroup	Displays *HVAC Mode* parameter sent from the Master to the Slaves

Name on tile	Data point name	Description
Heat Lockout Temperature Master	HeatLockoutTemp	Displays *Heat Lockout* parameter sent from the Master to the Slaves
Min.Discharge Temp.Setpt.Master	MinDischTempSetpt	Displays *Discharge Control Setpoints* parameter sent from the Master to the Slaves
Max.Discharge Temp.Setpt.Master	MaxDischTempSetpt	Displays *Discharge Control Setpoints* parameter sent from the Master to the Slaves
Min.Disch.Temp. Alarm Offset Master	DischTempMinAlarmOffset	Displays *Discharge Temperature Alarms* parameter sent from the Master to the Slaves
Max.Disch.Temp. Alarm Offset Master	DischTempMaxAlarmOffset	Displays *Discharge Temperature Alarms* parameter sent from the Master to the Slaves
Disch.Temp. Alarm Hysteresis Master	DischTempAlarmHys	Displays *Discharge Temperature Alarms* parameter sent from the Master to the Slaves
Disch.Temp. Alarm Delay Master	DischTempAlarmDelay	Displays *Discharge Temperature Alarms* parameter sent from the Master to the Slaves
Disch.Temp. Alarm Reset Master	DischTempAlarmReset	Displays *Discharge Temperature Alarms* reset sent from the Master to the Slaves
Off Delay Fan Master	OffDelayFan	Displays *Fan Heat Sequence* parameter sent from the Master to the Slaves
External Air Flow Setpoint Active	SupplyAirFlowSetptActiveMaster	Displays if the external air flow setpoint function is configured in the Master sent from the Master to the Slaves
Supply Air Flow Setpoint %	SupplyAirFlowSetptPrcntMaster	Displays the external Supply Air Flow Setpoint sent from the Master to the Slaves
Exhaust Air Flow Setpoint %	ExhaustAirFlowSetptPrcntMaster	Displays the Exhaust Air Flow Setpoint sent from the Master to the Slaves

Table 195: VAV-Group-Slave-Values (1) present values (right side of the tile)

Heat Sequence X Max Flow Master:

This is the parameter *Heat Sequence X Max Flow* of the *Air Flow Heat Sequence* that is sent from the “Master” to the “Slaves”. Please refer to the regarding definition in *Heat Sequence* of chapter 7.5.15.

Only the “Master” is executing the space temperature control and it sends the *Heat Control Output* to the “Slaves”. The “Slaves” do not execute any space temperature control but they receive the *Heat Control Output* from the “Master” and are operating the *Reheat/ Periph. Sequence* to calculate the *Reheat Control Output* or the *Setpoint Discharge Temp.* and the *Peripheral Heat Control Output*. The “Slaves” are operating the *Air Flow Heat Sequence* based the *Heat Control Output* from the “Master” as well to reset the air flow setpoint accordingly.

These sequence parameters are also sent from the “Master” to the “Slaves” and so they only have to be set in the “Master”: *Heat Sequence X Max Flow, Heat Sequence X Start Heat1*, *Heat Sequence X Max Heat1*, *Heat Sequence X Start Heat2*, *Heat Sequence X Max Heat2*, *Heat Sequence Order 1==>2*, *Min.Discharge Temp.Setpt.*, *Max.Discharge Temp.Setpt.* This ensures that all *Air Flow Heat Sequences Reheat/ Periph. Sequences* of all VAV-Boxes in a room are operating with the same parameter values. Therefore, the parameterization of the *Heat Sequence Parameters* has only to be done on the “Master” device.

Heat Sequence X Start Heat1 Master:

This is the parameter *Heat Sequence X Start Heat1* of the *Reheat/ Periph. Sequence* that is sent from the “Master” to the “Slaves”. Please refer to the regarding definition in *Heat Sequence* of chapter 7.5.15.

Heat Sequence X Max Heat1 Master:

This is the parameter *Heat Sequence X Max Heat1* of the *Reheat/ Periph. Sequence* that is sent from the “Master” to the “Slaves”. Please refer to the regarding definition in *Heat Sequence* of chapter 7.5.15.

Heat Sequence X Start Heat2 Master:

This is the parameter *Heat Sequence X Start Heat2* of the *Reheat/ Periph. Sequence* that is sent from the “Master” to the “Slaves”. Please refer to the regarding definition in *Heat Sequence* of chapter 7.5.15.

Heat Sequence X Max Heat2 Master:

This is the parameter *Heat Sequence X Max Heat2* of the *Reheat/ Periph. Sequence* that is sent from the “Master” to the “Slaves”. Please refer to the regarding definition in *Heat Sequence* of chapter 7.5.15.

Heat Sequence Order Master:

This is the parameter *Heat Sequence Order 1==>2* of the *Reheat/ Periph. Sequence* that is sent from the “Master” to the “Slaves”. Please refer to the regarding definition in *Heat Sequence* of chapter 7.5.15.

Local Heat Control in WARMUP:

This is the parameter *Local Heat Control in WARMUP* of the *HVAC Mode* that is sent from the “Master” to the “Slaves”. Please refer to the regarding definition in *HVAC Mode settings* of chapter 7.5.11.1.

Heat Lockout Temperature Master:

This is the parameter *Reheat Lockout Outdoor Temp.>* of the *Heat Lockout* function that is sent from the “Master” to the “Slaves”. Please refer to the regarding definition in *Heat Lockout* of chapter 7.5.15.

Min.Discharge Temp.Setpt.Master:

This is the parameter *Min.Discharge Temp. Setpoint* of the *Discharge Control Setpoints* that is sent from the “Master” to the “Slaves”. Please refer to the regarding definition in *Heat Sequence* of chapter 7.5.8.2 .

Max.Discharge Temp.Setpt.Master:

This is the parameter *Max.Discharge Temp. Setpoint* of the *Discharge Control Setpoints* that is sent from the “Master” to the “Slaves”. Please refer to the regarding definition in *Heat Sequence* of chapter 7.5.8.2 .

Min.Disch.Temp. Alarm Offset Master:

This is the parameter *Min Alarm Limit Offset* of the *Discharge Temperature Alarms* that is sent from the “Master” to the “Slaves”. Please refer to the regarding definition in *Heat Sequence* of chapter 7.5.8.3 .

Max.Disch.Temp. Alarm Offset Master:

This is the parameter *Max Alarm Limit Offset* of the *Discharge Temperature Alarms* that is sent from the “Master” to the “Slaves”. Please refer to the regarding definition in chapter 7.5.8.3 .

Disch.Temp. Alarm Hysteresis Master:

This is the parameter *Alarm Hysteresis* of the *Discharge Temperature Alarms* that is sent from the “Master” to the “Slaves”. Please refer to the regarding definition chapter 7.5.8.3 .

Disch.Temp. Alarm Delay Master:

This is the parameter *Alarm Time Delay* of the *Discharge Temperature Alarms* that is sent from the “Master” to the “Slaves”. Please refer to the regarding definition chapter 7.5.8.3 .

Disch.Temp. Alarm Reset Master:

This is the value *Alarm Reset* of the *Discharge Temperature Alarms* that is sent from the “Master” to the “Slaves”. Please refer to the regarding definition chapter 7.5.8.3 .

Effective Occupancy Master:

This is the value *Effective Occupancy* that is sent from the “Master” to the “Slaves”. Please refer to the regarding definition chapter 7.5.12.1.

Off Delay Fan Master:

This is the value *Off Delay Time* of the *Fan Heat Sequence* that is sent from the “Master” to the “Slaves”. Please refer to the regarding definition chapter 7.5.14..

External Air Flow Setpoint active:

This shows if the *External Air Flow Setpoint* sensor function is configured in the VAV_Type of the “Master”. It is sent from the “Master” to the “Slaves”. The “Slaves” do not perform their own External Air Flow Setpoint sensor function, but they are led by the “Master” flow setpoint. See chapter 7.5.17 for the details.

Supply Air Flow Setpoint %:

This is the *External Setpoint% effective* resulting from the *External Air Flow Setpoint* sensor function that is sent from the “Master” to the supply air “Slaves”. Please refer to the regarding definition chapter 7.5.17.

Exhaust Air Flow Setpoint %:

This is the *Exhaust Air Flow Setpoint %* resulting from the *Exhaust Air Flow Setpoint Calculation* in the “Master” that is sent from the “Master” to the supply air “Slaves”. Please refer to the regarding definition chapter 7.6.2.3.

Figure 373 shows the tile VAV-Group-Slave-Values (2).

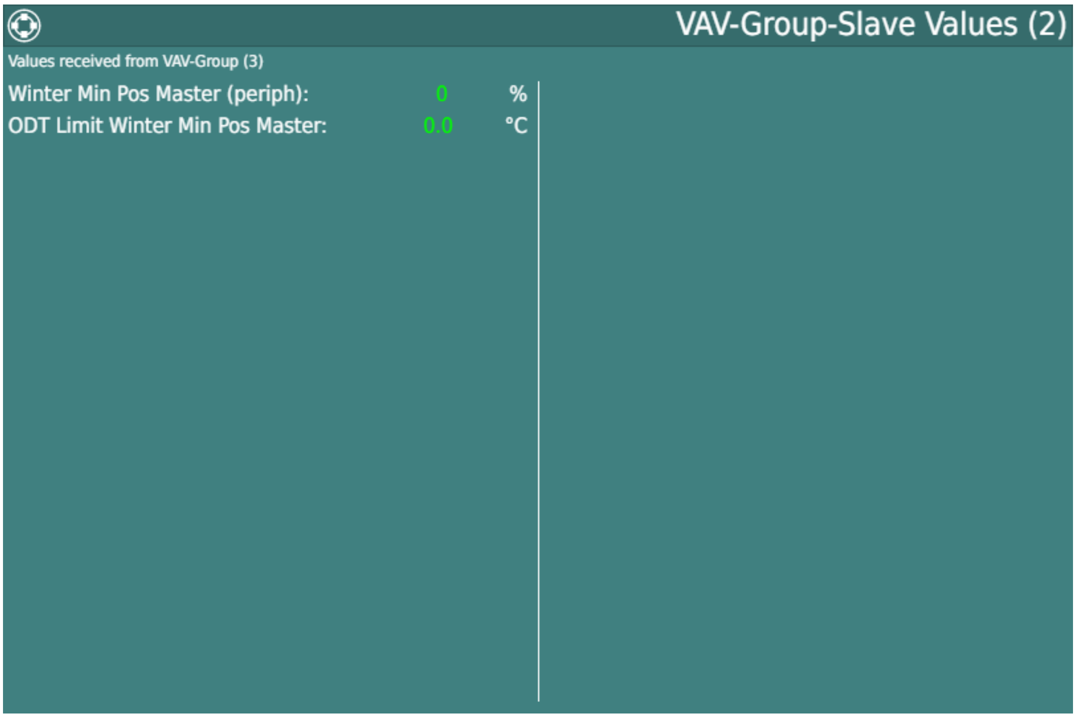

Figure 373: VAV-Group-Slave-Values (2)

Table 196 shows the VAV-Group-Slave-Values (2) present values (left side of the tile).

Path: User Registers.VAVcontrol.Core.Group

Name on tile	Data point name	Description
Winter Min Pos Master (periph)	WinterMinPosition	Displays the winter minimum position setpoint of the peripheral heat valv of the Master
ODT Limit Winter Min Pos Master	ODTlimitWinterMinPos	Displays the ODT limit in the Master to activate the winter minimum position function

Table 196: VAV-Group-Slave-Values (2) present values (right side of the tile)

Winter Min Pos Master (periph):

This displays the current winter minimum position of the peripheral heat valve in the master. See chapter 7.5.16 for the details.

ODT Limit Winter Min Pos Master:

This displays the current ODT limit that must be decreased to activate the winter minimum position function. See chapter 7.5.16 for the details.

7.6.2.3 Exhaust Air Flow Setpoint Calculation

As described above the “Master” is calculating an *Exhaust Air Flow Setpoint*, if there are exhaust “Slaves” configured in the VAV group. The “Slaves” are receiving and maintaining the flow setpoint coming from the “Master”.

This happens fully automatic if the VAV Group parameters are set properly. Also the *Air Flow Data Configuration* must be set properly, see chapter 7.5.5.2.

All supply boxes in the group are summing up the current supply air flow values and are communicating this value to the “Master” as *Summary Supply Air Flow*.

All exhaust boxes in the group are summing up the parameterized Max.Flow Cool values, (see chapter 7.5.5.2) and are communicating this value to the “Master” as *Summary Exhaust Max.Air Flow*. Therefore, the Master knows what the maximum air performance of the exhaust boxes is.

By using the *Exhaust Flow Rate* value, the “Master” calculates the requested Exhaust Air Flow Setpoint:

Exhaust AirFlow Setpoint = *Summary Supply Air Flow* * *Exhaust Flow Rate* /100

Because the exhaust boxes can have different sizes, the “Master” calculates an *Exhaust Air Flow Setpoint %* as a percentage value and communicates it to the exhaust “Slaves”:

Exhaust AirFlow Setpoint % = *Exhaust AirFlow Setpoint* / *Summary Exhaust Max.Air Flow *100*

The exhaust “Slaves” are receiving this setpoint and with the local parameterized *Max. Flow Cool* it calculates and maintains its individual *Flow Setpoint*:

Flow Setpoint = *Max. Flow Cool* * *Exhaust Air Flow Setpoint %* / 100

The exhaust air flow setpoint calculation of the “Master” can be watched on the *VAV-Group-Master Values* page of the *VAVstatu*s visualization project in the “Master” device as shown in Figure 374. Because this tile can be watched in the “Master” only and not the “Slaves”, it got the name: *VAV-Group-Master Values.*

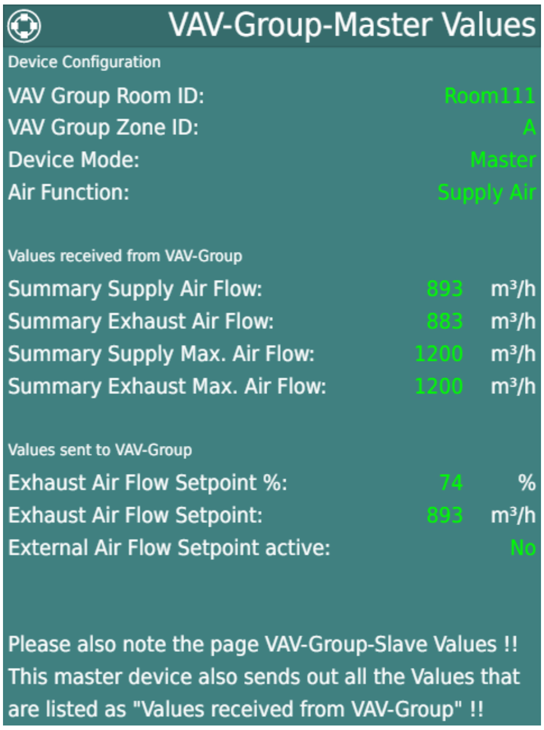

Figure 374: VAV-Group-Master-Values

Table 197 shows the VAV-Group-Master-Values present values.

Path: User Registers.VAVcontrol.Core.Group

Name on tile	**Data point name**	**Description**
VAV Group Room ID	idRoomFb	Displays the current Room ID
VAV Group Zone ID	VAVgroupZoneId	Displays the current Zone ID
Device Mode	VAVgroupDeviceMode	Displays the current device mode Master or Slave
Air Function	VAVgroupAirFunction	Displays the current air function supply air or exhaust air
Summary Supply Air Flow	SumSupplyAirFlow	Displays the summary of the current supply air flows of all supply VAV Boxes in the room
Summary Exhaust Air Flow	SumExhaustAirFlow	Displays the summary of the current exhaust air flows of all exhaust VAV Boxes in the room
Summary Supply Max. Air Flow	SumSupplyMaxAirFlow	Displays the summary of the maximum supply air flows of all supply VAV Boxes in the room

Name on tile	Data point name	Description
Summary Exhaust Max. Air Flow	SumExhaustMaxAirFlow	Displays the summary of the maximum exhaust air flows of all exhaust VAV Boxes in the room
Exhaust Air Flow Setpoint %	ExhaustAirFlowSetptPrcnt	Displays the resulting exhaust air flow setpoint as a percentage value that is sent to the slaves
Exhaust Air Flow Setpoint	ExhaustAirFlowSetpt	Displays the resulting exhaust air flow setpoint as an absolute value
External Air Flow Setpoint Active	SupplyAirFlowSetptActiveMaster	Displays if the external air flow setpoint function is configured in the Master

Table 197: VAV-Group-Master-Values present values

VAV Group Room ID:

This displays the configured value of the *Room ID*, see chapter above. For information purposes only.

VAV Group Zone ID:

This displays the configured value of the *Zone ID*, see chapter above. For information purposes only.

Device Mode:

This displays if the device is configured as Master or Slave, see chapter above. For information purposes only.

Air Function:

This displays if the device is configured as supply air or exhaust air, see chapter above. For information purposes only.

Summary Supply Air Flow:

This is only displayed and calculated if the device is configured as a “Master”. It shows the summary of the current supply air flows, the “Master” receives from all supply air boxes in the VAV Group. This is used to calculate the *Exhaust Air Flow Setpoint*.

Summary Exhaust Air Flow:

This is only displayed and calculated if the device is configured as a “Master”. It shows the summary of the current exhaust air flows, the “Master” receives from all exhaust air boxes in the VAV Group. This value is used for information purposes only.

Summary Supply Max. Air Flow:

This is only displayed and calculated if the device is configured as a “Master”. It shows the summary of the parameterized maximum supply air flows, the “Master” receives from all supply air boxes in the VAV Group. This is used for the IAQ Control, see IAQ Controller Group Function in chapter 7.5.8.4.

Summary Exhaust Max. Air Flow:

This is only displayed and calculated if the device is configured as a “Master”. It shows the summary of the parameterized maximum exhaust air flows, the “Master” receives from all exhaust air boxes in the VAV Group. This is used to calculate the *Exhaust Air Flow Setpoint*.

Exhaust Air Flow Setpoint %:

This is only displayed and calculated if the device is configured as a “Master”. It shows the resulting exhaust air flow setpoint as a percentage value that is sent from the “Master” to the “Slaves”. The slaves are calculating and maintaining their individual Flow Setpoints based on this value.

Exhaust Air Flow Setpoint:

This is only displayed and calculated if the device is configured as a “Master”. It shows the resulting exhaust air flow setpoint as a summary of all exhaust boxes in the room as an absolute value. This value is used for information purposes only.

External Air Flow Setpoint active:

This is only displayed and calculated if the device is configured as a “Master”. It shows if the External Air Flow Setpoint sensor function is configured in the VAV_Type of the “Master”. It is sent from the “Master” to the “Slaves”. The “Slaves” do not perform their own External Air Flow Setpoint sensor function, but they are led by the “Master” flow setpoint. See chapter 7.5.17 for the details.

7.6.2.4 Sensor Communication

As mentioned in the chapter 7.5.3 it is possible to connect sensors or L-STAT network thermostats or third party network thermostats to every LIOB-AIR device in a VAV-Group.

Usually a network thermostat L-STAT is connected to the L-STAT Modbus port of the "Master" device and is providing the sensor values and the button information to this VAV controller. The display functions of the L-STAT are also driven by the connected VAV controller. It is also possible to connect L-STATs to the other "Slave" controllers even if no L-STAT is connected to the "Master". All the sensor values and button actions of the multiple L-STATs are aggregated and communicated to the "Master" automatically. All the L-STATs in the group will display the same values automatically.

If there are hardwired sensors connected to any VAV controller, local I/O in the group these values are also aggregated and communicated to the "Master" automatically even if no sensor is connected to the "Master". Please note that either an L-STAT network thermostat or hardwired sensors should be connected to a dedicated VAV controller to gain a proper function of the automatic aggregation and communication.

It is also possible to use third party network thermostats in a VAV Group. However, these will not provide the complete button and display functionality as L-STATs. The sensor values have to be connected to the regarding Favorites. These values will have the same functionality as hardwired sensors to the local I/O.

The VAV application detects if an L-STAT is connected to the local Modbus port or a hardwired sensor is connected to the local I/O or a third party network thermostat is connected using Favorites and uses the connected sensor value.

Therefore, every LIOB-AIR device in a VAV Group can provide a sensor value as space temperature, or space temperature external setpoint offset, or relative humidity, or occupancy, or occupancy override, or CO_2, or VOC, or Window contact, or external flow setpoint to the VAV Group individually.

In the VAV Group, the multiple sensors are aggregated and used by the "Master" as the control value automatically.

The *Space Temperature* is aggregated as the average value of all space temperature sensors of the group and is used as the control value for the *Space Temperature Control*, see chapter 7.5.6.1.

The *Space Temperature external Setpoint Offset* is aggregated as the value of all space temperature sensors offset of the group that has changed last is used to shift the control setpoint for the *Space Temperature Control*, see chapter 7.5.6.3. The best performance is gained using L-STAT network thermostats.

The *relative Space Humidity* is aggregated as the average value of all relative space humidity sensors of the group and is used as the control value for the *Space Humidity Control*, see chapter 7.5.10.

The *Occupancy* is aggregated as the maximum value (occupied) of all occupancy sensors of the group and is used as the input value of the *Effective Presence*, see chapter 7.5.12.2.

The *Occupancy Override* is aggregated as the maximum value (override) of all occupancy override sensors of the group and is used as the input value of the *Occ Override Status*, see chapter 7.5.12.3.

The *CO_2 Concentration* is aggregated as the maximum value of all CO_2 sensors of the group and is used as the control value for the *IAQ Control*, see chapter 7.5.9.1.

The *VOC Concentration* is aggregated as the maximum value of all VOC sensors of the group and is used as the control value for the *IAQ Control*, see chapter 7.5.9.1

The *Window Contact* is aggregated as the maximum value (window open) of all window contact sensors of the group and is used as the input value for the *EnergyHoldOff State* see chapter 7.5.7.

The *External Flow Setpoint* is aggregated as the value of all external flow setpoint sensors offset of the group that has changed last is used to shift the control setpoint for the *AirFlow Control*, see chapter 7.5.17.

7.6.3 Weather Data

The weather data that is broadcasted by the manager device is received by all connected VAV controllers. The received weather data is visualized in the managers and the VAV controllers as well. See chapter 7.7.1.8 for more details about the weather data broadcast.

Every receiver executes a watchdog function. If the weather data is not updated longer than a fixed tolerance time (120 sec) this is indicated on the weather data tile, without triggering an alarm.

The received weather data is shown on the *Weather Data* page of the *VAVstatus* visualization project as shown in Figure 375.

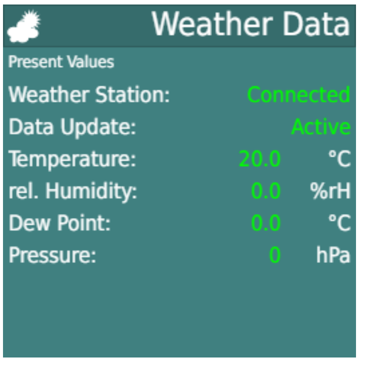

Figure 375: Received weather data

Table 198 shows the weather data received present values.

Path: User Registers.VAVcontrol.Core.AHUcommunication

Name on tile	**Data point name**	**Description**
Weather Station	WeatherStationStatus	Displays if the cyclic weather data is received
Data Update	WeatherDataUpdate	Displays if the cyclic weather data is received and there is no sensor failure received
Temperature	OutdoorTemperature	Displays the received outdoor temperature
rel. Humidity	OutdoorRelHumidity	Displays the received outdoor relative humidity
Dew Point	OutdoorDewPoint	Displays the received outdoor dew point
Pressure	OutdoorPressure	Displays the received outdoor pressure

Table 198: Received weather data present values

Weather Station:

This displays the result of the receiver watchdog function. If the cyclic weather data is received current, it shows “Connected”. If the cyclic weather data is not received longer than 120 sec, it shows “Not Connected”.

Data Update:

This displays if the cyclic weather data is received and there is no sensor failure received.

Temperature:

This displays the received outdoor temperature. This value is operated in the VAV controllers for e.g. Heat Lockout or Summer Compensation.

rel. Humidity:

This displays the received outdoor relative humidity. This value is not operated for any function in the VAV controllers actually.

DewPoint:

This displays the received outdoor dew point. This value is not operated for any function in the VAV controllers actually.

Pressure:

This displays the received outdoor pressure. This value is not operated for any function in the VAV controllers actually.

7.7 Manager Functions

The basic information regarding the managers is described in chapter 7.5.2. The AHU Communication in the VAV controllers to the managers is described in chapter 7.6.1. The following chapter describes which functions are performed in the managers.

The managers communicate with the AHU control bidirectionally using standard communication BACnet or OPC. The managers communicate with the VAV controllers bidirectionally using the AHU communication as the internal serial communication system. The Values from the VAV controllers are aggregated in the manager and sent to the AHU control. The Values from the AHU are received from the manager and sent to the connected VAV controllers.

The managers monitor the communication to the VAV controllers and the communication between the managers with watchdogs. If the communication fails, the watchdogs will trigger dedicated alarms.

Depending on the VAV system design, there are multiple manager types available to build the VAV system structure, see chapter 7.1.

Adhoc design:

This is the most useful design. It shall be used if there is one AHU with up to 100 VAV Boxes. For the Adhoc design, the “Multi Manager” has to be used as the manager function. The VAV controllers are communicating with the Multi Manager. The Multi Manager contains 5 Areas. To every Area up to 20 VAV controllers can be connected. The Aggregation of VAV data is operated in the Areas. The Multi manager performs the aggregation of all the 5 Areas. The Multi Manager communicates with only one AHU control. So all the managers included in the Multi manager support only one Air Supply Zone.

It is possible to have multiple AHUs in an L-STUDIO AIR solution that supply separate VAV-Box systems using multiple Multi Managers. In this case, every Multi Manager operates a dedicated AHU with assigned VAV controllers. The Multi Managers do not communicate to other Multi Managers.

The Adhoc Design using a Multi Manager is displayed in Figure 376.

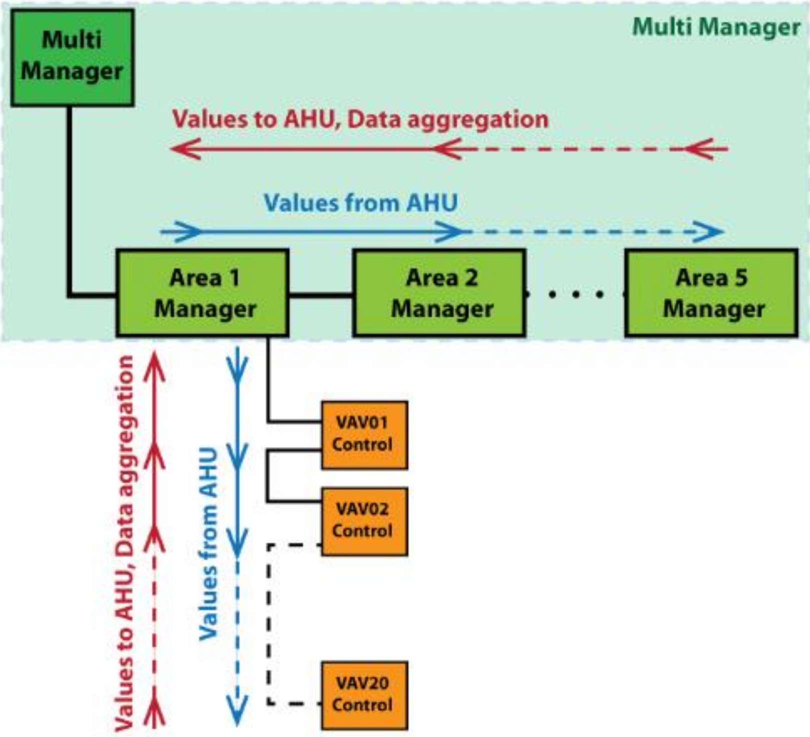

Figure 376: Adhoc design with Multi Manager communication

Structured Design:

This is the design for systems that have a strong structure. If buildings consist of areas which are repeating on each floor and the instrumentation of these building areas with VAV controllers is identical, the Structured Design can be recommended. It consists of "Area- Floor- and Building- Managers". The VAV controllers are communicating with Area Manager. The Aggregation of the VAV data is operated in the Area Manager. The multiple Area Managers are communicating with the Floor Manager. The aggregation of all the Areas data is operated in the Floor Manager. The multiple Floor Managers are communicating with the Building Manager. The aggregation of all the Floors data is operated in the Building Manager. The Building Manager communicates with up to 4 AHU controls. So all the managers used in the Structured Design, support 4 Air Supply Zones. Every VAV needs to be assigned to one of the 4 AHUs for a proper operation of the data aggregation.

The Structured Design using Area- Floor- and Building-Managers is displayed in Figure 376.

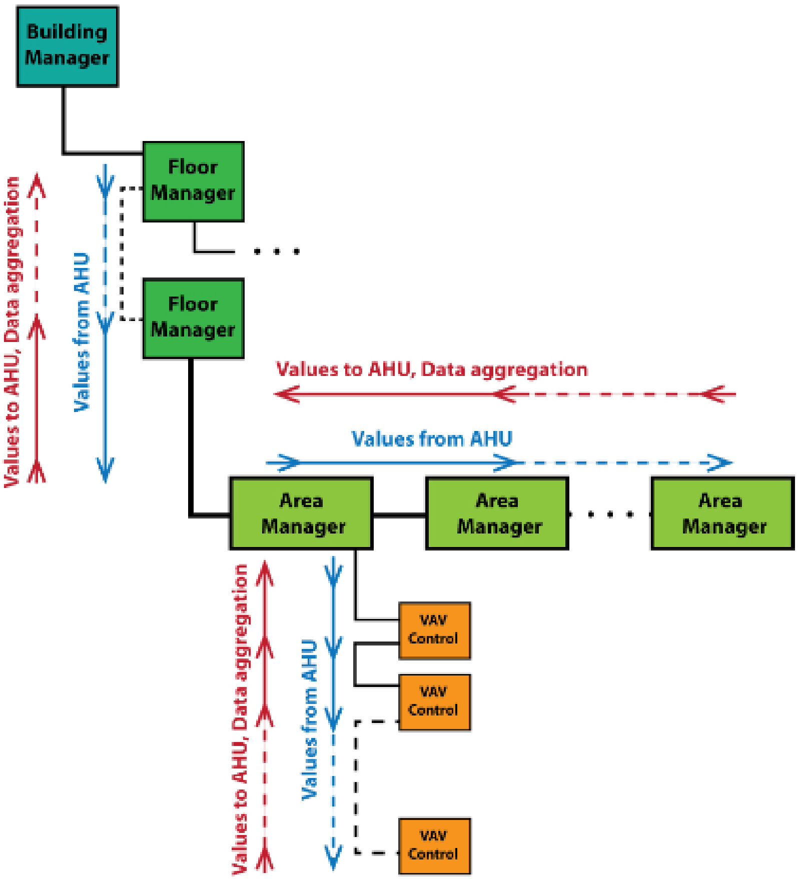

Figure 377: Structured Design with dedicated managers communication

<u>Communication levels:</u>

In the managers, there are two communication levels: the local level communication and the high level communication.

The <u>local level</u> communication is the communication to the devices on the same (local) level with the identical *AirSupplyZoneID*:

- - The Area Manager communicates to the VAV controllers.
- - The Multi Manager communicates to the included 5 Area Managers.
- - The Floor Manager communicates to the Area Managers.
- - The Building Manager communicates with the Floor Managers.

The <u>high level</u> communication is the communication to the devices of the higher level with the identical *AirSupplyZoneID*:

- - The included Area Manager communicates to the Multi Manager.
- - The Area Manager communicates to the Floor Manager.
- - The Floor Manager communicates to the Building Manager

7.7.1 MultiManager

The Multi Manager is used in the Adhoc Design. It internally consists of 5 Areas. Every Area aggregates data from up to 20 connected VAV controllers. The data of the 5 Areas is aggregated in the Multi manager and communicated to the AHU control. The Data that is communicated from the AHU to the Multi Manager is forwarded to all the VAV controllers connected to the 5 Areas by the Multi Manager. The aggregated data of all VAV controllers of the Area is available for user monitoring in the dedicated Area manager. The aggregated data of the 5 included Areas is available for user monitoring in the Multi Manager. The principle of the data aggregation “Values to AHU” and the data communication from the AHU “Values from AHU” is displayed in Figure 376.

7.7.1.1 Visualization

All the aggregated data from the VAV controllers, all the data communicated from the AHU to the Multi Manager and all the settings of the Multi manager can be watched and operated in the common *VAVmultiManagerStatus.lweb2* standard LWEB visualization project that is hosted in the LIOB-AIR device where the manager function is instantiated.

The overview of the Multi Manager visualization is shown in Figure 378.

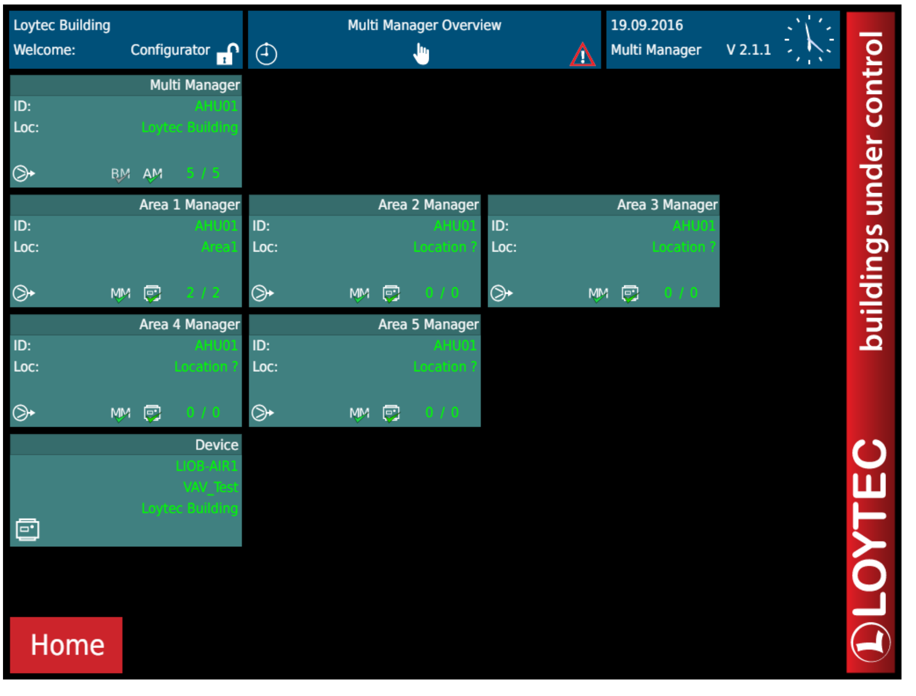

Figure 378: Multi Manager Overview

In the overview, the top level tiles of the Multi Manager and the included 5 Area Managers are shown. The Tiles show the top level information of the regarding Manager. A click on this tile leads to the detailed information and configuration / operation pages of the regarding manager data visualization.

Please note that all the managers included in the Multi Manager have dedicated pages and tiles in the *VAVmultiManagerStatus* visualization project. However, the pages look quite identical so the user needs to know which manager information is currently displayed. This can be identified on the right part pf the headline, as shown in Figure 379 and Figure 380.

Figure 379: Display of Multi Manager information

Figure 380: Display of Area 1 Manager information

7.7.1.2 Manager Tiles and Watchdogs

The Multi Manager tile is shown on the *Multi Manager Overview* page of the *VAVmultiManagerStatus* visualization project as shown in Figure 381.

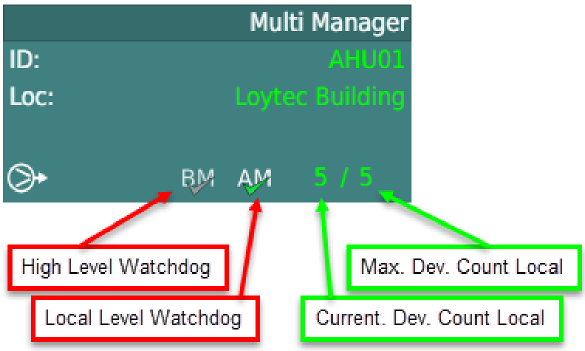

Figure 381: Multi Manager tile in Multi Manager Overview

The 5 Area Manager tiles are shown on the *Multi Manager Overview* page of the *VAVmultiManagerStatus* visualization project. As an example, the Area 1 Manager tile is shown in Figure 382.

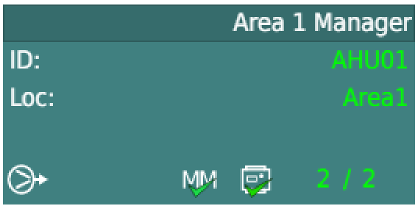

Figure 382: Area 1 Manager tile in Multi Manager Overview

Table 199 shows the Managers tiles present values.

Path: User Registers.VAVmultiManager.Floor.Zone ***)**

Name on tile	Data point name	Description
ID	AirSupplyZoneId	Displays the current ID of the air supply zone the manager is operating
Loc	DeviceLocation	Displays the location the manager is operating, documentation for a better overview
(High Level Watchdog)	HighLevelWatchdog	Displays the watchdog to the next higher level manager
(Local Level Watchdog)	LocalLevelWatchdog	Displays the watchdog to the local level devices
(Current Dev. Count Local)	CurrLocalLevelDevCnt	Displays the current number of local level devices
(Max. Dev. Count Local)	MaxLocalLevelDevCnt	Displays the maximum number of local level devices

Table 199: Multi Manager tile present values

***)**: Please note that the data point path is depending on the manager type and number:

Multi Manager	folder name: Floor.Zone
Area 1 Manager	folder name: Area1.Zone
Area 2 Manager	folder name: Area2.Zone
Area 3 Manager	folder name: Area3.Zone
Area 4 Manager	folder name: Area4.Zone
Area 5 Manager	folder name: Area5.Zone

ID:

Displays the current *AirSupplyZoneID* this manager is operating. All Managers and all VAV controllers that are assigned to one AHU must have the identical *AirSupplyZoneID* (e.g. AHU01) to establish the communication and to enable the data aggregation function. In case of a Multi Manager the *AirSupplyZoneID* is set automatically to the included 5 Area managers if it is set in the Multi Manager.

Loc:

Displays the location the manager is operating. This is for documentation purposes only and gains to a better overview to the user.

High Level Watchdog:

Displays if the communication of the regarding manager to the higher level manager is ok or not. In case of the Multi Manager there is no higher level manager existing. The higher managers are sending data to the local level devices in a fixed cycle. The watchdog is enabled if the *AirSupplyZoneID* is not empty and the first data is received from the higher level manager. If the communication fails longer than a fixed tolerance time, the watchdog indicates a failure icon and triggers a high level watchdog alarm. If the communication is operating properly, the alarm is reset self-sufficient.

Please note that the alarm is triggered by this function and only this is described in this chapter. In the device, this alarm is operated as a "generic" alarm that is reported to BACnet alarm server in parallel. The complete alarming with alarm servers, alarm lists, alarm status, acknowledgement, alarm notification and further things are standard LOYTEC data point functions of the LIOB-AIR operating system.

Local Level Watchdog:

Displays if the communication of the regarding manager to local level devices is ok or not. The manager is counting all devices on the local level when the communication is established. This result is displayed in *Max. Dev. Count Local* on the tile. The counting of the local devices is executed in a fixed cycle by the manager. If new devices are recognized in the chain the *Max. Dev. Count Local* will be increased. If the communication to one or more local devices fails, the number of the counted devices *Current Dev. Count Local* will be decreased. The local level watchdog function will detect the difference of the missing devices and will indicate a failure icon and trigger a local level watchdog alarm after a fixed tolerance time has expired. If the communication is operating properly, the *Current Dev. Count Local* will be equal to the *Max. Dev. Count Local* and the alarm is reset self-sufficient.

In case of an Area Manager, the number of the connected VAV controllers with the identical *AirSupplyZoneID* is counted. In case of a Multi Manager the number of the included 5 Area Managers with the identical *AirSupplyZoneID* is counted. In case of a Floor Manager the number of the connected Area Managers with the identical *AirSupplyZoneID* is counted. In case of a Building Manager the number of the connected Floor Managers with the identical *AirSupplyZoneID* is counted.

Please note that the alarm is triggered by this function and only this is described in this chapter. In the device, this alarm is operated as a "generic" alarm that is reported to BACnet alarm server in parallel. The complete alarming with alarm servers, alarm lists, alarm status, acknowledgement, alarm notification and further things are standard LOYTEC data point functions of the LIOB-AIR operating system.

Current Dev. Count Local:

This displays the current number of the local level devices counted by the manager The Local Level Watchdog uses this number to monitor the local level communication.

Max. Dev. Count Local:

This displays the maximum number of the local level devices counted by the manager The Local Level Watchdog uses this number to monitor the local level communication.

7.7.1.3 Configuring a Manager

<u>Air Supply Zone ID:</u>

To establish the AHU communication in the Multi Manager to the internal Areas and to the VAV controllers an Air Supply Zone has to be configured. The configuration of the Air Supply Zone in the VAV controllers is described in chapter 7.6.1.1. The Air Supply Zone is configured very easy by setting the identical *AirSupplyZoneID* in the VAV controllers and in the managers.

Because the Multi Manager consists of the Multi Manager and 5 Area Managers, the *AirSupplyZoneID* has to be set in every dedicated manager. The Multi Manager only supports one Air Supply Zone. Therefore, the *AirSupplyZoneID* must be identical in all included managers to gain the proper function of the Multi Manager. For that reason, the *AirSupplyZoneID* has to be entered only on the Multi Manager tile and it is entered in the included Area manager tiles automatically.

The setting of the *AirSupplyZoneID* can be done during the runtime of the Multi Manager in the *VAVmultiManagerStatus* visualization project.

The *AirSupplyZoneID* in the Multi Manager can be configured on the *ID´s Configuration* page of the *VAVmultiManagerStatus* visualization project as shown in Figure 383.

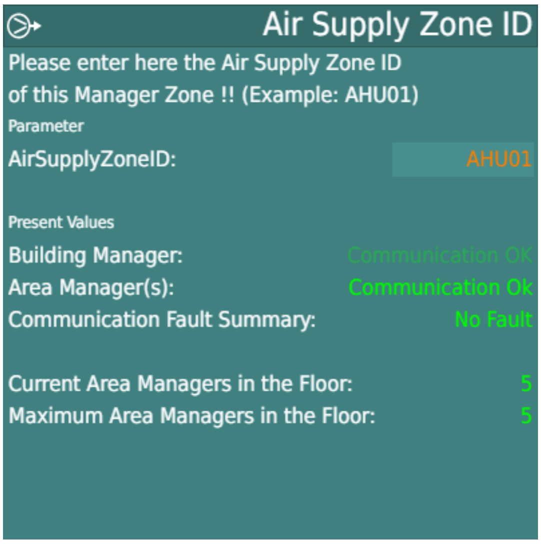

Figure 383: Multi Manager Air Supply Zone configuration

In the included 5 Area Managers, the same tiles exist. Because the Area Managers have a lower communication level, the high level and low level watchdogs and the device counters as well have different names as in the Multi Manager. As an example the Area 1 Manager is displayed in Figure 384. The parameters and present values of the Multi Manager and the included 5 Area Managers on this tile are described commonly as follows.

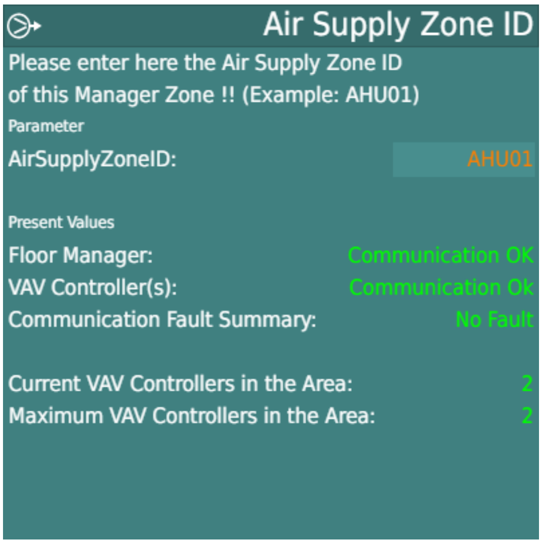

Figure 384: Area 1 manager Air Supply Zone ID configuration

Table 200 shows the Multi Manager Air Supply Zone ID parameters.

Path: User Registers.VAVmultiManager.Floor.Zone ***)**

Name on tile	Data point name	Default	Description
AirSupplyZoneID	AirSupplyZoneID	--	Definition of the Air Supply Zone ID

Table 200: Multi Manager Air Supply Zone ID parameters

***)**: Please note that the data point path is depending on the manager type and number:

Multi Manager	folder name: Floor.Zone
Area 1 Manager	folder name: Area1.Zone
Area 2 Manager	folder name: Area2.Zone
Area 3 Manager	folder name: Area3.Zone
Area 4 Manager	folder name: Area4.Zone
Area 5 Manager	folder name: Area5.Zone

AirSupplyZoneID:

This defines the *AirSupplyZoneID* this manager is operating. All Managers and all VAV controllers that are assigned to one AHU must have the identical *AirSupplyZoneID* (e.g. AHU01) to establish the communication and to enable the data aggregation function. In case of a Multi Manager, the *AirSupplyZoneID* is set automatically to the included 5 Area Managers if it is set in the Multi manager.

Path: User Registers.VAVmultiManager.Floor.Zone ***)**

Name on tile	**Data point name**	**Description**
Building Manager	HighLevelWatchdog	Displays the watchdog to the next higher level manager, not used in case of Multi Manager
Area Manager	LocalLevelWatchdog	Displays the watchdog to the local level devices
Floor Manager	HighLevelWatchdog	Displays the watchdog to the next higher level manager
VAV controller(s)	LocalLevelWatchdog	Displays the watchdog to the local level devices
Communication Fault Summary	CommFaultSummary	Displays if the communication of the local level devices and the communication down to the lowest level is ok
Current Area managers in the Floor	CurrLocalLevelDevCnt	Displays the current number of local level devices
Maximum Area managers in the Floor	MaxLocalLevelDevCnt	Displays the maximum number of local level devices
Current VAV controllers in the Area	CurrLocalLevelDevCnt	Displays the current number of local level devices
Maximum VAV controllers in the Area	MaxLocalLevelDevCnt	Displays the maximum number of local level devices

Table 201: Multi Manager Air Supply Zone ID present values

***)**: Please note that the data point path is depending on the manager type and number, see comment to Table 200.

Building Manager:

This is only displayed on the Multi Manager or Floor Manager level. It is the High Level Watchdog display (see chapter 7.7.1.2) that indicates the status of the communication to the next higher manager level. In case of a Multi Manager, there is no higher level existing and so this value will persist as invalid. In case of a Floor manager, this is the communication to the Building Manager.

Area Manager(s):

This is only displayed on the Multi Manager or Floor Manager level. It is the Local Level Watchdog display (see chapter 7.7.1.2) that indicates the status of the communication to the local level devices. In case of a Multi Manager or Floor Manager, this is the communication to the (included) Area Managers.

Floor Manager:

This is only displayed on the Area Manager level. It is the High Level Watchdog display (see chapter 7.7.1.2) that indicates the status of the communication to the next higher manager level. In case of an Area Manager, this is the communication to the Floor Manager or to the included Multi Manager.

VAV Controller(s):

This is only displayed on the Area Manager level. It is the Local Level Watchdog display (see chapter 7.7.1.2) that indicates the status of the communication to the local level devices. In case of an Area Manager, this is the communication to the connected VAV controllers.

Communication Fault Summary:

This indicates if the local level Watchdog is triggered or not. It also indicates if a Watchdog in a lower level is triggered. If the *AirSupplyZoneID* of this manager is empty, it also indicates. So it is a common communication fault summary of all devices connected below this local level manager. This value is also communicated to the high level manager. So on every manager level the health of the communication can be monitored. This present value does not trigger an alarm, because this is executed by the Local and High Level Watchdogs.

Current Area Managers in the Floor:

This is only displayed on the Multi Manager or Floor Manager level. It is the current number of the counted local level devices used by the Local Level Watchdog, see chapter 7.7.1.2. In case of the Multi Manager or Floor Manager the number of Area Managers is counted as the local level devices.

Maximum Area Managers in the Floor:

This is only displayed on the Multi Manager or Floor Manager level. It is the maximum number of the counted local level devices used by the Local Level Watchdog, see chapter 7.7.1.2. In case of the Multi Manager or Floor Manager the number of Area Managers is counted as the local level devices.

Current VAV Controllers in the Area:

This is only displayed on the Area Manager level. It is the current number of the counted local level devices used by the Local Level Watchdog, see chapter 7.7.1.2. In case of the Area Manager, the number of VAV Controllers is counted as the local level devices.

Maximum VAV Controllers in the Area:

This is only displayed on the Area Manager level. It is the maximum number of the counted local level devices used by the Local Level Watchdog, see chapter 7.7.1.2. In case of the Area Manager, the number of VAV Controllers is counted as the local level devices.

VAV Manager ID:

To gain a proper function of the internal serial communication every manager needs a Manager ID to be set. This Manager ID has to be unique if there are multiple manager functions instantiated in a device. Therefore, this is important using the Multi manager or using multiple Area- Floor- or Building- Managers in one device.

Because of the significance of this Manager ID, it is set automatically to a proper value if it is empty. However, it can be modified for special user demands if it is needed in special cases. Usually this Manager ID should not be modified by the user.

The VAV Manager ID in the Multi Manager can be configured on the *ID´s Configuration* page of the *VAVmultiManagerStatu*s visualization project as shown in Figure 385. The name of the VAV Manager ID is depending on the manager level. On the Multi Manager level, it is named as the *Floor ID* as shown in Figure 385.

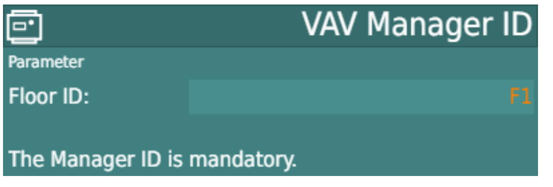

Figure 385: Multi Manager, VAV Manager ID configuration

In the Area Managers that are included in the Multi Manager, it is named as the *Area ID* as shown in Figure 386 as an example for the Area 1 Manager.

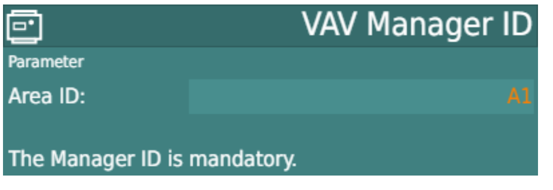

Figure 386: Area Manager, VAV Manager ID configuration

Table 202 shows the VAV Manager ID parameters.

Path: User Registers.VAVmultiManager.Floor.Zone ***)**

Name on tile	Data point name	Default	Description
Floor ID	ManagerID	--	Definition of the Manager ID in a Multi Manager or a Floor Manager
Area ID	ManagerID	--	Definition of the Manager ID in an Area Manager

Table 202: VAV Manager ID parameters

***)**: Please note that the data point path is depending on the manager type and number, see comment to Table 200.

Floor ID:

This is only displayed on the Multi Manager or Floor Manager level. If defines the Manager ID of the Multi Manager or the Floor Manager to engage the internal serial communication. It is set to a proper value (F1) automatically if it is empty.

Area ID:

This is only displayed on the Area Manager level. If defines the Manager ID of the Area Manager to engage the internal serial communication. It is set to a proper value (A1, A2, A3, A4, and A5) automatically if it is empty.

<u>Device Location:</u>

To get a better overview to the Multi Manager and the included 5 Area Managers a *Device Location* parameter can be set dedicated for every manager. Because the Multi Manger is the top level manager the *Device Location* is taken from the *Device Data* tile, see chapter 7.5.4. However, the *Device Location* of the 5 included Area Managers can be set individually, to indicate which area of the VAV controllers is operated by the dedicated Area Manager, e.g. "Area West". Please note that the *Device Location* is only for documentation and overview purposes. It does not have any effect to the manager function.

This *Device Location* is also shown on the Manager tiles on the *Multi Manager Overview* page of the *VAVmultiManagerStatus* visualization project as shown in Figure 381 in chapter 7.7.1.2.

The *Device Location* can be parameterized on the *Device Data* tile, shown on the *Multi Manager Overview* page of the *VAVmultiManagerStatus* visualization project as shown in Figure 387 as an example for the Multi Manager. Every dedicated manager included in the Multi Manager has its own tile to set the *Device Location* individually.

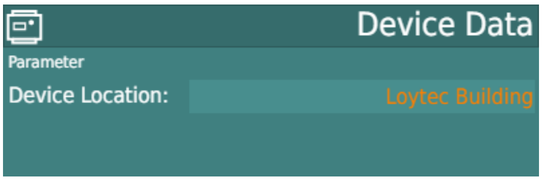

Figure 387: Multi Manager, Device Location configuration

Table 203 shows the Multi Manager Air Supply Zone ID parameters.

Path: User Registers.VAVmultiManager.Floor.Navigation.Label ***)**

Name on tile	**Data point name**	**Default**	**Description**
Device Location	DeviceLocation	--	Definition of the Device Location

Table 203: Multi Manager Device Data parameters

***)**: Please note that the data point path is depending on the manager type and number:

Multi Manager	folder name: Floor. Navigation.Label
Area 1 Manager	folder name: Area1. Navigation.Label
Area 2 Manager	folder name: Area2. Navigation.Label
Area 3 Manager	folder name: Area3. Navigation.Label
Area 4 Manager	folder name: Area4. Navigation.Label
Area 5 Manager	folder name: Area5. Navigation.Label

Device Location:

This defines the location of the devices the manager is operating to gain a better overview. Every manager has its individual *Device Location* tile.

7.7.1.4 Values to AHU (Data Aggregation)

As described in chapter 7.6.1.4 the VAV controllers are sending data that is aggregated by the Area Manager. The aggregated data of the 5 Area Managers is aggregated by the Multi Manager. This is data aggregation communication is operated by the internal serial communication system.

The Multi Manager provides this aggregated data to the AHU control using standard communication as BACnet or OPC.

All the aggregated data from the VAV controllers (Values to AHU) can be watched and operated in the common *VAVmultiManagerStatus.lweb2* standard LWEB visualization project that is hosted in the LIOB-AIR device where the manager function is instantiated. The aggregation data can be watched separately for every Area Manager and also for the complete Multi Manager.

The tiles that display the data in the Area managers and in the Multi Manager have the same structure and the same data points. They only display data from different local levels, see the definition of the "communication levels" described above. So the tiles will be described here valid for the Area managers, the Floor Manager, the Building manager and the Multi Manager.

<u>Manager Aggregation Example *Occupied Mode*</u>:

On the Area Manager the *Occupied Mode* is the Maximum aggregated *Effective Occupancy* state (5= Occupied) of all VAV controllers connected to this Area manager with the identical *AirSupplyZoneID*.

On the Multi Manager the *Occupied Mode* is the Maximum aggregated *Occupied Mode* (5= Occupied) of the 5 Area Managers internally connected to this Multi Manager with the identical *AirSupplyZoneID*. This value can be communicated to the AHU control using BACnet or OPC standard communication.

On the Floor Manager the *Occupied Mode* is the Maximum aggregated *Occupied Mode* (5= Occupied) of all the Area Managers connected to this Floor Manager with the identical *AirSupplyZoneID*.

On the Building Manager the *Occupied Mode* is the Maximum aggregated *Occupied Mode* (5= Occupied) of all the Floor Managers connected to this Building Manager with the identical *AirSupplyZoneID*. This value can be communicated to the AHU control using BACnet or OPC standard communication.

As described in chapter 7.6.1.4 there are two methods of data aggregation of the values to AHU:

Method #1: Values are aggregated as minimum, maximum and summary and the number of aggregated values is counted. This allows the AHU control to calculate average values and to do a simple control based on the minimum, maximum and averaged values.

Method #2: The most important values e.g., the damper position is also aggregated in classes. That means that e.g. the damper position is classified if it is actually operating in a predefined position range 0-25%, 25-50%, 50%-75%. 75-90%, >90%. The aggregation counts all the devices that have e.g. the damper position in the dedicated classes. The AHU control interprets the number of the devices with the classified damper positions as "calls" to e.g. adjust the static supply pressure setpoint of the AHU. There are several other values aggregated in classes also.

Values to AHU Method #1

The values that are communicated and aggregated as minimum, maximum and summary and the number of aggregated values from the VAV controllers to the Area Managers, or from the Area Managers to the Multi Manager, can be watched on the *Values between Manager and AHU* page of the *VAVmultiManagerStatus* visualization project as shown in Figure 388 and Figure 389. The information is distributed on multiple tiles because of the number of data points. This is also valid for the values that are communicated and aggregated from any manager type to the high level manager in the structured design.

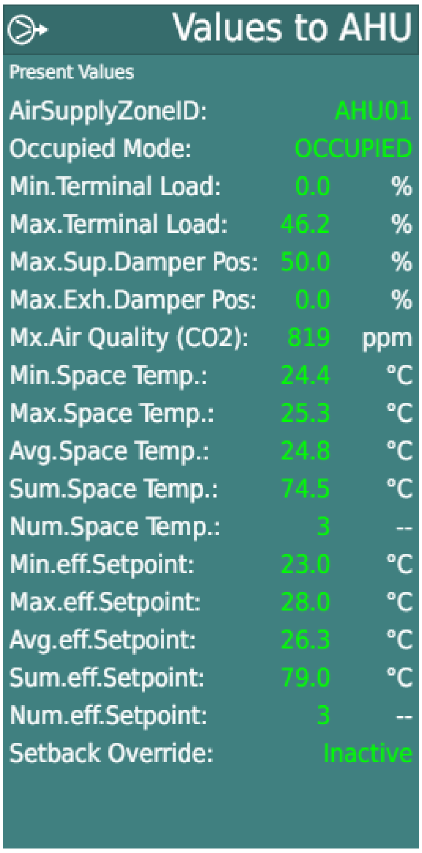

Figure 388: Values to AHU in a manager (tile #1)

Table 204 shows the Manager Values to AHU tile #1 present values.

Path: User Registers.VAVmultiManager.Floor.Zone ***)**

Name on tile	**Data point name**	**Description**
AirSupplyZoneID	AirSupplyZoneId	Displays the current ID of the air supply zone the manager is operating
Occupied Mode	OccupiedModeToAHU	Displays the maximum aggregated Effective Occupancy of this manager
Min.Terminal Load	MinTerminalLoadToAHU	Displays the minimum aggregated Terminal Load of this manager
Max.Terminal Load	MaxTerminalLoadToAHU	Displays the maximum aggregated Terminal Load of this manager
Max.Sup.Damper Pos	MaxSupDamperPositionToAHU	Displays the maximum aggregated supply damper position of this the manager
Max.Exh.Damper Pos	MaxExhDamperPositionToAHU	Displays the maximum aggregated exhaust damper position of this the manager
Mx.Air Quality (CO2)	MaxIAQtoAHU	Displays the maximum aggregated CO2 concentration of this manager
Min.Space Temp.	MinSpaceTempToAHU	Displays the minimum aggregated space temperature of this manager
Max.Space Temp.	MaxSpaceTempToAHU	Displays the maximum aggregated space temperature of this manager
Avg.Space Temp.	AvgSpaceTempLevel	Displays the average space temperature of this manager level
Sum.Space Temp.	SumSpaceTempToAHU	Displays the summary aggregated space temperature of this manager
Num.Space Temp.	NumSpaceTempToAHU	Displays the number of the summary aggregated space temperatures of this manager
Min.eff.Setpoint	MinEffSetpointToAHU	Displays the minimum aggregated effective setpoint of this manager
Max.eff.Setpoint	MaxEffSetpointToAHU	Displays the maximum aggregated effective setpoint of this manager
Avg.eff.Setpoint	AvgEffSetpointLevel	Displays the average effective setpoint of this manager level
Sum.eff.Setpoint	SumEffSetpointToAHU	Displays the summary aggregated effective setpoint of this manager
Num.eff.Setpoint	NumEffSetpointToAHU	Displays the number of the summary aggregated effective

Name on tile	Data point name	Description
		setpoints of this manager
Setback Override	SetbackOverrideToAHU	Displays the maximum aggregated Occ. Override Status of this manager

Table 204: Manager Values to AHU tile #1 present values

***)**: Please note that the data point path is depending on the manager type and number:

Multi Manager folder name: Floor.Zone

Area 1 Manager folder name: Area1.Zone

Area 2 Manager folder name: Area2.Zone

Area 3 Manager folder name: Area3.Zone

Area 4 Manager folder name: Area4.Zone

Area 5 Manager folder name: Area5.Zone

AirSupplyZoneID:

Displays the current *AirSupplyZoneID* this manager is operating. All Managers and all VAV controllers that are assigned to one AHU must have the identical *AirSupplyZoneID* (e.g. AHU01) to establish the communication and to enable the data aggregation function. In case of a Multi Manager, the *AirSupplyZoneID* is set automatically to the included 5 Area Managers if it is set in the Multi manager.

Occupied Mode:

This is the maximum aggregated *Effective Occupancy* state (5= Occupied) of all VAV controllers enabled for aggregation and connected to an Area Manager, see chapter 7.6.1.4. This is also the maximum aggregated *Occupied Mode* of the local level in the higher level manager devices. The AHU control can use this value e.g. as a request for operation.

Min.Terminal Load:

This is the minimum aggregated *Terminal Load* of all VAV controllers enabled for aggregation and connected to an Area Manager, see chapter 7.6.1.4. This is also the minimum aggregated *Min.Terminal Load* of the local level in the higher level manager devices. The AHU control can use this value for e.g. the supply air temperature setpoint reset.

Max.Terminal Load:

This is the maximum aggregated *Terminal Load* of all VAV controllers enabled for aggregation and connected to an Area Manager, see chapter 7.6.1.4. This is also the maximum aggregated *Max.Terminal Load* of the local level in the higher level manager devices. The AHU control can use this value for e.g. the supply air temperature setpoint reset.

Max.Sup.Damper Pos:

This is the maximum aggregated *Control Output* of the Air Flow Controller of all supply air VAV controllers enabled for aggregation and connected to an Area Manager, see chapter 7.6.1.4. This is also the maximum aggregated *Max.Sup.Damper Pos* of the local level in the higher level manager devices. The AHU control can use this value e.g. for the supply air static pressure setpoint reset.

Max.Exh.Damper Pos:

This is the maximum aggregated *Control Output* of the Air Flow Controller of all exhaust air VAV controllers enabled for aggregation and connected to an Area Manager, see chapter 7.6.1.4. This is also the maximum aggregated *Max.Exh.Damper Pos* of the local level in the higher level manager devices. The AHU control can use this value e.g. for the supply air static pressure setpoint reset.

Air Quality (CO2):

This is the maximum aggregated *CO_2 damped* value of all VAV controllers enabled for aggregation and connected to an Area Manager, see chapter 7.6.1.4. This is also the maximum aggregated *Mx.Air Quality (CO2)* of the local level in the higher level manager devices. The AHU control can use this value e.g. for the outdoor air damper control.

Min.Space Temp.:

This displays the minimum aggregated *Space Temperature* value of all VAV controllers enabled for aggregation and connected to an Area Manager, see chapter 7.6.1.4. This is also the minimum aggregated *Min.Space Temp.* of the local level in the higher level manager devices. The AHU control can use this value e.g. for the supply air temperature setpoint reset.

Max.Space Temp.:

This displays the maximum aggregated *Space Temperature* value of all VAV controllers enabled for aggregation and connected to an Area Manager, see chapter 7.6.1.4. This is also the maximum aggregated *Max.Space Temp.* of the local level in the higher level manager devices. The AHU control can use this value e.g. for the supply air temperature setpoint reset.

Avg.Space Temp.:

This displays the average space temperature value of all aggregated VAV controllers up to the current manager level. The local level aggregated *Sum.Space Temp.* and *Num.Space Temp.* are used to calculate this average value. The purpose of this value on the area manager level is only for user information and it is not aggregated to the higher manager levels. On the highest manager level, this average value can be communicated to the AHU. The AHU control can use this value e.g. for the supply air temperature setpoint reset.

Sum.Space Temp.:

This displays the summary aggregated *Space Temperature* value of all VAV controllers enabled for aggregation and connected to an Area Manager, see chapter 7.6.1.4. These values are aggregated using the weight factor in the dedicated devices. This is also the summary aggregated *Sum.Space Temp.* value of the local level in the higher level manager devices. Using also *Num.Space Temp.* the *Avg.SpaceTemp* is calculated on the local level manager. The AHU control can use this value e.g. for the supply air temperature setpoint reset.

Num.Space Temp.:

This displays the number of all summary aggregated *Space Temperature* values of all VAV controllers enabled for aggregation and connected to an Area Manager, see chapter 7.6.1.4. These values are aggregated using the weight factor in the dedicated devices. This is also the number of all summary aggregated *Num.Space Temp.* values of the local level in the higher level manager devices. Using also *Sum.Space Temp.* the *Avg.SpaceTemp* is calculated on the local level manager. The AHU control can use this value e.g. for the supply air temperature setpoint reset.

Min.eff.Setpoint:

This displays the minimum aggregated *Effective Setpoint* (of space temp. control) value of all VAV controllers enabled for aggregation and connected to an Area Manager, see chapter 7.6.1.4. This is also the minimum aggregated *Min.eff.Setpoint* of the local level in the higher level manager devices. The AHU control can use this value e.g. for the supply air temperature setpoint reset.

Max.eff.Setpoint:

This displays the maximum aggregated *Effective Setpoint* (of space temp. control) value of all VAV controllers enabled for aggregation and connected to an Area Manager, see chapter 7.6.1.4. This is also the maximum aggregated *Max.eff.Setpoint* of the local level in the higher level manager devices. The AHU control can use this value e.g. for the supply air temperature setpoint reset.

Avg.eff.Setpoint:

This displays the average effective setpoint (of space temp. control) value of all aggregated VAV controllers up to the current manager level. The local level aggregated *Sum.eff.Setpoint* and *Num. eff.Setpoint* are used to calculate this average value. The purpose of this value on the area manager level is only for user information and it is not aggregated to the higher manager levels. On the highest manager level, this average value can be communicated to the AHU. The AHU control can use this value e.g. for the supply air temperature setpoint reset.

Sum.eff.Setpoint:

This displays the summary aggregated *Effective Setpoint* (of space temp. control) value of all VAV controllers enabled for aggregation and connected to an Area Manager, see chapter 7.6.1.4. These values are aggregated using the weight factor in the dedicated devices. This is also the summary aggregated *Sum.eff.Setpoint* value of the local level in the higher level manager devices. Using also *Num.Space Temp.* the *Avg.eff.Setpoint* is calculated on the local level manager. The AHU control can use this value e.g. for the supply air temperature setpoint reset.

Num.eff.Setpoint:

This displays the number of all summary aggregated *Effective Setpoint* (of space temp. control) values of all VAV controllers enabled for aggregation and connected to an Area Manager, see chapter 7.6.1.4. These values are aggregated using the weight factor in the dedicated devices. This is also the number of all summary aggregated *Num.eff.Setpoint* values of the local level in the higher level manager devices. Using also *Sum.Space Temp.* the *Avg.eff.Setpoint* is calculated on the local level manager. The AHU control can use this value e.g. for the supply air temperature setpoint reset.

Setback Override:

This displays the maximum aggregated *Occ. Override Status* (= Active) value of all VAV controllers enabled for aggregation and connected to an Area Manager, see chapter 7.6.1.4. This is also the maximum aggregated *Setback Override.* of the local level in the higher level manager devices. The AHU can use this value e.g. as a request for operation.

Further values that are communicated and aggregated from the VAV controllers to the Area Managers, or from the Area Managers to the Multi Manager, can be watched on the *Values between Manager and AHU* page of the *VAVmultiManagerStatus* visualization project as shown in Figure 389.

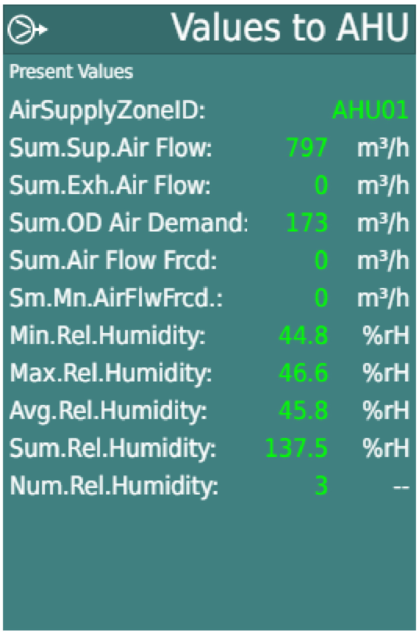

Figure 389: Values to AHU in a manager (tile #2)

Table 205 shows the Manager Values to AHU tile #2 present values.

Path: User Registers.VAVmultiManager.Floor.Zone ***)**

Name on tile	**Data point name**	**Description**
AirSupplyZoneID	AirSupplyZoneId	Displays the current ID of the air supply zone the manager is operating
Sum.Sup.Air Flow	SumSupplyAirFlowToAHU	Displays the summary aggregated supply air flow of this manager
Sum.Exh.Air Flow	SumExhaustAirFlowToAHU	Displays the summary aggregated exhaust air flow of this manager
Sum.OD Air Demand	SumOutdoorAirFlowDemandToAHU	Displays the summary aggregated outdoor air flow demand of this manager

Name on tile	Data point name	Description
Sum.Air Flow Frcd	SumAirFlowForcedToAHU	Not supported in the actual version
Sum.Mn.AirFlwFrcd	SumMinAirFlowForcedToAHU	Not supported in the actual version
Min.Rel.Humidity	MinHumidityToAHU	Displays the minimum aggregated relative humidity of this manager
Max.Rel.Humidity	MaxHumidityToAHU	Displays the maximum aggregated relative humidity of this manager
Avg.Rel.Humidity	AvgRelHumidityLevel	Displays the average relative humidity of this manager level
Sum.Rel.Humidity	SumHumidityToAHU	Displays the summary aggregated relative humidity of this manager
Num.Rel.Humidity	NumHumidityToAHU	Displays the number of summary aggregated relative humidity of this manager

Table 205: Manager Values to AHU tile #2 present values

***)**: See regarding comment of tile #1.

AirSupplyZoneID:

See regarding comment of tile #1.

Sum.Sup.Air Flow:

This is the summary aggregated *Air Flow* value of all supply air VAV controllers enabled for aggregation and connected to an Area Manager, see chapter 7.6.1.4. This is also the summary aggregated *Sum.Sup.Air Flow* of the local level in the higher level manager devices. The AHU control can use this value e.g. for the supply fan speed control.

Sum.Exh.Air Flow:

This is the summary aggregated *Air Flow* value of all exhaust air VAV controllers enabled for aggregation and connected to an Area Manager, see chapter 7.6.1.4. This is also the summary aggregated *Sum.Exh.Air Flow* of the local level in the higher level manager devices. The AHU control can use this value e.g. for the exhaust fan speed control.

Sum.OD Air Demand:

This is the summary aggregated *Current Outdoor Air Demand* value supply air VAV controllers enabled for aggregation and connected to an Area Manager, see chapter 7.6.1.4. This is also the summary aggregated *Sum.OD Air Demand* of the local level in the higher level manager devices. The AHU control can use this value e.g. for the outdoor air flow control.

Sum.Air Flow Frcd:

This function is not supported in the actual version.

Sum.Mn.AirFlwFrcd:

This function is not supported in the actual version.

Min.Rel.Humidity:

This displays the minimum aggregated *Relative Humidity* value of all VAV controllers enabled for aggregation and connected to an Area Manager, see chapter 7.6.1.4. This is also the minimum aggregated *Min.Rel.Humidity* of the local level in the higher level manager devices. The AHU can use this value e.g. for the supply air humidity setpoint reset.

Max.Rel.Humidity:

This displays the maximum aggregated *Relative Humidity* value of all VAV controllers enabled for aggregation and connected to an Area Manager, see chapter 7.6.1.4. This is also the maximum aggregated *Max.Rel.Humidity* of the local level in the higher level manager devices. The AHU can use this value e.g. for the supply air humidity setpoint reset.

Avg.Rel.Humidity:

This displays the average relative humidity value of all aggregated VAV controllers up to the current manager level. The local level aggregated *Sum.Rel.Humidity* and *Num.Rel.Humidity* are used to calculate this average value. The purpose of this value on the area manager level is only for user information and it is not aggregated to the higher manager levels. On the highest manager level, this average value can be communicated to the AHU. The AHU control can use this value e.g. for the supply air humidity setpoint reset.

Sum.Rel.Humidity:

This displays the summary aggregated *Relative Humidity* value of all VAV controllers enabled for aggregation and connected to an Area Manager, see chapter 7.6.1.4. These values are aggregated using the weight factor in the dedicated devices. This is also the summary aggregated *Sum.Rel.Humidity* value of the local level in the higher level manager devices. Using also *Num.Rel.Humidity* the *Avg.Rel.Humidity* is calculated on the local level manager. The AHU control can use this value e.g. for the supply air humidity setpoint reset.

Num.Rel.Humidity:

This displays the number of all summary aggregated *Relative Humidity* values of all VAV controllers enabled for aggregation and connected to an Area Manager, see chapter 7.6.1.4. These values are aggregated using the weight factor in the dedicated devices. This is also the number of all summary aggregated *Num.Rel.Humidity* values of the local level in the higher level manager devices. Using also *Sum.Rel.Humidity* the *Avg.Rel.Humidity* is calculated on the local level manager. The AHU control can use this value e.g. for the supply air humidity setpoint reset.

Values to AHU Method #2

The values that are communicated and aggregated as demand classes from the VAV controllers to the Area Managers, or from the Area Managers to the Multi Manager, can be watched on the *Demands from Manager to AHU* pages of the *VAVmultiManagerStatus* visualization project as shown in the following Figures. For every demand, class aggregation type separate tiles exist to display the aggregated class values.

To explain the principle of the class aggregation, see the following example of the class aggregation of a damper position:

In the devices, the current local damper position is identified in predefined position ranges 0-25%, 25-50%, 50%-75%. 75-90%, >90%. Every range is defined as a position class. If the current damper position is e.g. 60%, it is identified in the 50-75% position class in the device. If the data aggregation is enabled in the device, the damper position class 50-75% is counted with 1 multiplied with the weight factor in the class aggregation. Therefore, it is possible to disable the data aggregation for this device if it is a small or less important room. It is also possible to put more weight to the device if it is a large or more important room. The higher the weight factor set in the device, the room gets more impact to the aggregation. The enable of aggregation and the weight factor are set in the devices, see chapter 7.6.1.2 and chapter 7.6.1.3.

On every manager level, the number of weighted devices in the position classes are also calculated as percentage values. These percentage values are calculated relating to the total number of aggregated weighted devices on this manager level. Therefore, the AHU control can either use the number of devices in the position classes or the percentage values as calls to e.g. operate a static pressure setpoint reset.

Supply Air Damper Position Classes:

The aggregation results of the supply air damper position classes of all supply air VAV controllers enabled for aggregation and connected to an Area Manager is shown in Figure 390. It shows the number of devices that have current supply air damper positions in the dedicated position classes. These are also the aggregation results of the supply air damper position classes of the local level in the higher level manager devices. Additionally the percentages of devices with damper positions in the dedicated position classes relating to the total number of weighted supply air devices is calculated.

The AHU control can use these class values (number of devices or percentage values) as “calls” e.g. for the supply air static pressure setpoint reset. If most of the devices are counted in the position class 50 – 75% or in lower position classes, the current supply air static pressure is too high and needs to be decreased by the AHU control. If most of the devices are counted in the position class >90% the current supply air static pressure is too low and needs to be increased by the AHU control.

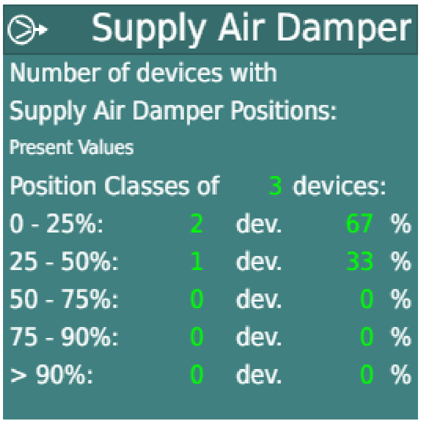

Figure 390: Supply Air Damper Position Classes

Table 215 shows the Supply Air Damper Position Classes present values.

Path: User Registers.VAVmultiManager.Floor.Zone ***)**.SupDampPosToAHU

Name on tile	**Data point name**	**Description**
Position Classes of x devices	NumDevWghtAgg	Displays total number of aggregated (weighted) supply air devices
0 – 25%	SupDamperPosClass1	Displays the aggregated number of (weighted) devices with current supply air damper positions in the range 0-25%
0 – 25%	SupDamperPosClass1p	Displays the percentage of aggregated (weighted) devices with current supply air damper positions in the range 0-25%
25 – 50%	SupDamperPosClass2	Displays the aggregated number of (weighted) devices with current supply air damper positions in the range 25-50%
25 – 50%	SupDamperPosClass2p	Displays the percentage of aggregated (weighted) devices with current supply air damper positions in the range 25-50%
50 – 75%	SupDamperPosClass3	Displays the aggregated number of (weighted) devices

Name on tile	Data point name	Description
		with current supply air damper positions in the range 50-75%
50 – 75%	SupDamperPosClass3p	Displays the percentage of aggregated (weighted) devices with current supply air damper positions in the range 50-75%
75 – 90%	SupDamperPosClass4	Displays the aggregated number of (weighted) devices with current supply air damper positions in the range 75-90%
75 – 90%	SupDamperPosClass4p	Displays the percentage of aggregated (weighted) devices with current supply air damper positions in the range 75-90%
> 90%	SupDamperPosClass5	Displays the aggregated number of (weighted) devices with current supply air damper positions in the range > 90%
> 90%	SupDamperPosClass5p	Displays the percentage of aggregated (weighted) devices with current supply air damper positions in the range > 90%

Table 206: Supply Air Damper Position Classes present values

***)**: Please note that the data point path is depending on the manager type and number:

Multi Manager	folder name: Floor.Zone
Area 1 Manager	folder name: Area1.Zone
Area 2 Manager	folder name: Area2.Zone
Area 3 Manager	folder name: Area3.Zone
Area 4 Manager	folder name: Area4.Zone
Area 5 Manager	folder name: Area5.Zone

Position Classes of x devices:

This is the headline of the following data point value displays and it shows the total number of aggregated weighted devices. The percentage calculation is relating to this value as the 100% base.

0 – 25%:

This is the aggregated number of weighted devices with current supply air damper positions in this range on this manager level. The percentage of this number of weighted devices related to the total number of aggregated weighted supply air devices is also calculated and displayed here.

25 – 50%:

This is the aggregated number of weighted devices with current supply air damper positions in this range on this manager level. The percentage of this number of weighted devices related to the total number of aggregated weighted supply air devices is also calculated and displayed here.

50 – 75%:

This is the aggregated number of weighted devices with current supply air damper positions in this range on this manager level. The percentage of this number of weighted devices related to the total number of aggregated weighted supply air devices is also calculated and displayed here.

75 – 90%:

This is the aggregated number of weighted devices with current supply air damper positions in this range on this manager level. The percentage of this number of weighted devices related to the total number of aggregated weighted supply air devices is also calculated and displayed here.

> 90%:

This is the aggregated number of weighted devices with current supply air damper positions in this range on this manager level. The percentage of this number of weighted devices related to the total number of aggregated weighted supply air devices is also calculated and displayed here.

Exhaust Air Damper Position Classes:

The aggregation results of the exhaust air damper position classes of all exhaust air VAV controllers enabled for aggregation and connected to an Area Manager is shown in Figure 391. It shows the number of devices that have current exhaust air damper positions in the dedicated position classes. These are also the aggregation results of the exhaust air damper position classes of the local level in the higher level manager devices. Additionally the percentages of devices with damper positions in the dedicated position classes relating to the total number of weighted supply air devices is calculated.

The AHU control can use these class values (number of devices or percentage values) as “calls” e.g. for the exhaust air static pressure setpoint reset. If most of the devices are counted in the position class 50 – 75% or in lower position classes, the current exhaust air static pressure is too high and needs to be decreased by the AHU control. If most of the devices are counted in the position class >90% the current exhaust air static pressure is too low and needs to be increased by the AHU control.

Because in the US market exhaust boxes are used exceptionally only the tile that shows the Exhaust Air Damper Position Classes present values is only visible in case there is one exhaust air damper aggregated in minimum in one of the position classes. If no exhaust damper is recognized and aggregated on this local level the tile is not visible.

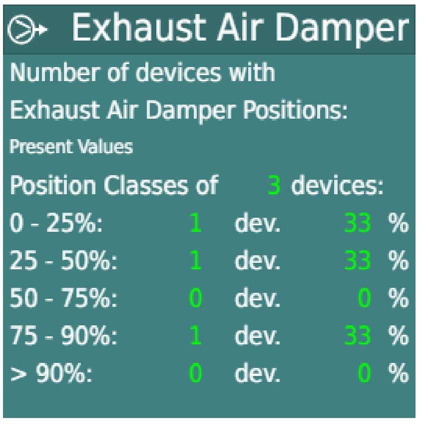

Figure 391: Exhaust Air Damper Position Classes

Table 207 shows the Exhaust Air Damper Position Classes present values.

Path: User Registers.VAVmultiManager.Floor.Zone ***)**.ExhDampPosToAHU

Name on tile	**Data point name**	**Description**
Position Classes of x devices	NumDevWghtAgg	Displays total number of aggregated (weighted) exhaust air devices
0 – 25%	ExhDampPosClass1	Displays the aggregated weighted number of devices with current exhaust air damper positions in the range 0-25%
0 – 25%	ExhDampPosClass1p	Displays the percentage of aggregated (weighted) of devices with current exhaust air damper positions in the range 0-25%
25 – 50%	ExhDampPosClass2	Displays the aggregated number of devices with current exhaust air damper positions in the range 25-50%

Name on tile	Data point name	Description
25 – 50%	ExhDampPosClass2p	Displays the percentage of aggregated (weighted) of devices with current exhaust air damper positions in the range 25-50%
50 – 75%	ExhDampPosClass3	Displays the aggregated weighted number of devices with current exhaust air damper positions in the range 50-75%
50 – 75%	ExhDampPosClass3p	Displays the percentage of aggregated (weighted) devices with current exhaust air damper positions in the range 50-75%
75 – 90%	ExhDampPosClass4	Displays the aggregated weighted number of devices with current exhaust air damper positions in the range 75-90%
75 – 90%	ExhDampPosClass4p	Displays the percentage of aggregated (weighted) devices with current exhaust air damper positions in the range 75-90%
> 90%	ExhDampPosClass5	Displays the aggregated weighted number of devices with current exhaust air damper positions in the range > 90%
> 90%	ExhDampPosClass5p	Displays the percentage of aggregated (weighted) devices with current exhaust air damper positions in the range > 90%

Table 207: Exhaust Air Damper Position Classes present values

***)**: See regarding comment of Table 206.

Position Classes of x devices:

This is the headline of the following data point value displays and it shows the total number of aggregated weighted devices. The percentage calculation is relating to this value as the 100% base.

0 – 25%:

This is the aggregated number of weighted devices with current exhaust air damper positions in this range on this manager level. The percentage of this number of weighted devices related to the total number of aggregated weighted exhaust air devices is also calculated and displayed here.

25 – 50%:

This is the aggregated number of weighted devices with current exhaust air damper positions in this range on this manager level. The percentage of this number of weighted devices related to the total number of aggregated weighted exhaust air devices is also calculated and displayed here.

50 – 75%:

This is the aggregated number of weighted devices with current exhaust air damper positions in this range on this manager level. The percentage of this number of weighted devices related to the total number of aggregated weighted exhaust air devices is also calculated and displayed here.

75 – 90%:

This is the aggregated number of weighted devices with current exhaust air damper positions in this range on this manager level. The percentage of this number of weighted devices related to the total number of aggregated weighted exhaust air devices is also calculated and displayed here.

> 90%:

This is the aggregated number of weighted devices with current exhaust air damper positions in this range on this manager level. The percentage of this number of weighted devices related to the total number of aggregated weighted exhaust air devices is also calculated and displayed here.

Terminal Load Cool Demand Classes:

The aggregation results of the terminal load cool demand classes of all VAV controllers "Master" devices enabled for aggregation and connected to an Area Manager is shown in Figure 392. It shows the number of rooms ("Masters") that have current terminal load cool in the dedicated demand classes. These are also the aggregation results of the terminal load cool demand classes of the local level in the higher level manager devices. Additionally the percentages of rooms with terminal loads cool in the dedicated demand classes relating to the total number of weighted rooms ("Masters") is calculated.

The AHU control can use these class values (number of rooms or percentage values) as "calls" e.g. for the supply air temperature reset. If most of the devices are counted in the demand class 50 – 75% or in lower demand classes, the current supply air temperature is too low and needs to be increased by the AHU control. If most of the devices are counted in the demand class >90% the current supply air temperature is too high and needs to be decreased by the AHU control.

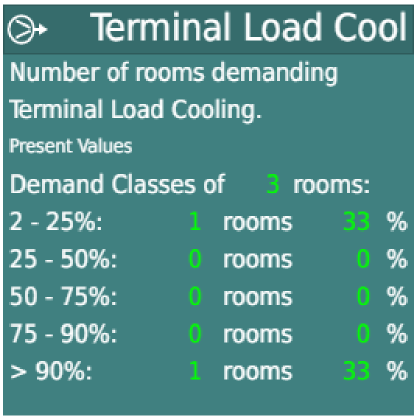

Figure 392: Terminal Load Cool Demand Classes

Table 208 shows the Terminal Load Cool Demand Classes present values.

Path: User Registers.VAVmultiManager.Floor.Zone ***)**.TermLdCoolToAHU

Name on tile	**Data point name**	**Description**
Demand Classes of x rooms	NumRoomWghtAgg	Displays total number of aggregated (weighted) rooms
2 – 25%	TermLdCoolClass1	Displays the aggregated number of (weighted) rooms with current terminal load cool demands in the range 2-25%
2 – 25%	TermLdCoolClass1p	Displays the percentage of aggregated (weighted) rooms with current terminal load cool demands in the range 2-25%
25 – 50%	TermLdCoolClass2	Displays the aggregated number of (weighted) rooms with current terminal load cool demands in the range 25-50%
25 – 50%	TermLdCoolClass2p	Displays the percentage of aggregated (weighted) rooms with current terminal load cool demands in the range 25-50%

Name on tile	Data point name	Description
50 – 75%	TermLdCoolClass3	Displays the aggregated number of (weighted) rooms with current terminal load cool demands in the range 50-75%
50 – 75%	TermLdCoolClass3p	Displays the percentage of aggregated (weighted) rooms with current terminal load cool demands in the range 50-75%
75 – 90%	TermLdCoolClass4	Displays the aggregated number of (weighted) rooms with current terminal load cool demands in the range 75-90%
75 – 90%	TermLdCoolClass4p	Displays the percentage of aggregated (weighted) rooms with current terminal load cool demands in the range 75-90%
> 90%	TermLdCoolClass5	Displays the aggregated number of (weighted) rooms with current terminal load cool demands in the range > 90%
> 90%	TermLdCoolClass5p	Displays the percentage of aggregated (weighted) rooms with current terminal load cool demands in the range > 90%

Table 208: Terminal Load Cool Demand Classes present values

***)**: See regarding comment of Table 206.

Demand Classes of x rooms:

This is the headline of the following data point value displays and it shows the total number of aggregated weighted rooms. The percentage calculation is relating to this value as the 100% base. Please note that the demand classes start at 2%. If there are terminal load cool demands below 2% they are not aggregated in any of the demand classes. However, of course the total number of aggregated weighted rooms is still a constant value. That is the reason why the summary of all percentage values in the demand classes can be < 100%.

2 – 25%:

This is the aggregated number of weighted rooms with current terminal load cool demands in this range on this manager level. The percentage of this number of weighted rooms related to the total number of aggregated weighted rooms is also calculated and displayed here.

25 – 50%:

This is the aggregated number of weighted rooms with current terminal load cool demands in this range on this manager level. The percentage of this number of weighted rooms related to the total number of aggregated weighted rooms is also calculated and displayed here.

50 – 75%:

This is the aggregated number of weighted rooms with current terminal load cool demands in this range on this manager level. The percentage of this number of weighted rooms related to the total number of aggregated weighted rooms is also calculated and displayed here.

75 – 90%:

This is the aggregated number of weighted rooms with current terminal load cool demands in this range on this manager level. The percentage of this number of weighted rooms related to the total number of aggregated weighted rooms is also calculated and displayed here.

> 90%:

This is the aggregated number of weighted rooms with current terminal load cool demands in this range on this manager level. The percentage of this number of weighted rooms related to the total number of aggregated weighted rooms is also calculated and displayed here.

Terminal Load Heat Demand Classes:

The aggregation results of the terminal load heat demand classes of all VAV controllers “Master” devices enabled for aggregation and connected to an Area Manager is shown in Figure 393. It shows the number of rooms (“Masters”) that have current terminal load heat in the dedicated demand classes. These are also the aggregation results of the terminal load heat demand classes of the local level in the higher level manager devices. Additionally the percentages of rooms with terminal loads heat in the dedicated demand classes relating to the total number of weighted rooms (“Masters”) is calculated.

The AHU control can use these class values (number of rooms or percentage values) as “calls” e.g. for the supply air temperature reset. If most of the devices are counted in the demand class 50 – 75% or in lower demand classes, the current supply air temperature is too high and needs to be decreased by the AHU control. If most of the devices are counted in the demand class >90% the current supply air temperature is too low and needs to be increased by the AHU control.

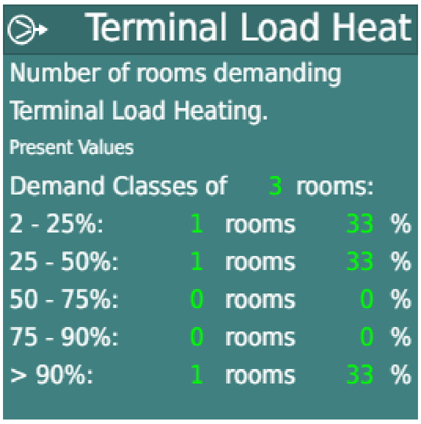

Figure 393: Terminal Load Heat Demand Classes

Table 209 shows the Terminal Load Heat Demand Classes present values.

Path: User Registers.VAVmultiManager.Floor.Zone ***)**.TermLdHeatToAHU

Name on tile	**Data point name**	**Description**
Demand Classes of x rooms	NumRoomWghtAgg	Displays total number of aggregated (weighted) rooms
2 – 25%	TermLdHeatClass1	Displays the aggregated number of (weighted) rooms with current terminal load heat demands in the range 2-25%
2 – 25%	TermLdHeatClass1p	Displays the percentage of aggregated (weighted) rooms with current terminal load heat demands in the range 2-25%
25 – 50%	TermLdHeatClass2	Displays the aggregated number of (weighted) rooms with current terminal load heat demands in the range 25-50%
25 – 50%	TermLdHeatClass2p	Displays the percentage of aggregated (weighted) rooms with current terminal load heat demands in the range 25-50%

Name on tile	Data point name	Description
50 – 75%	TermLdHeatClass3	Displays the aggregated number of (weighted) rooms with current terminal load heat demands in the range 50-75%
50 – 75%	TermLdHeatClass3p	Displays the percentage of aggregated (weighted) rooms with current terminal load heat demands in the range 50-75%
75 – 90%	TermLdHeatClass4	Displays the aggregated number of (weighted) rooms with current terminal load heat demands in the range 75-90%
75 – 90%	TermLdHeatClass4p	Displays the percentage of aggregated (weighted) rooms with current terminal load heat demands in the range 75-90%
> 90%	TermLdHeatClass5	Displays the aggregated number of (weighted) rooms with current terminal load heat demands in the range > 90%
> 90%	TermLdHeatClass5p	Displays the percentage of aggregated (weighted) rooms with current terminal load heat demands in the range > 90%

Table 209: Terminal Load Heat Demand Classes present values

***)**: See regarding comment of Table 206.

Demand Classes of x rooms:

This is the headline of the following data point value displays and it shows the total number of aggregated weighted rooms. The percentage calculation is relating to this value as the 100% base. Please note that the demand classes start at 2%. If there are terminal load heat demands below 2% they are not aggregated in any of the demand classes. However, of course the total number of aggregated weighted rooms is still a constant value. That is the reason why the summary of all percentage values in the demand classes can be < 100%.

2 – 25%:

This is the aggregated number of weighted rooms with current terminal load heat demands in this range on this manager level. The percentage of this number of weighted rooms related to the total number of aggregated weighted rooms is also calculated and displayed here.

25 – 50%:

This is the aggregated number of weighted rooms with current terminal load heat demands in this range on this manager level. The percentage of this number of weighted rooms related to the total number of aggregated weighted rooms is also calculated and displayed here.

50 – 75%:

This is the aggregated number of weighted rooms with current terminal load heat demands in this range on this manager level. The percentage of this number of weighted rooms related to the total number of aggregated weighted rooms is also calculated and displayed here.

75 – 90%:

This is the aggregated number of weighted rooms with current terminal load heat demands in this range on this manager level. The percentage of this number of weighted rooms related to the total number of aggregated weighted rooms is also calculated and displayed here.

> 90%:

This is the aggregated number of weighted rooms with current terminal load heat demands in this range on this manager level. The percentage of this number of weighted rooms related to the total number of aggregated weighted rooms is also calculated and displayed here.

Humidification Demand Classes:

The aggregation results of the humidification demand classes of all VAV controllers "Master" devices enabled for aggregation and connected to an Area Manager is shown in Figure 394. It shows the number of rooms ("Masters") that have current humidification demand in the dedicated demand classes. These are also the aggregation results of the humidification demand classes of the local level in the higher level manager devices. Additionally the percentages of rooms with humidification demands in the dedicated demand classes relating to the total number of weighted rooms ("Masters") is calculated.

The AHU control can use these class values (number of rooms or percentage values) as "calls" e.g. for the supply air humidity reset. If most of the devices are counted in the demand class 50 – 75% or in lower demand classes, the current supply air humidity is too high and needs to be decreased by the AHU control. If most of the devices are counted in the demand class >90% the current supply air humidity is too low and needs to be increased by the AHU control.

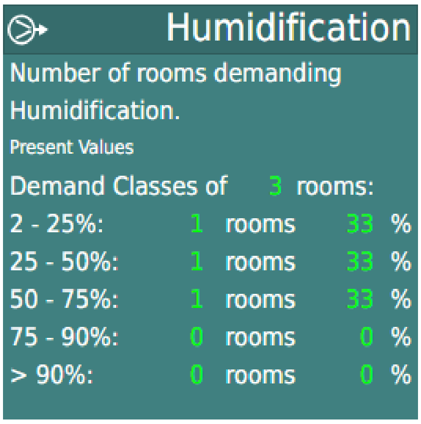

Figure 394: Humidification Demand Classes

Table 210 shows the Humidification Demand Classes present values.

Path: User Registers.VAVmultiManager.Floor.Zone ***)**.HumDemToAHU

Name on tile	**Data point name**	**Description**
Demand Classes of x rooms	NumRoomWghtAgg	Displays total number of aggregated (weighted) rooms
2 – 25%	HumDemClass1	Displays the aggregated number of (weighted) rooms with current humidification demands in the range 2-25%
2 – 25%	HumDemClass1p	Displays the percentage of aggregated (weighted) rooms with current humidification demands in the range 2-25%
25 – 50%	HumDemClass2	Displays the aggregated number of (weighted) rooms with current humidification demands in the range 25-50%
25 – 50%	HumDemClass2p	Displays the percentage of aggregated (weighted) rooms with current humidification demands in the range 25-50%
50 – 75%	HumDemClass3	Displays the aggregated number of (weighted) rooms

Name on tile	Data point name	Description
		with current humidification demands in the range 50-75%
50 – 75%	HumDemClass3p	Displays the percentage of aggregated (weighted) rooms with current humidification demands in the range 50-75%
75 – 90%	HumDemClass4	Displays the aggregated number of (weighted) rooms with current humidification demands in the range 75-90%
75 – 90%	HumDemClass4p	Displays the percentage of aggregated (weighted) rooms with current humidification demands in the range 75-90%
> 90%	HumDemClass5	Displays the aggregated number of (weighted) rooms with current humidification demands in the range > 90%
> 90%	HumDemClass5p	Displays the percentage of aggregated (weighted) rooms with current humidification demands in the range > 90%

Table 210: Humidification Demand Classes present values

***)**: See regarding comment of Table 206.

Demand Classes of x rooms:

This is the headline of the following data point value displays and it shows the total number of aggregated weighted rooms. The percentage calculation is relating to this value as the 100% base. Please note that the demand classes start at 2%. If there are humidification demands below 2% they are not aggregated in any of the demand classes. However, of course the total number of aggregated weighted rooms is still a constant value. That is the reason why the summary of all percentage values in the demand classes can be < 100%.

2 – 25%:

This is the aggregated number of weighted rooms with current humidification demands in this range on this manager level. The percentage of this number of weighted rooms related to the total number of aggregated weighted rooms is also calculated and displayed here.

25 – 50%:

This is the aggregated number of weighted rooms with current humidification demands in this range on this manager level. The percentage of this number of weighted rooms related to the total number of aggregated weighted rooms is also calculated and displayed here.

50 – 75%:

This is the aggregated number of weighted rooms with current humidification demands in this range on this manager level. The percentage of this number of weighted rooms related to the total number of aggregated weighted rooms is also calculated and displayed here.

75 – 90%:

This is the aggregated number of weighted rooms with current humidification demands in this range on this manager level. The percentage of this number of weighted rooms related to the total number of aggregated weighted rooms is also calculated and displayed here.

> 90%:

This is the aggregated number of weighted rooms with current humidification demands in this range on this manager level. The percentage of this number of weighted rooms related to the total number of aggregated weighted rooms is also calculated and displayed here.

Dehumidification Demand Classes:

The aggregation results of the dehumidification demand classes of all VAV controllers "Master" devices enabled for aggregation and connected to an Area Manager is shown in Figure 395. It shows the number of rooms ("Masters") that have current dehumidification demand in the dedicated demand classes. These are also the aggregation results of the dehumidification demand classes of the local level in the higher level manager devices. Additionally the percentages of rooms with dehumidification demands in the dedicated demand classes relating to the total number of weighted rooms ("Masters") is calculated.

The AHU control can use these class values (number of rooms or percentage values) as "calls" e.g. for the supply air humidity reset. If most of the devices are counted in the demand class 50 – 75% or in lower demand classes, the current supply air humidity is too low and needs to be increased by the AHU control. If most of the devices are counted in the demand class >90% the current supply air humidity is too high and needs to be decreased by the AHU control.

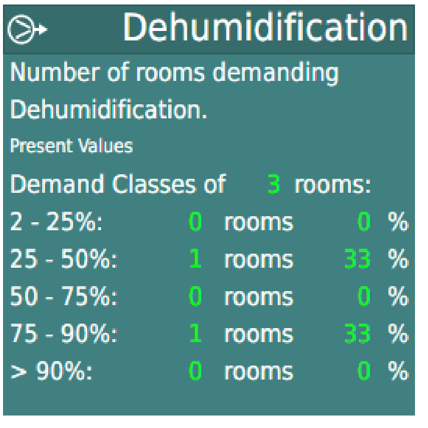

Figure 395: Dehumidification Demand Classes

Table 211 shows the Dehumidification Demand Classes present values.

Path: User Registers.VAVmultiManager.Floor.Zone ***)**.DehumDemToAHU

Name on tile	**Data point name**	**Description**
Demand Classes of x rooms	NumRoomWghtAgg	Displays total number of aggregated (weighted) rooms
2 – 25%	DehumDemClass1	Displays the aggregated number of (weighted) rooms with current dehumidification demands in the range 2-25%
2 – 25%	DehumDemClass1p	Displays the percentage of aggregated (weighted) rooms with current dehumidification demands in the range 2-25%
25 – 50%	DehumDemClass2	Displays the aggregated number of (weighted) rooms with current dehumidification demands in the range 25-50%
25 – 50%	DehumDemClass2p	Displays the percentage of aggregated (weighted) rooms with current dehumidification demands in the range 25-50%

Name on tile	Data point name	Description
50 – 75%	DehumDemClass3	Displays the aggregated number of (weighted) rooms with current dehumidification demands in the range 50-75%
50 – 75%	DehumDemClass3p	Displays the percentage of aggregated (weighted) rooms with current dehumidification demands in the range 50-75%
75 – 90%	DehumDemClass4	Displays the aggregated number of (weighted) rooms with current dehumidification demands in the range 75-90%
75 – 90%	DehumDemClass4p	Displays the percentage of aggregated (weighted) rooms with current dehumidification demands in the range 75-90%
> 90%	DehumDemClass5	Displays the aggregated number of (weighted) rooms with current dehumidification demands in the range > 90%
> 90%	DehumDemClass5p	Displays the percentage of aggregated (weighted) rooms with current dehumidification demands in the range > 90%

Table 211: Dehumidification Demand Classes present values

***)**: See regarding comment of Table 206.

Demand Classes of x rooms:

This is the headline of the following data point value displays and it shows the total number of aggregated weighted rooms. The percentage calculation is relating to this value as the 100% base. Please note that the demand classes start at 2%. If there are dehumidification demands below 2% they are not aggregated in any of the demand classes. However, of course the total number of aggregated weighted rooms is still a constant value. That is the reason why the summary of all percentage values in the demand classes can be < 100%.

2 – 25%:

This is the aggregated number of weighted rooms with current dehumidification demands in this range on this manager level. The percentage of this number of weighted rooms related to the total number of aggregated weighted rooms is also calculated and displayed here.

25 – 50%:

This is the aggregated number of weighted rooms with current dehumidification demands in this range on this manager level. The percentage of this number of weighted rooms related to the total number of aggregated weighted rooms is also calculated and displayed here.

50 – 75%:

This is the aggregated number of weighted rooms with current dehumidification demands in this range on this manager level. The percentage of this number of weighted rooms related to the total number of aggregated weighted rooms is also calculated and displayed here.

75 – 90%:

This is the aggregated number of weighted rooms with current dehumidification demands in this range on this manager level. The percentage of this number of weighted rooms related to the total number of aggregated weighted rooms is also calculated and displayed here.

> 90%:

This is the aggregated number of weighted rooms with current dehumidification demands in this range on this manager level. The percentage of this number of weighted rooms related to the total number of aggregated weighted rooms is also calculated and displayed here.

Occupancy States Count:

The aggregation results of the occupancy states of all VAV controllers “Master” devices enabled for aggregation and connected to an Area Manager is shown in Figure 396. It shows the number of rooms (“Masters”) that have current occupancy state in the dedicated occupancy classes. These are also the aggregation results of the occupancy state classes of the local level in the higher level manager devices. Additionally the percentages of rooms with occupancy states in the dedicated occupancy classes relating to the total number of weighted rooms (“Masters”) is calculated.

The AHU control can use these class values (number of rooms or percentage values) as “calls” e.g. to bring the AHU to operation or not. If e.g. a definable number of the rooms are counted in the occupancy class Occupied the AHU can be enabled for operation by the AHU control. If e.g. the number of rooms counted in the occupancy class Occupied is decreasing below a definable number, the AHU can be disabled for operation by the AHU control.

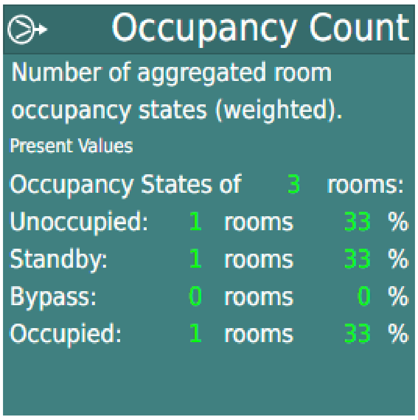

Figure 396: Occupancy States Count

Table 212 shows the Occupancy States Count present values.

Path: User Registers.VAVmultiManager.Floor.Zone ***)**.EffOccCountToAHU

Name on tile	**Data point name**	**Description**
Occupancy States of x rooms	NumRoomWghtAgg	Displays total number of aggregated (weighted) rooms
Unoccupied	NumUnoccAgg	Displays the aggregated number of (weighted) rooms with current occupancy state unoccupied
Unoccupied	NumUnoccAggP	Displays the percentage of aggregated (weighted) rooms with current occupancy state unoccupied
Standby	NumStbyAgg	Displays the aggregated number of (weighted) rooms with current occupancy state standby
Standby	NumStbyAggP	Displays the percentage of aggregated (weighted) rooms with current occupancy state standby
Bypass	NumBypAgg	Displays the aggregated number of (weighted) rooms with current occupancy state bypass

Name on tile	Data point name	Description
Bypass	NumBypAggP	Displays the percentage of aggregated (weighted) rooms with current occupancy state bypass
Occupied	NumOccAgg	Displays the aggregated number of (weighted) rooms with current occupancy state occupied
Occupied	NumOccAggP	Displays the percentage of aggregated (weighted) rooms with current occupancy state occupied

Table 212: Occupancy States Count present values

***)**: See regarding comment of Table 206.

Occupancy States of x rooms:

This is the headline of the following data point value displays and it shows the total number of aggregated weighted rooms. The percentage calculation is relating to this value as the 100% base.

Unoccupied:

This is the aggregated number of devices with this current occupancy state on this manager level. The percentage of this number of weighted rooms related to the total number of aggregated weighted rooms is also calculated and displayed here.

Standby:

This is the aggregated number of devices with this current occupancy state on this manager level. The percentage of this number of weighted rooms related to the total number of aggregated weighted rooms is also calculated and displayed here.

Bypass:

This is the aggregated number of devices with this current occupancy state on this manager level. The percentage of this number of weighted rooms related to the total number of aggregated weighted rooms is also calculated and displayed here.

Occupied:

This is the aggregated number of devices with this current occupancy state on this manager level. The percentage of this number of weighted rooms related to the total number of aggregated weighted rooms is also calculated and displayed here.

HVAC Mode Requests Count:

The aggregation results of the requested HVAC Modes (Optimum Start) of all VAV controllers “Master” devices enabled for aggregation and connected to an Area Manager is shown in Figure 397. It shows the number of rooms (“Masters”) that have current HVAC Modes in the dedicated HVAC Mode classes. Because this is used only by the Optimum Start function, only the HVAC Mode classes WARMUP and PRE_COOL are aggregated. These are also the aggregation results of the HVAC Mode classes of the local level in the higher level manager devices. Additionally the percentages of rooms with HVAC requests in the dedicated request classes relating to the total number of weighted rooms (“Masters”) is calculated.

The AHU control can use these class values (number of rooms or percentage values) as “calls” to operate the AHU in WARMUP or in PRE_COOL mode. If e.g. a definable number (or percentage) of the rooms are counted in the HVAC Mode class WARMUP, the AHU can be switched to WARMUP operation by the AHU control. If e.g. the number (or percentage) of rooms counted in the HVAC Mode class WARMUP is decreasing below a definable number, the AHU can switch to AUTO operation by the AHU control.

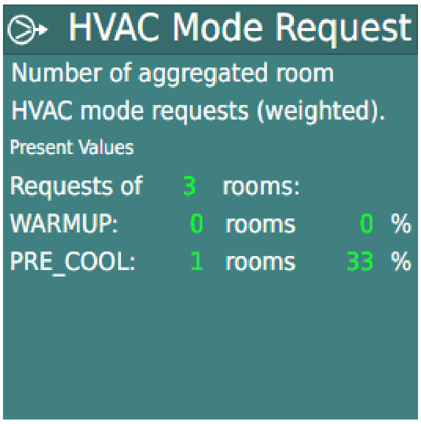

Figure 397: HVAC Mode Requests Count

Table 213 shows the HVAC Mode Requests Count present values.

Path: User Registers.VAVmultiManager.Floor.Zone ***)**.HVACreqCountToAHU

Name on tile	**Data point name**	**Description**
Requests of x rooms	NumRoomWghtAgg	Displays total number of aggregated (weighted) rooms
WARMUP	NumWarmUpAgg	Displays the aggregated number of (weighted)rooms with current HVAC Mode Request WARMUP
WARMUP	NumWarmUpAggP	Displays the percentage of aggregated (weighted)rooms with current HVAC Mode Request WARMUP
PRE_COOL	NumPreCoolAgg	Displays the aggregated number of (weighted)rooms with current HVAC Mode Request PRE_COOL
PRE_COOL	NumPreCoolAggP	Displays the percentage of aggregated (weighted)rooms with current HVAC Mode Request PRE_COOL

Table 213: HVAC Mode Requests Count present values

***)**: See regarding comment of Table 206.

Requests of x rooms:

This is the headline of the following data point value displays and it shows the total number of aggregated weighted rooms. The percentage calculation is relating to this value as the 100% base. Please note that the only the PRE_COOL and WARMUP requests are aggregated. If there are other HVAC mode requests, they are not aggregated in any of the request classes. However, of course the total number of aggregated weighted rooms is still a constant value. That is the reason why the summary of all percentage values in the request classes can be < 100%.

WARMUP:

This is the aggregated number of devices with this current HVAC Mode on this manager level. The percentage of this number of weighted rooms related to the total number of aggregated weighted rooms is also calculated and displayed here.

PRE_COOL:

This is the aggregated number of devices with this current HVAC Mode on this manager level. The percentage of this number of weighted rooms related to the total number of aggregated weighted rooms is also calculated and displayed here.

Device and Room Count:

The aggregation results of the device and room counts of all VAV controllers enabled for aggregation and connected to an Area Manager is shown in Figure 398. It shows the number of aggregated devices and the number of aggregated rooms (“Masters”). In addition, the number of aggregated devices and rooms (“Masters”) multiplied with the weight factors are shown. The numbers of weighted supply air devices and exhaust air devices are shown as well. These are also the aggregation results of the device and room counts of the local level in the higher level manager devices. The AHU control can use these count values for multiple purposes. On the local manager level, these weighted numbers of devices and rooms are used to calculate the class numbers of the class aggregations as percentage values, see the chapters before.

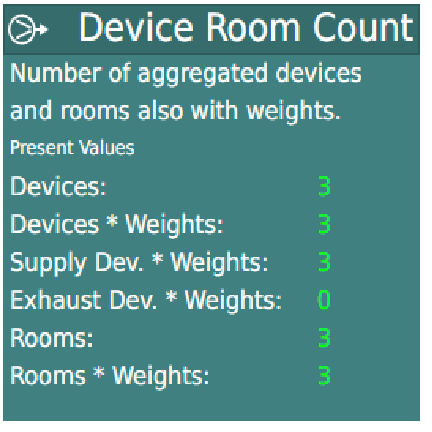

Figure 398: Device and Room Count

Table 214 shows the Device and Room Count present values.

Path: User Registers.VAVmultiManager.Floor.Zone ***)**.DevRmCountToAHU

Name on tile	**Data point name**	**Description**
Devices	NumDevicesAgg	Displays the aggregated number of devices
Devices*Weights	NumberDevWghtAgg	Displays the aggregated number of devices multiplied with the weight factors
Supply Dev*Weights	NumSupWghtAgg	Displays the aggregated number of supply air devices multiplied with the weight factors
Exhaust Dev*Weights	NumExhWghtAgg	Displays the aggregated number of exhaust air devices multiplied with the weight factors
Rooms	NumRoomsAgg	Displays the aggregated number of rooms
Rooms*Weights	NumRmWghtAgg	Displays the aggregated number of rooms multiplied with the weight factors

Table 214: Device and Room Count present values

***)**: See regarding comment of Table 206.

Devices:

This is the aggregated number of devices on this manager level. It is only for information purposes.

Devices * Weights:

This is the aggregated number of devices multiplied with the weight factors in the devices on this manager level. . It is only for information purposes.

Supply Dev * Weights:

This is the aggregated number of supply air devices multiplied with the weight factors in the devices on this manager level. This is used as the 100% base value of the total number of weighted supply air devices in the percentage calculation of the supply air damper position classes.

Exhaust Dev * Weights:

This is the aggregated number of exhaust air devices multiplied with the weight factors in the devices on this manager level. This is used as the 100% base value of the total number of weighted exhaust air devices in the percentage calculation of the exhaust air damper position classes.

Rooms:

This is the aggregated number of rooms (“Masters”) on this manager level. It is only for information purposes.

Rooms * Weights:

This is the aggregated number of rooms (“Masters”) multiplied with the weight factors in the rooms on this manager level. This is used as the 100% base value of the total number of weighted rooms in the percentage calculation of the terminal load cool, terminal load heat, humidification, dehumidification, occupancy count and HVAC mode demand classes.

7.7.1.5 Values from AHU

As described in chapter 7.6.1.4 the Multi Manager is receiving data from the AHU control. These data it sends out to the included local level 5 Area Managers sends like a broadcast. The 5 Area Managers also send out these data to the VAV controllers like a broadcast. The VAV controllers are operating their control functions regarding to the information received from the manager.

So this data is only forwarded to the devices of the next lower level like a broadcast. In this direction there is no data aggregation executed.

The values that are sent by the manager to the devices of the next lower level are shown on the *Values between Manager and AHU* page of the *VAVmultiManagerStatus* visualization project as shown in Figure 399. This is an example for the Multi Manager, but for the 5 included Area Managers there are individual tiles that show the Values from AHU sent out by this manager.

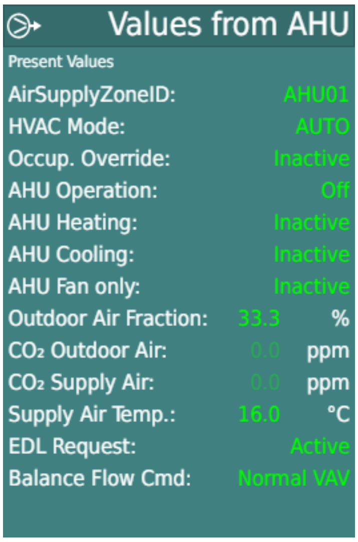

Figure 399: Multi Manager, Values from AHU

Table 215 shows the Multi Manager Values from AHU present values.

Path: User Registers.VAVmultiManager.Floor.Zone ***)**

Name on tile	Data point name	Description
AirSupplyZoneID	AirSupplyZoneId	Displays the current ID of the air supply zone the manager is operating
HVAC Mode	HvacModeFromAHU	Displays the HVAC Mode sent by the manager to local level devices
Occup. Override	OccupOverrideFromAHU	Displays the Occupancy Override sent by the manager to the local level devices
AHU Operation	OnOffFromAHU	Displays the AHU Operation contact sent by the manager to the local level devices

Name on tile	Data point name	Description
AHU Heating	HeatingFromAHU	Displays the AHU Heating contact sent by the manager to the local level devices
AHU Cooling	CoolingFromAHU	Displays the AHU Cooling contact sent by the manager to the local level devices
AHU Fan only	FanOnlyFromAHU	Displays the AHU Fan only contact sent by the manager to the local level devices
Outdoor Air Fraction	OutdoorAirFractionFromAHU	Displays the Outdoor Air Fraction sent by the manager to the local level devices
CO_2 Outdoor Air	CO2outdoorAirFromAHU	Displays the CO_2 concentration of the outdoor air sent by the manager to the local level devices
CO_2 Supply Air	CO2supplyAirFromAHU	Displays the CO_2 concentration of the supply air sent by the manager to the local level devices
Supply Air temp.	SupplyAirTempFromAHU	Displays the primary supply air temperature sent by the manager to the local level devices
EDL Request	EnergyDemandLimitFromAHU	Displays the Energy Demand Limit request sent by the manager to the local level devices
Balance Flow Cmd	BalanceFlowCmdFromAHU	Displays the balance flow command sent by the manager to the local level devices
Balance Flow Val	BalanceFlowValueFromAHU	Displays the balance flow value sent by the manager to the local level devices

Table 215: Multi Manager, Values from AHU present values

***)**: Please note that the data point path is depending on the manager type and number, see comment to Table 200.

AirSupplyZoneID:

Displays the current *AirSupplyZoneID* this manager is operating. All Managers and all VAV controllers that are assigned to one AHU must have the identical *AirSupplyZoneID* (e.g. AHU01) to establish the communication. In case of a Multi Manager, the *AirSupplyZoneID* is set automatically to the included 5 Area Managers if it is set in the Multi manager.

HVAC Mode:

This displays the *HVAC Mode* that is sent by the manager to the local level devices. On the lowest level, the VAV controllers receive and operate this information as *HVAC Mode from AHU* in the HVAC Mode Control, see chapter 7.5.11.1.

Occupancy Override:

This displays the *Occupancy Override* that is sent by the manager to the local level devices. On the lowest level, the VAV controllers receive and operate this information as *Occupancy Override from AHU* in the Effective Occupancy Control, see chapter 7.5.12.

AHU Operation:

This displays the contact *AHU Operation* that is sent by the manager to the local level devices. On the lowest level, the VAV controllers receive and operate this information as *AHU Operation* in the HVAC Mode Control, contacts from AHU, see chapter 7.5.11.1.

AHU Heating:

This displays the contact *AHU Heating* that is sent by the manager to the local level devices. On the lowest level, the VAV controllers receive and operate this information as *AHU Heating* in the HVAC Mode Control, contacts from AHU, see chapter 7.5.11.1.

AHU Cooling:

This displays the contact *AHU Cooling* that is sent by the manager to the local level devices. On the lowest level, the VAV controllers receive and operate this information as *AHU Cooling* in the HVAC Mode Control, contacts from AHU, see chapter 7.5.11.1.

AHU Fan only:

This displays the contact *AHU Fan only* that is sent by the manager to the local level devices. On the lowest level, the VAV controllers receive and operate this information as *AHU Fan only* in the HVAC Mode Control, contacts from AHU, see chapter 7.5.11.1.

Outdoor Air Fraction:

This displays the *Outdoor Air Fraction* that is sent by the manager to the local level devices. On the lowest level, the VAV controllers receive and operate this information as *Outdoor Air Fraction (from AHU)* in the IAQ Control (Method 2), see chapter 7.5.9.3.

CO_2 Outdoor Air:

This displays the CO2 concentration of the outdoor air that is sent by the manager to the local level devices. On the lowest level, the VAV controllers receive but do not operate this information actually. It is meant for future purposes probably in the in the IAQ Control, see chapter 7.5.8.4.

CO_2 Supply Air:

This displays the CO2 concentration of the supply air that is sent by the manager to the local level devices. On the lowest level, the VAV controllers receive but do not operate this information actually. It is meant for future purposes probably in the in the IAQ Control, see chapter 7.5.8.4.

Supply Air Temperature:

This displays the primary supply air temperature of the AHU that is sent by the manager to the local level devices. On the lowest level, the VAV controllers receive and operate this information as *Supply Air Temperature* in the plenum temperature function.

EDL Request:

This displays the Energy Demand Limiting request of the AHU that is sent by the manager to the local level devices. On the lowest level, the VAV controllers receive and operate this information as *EDL Request* in the local Energy Demand Limiting function.

Balance Flow Command:

This displays the *Balance Flow Command* that is sent by the manager to the local level devices. On the lowest level, the VAV controllers receive and operate this information for the flow setpoint selection in the air flow control. This is only for commissioning purposes, see chapter 7.5.5.3. The *Balance Flow Command* is set by the *Balance Flow Manager*, see chapter 7.7.1.7.

Balance Flow Value:

This is only displayed if the *Balance Flow Command* is set to “Flow Value”. This displays the *Balance Flow Value* that is sent by the manager to the local level devices. On the lowest level, the VAV controllers receive and operate this information for the flow setpoint selection in the air flow control in case the *Balance Flow Command* is “Flow Value”. This is only for commissioning purposes, see chapter 7.5.5.3. The *Balance Flow Value* is set by the *Balance Flow Manager*, see chapter 7.7.1.7.

7.7.1.6 Local operation of the Values from AHU

For commissioning and maintenance purposes, some important Values from AHU can be overwritten in a manual mode on every manager level. If a value is overwritten manually in a manager, this manual value is communicated to the devices of the lower level. All devices of the lower level are operating this value. As an example: it is possible to set the *HVAC Mode* from AHU to HEAT manually on the Area 1 Manager level and check

However, please note that actually, there is no Manual Alarm triggered and there is no manual mode indicator on the manager level if a Value from AHU is set to a manual mode. Therefore, the user has to manage and to take care that the Values from AHU are reset to auto mode to gain the proper function of the AHU communication of these values.

The local operation is available on every dedicated manager level. Therefore, there are individual tiles in the Multi Manager, but for the 5 included Area Managers there are individual tiles available as well. The following tiles are explained for the Multi Manager for example.

For the details of the Values from AHU, see chapter 7.7.1.5.

HVAC Mode:

The *HVAC Mode* from AHU can be overwritten manually in the manger on the *Local Operation of Values from AHU* page of the *VAVmultiManagerStatus* visualization project as shown in Figure 400.

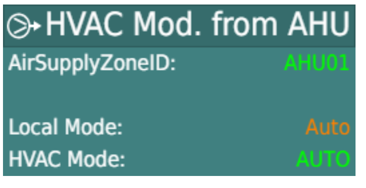

Figure 400: Local Operation of HVAC Mode from AHU

Table 216 shows the Local Operation of HVAC Mode present values.

Path: User Registers.VAVmultiManager.Floor.Zone ***)**

Name on tile	**Data point name**	**Description**
AirSupplyZoneID	AirSupplyZoneId	Displays the current ID of the air supply zone the manager is operating
HVAC Mode	HvacModeFromAHU	Displays the HVAC Mode sent by the manager to local level devices

Table 216: Local Operation of HVAC Mode present values

***)**: Please note that the data point path is depending on the manager type and number, see comment to Table 200.

AirSupplyZoneID:

Displays the current *AirSupplyZoneID* this manager is operating.

HVAC Mode:

This displays the *HVAC Mode* that is sent by the manager to the local level devices. It can be overwritten manually using the *Local Mode*.

Table 217 shows the Local Operation of HVAC Mode parameters.

Path: User Registers.VAVmultiManager.Floor.Zone ***)**

Name on tile	Data point name	Default	Description
Local Mode	ModeHVACmodeFromAHU	Auto	Mode of the Local Operation of the HVAC Mode

Table 217: Local Operation of HVAC Mode parameters

***)**: Please note that the data point path is depending on the manager type and number, see comment to Table 200.

Local Mode:

This defines the *Local Mode* of the *HVAC Mode* from AHU. If it is in the normal "Auto" mode, the manager sends the value received from the higher level device to the local level devices. It is possible to select all supported HVAC Modes in the "Manual" mode. Then the manager sends the value selected by the *Local Mode* to the local level devices.

<u>Occupancy Override:</u>

The *Occup. Override* from AHU can be overwritten manually in the manger on the *Local Operation of Values from AHU* page of the *VAVmultiManagerStatu*s visualization project as shown in Figure 401.

Figure 401: Local Operation of Occupancy Override from AHU

Table 218 shows the Local Operation of Occupancy Override present values.

Path: User Registers.VAVmultiManager.Floor.Zone ***)**

Name on tile	Data point name	Description
AirSupplyZoneID	AirSupplyZoneId	Displays the current ID of the air supply zone the manager is operating
Occup. Override	OccupOverrideFromAHU	Displays the Occupancy Override sent by the manager to local level devices

Table 218: Local Operation of Occupancy Override present values

***)**: Please note that the data point path is depending on the manager type and number, see comment to Table 200.

AirSupplyZoneID:

Displays the current *AirSupplyZoneID* this manager is operating.

Occup. Override:

This displays the *Occup. Override* sent by the manager to the local level devices. It can be overwritten manually using the *Local Mode*.

Table 219 shows the Local Operation of Occupancy Override parameters.

Path: User Registers.VAVmultiManager.Floor.Zone ***)**

Name on tile	**Data point name**	**Default**	**Description**
Local Mode	ModeOccupOverrideFromAHU	Auto	Mode of the Local Operation of the Occupancy Override

Table 219: Local Operation of Occupancy Override parameters

***)**: Please note that the data point path is depending on the manager type and number, see comment to Table 200.

Local Mode:

This defines the *Local Mode* of the *Occup. Override* from AHU. If it is in the normal "Auto" mode, the manager sends the value received from the higher level device to the local level devices. It is possible to select "Active" or "Inactive" in the "Manual" mode. Then the manager sends the value selected by the *Local Mode* to the local level devices.

<u>AHU Operation:</u>

The *AHU Operation* can be overwritten manually in the manger on the *Local Operation of Values from AHU* page of the *VAVmultiManagerStatus* visualization project as shown in Figure 402.

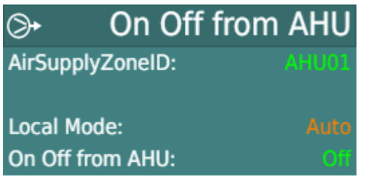

Figure 402: Local Operation of On Off from AHU

Table 220 shows the Local Operation of On Off from AHU present values.

Path: User Registers.VAVmultiManager.Floor.Zone ***)**

Name on tile	Data point name	Description
AirSupplyZoneID	AirSupplyZoneId	Displays the current ID of the air supply zone the manager is operating
On Off from AHU	OnOffFromAHU	Displays the AHU Operation sent by the manager to local level devices

Table 220: Local Operation of On Off from AHU present values

***)**: Please note that the data point path is depending on the manager type and number, see comment to Table 200.

AirSupplyZoneID:

Displays the current *AirSupplyZoneID* this manager is operating.

On Off From AHU:

This displays the *AHU Operation* sent by the manager to the local level devices. It can be overwritten manually using the *Local Mode*.

Table 221 shows the Local Operation of On Off from AHU parameters.

Path: User Registers.VAVmultiManager.Floor.Zone ***)**

Name on tile	Data point name	Default	Description
Local Mode	ModeOnOffFromAHU	Auto	Mode of the Local Operation of the On Off from AHU

Table 221: Local Operation of On Off from AHU parameters

***)**: Please note that the data point path is depending on the manager type and number, see comment to Table 200.

Local Mode:

This defines the *Local Mode* of the *On Off from AHU*. If it is in the normal “Auto” mode, the manager sends the value received from the higher level device to the local level devices. It is possible to select “On” or “Off” in the “Manual” mode. Then the manager sends the value selected by the *Local Mode* to the local level devices.

AHU Heating:

The *AHU Heating* can be overwritten manually in the manger on the *Local Operation of Values from AHU* page of the *VAVmultiManagerStatus* visualization project as shown in Figure 403.

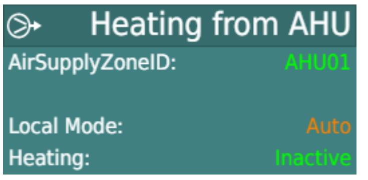

Figure 403: Local Operation of Heating from AHU

Table 222 shows the Local Operation of Heating from AHU present values.

Path: User Registers.VAVmultiManager.Floor.Zone ***)**

Name on tile	**Data point name**	**Description**
AirSupplyZoneID	AirSupplyZoneId	Displays the current ID of the air supply zone the manager is operating
Heating	HeatingFromAHU	Displays the AHU Heating sent by the manager to local level devices

Table 222: Local Operation of Heating from AHU present values

***)**: Please note that the data point path is depending on the manager type and number, see comment to Table 200.

AirSupplyZoneID:

Displays the current *AirSupplyZoneID* this manager is operating.

Heating:

This displays the *AHU Heating* sent by the manager to the local level devices. It can be overwritten manually using the *Local Mode*.

Table 223 shows the Local Operation of Heating from AHU parameters.

Path: User Registers.VAVmultiManager.Floor.Zone ***)**

Name on tile	**Data point name**	**Default**	**Description**
Local Mode	ModeHeatingFromAHU	Auto	Mode of the Local Operation of the Heating from AHU

Table 223: Local Operation of Heating from AHU parameters

***)**: Please note that the data point path is depending on the manager type and number, see comment to Table 200.

Local Mode:

This defines the *Local Mode* of the *Heating*. If it is in the normal “Auto” mode, the manager sends the value received from the higher level device to the local level devices. It is possible to select “Active” or “Inactive” in the “Manual” mode. Then the manager sends the value selected by the *Local Mode* to the local level devices.

AHU Cooling:

The *AHU Cooling* can be overwritten manually in the manger on the *Local Operation of Values from AHU* page of the *VAVmultiManagerStatus* visualization project as shown in Figure 404.

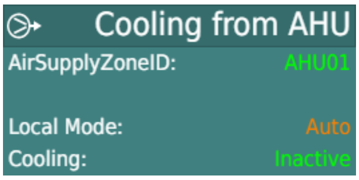

Figure 404: Local Operation of Cooling from AHU

Table 224 shows the Local Operation of Cooling from AHU present values.

Path: User Registers.VAVmultiManager.Floor.Zone ***)**

Name on tile	**Data point name**	**Description**
AirSupplyZoneID	AirSupplyZoneId	Displays the current ID of the air supply zone the manager is operating
Cooling	CoolingFromAHU	Displays the AHU Cooling sent by the manager to local level devices

Table 224: Local Operation of Cooling from AHU present values

***)**: Please note that the data point path is depending on the manager type and number, see comment to Table 200.

AirSupplyZoneID:

Displays the current *AirSupplyZoneID* this manager is operating.

Cooling:

This displays the *AHU Cooling* sent by the manager to the local level devices. It can be overwritten manually using the *Local Mode*.

Table 225 shows the Local Operation of Cooling from AHU parameters.

Path: User Registers.VAVmultiManager.Floor.Zone ***)**

Name on tile	**Data point name**	**Default**	**Description**
Local Mode	ModeCoolingFromAHU	Auto	Mode of the Local Operation of the Cooling from AHU

Table 225: Local Operation of Cooling from AHU parameters

***)**: Please note that the data point path is depending on the manager type and number, see comment to Table 200.

Local Mode:

This defines the *Local Mode* of the *Cooling*. If it is in the normal “Auto” mode, the manager sends the value received from the higher level device to the local level devices. It is possible to select “Active” or “Inactive” in the “Manual” mode. Then the manager sends the value selected by the *Local Mode* to the local level devices.

<u>AHU Fan only:</u>

The *AHU Fan only* can be overwritten manually in the manger on the *Local Operation of Values from AHU* page of the *VAVmultiManagerStatus* visualization project as shown in Figure 405.

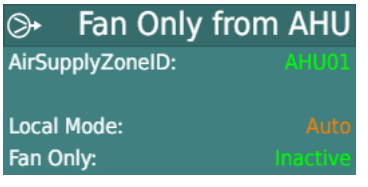

Figure 405: Local Operation of Fan Only from AHU

Table 226 shows the Local Operation of Fan Only from AHU present values.

Path: User Registers.VAVmultiManager.Floor.Zone ***)**

Name on tile	**Data point name**	**Description**
AirSupplyZoneID	AirSupplyZoneId	Displays the current ID of the air supply zone the manager is operating
Fan Only	FanOnlyFromAHU	Displays the AHU Fan only sent by the manager to local level devices

Table 226: Local Operation of Fan Only from AHU present values

***)**: Please note that the data point path is depending on the manager type and number, see comment to Table 200.

AirSupplyZoneID:

Displays the current *AirSupplyZoneID* this manager is operating.

Fan Only:

This displays the *AHU Fan only* sent by the manager to the local level devices. It can be overwritten manually using the *Local Mode*.

Table 227 shows the Local Operation of Fan Only from AHU parameters.

Path: User Registers.VAVmultiManager.Floor.Zone ***)**

Name on tile	**Data point name**	**Default**	**Description**
Local Mode	ModeFanOnlyFromAHU	Auto	Mode of the Local Operation of the Fan Only from AHU

Table 227: Local Operation of Fan Only from AHU parameters

***)**: Please note that the data point path is depending on the manager type and number, see comment to Table 200.

Local Mode:

This defines the *Local Mode* of the *Fan Only*. If it is in the normal “Auto” mode, the manager sends the value received from the higher level device to the local level devices. It is possible to select “Active” or “Inactive” in the “Manual” mode. Then the manager sends the value selected by the *Local Mode* to the local level devices.

<u>EDL from AHU:</u>

The *EDL Request* (Energy Demand Limiting) can be overwritten manually in the manger on the *Local Operation of Values from AHU* page of the *VAVmultiManagerStatus* visualization project as shown in Figure 406.

Figure 406: Local Operation of EDL from AHU

Table 228 shows the Local Operation of EDL from AHU present values.

Path: User Registers.VAVmultiManager.Floor.Zone ***)**

Name on tile	**Data point name**	**Description**
AirSupplyZoneID	AirSupplyZoneId	Displays the current ID of the air supply zone the manager is operating
EDL Request	EnergyDemandLimitFromAHU	Displays the EDL Request sent by the manager to local level devices

Table 228: Local Operation of EDL from AHU present values

***)**: Please note that the data point path is depending on the manager type and number, see comment to Table 200.

AirSupplyZoneID:

Displays the current *AirSupplyZoneID* this manager is operating.

EDL Request:

This displays the *EDL Request* sent by the manager to the local level devices. It can be overwritten manually using the *Local Mode*.

Table 229 shows the Local Operation of EDL from AHU parameters.

Path: User Registers.VAVmultiManager.Floor.Zone ***)**

Name on tile	**Data point name**	**Default**	**Description**
Local Mode	ModeEnergyDemandLimitFromAHU	Auto	Mode of the Local Operation of the EDL from AHU

Table 229: Local Operation of EDL from AHU parameters

***)**: Please note that the data point path is depending on the manager type and number, see comment to Table 200.

Local Mode:

This defines the *Local Mode* of the *EDL Request*. If it is in the normal “Auto” mode, the manager sends the value received from the higher level device to the local level devices. It is possible to select “Active” or “Inactive” in the “Manual” mode. Then the manager sends the value selected by the *Local Mode* to the local level devices.

7.7.1.7 Balance Flow Manager

For commissioning and maintenance purposes, the Balance Flow Manager is available on every manager level. The balance Flow Manager allows setting the Air Flow Setpoint commonly for all VAV controllers connected to this local level manager. Therefore, during the commissioning and balancing process of a project the balancer can set the Air Flow Setpoint commonly for all VAV controllers of an Area Manager or for all VAV controllers of a Multi Manager. Using the Balance Flow manager, the balancer can check the air flow and pressure performance of multiple VAV controllers and the ductwork in different flow situations only with a few clicks.

The Balance Flow Manager command is communicated by the manager to the local level devices like a broadcast using the internal serial communication. On the lowest level, the VAV controllers receive the Balance Flow Manager command and are operating the Air Flow control maintaining the manual Air Flow Setpoint coming from the Balance Flow Manager. If the Balance Flow Manager is in “Auto” mode, the VAV controllers execute the Air Flow control with the “normal” setpoint selection.

Note that actually there is no Manual Alarm triggered and there is no manual mode indicator on the manager level if the Balance Flow Manager is set to a manual mode. So the user has to manage and to take care that the Balance Flow Managers are reset to auto mode to gain the proper function of the VAV controllers, see Air Flow Setpoint selection in chapter 7.5.5.3.

The Balance Flow Manager is available on every dedicated manager level. Therefore, there are individual tiles in the Multi Manager, but for the 5 included Area Managers there are individual tiles available as well. The following tiles are explained for the Multi Manager for example.

The Balance Flow Manager can be operated manually in the manger on the *Balance Flow Manager* page of the *VAVmultiManagerStatus* visualization project as shown in Figure 407.

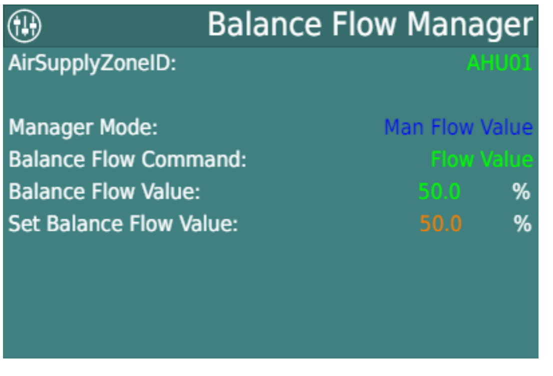

Figure 407: Balance Flow Manager

Table 230 shows the Balance Flow Manager present values.

Path: User Registers.VAVmultiManager.Floor.Zone ***)**

Name on tile	Data point name	Description
AirSupplyZoneID	AirSupplyZoneId	Displays the current ID of the air supply zone the manager is operating
Balance Flow Command	BalanceFlowCmdFromAHU	Displays the Balance Flow Command sent by the manager to local level devices
Balance Flow Value	BalanceFlowValueFromAHU	Displays the Balance Flow Value sent by the manager to local level devices

Table 230: Balance Flow Manager present values

***)**: Please note that the data point path is depending on the manager type and number, see comment to Table 200.

AirSupplyZoneID:

Displays the current *AirSupplyZoneID* this manager is operating.

Balance Flow Command:

This displays the current *Balance Flow Command* sent by the manager to the local level devices. It can be overwritten manually using the *Manager Mode*. The VAV controllers on the lowest level are executing the Air Flow Setpoint selection and the Air Flow control accordingly.

Possible Balance Flow Command states are:

Normal VAV: The Air Flow Controller selects and maintains an Air Flow Setpoint depending on the local control, see chapter 7.5.5.3.

Zero Flow: The Air Flow Controller selects and maintains the zero Flow setpoint. This will close the damper.

Min Heat Flow: The Air Flow Controller selects and maintains the local parameterized *Min. Flow Heat* setpoint.

Min Cool Flow: The Air Flow Controller selects and maintains the local parameterized *Min. Flow Cool* setpoint.

Min Unit Heat Flw: The Air Flow Controller selects and maintains the local parameterized *Min. Flow Unit Heat* setpoint.

Max Heat Flow: The Air Flow Controller selects and maintains the local parameterized *Max. Flow Heat* setpoint.

Max Cool Flow: The Air Flow Controller selects and maintains the local parameterized *Max. Flow Cool* setpoint.

Max Unit Heat Flw: The Air Flow Controller selects and maintains the local parameterized *Max. Flow Unit Heat* setpoint.

Flow Value: The Air Flow Controller selects and maintains a percentage setpoint *Balance Flow Value* that is sent by the manager.

Balance Flow Value:

This is only displayed, if the *Balance Flow Command* is “Flow Value”. This displays the current *Balance Flow Value* sent by the manager to the local level devices. It can be overwritten manually in the manager on *Set Balance Flow Value* if the *Manager Mode* is “Man Flow Value”. The VAV controllers on the lowest level are calculating and maintaining the Air Flow Setpoint according to the received Balance Flow Value and their individual air flow parameters.

Table 231 shows the Balance Flow Manager parameters.

Path: User Registers.VAVmultiManager.Floor.Zone ***)**

Name on tile	**Data point name**	**Default**	**Description**
Manager Mode	ModeBalanceFlowCmdFromAHU	Auto	Mode of the Balance Flow Manager
Set Balance Flow Value	ManualBalanceFlowValueFromAHU	0%	Manual setting of the Flow Value

Table 231: Balance Flow Manager parameters

Manager Mode:

This defines the *Manager Mode* of the *Balance Flow Command*. If it is in the normal “Auto” mode, the manager sends the *Balance Flow Command* and the *Balance Flow Value* received from the higher level device to the local level devices. On the highest level manager, the default value of the *Balance Flow Command* is “Normal VAV” if the *Manager Mode* is in the “Auto” mode. It is possible to set all supported *Balance Flow Command* states in the “Manual” mode. Then the manager sends the *Balance Flow Command* value selected by the *Manual Mode* to the local level devices.

Set Balance Flow Value:

This is only displayed if the local *Manager Mode* is set to “Man Flow Value”. The *Balance Flow Value* is set to the *Set Balance Flow Value* in this case. The Balance Flow Value is set for all local level devices.

7.7.1.8 Weather Data

<u>Weather Data sender:</u>

Managers can supply weather data to the VAV system. The weather station sensors or the weather data can be connected to the top level Manager (Building Manager or Multi Manager). The manager is communicating the weather data with broadcasts using the internal serial communication to all devices that are connected on the local level down to the lowest level devices. The broadcast of the weather data is executed in a fixed 60 sec cycle. All connected devices receive the weather data and display this on the Weather Data tile. Actually only the temperature value is used e.g. for Heat Lockout or Summer Compensation in the VAV controllers.

The weather data values as Temperature, rel. Humidity, Dew Point and Pressure are measured by sensors of a weather station or dedicated sensors and can be connected hardwired to the local inputs of the LIOB-AIR device where the manager is instantiated. The weather data can also be communicated to the manager device using standard communication as BACnet or OPC, see chapter 7.7.3.3.

<u>Sensor Inputs:</u>

In the LIOB-AIR I/O Standard configuration, the weather data is not located on any universal inputs *UIx*. This has to be done with the LINX-Configurator tool (L-IOB/Local I/O) in the VAV Device Type configuration. For more information see chapter *7.3.2 Device Configuration*.

<u>Favorites:</u>

The Favorites of the weather sensors are shown in Table 232.

Path: Favorites.VAVmultiManager.WeatherSensors.Air.IO

Favorite name	**Description**
SensorFailure	Present value of the status of the weather sensors
Temperature	Present value of the temperature sensor
RelHumidity	Present value of the humidity sensor
DewPoint	Present value of the dew point sensor
Pressure	Present value of the pressure sensor

Table 232: Weather sensors Favorites

SensorFailure:

This is the Favorite of the sensor failure input. To this Favorite, no Local I/O *UIx* is connected (see I/O Standard configuration). This has to be done individually with the LINX-Configurator tool (L-IOB/Local I/O) in the VAV Device Type configuration. The sensor failure can be detected and sent by the external controller that sends the weather data to the manager. In the VAV controllers, the sensor failure is not operated actually.

Temperature:

This is the Favorite of the outdoor temperature input. To this Favorite, no Local I/O *UIx* is connected (see I/O Standard configuration). This has to be done individually with the LINX-Configurator tool (L-IOB/Local I/O) in the VAV Device Type configuration. The VAV controllers are using this value for e.g. Heat Lockout or Summer Compensation.

RelHumidity:

This is the Favorite of the outdoor relative humidity input. To this Favorite, no Local I/O *UIx* is connected (see I/O Standard configuration). This has to be done individually with the LINX-Configurator tool (L-IOB/Local I/O) in the VAV Device Type configuration. This value is received by the VAV controllers but actually, it is not operated in a function.

Dew Point:

This is the Favorite of the outdoor dew point input. To this Favorite, no Local I/O *UIx* is connected (see I/O Standard configuration). This has to be done individually with the LINX-Configurator tool (L-IOB/Local I/O) in the VAV Device Type configuration. This value is received by the VAV controllers but actually, it is not operated in a function.

Pressure:

This is the Favorite of the outdoor pressure input. To this Favorite, no Local I/O *UIx* is connected (see I/O Standard configuration). This has to be done individually with the LINX-Configurator tool (L-IOB/Local I/O) in the VAV Device Type configuration. This value is received by the VAV controllers but actually, it is not operated in a function.

<u>BACnet Values:</u>

The Favorites of the weather data are internally synchronized with dedicated BACnet server objects. Therefore, the weather sensors can be connected physically to an external BACnet controller e.g. a LINX-151 controller operating the AHU control. Then it is possible to create client mappings on the external controller to the weather data server objects of the manager LIOB-AIR device. These client mappings will communicate the weather data to the LIOB-AIR manager device. The principle is shown in Figure 414 in chapter 7.7.3.

The BACnet server objects of the weather sensors are shown in Table 233.

First Part of Server Object Name: VAVmultiManager_WeatherSensors_Air_IO_

Server Object Name	Description
SensorFailure_Value	Present value of the status of the weather sensors
Temperature_Value	Present value of the temperature sensor
RelHumidity_Value	Present value of the humidity sensor
DewPoint_Value	Present value of the dew point sensor
Pressure_Value	Present value of the pressure sensor

Table 233: Weather sensors BACnet server objects

SensorFailure_Value:

This is the BACnet server object of the sensor failure input in the manager LIOB-AIR device. Further details see Favorite.

Temperature_Value:

This is the BACnet server object of the outdoor temperature input in the manager LIOB-AIR device. The VAV controllers are using this value for e.g. Heat Lockout or Summer Compensation.

RelHumidity_Value:

This is the BACnet server object of the outdoor relative humidity input in the manager LIOB-AIR device. The VAV controllers are not operating this value in any function actually.

DewPoint_Value:

This is the BACnet server object of the outdoor dew point input in the manager LIOB-AIR device. The VAV controllers are not operating this value in any function actually.

Pressure_Value:

This is the BACnet server object of the outdoor pressure input in the manager LIOB-AIR device. The VAV controllers are not operating this value in any function actually.

Weather Data receivers:

The weather data that is broadcasted by the manager device is received by all connected devices on every level. The received weather data is visualized in the managers and the VAV controllers as well. This received data visualization is also available in the manager that broadcasts the weather data.

Every receiver executes a watchdog function. If the weather data is not updated longer than a fixed tolerance time (120 sec) this is indicated on the weather data tile, without triggering an alarm.

The received weather data is shown on the *Weather Data* page of the *VAVmultiManagerStatus* visualization project as shown in Figure 408.

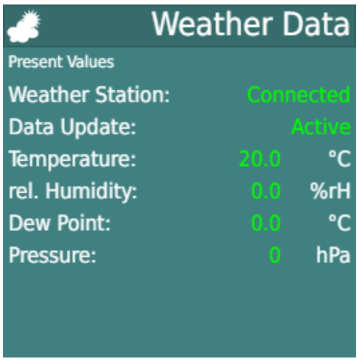

Figure 408: Received weather data

Table 234 shows the weather data received present values.

Path: User Registers.VAVmultiManager.Floor.WeatherDataAir ***)**

Name on tile	**Data point name**	**Description**
Weather Station	WeatherStationStatus	Displays if the cyclic weather data is received
Data Update	WeatherDataUpdate	Displays if the cyclic weather data is received and there is no sensor failure received
Temperature	OutdoorTemperature	Displays the received outdoor temperature
rel. Humidity	OutdoorRelHumidity	Displays the received outdoor relative humidity
Dew Point	OutdoorDewPoint	Displays the received outdoor dew point
Pressure	OutdoorPressure	Displays the received outdoor pressure

Table 234: Received weather data present values

***)**: Please note that the data point path is depending on the manager type and number:

Multi Manager	folder name: Floor.WeatherDataAir
Area 1 Manager	folder name: Area1.WeatherDataAir
Area 2 Manager	folder name: Area2.WeatherDataAir
Area 3 Manager	folder name: Area3.WeatherDataAir
Area 4 Manager	folder name: Area4.WeatherDataAir
Area 5 Manager	folder name: Area5.WeatherDataAir

Weather Station:

This displays the result of the receiver watchdog function. If the cyclic weather data is received current, it shows “Connected”. If the cyclic weather data is not received longer than 120 sec, it shows “Not Connected”.

Data Update:

This displays if the cyclic weather data is received and there is no sensor failure received.

Temperature:

This displays the received outdoor temperature. This value is operated in the VAV controllers for e.g. Heat Lockout or Summer Compensation.

rel. Humidity:

This displays the received outdoor relative humidity. This value is not operated for any function in the VAV controllers actually.

DewPoint:

This displays the received outdoor dew point. This value is not operated for any function in the VAV controllers actually.

Pressure:

This displays the received outdoor pressure. This value is not operated for any function in the VAV controllers actually.

7.7.2 Dedicated Managers

The dedicated managers as Area- Floor- and Building- Managers are used in the Structured Design. Multiple VAV controllers can be connected to an Area Manager. Multiple Area Managers can be connected to a Floor Manager. Multiple Floor Managers can be connected to a Building Manager. If Structured Design is used, there must be one manager of every type existing in minimum. Every Area Manager aggregates data from the connected VAV controllers. The data of the Area Managers is aggregated in the Floor Manager. The data of the Floor Managers is aggregated in the Building Manager and communicated to the AHU control. The Data that is communicated from the AHU to the Building Manager is forwarded to all the Floor Managers and to all Area Managers and to all VAV controllers connected to the Area Managers. The aggregated data of all VAV controllers of the Area Manager is available for user monitoring in the dedicated Area Manager. The aggregated data of the Area Managers is available for user monitoring in the Floor Manager. The aggregated data of the Floor Managers is available for user monitoring in the Building Manager The dedicated managers support 4 Air Supply Zones. The entire AHU communication is performed for every Air Supply Zone independently. The principle of the data aggregation “Values to AHU” and the data communication from the AHU “Values from AHU” is displayed in Figure 377.

Please note that the functions of the Multi Manager and the dedicated managers are nearly identical. This chapter only describes the facts that are different to the Multi Manager. For the most details please refer to the Multi Manager, see chapter 7.7.1.

7.7.2.1 Visualization

All the aggregated data from the VAV controllers, all the data communicated from the AHU to the Building Manager and all the settings of the Manager can be watched and operated in the common *VAVmanagerStatus.lweb2* standard LWEB visualization project that is hosted in the LIOB-AIR device where the manager function is instantiated. This is a universal visualization for every of the manager types. It displays the information and allows the operation on the dedicated manager level it is instantiated in. Therefore, it looks the same in every manager type but the data that is displayed and operated is different.

The overview of the Building Manager visualization is shown in Figure 409.

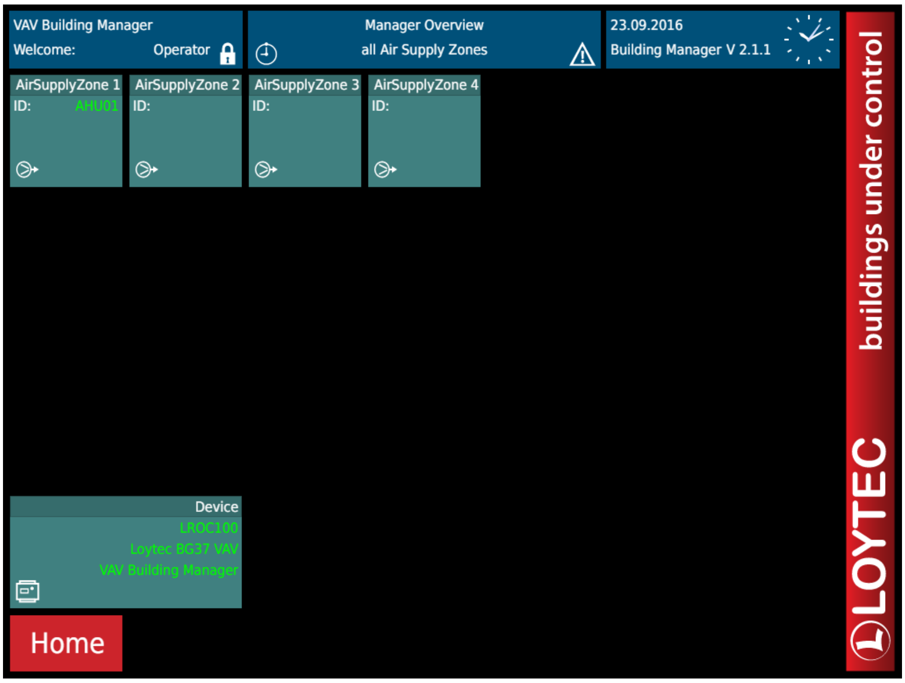

Figure 409: Building Manager Overview

In the overview, the top level tiles of the 4 Air Supply Zones are shown. The Tiles show the top level information of the regarding Air Supply Zone. A click on this tile leads to the detailed information and configuration / operation pages of the regarding Air Supply Zone data visualization in this manager.

Please note that this displayed here for the Building Manager as an example. Because the same visualization *VAVmanagerStatus* is instantiated in every manger, the visualization looks the same for the Area- and Floor- Managers. The pages look quite identical so the user needs to know which manager information is currently displayed. This can be identified on the right part pf the headline, as shown in Figure 410, Figure 411 and Figure 412.

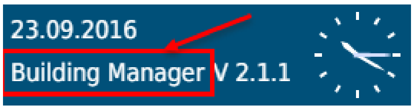

Figure 410: Display of Building Manager information

Figure 411: Display of Floor Manager information

Figure 412: Display of Area Manager information

7.7.2.2 Manager Tiles and Watchdogs

The 4 Air Supply Zone tiles are shown on the *Manager Overview* page of the *VAVmanagerStatus* visualization project as shown in Figure 413.

Figure 413: Air Supply Zone 1 tile in manager Overview

The AirSupplyZoneID is shown here and the resulting alarm indicator if the High Level Watchdog or the Local Level Watchdog have triggered an alarm.

Table 235 shows the Managers top level tiles present values.

Path: User Registers.VAVbuilding.AirSupplyZones.Zone1 ***)**

Name on tile	**Data point name**	**Description**
ID	AirSupplyZoneId	Displays the current ID of the air supply zone the manager is operating

Table 235: Manager top level tile present values

***)**: Please note that the data point path is depending on the manager type and zone number:

Building Manager, Zone1	folder name: VAVbuilding.AirSupplyZones.Zone1
Building Manager, Zone2	folder name: VAVbuilding.AirSupplyZones.Zone2
Building Manager, Zone3	folder name: VAVbuilding.AirSupplyZones.Zone3
Building Manager, Zone4	folder name: VAVbuilding.AirSupplyZones.Zone4
Floor Manager, Zone1	folder name: VAVfloor.AirSupplyZones.Zone1
Floor Manager, Zone2	folder name: VAVfloor.AirSupplyZones.Zone2
Floor Manager, Zone3	folder name: VAVfloor.AirSupplyZones.Zone3
Floor Manager, Zone4	folder name: VAVfloor.AirSupplyZones.Zone4
Area Manager, Zone1	folder name: VAVarea.AirSupplyZones.Zone1
Area Manager, Zone2	folder name: VAVarea.AirSupplyZones.Zone2
Area Manager, Zone3	folder name: VAVarea.AirSupplyZones.Zone3
Area Manager, Zone4	folder name: VAVarea.AirSupplyZones.Zone4

Please note that these path declarations are valid for all the data points in the dedicated managers!

ID:

Displays the current *AirSupplyZoneID* this manager is operating. All Managers and all VAV controllers that are assigned to one AHU must have the identical *AirSupplyZoneID* (e.g. AHU01) to establish the communication and to enable the data aggregation function.

<u>Watchdog Functions:</u>

The High Level Watchdog and the Local Level Watchdog are performed in the identical way as described in the Multi manager, see chapter 7.7.1.2. But in this case, there is no dedicated indication available on the tiles.

7.7.2.3 Configuring a Manager

Air Supply Zone ID:

This is identical to the Multi Manager, see chapter 7.7.1.3. However, the dedicated managers do support 4 Air Supply Zones. So the *AirSupplyZoneID* can be configured individually for every Air Supply Zone. To gain a proper AHU communication function, it is not allowed to have identical IDs in the 4 Air Supply Zones of a manager.

The data point path declaration of the dedicated managers is described in chapter 7.7.2.2.

VAV Manager ID:

This is identical to the Multi Manager, see chapter 7.7.1.3. However, there is no tile available to modify this *VAV Manager ID,* because it is not needed usually.

The data point path declaration of the dedicated managers is described in chapter 7.7.2.2.

Device Location:

This is identical to the Multi Manager, see chapter 7.7.1.3. However, because every manager function is a separate instance in the LIOB-Air device, the device location has to be set on the *Device Data* tile on the *Manager Device Data* page.

The data point path declaration of the dedicated managers is described in chapter 7.7.2.2.

7.7.2.4 Values to AHU (Data Aggregation)

This is nearly identical to the Multi Manager, see chapter 7.7.1.4. The data aggregation is operated in every dedicated manager using the values coming from the local level devices. This happens for the 4 Air Supply Zones independently in every manager. Therefore, for every Air Supply Zone there are separate tiles available.

The Building Manager provides this aggregated data to the AHU control using standard communication as BACnet or OPC.

The data point path declaration of the dedicated managers is described in chapter 7.7.2.2.

7.7.2.5 Values from AHU

This is nearly identical to the Multi Manager, see chapter 7.7.1.5. As described in chapter 7.6.1.3 the Building Manager is receiving data from up to 4 AHU controls. The broadcast of the Values from AHU is executed for the 4 Air Supply Zones independently in every manager.

The data point path declaration of the dedicated managers is described in chapter 7.7.2.2.

7.7.2.6 Local operation of the Values from AHU

This is nearly identical to the Multi Manager, see chapter 7.7.1.6. Because the dedicated managers supply 4 Air Supply Zones the local operation of the Values from AHU is available for the 4 Air Supply Zones independently in every manager.

The data point path declaration of the dedicated managers is described in chapter 7.7.2.2.

7.7.2.7 Balance Flow Manager

This is nearly identical to the Multi Manager, see chapter 7.7.1.7. Because the dedicated managers supply 4 Air Supply Zones, the Balance Flow Manager is available for the 4 Air Supply Zones independently in every manager.

The data point path declaration of the dedicated managers is described in chapter 7.7.2.2.

7.7.2.8 Weather Data

Weather Data sender:

This is nearly identical to the Multi Manager, see chapter 7.7.1.8. The weather station sensors or the weather data can be connected to the Building Manager. This weather data is broadcasted using the internal serial communication to the 4 Air Supply Zones of all devices that are connected on the local level down to the lowest level devices. Please note that a Building Manager only supports one source of the weather data, not a dedicated weather data source for every Air Supply Zone.

The data point path declaration of the dedicated managers is described in chapter 7.7.2.2.

Weather Data receivers:

This is nearly identical to the Multi Manager, see chapter 7.7.1.8. The weather data that is broadcasted by the manager device is received in the 4 Air Supply Zones by all connected devices on every level.

The data point path declaration of the dedicated managers is described in chapter 7.7.2.2.

7.7.3 Communication to the AHU Control

The Multi Manager or the Building Manager are intended to perform the communication to the external AHU controller. This communication can be a standard communication as BACnet or OPC. This communication has to be established by the system integrator.

The aggregated data Values to AHU can be sent from the manager to the AHU control. The AHU control can use this data for an energy optimal control, based on the data coming from the VAV controllers.

The Values from AHU are sent by the AHU control(s) to the manager. The assigned VAV controllers are operating their control functions regarding to the information received from the manager.

The weather data is sent by the AHU control to the manager. The weather data that is broadcasted by the manager device is received by all connected devices on every level.

The principle of the communication between a Multi Manager (or Building Manager) and an external AHU controller (e.g. LIOB-581) is displayed in Figure 414.

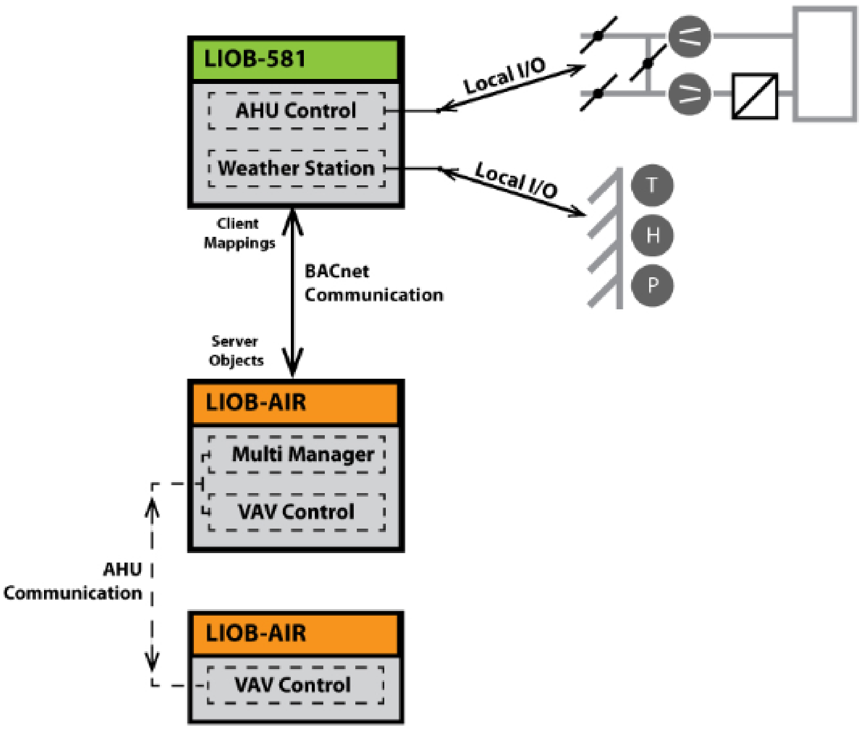

Figure 414: Principle communication between manager and AHU controller

For example, the external AHU controller can act as follows: The external AHU controller is operating the AHU control function. The sensors and actuators of the AHU can be connected to the Local I/O of this controller. The sensors of the Weather Station can also be connected to the Local I/O of this controller. So all information of the AHU control is available by the data points of the external AHU controller.

The aggregated data Values to AHU, the Values from AHU and the weather data is available as BACnet Server Objects in the Multi Manager.

To establish the BACnet communication the external AHU controller has to create BACnet Client Mappings to the Server Objects of the Multi Manager. This can be done performing a "Scan for BACnet Objects" using the LINX-Configurator of the external AHU controller. This is described in the LINX Configurator User Manual [2]. The LIOB-AIR device of the Multi Manager will be discovered by the scan process. The Server Objects needed for communication can be selected and the "Use on Device" command creates the client mappings on the external AHU controller device. The BACnet communication will be established after this process has been finished.

7.7.3.1 Values to AHU

SumSupplyAirFlowToAHU	Analog Value	The summary aggregated supply air flow of this manager sent to the AHU
SumExhaustAirFlowToAHU	Analog Value	The summary aggregated exhaust air flow of this manager sent to the AHU
SumOutdoorAirFlowDemandToAHU	Analog Value	The summary aggregated outdoor air flow demand of this manager sent to the AHU

Table 236 shows the BACnet Server Objects of the Values to AHU by name in the LIOB-AIR Multi Manager (or Building Manager), that provide information to the external AHU controller. For the data point details, please refer to chapter 7.7.1.4.

Please note that the instance numbers of the server objects are assigned automatically and so they are defined during the individual configuration of the manager device type.

First Part of Object Name (Multi Manager): VAVmultiManager_Floor_Zone_ ***)**

Server Object Name	**Server Object Type**	**Description**
OccupiedModeToAHU	Multistate Value	The maximum aggregated Effective Occupancy of this manager sent to the AHU
MaxTerminalLoadToAHU	Analog Value	The maximum aggregated Terminal Load of this manager sent to the AHU
MinTerminalLoadToAHU	Analog Value	The minimum aggregated Terminal Load of this manager sent to the AHU
MaxSupDamperPosition	Analog Value	The maximum aggregated supply damper position of this the manager sent to the AHU
MaxExhDamperPositionToAHU	Analog Value	The maximum aggregated exhaust damper position of this the manager sent to the AHU
MaxIAQtoAHU	Analog Value	The maximum aggregated CO2 concentration of this manager sent to the AHU
MinSpaceTempToAHU	Analog Value	The minimum aggregated space temperature of this manager sent to the AHU

Server Object Name	Server Object Type	Description
MaxSpaceTempToAHU	Analog Value	The maximum aggregated space temperature of this manager sent to the AHU
AvgSpaceTempLevel	Analog Value	The average space temperature of this manager level sent to the AHU
SumSpaceTempToAHU	Analog Value	The summary aggregated space temperature of this manager sent to the AHU
NumSpaceTempToAHU	Analog Value	The number of the summary aggregated space temperatures of this manager sent to the AHU
MinEffSetpointToAHU	Analog Value	The minimum aggregated effective setpoint of this manager sent to the AHU
MaxEffSetpointToAHU	Analog Value	The maximum aggregated effective setpoint of this manager sent to the AHU
AvgEffSetpointLevel	Analog Value	The average effective of this manager level sent to the AHU
SumEffSetpointToAHU	Analog Value	The summary aggregated effective setpoint of this manager sent to the AHU
NumSEffSetpointToAHU	Analog Value	The number of the summary aggregated effective setpoints of this manager sent to the AHU
SetbackOverrideToAHU	Binary Value	The maximum aggregated Occ. Override Status of this manager sent to the AHU
MinHumidityToAHU	Analog Value	The minimum aggregated relative humidity of this manager sent to the AHU
MaxHumidityToAHU	Analog Value	The maximum aggregated relative humidity of this manager sent to the AHU
AvgRelHumidityLevel	Analog Value	The maximum aggregated relative humidity of this manager sent to the AHU
SumHumidityToAHU	Analog Value	The summary aggregated relative humidity of this manager sent to the AHU
NumHumidityToAHU	Analog Value	The number of summary aggregated relative humidity of this manager sent to the AHU
SumSupplyAirFlowToAHU	Analog Value	The summary aggregated supply air

Server Object Name	**Server Object Type**	**Description**
		flow of this manager sent to the AHU
SumExhaustAirFlowToAHU	Analog Value	The summary aggregated exhaust air flow of this manager sent to the AHU
SumOutdoorAirFlowDemandToAHU	Analog Value	The summary aggregated outdoor air flow demand of this manager sent to the AHU

Table 236: Values to AHU, BACnet Server Objects

***)**: Please note that the first part of the Server Object Name in a Building Manager is different to the Multi Manager and is depending on the zone number:

Building Manager, Zone1 first part: VAVbuilding_AirSupplyZones_Zone1

Building Manager, Zone2 first part: VAVbuilding_AirSupplyZones_Zone2

Building Manager, Zone3 first part: VAVbuilding_AirSupplyZones_Zone3

Building Manager, Zone4 first part: VAVbuilding_AirSupplyZones_Zone4

7.7.3.2 Values from AHU

Table 237 shows the BACnet Server Objects of the Values from AHU by name in the LIOB-AIR Multi Manager (or Building Manager), that provide information from the external AHU controller to the LIOB-Air Multi Manager. For the data point details, please refer to chapter 7.7.1.5.

Please note that the instance numbers of the server objects are assigned automatically and so they are defined during the individual configuration of the manager device type.

First Part of Object Name (Multi Manager): VAVmultiManager_Floor_Zone_ ***)**

Server Object Name	**Server Object Type**	**Description**
HvacModeFromAHU	Multistate Value	The HVAC Mode received by the manager from the AHU
OccupOverrideFromAHU	Binary Value	The Occupancy Override received by the manager from the AHU
OnOffFromAHU	Binary Value	The AHU Operation contact received by the manager from the AHU
HeatingFromAHU	Binary Value	The AHU Heating contact received by the manager from the AHU
CoolingFromAHU	Binary Value	The AHU Cooling contact sent by the manager to the local level devices
FanOnlyFromAHU	Binary Value	The AHU Fan only contact received by the manager from the AHU
OutdoorAirFractionFromAHU	Analog Value	The Outdoor Air Fraction received by the manager from the AHU
CO2outdoorAirFromAHU	Analog Value	The CO_2 concentration of the outdoor air received by the manager from the AHU
CO2supplyAirFromAHU	Analog Value	The CO_2 concentration of the supply air received by the manager from the AHU
SupplyAirTempFromAHU	Analog Value	The primary supply air temperature received by the manager from the AHU
EnergyDemandLimitFromAHU	Binary Value	The Energy Demand limiting request received by the manager from the AHU

Table 237: Values from AHU, BACnet Server Objects

***)**: Please note that the first part of the Server Object Name in a Building Manager is different to the Multi Manager and is depending on the zone number:

Building Manager, Zone1 first part: VAVbuilding_AirSupplyZones_Zone1

Building Manager, Zone2 first part: VAVbuilding_AirSupplyZones_Zone2

Building Manager, Zone3 first part: VAVbuilding_AirSupplyZones_Zone3

Building Manager, Zone4 first part: VAVbuilding_AirSupplyZones_Zone4

7.7.3.3 Weather Data

Table 238 shows the BACnet Server Objects of the Weather Data by name in the LIOB-AIR Multi Manager (or Building Manager), that provide information from the external AHU controller to the LIOB-Air Multi Manager. For the data point details, please refer to chapter 7.7.1.8.

Please note that the instance numbers of the server objects are assigned automatically and so they are defined during the individual configuration of the manager device type.

First Part of Server Object Name: VAVmultiManager_WeatherSensors_Air_IO_***)**

Server Object Name	**Server Object Type**	**Description**
SensorFailure	Binary Value	The outdoor air sensor failure received by the manager from the AHU
Temperature	Analog Value	The outdoor air temperature received by the manager from the AHU
RelHumidity	Analog Value	The outdoor air relative humidity received by the manager from the AHU
DewPoint	Analog Value	The outdoor air dew point received by the manager from the AHU
Pressure	Analog Value	The outdoor air pressure received by the manager from the AHU

Table 238: Weather Data from AHU, BACnet Server Objects

***)**: Please note that the first part of the Server Object Name in a Building Manager is different to the Multi Manager:

Building Manager first part: VAVbuilding_WeatherSensors_Air_IO_

7.8 L-STAT Support

The LOYTEC L-STAT network thermostat with a modern, minimalistic look that fits any interior design. It has to be directly connected to a LIOB-AIR controller using the L-STAT port that is an internal Modbus interface.

One L-STAT device can be connected to a LIOB-AIR controller.

The L-STAT is equipped with a segmented LCD display featuring an RGB backlight with adjustable color, offering a neat way to make the L-STAT match the interior color concept of an office building. Four capacitive touch buttons are used to cycle through sensor values, display parameters, and adjust setpoints

The L-STAT's internal sensors measure temperature, humidity, dew point and optionally ambient light, occupancy, and CO2 level. Sensor values can be displayed in SI or US units. Additionally, the date and time as well as the current level of eco-friendliness in the form of green leafs are also displayed on the LCD display.

A buzzer provides acoustic feedback for the touch buttons. To prevent unauthorized modifications, two access levels (end user, system integrator) can be used, which are secured via 4-digit pin codes. Device replacement, firmware upgrade, and L-STAT configuration are performed with very little effort through the LIOB-AIR controller.

In case the L-STAT-80x-G3-L1 is connected to a LIOB-AIR device running the VAV application the L-STAT is configured by the VAV application automatically. This will provide plug and play functionality.

The L-STAT-80x-G3-L1 is the usual type for use with VAV controllers. For this type, the automatic configuration realized. There are buttons to increase and decrease the space temperature setpoint offset, a button to view some sensor values and an occupancy override button, see Figure 415.

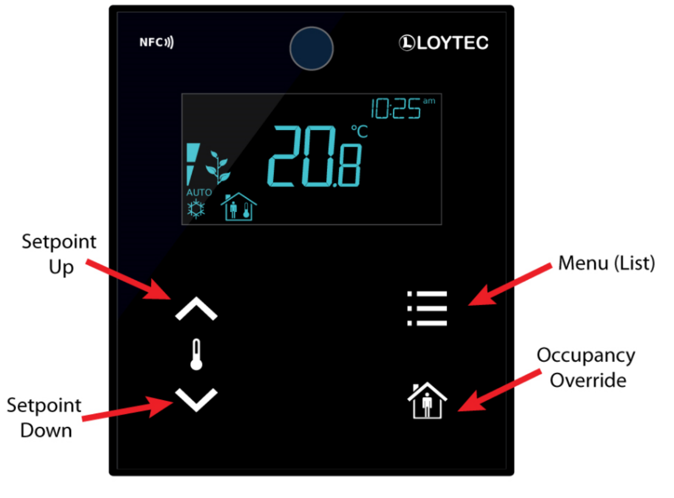

Figure 415: L-STAT-80x-G3-L1

For detailed information regarding the L-STAT network thermostat, please refer to the L-STAT User Manual [6].

7.8.1 Basic Operation of the L-STAT with LIOB-AIR

This chapter describes the basic user operation of the L-STAT when it was automatically configured with the default settings by the LIOB-AIR device. By modifying the settings as described in the following chapters, the display functions can be adapted to the project demands.

The L-STAT display functions that are supported by the LIOB-AIR VAV application are displayed in Figure 416.

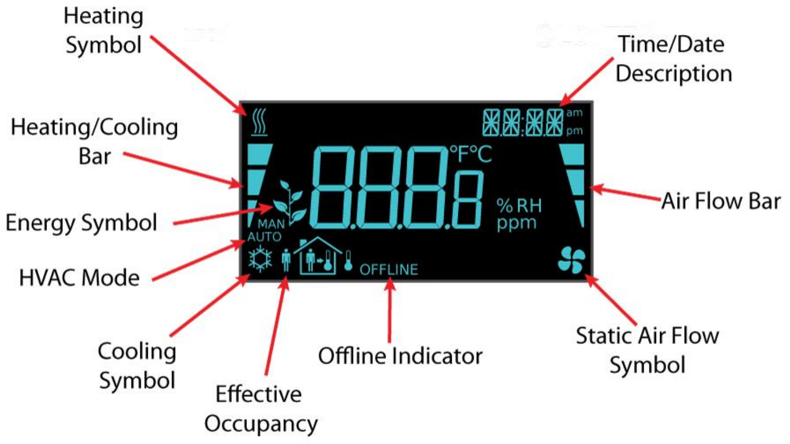

Figure 416: L-STAT display supported by LIOB-AIR

As the default display, the current space temperature is shown. This is the value the space temperature cooling or heating controller is actually operating, see chapter 7.5.6.1. The time and the date are shown alternately in the top right edge of the display.

The effective occupancy state of the VAV controller is shown as a symbol on the left bottom of the display:

Man outside the house (not flashing):	Unoccupied
Man outside the house (flashing):	Standby
Man inside the house (not flashing):	Occupied
Man inside the house (flashing):	Bypass, Occupancy Override

Using the Setpoint Up and Setpoint Down buttons the external space temperature setpoint offset in the VAV controller (see chapter 7.5.6.3) is increased or decreased. If a setpoint button is pressed, the display shows the current space temperature setpoint offset. After a few seconds, the default display is shown again.

Pressing the Menu (List) button a configurable list of values is shown as user information. As default, the current space temperature and the effective space temperature setpoint (see chapter 7.5.6.2) are shown in the list. Every touch of the List button switches to the next value. The description of the current displayed value is shown in the top right edge of the display.

The default display is shown again, when a fixed time (60 sec) has elapsed after the last press of the List button.

Pressing the Occupancy Override button the Occupancy Override sensor function is triggered in the VAV controller. The effective occupancy state will switch to Bypass for the parameterized bypass time duration, see chapter 7.5.12.3.

The energy symbol is a tree with 4 leaves. It indicates if the current operation of the room is more or less energy efficient. If all the 4 leaves are displayed it indicates the best energy efficiency. The best energy efficiency is gained if the effective space temperature setpoint is less or equals the standard occupied heat setpoint or is greater or equals the standard occupied cool setpoint.

The cooling or heating symbols display if the space temperature cooling or heating controller is in operation.

The LSTAT sensor values are communicated to the regarding functions in the VAV application automatically. If there are multiple LIOB-AIR devices in a room, they have to be parameterized as a “VAV Group” to be able to operate a proper room control. Either a device can have hard-wired sensors or L-STATs connected (not both at the same time) or no sensor connected.

The space temperature is calculated as the average value of all sensors and L-STATs in the VAV Group automatically and used as the control value. This value is displayed as the “Zone” temperature on the default display.

The space humidity is calculated as the average value of all sensors and L-STATs in the VAV Group automatically and used as the control value. This value can be displayed as the “Zone” relative humidity in the L-STAT list (List-button).

The resulting occupancy sensor state is calculated as the maximum state of all sensors and L-STATs in the VAV Group automatically and used as the control value to detect the *Effective Presence*. This state is displayed as the effective occupancy symbol

The CO_2 concentration is calculated as the maximum value of all sensors and L-STATs in the VAV Group automatically and used as the control value. This value can be displayed as the “Zone” CO_2 concentration in the L-STAT list (List-button).

7.8.2 Connecting L-STAT to LIOB-AIR

The L-STAT-80x-G3-L1 has to be connected to the L-STAT port of the LIOB-AIR device with a 1:1 connection of the 4 terminals (24VDC +/-, Modbus +/-). Please note that this is a Modbus communication but this port is dedicated to connect an L-STAT device.

The LOB-AIR device has to be deployed with a VAV application with an LSTAT800 CAT instantiated and connected to the Core in the VAV_Type as described in chapter 7.2.4. This is a basic requirement for the automatic configuration and establishment of communication!

When the LIOB-AIR device is powered on, the connected L-STAT is also starting. The L-STAT is automatically commissioned and the communication is established automatically by the LIOB-AIR device. The factory default settings have to be used in both devices to enable the communication. The default settings of the L-STAT port can be checked in the WebUI of the LIOB-AIR and are shown in Figure 417. LIOB-AIR is the Modbus Master.

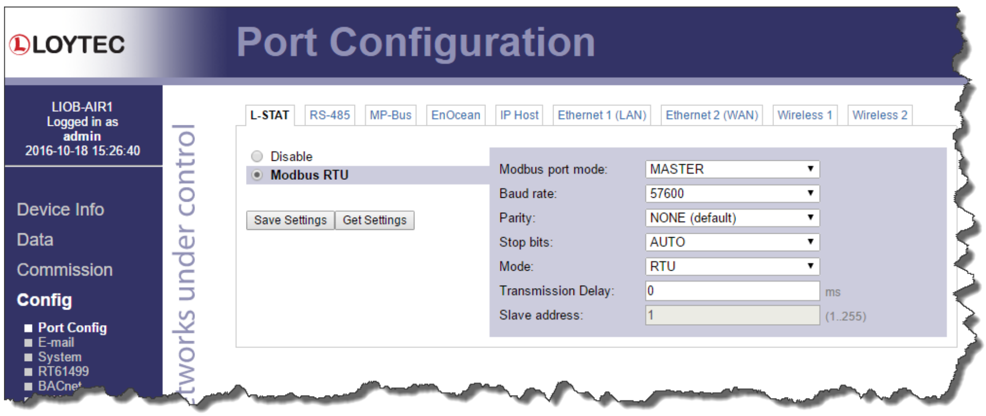

Figure 417: Default settings of the L-STAT port

The default settings in the L-STAT device are corresponding as a Modbus Slave device and using the Address: “1”.

If the L-STAT was commissioned by the LIOB-AIR and the communication is established properly the Status “OK” is shown on the Modbus Commissioning page of the WebUI as shown in Figure 418. The indication “Offline” also disappears from the L-STAT display.

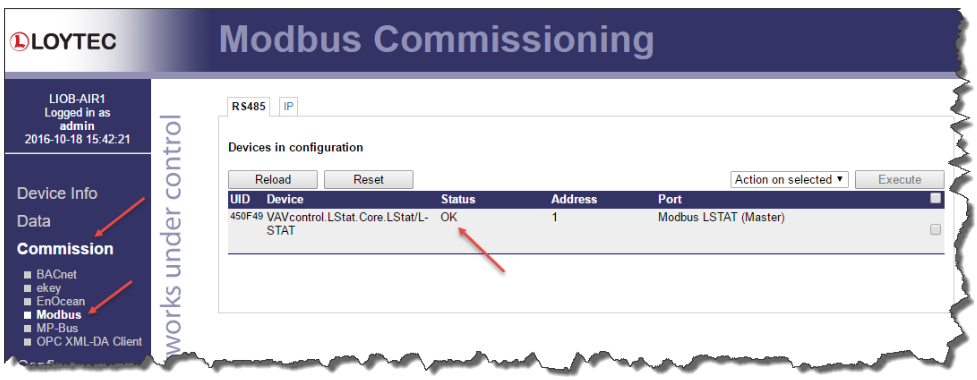

Figure 418: L-STAT status is “OK”

The L-STAT is now operating with the default configuration. How to modify the default configuration is described in the next chapter.

7.8.3 Configuring the L-STAT

7.8.3.1 LSTAT800 CAT

Outside of an LIOB-AIR system usually an L-STAT has to be configured setting the regarding Modbus registers. However, the LSTAT800 CAT that is included in the LIOB-AIR VAV library supports the automatic configuration and communication of the L-STAT device. Therefore, there is no need to do some configuration work using the Modbus registers that saves engineering work.

As described in chapter 7.2.4 the VAVtype_V0 maximum VAV_Type (and also the first copy VAVtype_V1) includes an instance of the LSTAT800 CAT that is connected to the dedicated port of the Core. This is shown in Figure 419.

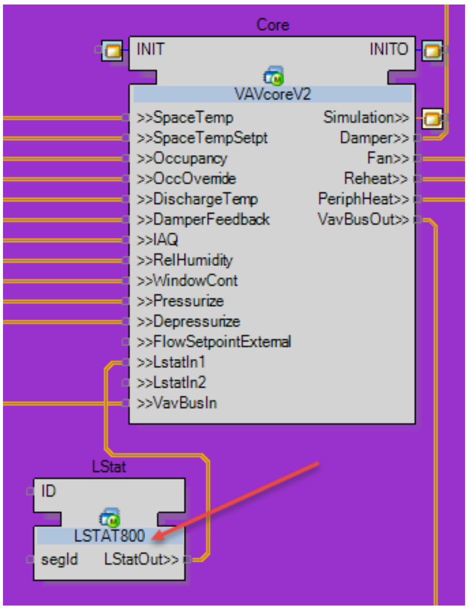

Figure 419: LSTAT800 connected to Core in VAVtype_V0

This is an instance of the LSTAT800 CAT in the LSTAT folder in the VAV application that was created based on the “VAV Start Solution” as shown in Figure 420.

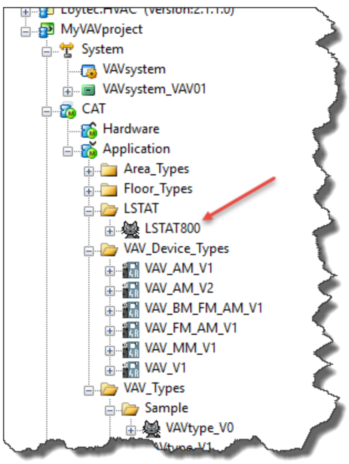

Figure 420: LSTAT800 cat in the VAV application folder

This LSTAT800 CAT includes all the default configuration and communication functions that are used between LIOB-AIR and L-STAT. The settings in this CAT can be modified to fit the project demands.

7.8.3.2 Multiple L-STAT Configurations

If there are different configurations of L-STAT devices are needed in a VAV project, this LSTAT800 cat has to be copied and pasted to a new LSTAT800 CAT e.g. LSTAT800_1. This new LSTAT800_1 Type can be modified to the project demands. Then it has to be instantiated in a VAV_Type e.g. VAVtype_V2 by modifying the instance type of the LSTAT800 CAT to LSTAT800_1. The modification of an instance type was already shown in chapter 7.2.5.2.

Of course, L-STUDIO-AIR is a type based system there are additional VAV_Types and also an additional VAV_Device_Types needed if there are multiple configurations of L-STAT devices existing in a project.

The case of an additional LSTAT800_1 instantiated in an additional VAVtype_V2 is shown in Figure 421.

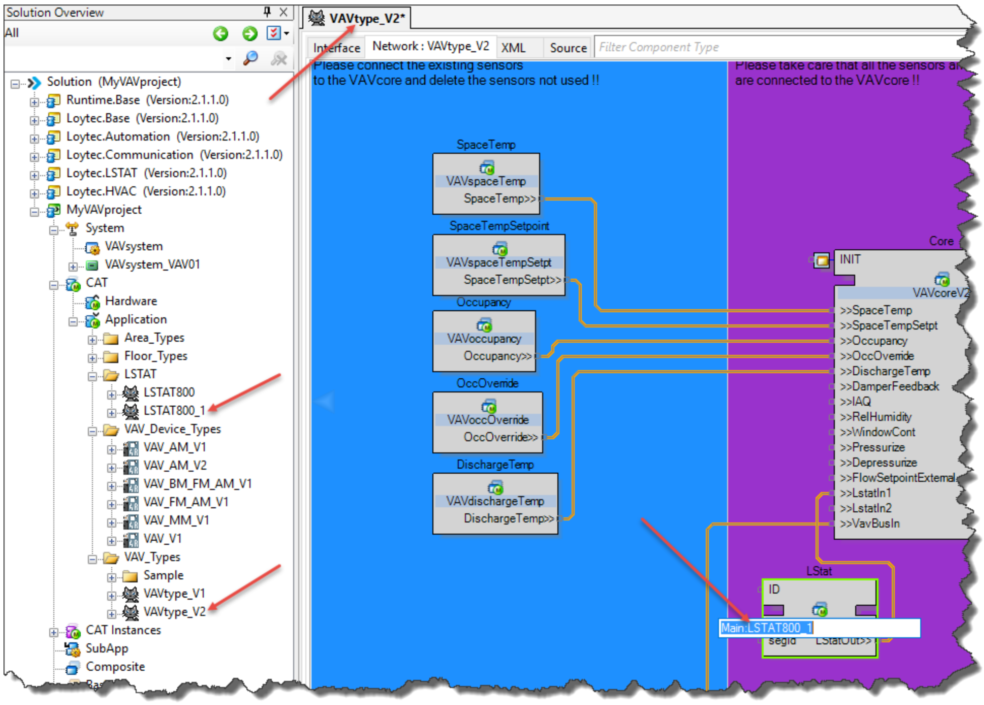

Figure 421: Additional LSTAT800_1 CAT in the VAVtype_V2

However, this is only needed in case there are different L-STAT configurations needed in a project!

7.8.3.3 Settings in the LSTAT800 CAT

This chapter shows how to change the settings in the LSTAT800 CAT and the regarding results on the L-STAT display. The relating buttons and symbols on the L-STAT device are shown in Figure 415and Figure 416.

A double click on the LSTAT800 CAT opens the CAT and on the Composite tab the instances of the multiple functions the L-STAT supports (Core, HVAC1, Light1, Sunblind1) are shown, see Figure 422. Because LSTAT800 is a common library CAT that is used in LIOB-AIR and L-ROC systems it contains many functions. Please note that the LIOB-AIR VAV application is only supporting the Core function and parts of the HVAC1 function. For that reason, only the Core and the HVAC1 settings are described in this manual.

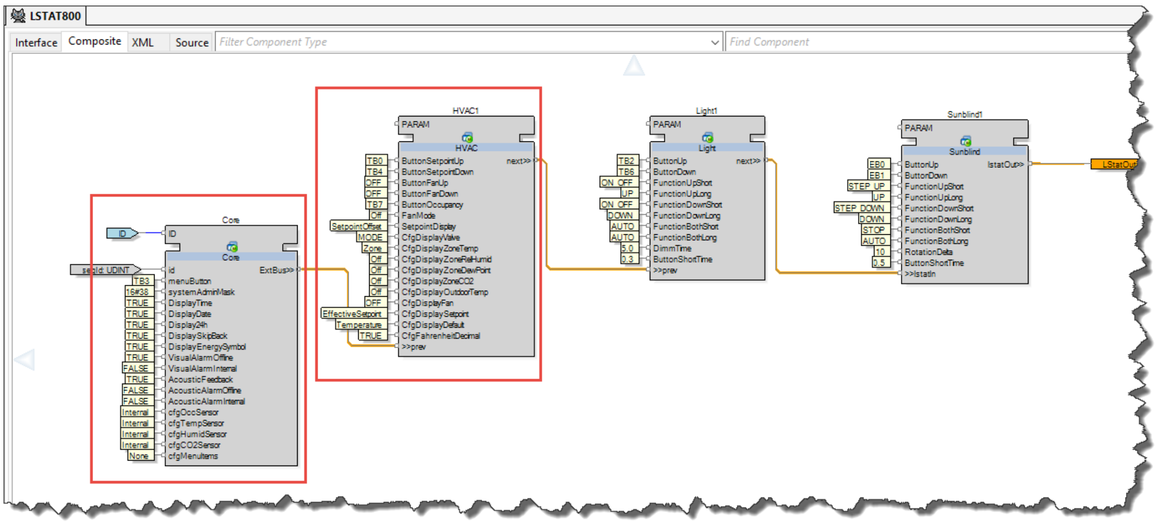

Figure 422: LSTAT800 functions

The Core function configures common functions of the L-STAT as display features like e.g. date and time and which sensor will be used. The HVAC1 function configures special HVAC functions of the L-STAT as e.g. which sensor values will be displayed and which display functions as icons or bar graphs are used.

The settings are defined by the inputs of the functions. The yellow value field connected to a dedicated input defines the individual setting. The yellow value fields can be modified to change the dedicated setting. The default values are useful settings in the VAV application. All the other items like e.g. the connections <u>must not</u> be modified in the LSTAT800 CAT.

Please note if modifications were done and deployed to the LIOB-AIR devices the L-STAT devices should be power cycled to establish the modifications.

The LSTAT800 CAT also ensures that the engineering unit system (SI / US) the LIOB_AIR device is operating is set in the L-STAT device accordingly without any user setting required.

<u>Settings in the LSTAT 800 Core function:</u>

The settings in the LSTAT800 Core function are listed in Table 239 with the default settings. Please note that the settings with the hint “To modify = No” should not be modified!

LSTAT800 Core function:

Name of Setting	**Default Value**	**To modify**	**Description**
menuButton	TB3	No	Touch button to open the L-STAT menu or list
systemAdminMask	16#38	No	Internal setting
DisplayTime	TRUE	Yes	Enables the time display
DisplayDate	TRUE	Yes	Enables the date display
Display24h	TRUE	Yes	Sets the time display to 24h format
DisplaySkipBack	TRUE	Yes	Enables to skip back to the default display value after a time has expired
DisplayEnergySymbol	TRUE	Yes	Enables the display to skip back to the default display value
VisualAlarmOffline	TRUE	Yes	Enables the display to show the offline indicator if there is no communication to the LIOB-AIR device
VisualAlarmInternal	FALSE	No	This is only for internal purposes and must not be modified
AcousticFeedback	TRUE	Yes	Enables the buzzer to indicate if a button is touched
AcousticAlarmOffline	FALSE	Yes	Enables the buzzer to indicate if there is no communication to the LIOB-AIR device
AcousticAlarmInternal	FALSE	No	This is only for internal purposes and must not be modified
cfgOccSensor	Internal	Yes	This enables the internal occupancy sensor, the value is sent to the LIOB-AIR device
cfgTempSensor	Internal	Yes	This enables the internal temperature sensor, the value is sent to the LIOB-AIR device
cfgHumidSensor	Internal	Yes	This enables the internal humidity sensor, the value is sent to the LIOB-AIR device
cfgCO2Sensor	Internal	Yes	This enables the internal CO_2 sensor, the value is sent to the LIOB-AIR device
cfgMenuItems	None	No	This setting must be None when used in the VAV application

Table 239: LSTAT800 Core function settings

menuButton: This defines the touch button to open the L-STAT Menu or List. This setting must not be modified.

systemAdminMask: This is for internal use only and must not be modified.

DisplayTime: This enables the display of the current time in the default display.

DisplayDate: This enables the display of the current date in the default display.

Display24: This sets the format of the displayed time to 24h format.

DisplaySkipBack: If this setting is TRUE, the default display value is shown after the last touch of the Menu/List Button when a fixed time (60 sec) has expired. If this setting is FALSE, the display remains on the last display value selected by the Menu/List Button. The default display is set in the HVAC1 function on the *CfgDisplayDefault* input.

DisplayEnergySymbol: This enables the leave display to indicate to the room occupant if the room is operating in an energy optimal mode. All 4 leaves are displayed, if the setpoint has not been decreased by the room occupant in cooling mode or has not been increased in heating mode.

VisualAlarmOffline: This enables the “Offline” indication on the Display if there is no communication to the LIOB-AIR device.

VisualAlarmInternal: This only for internal purposes and must not be modified.

AcousticFeedback: This enables the buzzer to do a click sound if a button is touched.

AcousticAlarmOffline: This enables the buzzer to do a sound if there is no communication to the LIOB-AIR device. This may be useful in the commissioning phase but it is not useful in the normal operation phase.

AcousticAlarmInternal: This only for internal purposes and must not be modified.

cfgOccSensor: This enables the internal occupancy sensor. The sensor value is sent to the LIOB-AIR device and it is received by the occupancy sensor function of the VAV application automatically, see chapter 7.5.12.2.

cfgTempSensor: This enables or disables the internal or external (terminal EB3) temperature sensor. The sensor value is sent to the LIOB-AIR device and it is received by the space temperature sensor function of the VAV application automatically, see chapter 7.5.6.1.

cfgHumidSensor: This enables or disables the internal humidity sensor. The sensor value is sent to the LIOB-AIR device and it is received by the space humidity sensor function of the VAV application automatically.

cfgCO2Sensor: This enables or disables the internal CO_2 sensor. The sensor value is sent to the LIOB-AIR device and it is received by the IAQ sensor function of the VAV application automatically, see chapter 7.5.9.1.

cfgMenuItems: This setting decides to show the internal sensor values in the list. However, this is not used in the VAV application and must not be changed here. The values in the list are configured in the HVAC1 function.

Settings in the LSTAT 800 HVAC1 function:

The settings in the LSTAT800 HVAC1 function are listed in with the default settings. Please note that the settings with the hint “To modify = No” should not be modified!

LSTAT800 HVAC1 function:

Name of Setting	**Default Value**	**to modify**	**Description**
ButtonSetpointUp	TB0	No	Touch button to increase the space temperature offset value
ButtonSetpointDown	TB4	No	Touch button to decrease the space temperature offset value
ButtonFanUp	OFF	No	Touch button to control a fan, not used in the VAV application
ButtonFanDown	OFF	No	Touch button to control a fan, not used in the VAV application
ButtonOccupancy	TB7	No	Touch button to trigger the occupancy override function
FanMode	Off	No	Fan mode is not used in the VAV application
SetpointDisplay	SetpointOffset	Yes	Fan mode is not used in the VAV application
CfgDisplayValve	Mode	Yes	Defines how the cooling or heating mode is displayed
CfgDisplayZoneTemp	Zone	Yes	Defines if and which value is displayed as the zone temperature
CfgDisplayZoneRelHumid	Off	Yes	Defines if and which value is displayed as the zone relative humidity in the list
CfgDisplayZoneDewPoint	Off	Yes	Defines if and which value is displayed as the zone dew point temp in the list
CfgDisplayZoneCO2	Off	Yes	Defines if and which value is displayed as the zone CO_2 concentration in the list
CfgDisplayOutdoorTemp	Off	Yes	Defines if the outdoor temperature is displayed in the list
CfgDisplayFan	OFF	Yes	Defines if air flow is displayed as a symbol
CfgDisplaySetpoint	EffectiveSetpoint	Yes	Defines which type of setpoint value is displayed in the list
CfgDisplayDefault	Temperature	Yes	Defines which value is shown as the standard display

Name of Setting	Default Value	to modify	Description
CfgFahrenheitDecimal	TRUE	Yes	Defines if Fahrenheit values are displayed with one decimal place

Table 240: LSTAT800 HVAC1 function settings

ButtonSetpointUp: This defines the touch button to increase the external space temperature setpoint offset in the VAV application. This setting must not be modified.

ButtonSetpointDown: This defines the touch button to decrease the external space temperature setpoint offset in the VAV application. This setting must not be modified.

ButtonFanUp: This defines the touch button to increase a fan speed. This function is not used in the VAV application. This setting must not be modified.

ButtonFanDown: This defines the touch button to decrease a fan speed. This function is not used in the VAV application. This setting must not be modified.

ButtonOccupancy: This defines the touch button to trigger the occupancy override function in the VAV application. This setting must not be modified.

FanMode: This is not supported in the VAV application. This setting must not be modified.

SetpointDisplay: This defines which setpoint of the VAV application is displayed if the Setpoint Up or Setpoint Down buttons are pressed: “Setpoint Offset”, or “Effective Setpoint”, or “Display Setpoint”. See chapter 7.5.6.2 for the definitions. Please note that always the external space temperature setpoint offset is increased or decreased in the VAV application by pressing these buttons.

CfgDisplayValve: This defines how the cooling or heating mode is displayed. The setting “Mode” means, that there will be the heating symbol displayed if the space temperature heating controller is active and the cooling symbol will be displayed if the space temperature cooling controller is active. If both controllers are inactive, none of both symbols is displayed. The current HVAC mode of the VAV application is also shown as a text on the left side. In HVAC mode Auto, the text “Auto” is displayed. In HVAC mode Off, no text is displayed. In all other HVAC modes, the text “Man” is displayed. The setting “Mode + Bar” means, that additionally to the heating and cooling symbols a bar graph is displayed on the left side that indicates the control output (terminal load) of the active space temperature heating or cooling controller. The setting “Off” means, that there will be no indication of the heating or cooling mode.

CfgDisplayZoneTemp: This decides if and which value is displayed as the space (zone) temperature in the default display and in the list. The setting “Off” means, that no space temperature will be displayed in the default display and in the list. The setting “Zone” means that the resulting space temperature of all LIOB-AIR devices and L-STATs in a room (VAV Group) will be displayed in the default display and in the list. The setting “LSTAT” means that, the value of the internal or external space temperature sensor will be displayed in the default display and in the list. This setting “LSTAT” is not recommended in the VAV application, because this setting does not support the VAV Group function.

CfgDisplayZoneRelHumid: This decides if and which value is displayed as the space (zone) relative humidity in the list. The setting “Off” means that no rel. humidity will be displayed in in the list. The setting “Zone” means that the resulting rel. humidity of all LIOB-AIR devices and L-STATs in a room (VAV Group) will be displayed in the list. The setting “LSTAT” means, that the value of the internal rel. humidity sensor will be displayed in the list. This setting “LSTAT” is not recommended in the VAV application if a humidity control function is configured in the VAV application, because this setting does not support the VAV Group function.

CfgDisplayDewPoint: This decides if and which value is displayed as the space (zone) dew point temperature in the list. The setting “Off” means that no dew point will be displayed in in the list. The setting “Zone” is not supported by the VAV application. The setting “LSTAT” means that the dew point value calculated in the L-STAT device using the internal temperature and rel. humidity sensor will be displayed in the list.

CfgDisplayZoneCO2: This decides if and which value is displayed as the space (zone) CO_2 concentration in the list. The setting “Off” means that no CO_2 concentration will be displayed in in the list. The setting “Zone” means that the resulting CO_2 concentration of all LIOB-AIR devices and L-STATs in a room (VAV Group) will be displayed in the list. The setting “LSTAT” means, that the value of the internal CO_2 concentration sensor will be displayed in the list. This setting “LSTAT” is not recommended in the VAV application if an IAQ control function is configured in the VAV application, because this setting does not support the VAV Group function.

CfgDisplayOutdoorTemp: This decides if the outdoor temperature is displayed in the list. The setting “Off” means that no outdoor temperature will be displayed in in the list. The setting “On” means that the outdoor temperature that is communicated from the managers to the LIOB-AIR devices will be displayed in the list.

CfgDisplayFan: This decides if the air flow is displayed with a fan symbol and bar graph on the right side. The setting “Off” means that no air flow indication will be displayed. The setting “Mode” means that there is a static fan symbol with a static Auto text displayed without any function, which is not useful in the VAV application. The setting “Mode+Bar” means that additionally a 3 stage bar graph is displayed on the right side that indicates the actual Air Flow as a percentage of the Max.Flow Cool.

CfgDisplaySetpoint: This decides if and which value is displayed as the space temperature setpoint in the list. The setting “None” means that no space temperature setpoint will be displayed in the list. The other settings decide to show the “Setpoint Offset”, or the “Display Setpoint”, or the “Effective Setpoint” in the list. See chapter 7.5.6.2 for the definitions.

CfgDisplayDefault: This decides if the space temperature or a setpoint is shown as the default display value. If “Temperature” is set the space temperature value selected by *CfgDisplayZoneTemp* is shown as default display value. If “Setpoint” is set the space temperature setpoint value selected by *CfgDisplaySetpoint* is shown as default display value. Please note that *CfgDisplayZoneTemp* must not be set on “Off” or *CfgDisplaySetpoint* must not be set on “None” if the regarding value is selected as default display value.

CfgFahrenheitDecimal: This defines if Fahrenheit values are displayed with one decimal place “TRUE” or as an integer “FALSE”. This is only valid if the LIOB-AIR devoice is operation the US engineering unit system.

7.8.3.4 Individual Settings in the WebUI

The LSTAT800 CAT also contains some User Register data points as parameters to do additional L-STAT settings in the LIOB-AIR device. These settings can be done and modified individually for every device during the runtime using the WebUI of the LIOB-AIR (or LWEB-900 parameter views).

The data points in the WebUI are shown in Figure 423 and Figure 424. Please note if modifications were done the L-STAT, devices should be power cycled to establish the modifications. For more detailed information, please refer to the L-STAT User Manual [6].

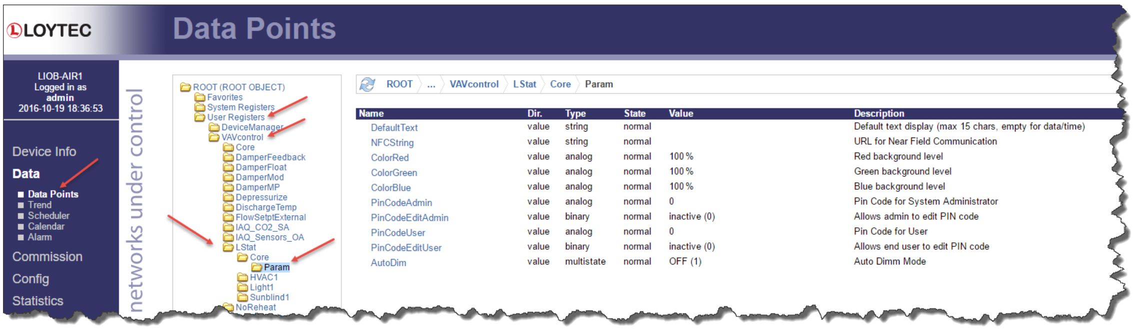

Figure 423: L-STAT settings in the WebUI (Core.Param)

The data points and default values are shown in Table 241.

Path: User Registers.VAVcontrol.LStat.Core.Param

Data point name	Default Value	Description
DefaultText		Default text display (max 15 chars, empty for data/time)
NFCString		URL for Near Field Communication
ColorRed	100%	Red background level
ColorGreen	100%	Green background level
ColorBlue	100%	Blue background level
PinCodeAdmin	0	Pin Code for System Administrator
PinCodeEditAdmin	Inactive (0)	Allows admin to edit PIN code
PinCodeUser	0	Pin Code for User
PinCodeEditUser	Inactive (0)	Allows end user to edit PIN code
AutoDim	OFF (1)	Auto Dimm Mode

Data point name	Default Value	Description
OccupancyMode	SENSOR (1)	Occupancy source (sensor/keypad)
TemperatureOffset	0°C 0°F	Temperature offset correction
RelHumidityOffset	0%rH	Relative humidity offset correction

Table 241: L-STAT settings in WebUI (Core.Param)

DefaultText: This is an individual text string that is displayed in the top right edge if the default display is active. This can be an individual room description or number. The length of the text is max 15 characters in capital letters. If the string is empty, the time and date are shown in the default display (if enabled in the LSTAT800 CAT settings, see previous chapter).

NFCString: Here e.g. an URL of an LWEB802 visualization project can be entered. For example, the *VAVmobileCalibration.lweb2* visualization (copied from the browser, see chapter 7.2.12.1):

http://192.168.23.217/lweb802_pre/?project=lstudio/System.VAVsystem_VAV01.VAVmobileCalibration.lweb2&address=192.168.23.217&port=80&https=false#lvisPage

If a mobile device with enabled NFC capability is placed near the L-STAT, the URL NFC string is received by the mobile device. If the mobile device is connected to the LIOB-AIR network, it can start the *VAVmobileCalibration.lweb2* visualization.

ColorRed: The color of the display background can be adjusted. This defines the percentage of the red level of the display color background.

ColorGreen: The color of the display background can be adjusted. This defines the percentage of the green level of the display color background.

ColorBlue: The color of the display background can be adjusted. This defines the percentage of the blue level of the display color background.

PinCodeAdmin: This is the PIN code for the Administrator access level on the L-STAT. It can be used to protect the system settings of the L-STAT device. If the value is “0” the PIN code protection is disabled.

PinCodeEditAdmin: This enables if the Administrator PIN code can be modified locally on the L-STAT device by the Administrator.

PinCodeUser: This is the PIN code for the End User access level on the L-STAT. It can be used to protect setpoints of the L-STAT device. If the value is “0” the PIN code protection is disabled. Please note that the End User PIN code protection is not supported by the VAV application.

PinCodeEditAdmin: This enables if the End User PIN code can be modified locally on the L-STAT device by the End User. Not used in the VAV application.

AutoDim: This configures the display Auto Dim function. The LCD brightness will be dimmed after 2 minutes with no interaction. The settings are: “OFF, 50%, 10%, 0%, and Occupancy”. If “Occupancy” is set, the built-in occupancy sensor activates the display.

OccupancyMode: This configures the occupancy detection function.

SENSOR (1): Internal occupancy sensor detects the room occupancy.

KEYS (2): Occupancy is detected if any of the buttons is touched.

SENSOR_KEYS (3): Occupancy is detected by the internal occupancy sensor or if any of the buttons is touched.

DISABLED (4): Occupancy detection is disabled for that dedicated LSTAT device.

Also, the HVAC1 sub-folder contains an important data point, as shown in Figure 424.

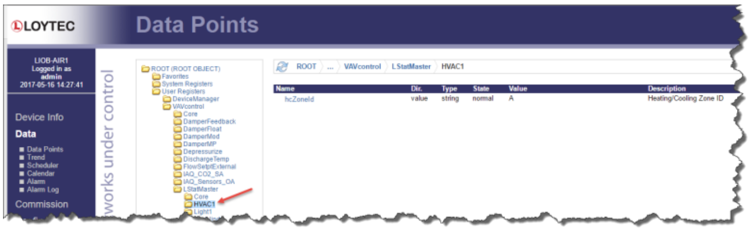

Figure 424: L-STAT settings in the WebUI (HVAC1)

The data points and default values are shown in Table 242.

Path: User Registers.VAVcontrol.LStat.HVAC1

Data point name	Default Value	Description
hcZoneId	A	Zone ID of the L-STAT communication

Table 242: L-STAT settings in WebUI (HVAC1)

hcZoneId: This is the name of the heating/cooling Zone. This is a definition of the L-ROC system. LIOB-AIR supports only one segment and one room. A room can be divided into multiple zones. This can be useful for sunblind or lighting control. However, the LIOB-AIR control functions of space temperature and air flow do not need a zoning in the room. The L-STAT is communicating with the LIOB-AIR device if the *Zone ID* (LIOB-AIR) matches the *hcZoneId* (L-STAT). The default value of the *ZoneID* is “A”in the LIOB-AIR, see chapter 7.5.4.1. The default value of the *hcZoneId* in the L-STAT is also “A”. So the communication is established automatically. Therefore, as long as there is only one zone existing, this parameter is already set properly and should not be changed.

8 BACnet Server Objects

As described in chapter 6.6 the function logic of the VAV application is directly operating the User Register data points. These User Register data points are synchronized to BACnet server objects automatically. Therefore, every time a data point value has changed on a User Register or on a BACnet server object the opposite data point is synchronized automatically. For that reason, LIOB-AIR devices can be integrated in BACnet systems with the complete functionality of operation and parameterization.

This chapter shows all the BACnet server objects of the LIOB-AIR device in tables with a short description. For more details regarding the functionality, please refer to the function descriptions in chapter 7.5 or chapter 7.6 or chapter 7.7.

Please note that the instance numbers of the server objects are defined by L-STUDIO-AIR during the definition of the VAV_Types and the VAV_Device_Types. Therefore, these instance numbers are depending on the configuration of the VAV controllers. This is the reason why the instance numbers cannot be listed in the following tables.

The server object name is consisting of the path name in the BACnet port as the prefix and the data point name. On the top of the table there is the prefix path name is listed and valid for all server object names in the table.

8.1 VAV Functions

This chapter contains the synchronized BACnet server objects regarding the VAV Functions described in chapter 7.5.

8.1.1 Device Settings

8.1.1.1 General Settings and Segment Data

For functional details, please refer to chapter 7.5.4.1

Prefix: VAVcontrol_Core_General_

Server Object Name	**Description**	**Type**	**Direction**
EngineeringUnits	General using these Engineering Units in this device	MV	read+write
Language	User Language Selection	MV	read+write

Table 243: BACnet Server Objects of general settings

8.1.1.2 Device Data

For functional details, please refer to chapter 7.5.4.2

Prefix: VAVcontrol_Core_Naviagation_Label_

Server Object Name	Description	Type	Direction
DeviceType	Type of LOYTEC device	ChStrV	read+write
ProjectName	Name of the Project	ChStrV	read+write
DeviceLocation	Definition of the device location	ChStrV	read+write

Table 244: BACnet Server Objects of device data

8.1.1.3 System Information

For functional details, please refer to chapter 7.5.4.3

Prefix: VAVcontrol_Core_Naviagation_Label_

Server Object Name	Description	Type	Direction
Hostname	Hostname of the device	ChStrV	read only
DeviceIPaddress	Device IP address	ChStrV	read only
FirmwareVersion	Firmware version of device	ChStrV	read only
SerialNumber	Serial number of device	ChStrV	read only
CPUload	CPU load	AV	read only
SystemTemp	System temperature	AV	read only
SupplyVoltage	Supply voltage	AV	read only
FreeMemory	Free memory	AV	read only
CoreVersion	Version of Core Software	ChStrV	read only
FreeFlash	Free flash	AV	read only
DeviceIPport	Device IP port	AV	read only
FunctionLevel	Function Level 1=VAV, 2=AM, 3=FM, 4 BM, 5=CM	MV	read only

Table 245: BACnet Server Objects of system information

8.1.2 Air Flow Control

8.1.2.1 Pressure Measurement

For functional details, please refer to chapter 7.5.5.1

Prefix: VAVcontrol_Core_

Server Object Name	**Description**	**Type**	**Direction**
TimeConstantPressure	Time Constant PT1 for damping the Pressure Value	AV	read+write
Pressure	Present Value of Pressure Input (not damped)	AV	read only
Pressure(damped)	Present Value of damped Pressure	AV	read only
PressureSensorFailure	Status of the pressure sensor failure	BV	read only
PressSensFailDamperPosCool	Damper Position if pressure sensor fails and cooling is active	AV	read+write
PressSensFailDamperPosHeat	Damper Position if pressure sensor fails and heating is active	AV	read+write

Table 246: BACnet Server Objects of pressure measurement

8.1.2.2 Air Flow Configuration

For functional details, please refer to chapter 7.5.5.2

Prefix: VAVcontrol_Core_Flow_FlowBoxData_

Server Object Name	**Description**	**Type**	**Direction**
DuctArea	Duct Area of the VAV box	AV	read+write
NominalFlowBox	Nominal Flow Value of the VAV box	AV	read+write
DuctDiameter	Duct Diameter of the VAV box	AV	read+write
Density	Air Density	AV	read+write
SelectFlowBoxData	Selection of the FlowBoxData Input	MV	read+write
InputFlowBoxData	Input of the Flow Box Data according to SelectFlowBoxData	AV	read+write
MinFlowCooling	Minimum Flow Limit for Cooling	AV	read+write
MaxFlowCooling	Maximum Flow Limit for Cooling	AV	read+write
MinFlowHeating	Minimum Flow Limit for Heating	AV	read+write
MaxFlowHeating	Maximum Flow Limit for Heating	AV	read+write
MinFlowUnitHeating	Minimum Flow Limit for Unit Heating	AV	read+write
MaxFlowUnitHeating	Maximum Flow Limit for Unit Heating	AV	read+write
PitotFactor	Pitot Factor provided by the VAV box vendor	AV	read only
K_cfm	Flow Coefficient (includes the area)	AV	read only
K_fpm	Velocity Coefficient (without area)	AV	read only
Kfactor	VAV-Box flow factor	AV	read only
DeltaPatVnom	Differential Pressure at nominal Flow	AV	read only

Table 247: BACnet Server Objects of air flow configuration

8.1.2.3 Air Flow Controller

For functional details, please refer to chapter 7.5.5.3.

Prefix: VAVcontrol_Core_Flow_FlowControl_

Server Object Name	**Description**	**Type**	**Direction**
DeadBandFlowControl	Dead Band of Controller Flow	AV	read+write
RuntimeFlowControl	Runtime of FlowControl between Min and Max Output	AV	read+write
HysteresisFlowControl	internal Hysteresis to activate the Control output to increment	AV	read+write
AirFlow	Present Value of Air Flow	AV	read only
AirFlowSetpoint	Present Value of Air Flow Setpoint	AV	read only
ControlOutput	Present Value of Control Output	AV	read only
AirVelocity	Present Value of Air Velocity	AV	read only
State	Present Value of Controller State	MV	read only
AirFlowPcnt	Current Air Flow as percentage of MaxFlowCooling	AV	read only
AirFlowSetpointSelection	Indication from which source the Air Flow Setpoint is selected	MV	read only

Table 248: BACnet Server Objects of air flow controller

8.1.2.4 Air Flow Alarms

For functional details, please refer to chapter 7.5.5.4.

Prefix: VAVcontrol_Core_Flow_Alarm_

Server Object Name	**Description**	**Type**	**Direction**
MinLimitOffset	Time Delay for the Minimum Air Flow Alarm	AV	read+write
MaxLimitOffset	Air Flow Offset as Minimum Alarm Limit	AV	read+write
DelayTime	Air Flow Offset as Maximum Alarm Limit	AV	read+write
Hysteresis	Air Flow Alarm Hysteresis to reset the Alarm	AV	read+write
Reset	Air Flow Alarm Reset	AV	read+write
MinAlarm	Present Value of Minimum Air Flow Alarm	BV	read only
MinAlarmLimit	Present Value of Maximum Air Flow Alarm	MV	read only
MaxAlarm	Present Value of Minimum Alarm Limit	AV	read only
MaxAlarmLimit	Present Value of Maximum Alarm Limit	AV	read only

Table 249: BACnet Server Objects of air flow alarms

8.1.2.5 Air Flow Calibration

For functional details, please refer to chapter 7.5.5.5.

Prefix: VAVcontrol_Core_Flow_FlowCalibration_

Server Object Name	**Description**	**Type**	**Direction**
CalibrationMode	Mode of Calibration inactive or active	BV	read+write
CalibrationSelect	Selection of Flow Calibration Point	MV	read+write
CalibrateNow	Take the Present Values into the Calibration Data now	BV	read+write
ResetCalibration	Reset the Calibration data to standard values	BV	read+write
DamperPosition	Requested Damper Position for Calibration	AV	read+write
InputReferenceFlow	Input of Reference Air Flow for the current Calibration Point	AV	read+write
PressureZeroFlow	Pressure calibration value for the zero flow point	AV	read+write
ZeroFlow	Air flow calibration value for the zero flow point	AV	read+write
PressureLowFlow	Pressure calibration value for the low flow point	AV	read+write
LowFlow	Air flow calibration value for the Low flow point	AV	read+write
PressureHighFlow	Pressure calibration value for the high flow point	AV	read+write
HighFlow	Air flow calibration value for the high flow point	AV	read+write
StatusZero	Calibration Status of Zero Flow Point	BV	read+write
StatusLow	Calibration Status of Low FlowPoint	BV	read only
StatusHigh	Calibration Status of High FlowPoint	BV	read only
PressureZeroDelay	Delay Time to leave Zero Pressure State	AV	read only
PressureZeroActive	Indicates if the Zero Pressure Suppression is active	BV	read+write
PitotFactorLow	Calculated PitotFactor for the Low Flow Calibration Point	AV	read+write
PitotFactorHigh	Calculated PitotFactor for the High Flow Calibration Point	AV	read only
PitotFactorActual	Calculated PitotFactor for the actual Pressure by Calibration	AV	read only
PitotLowBand	Tolerance Band for PitotFactor Low relative to PitotFactor High	AV	read+write
PitotLowLimited	Indication if the PitotFactor Low is limited	BV	read only
ControlOutSetByCalib	Indicates that the Flow Control Output is set by Calibration	BV	read+write
FlowSetpoint	Current Setpoint of Flow Controller	AV	read only
PressureZeroHys	Hysteresis of Zero Flow Point	AV	read+write

Table 250: BACnet Server Objects of air flow calibration

8.1.3 Space Temperature Control

8.1.3.1 Space Temperature Measurement

For functional details, please refer to chapter 7.5.6.1

Prefix: VAVcontrol_SpaceTemp_Control_

Name	Description	Type	Direction
SpaceTemp	Present Value of Space Temp (Converted)	AV	read only
SensorFailure	Sensor Failure if Space temperature sensor	BV	read only

Table 251: BACnet Server Objects of space temperature measurement

8.1.3.2 Space Temperature Setpoints

For functional details, please refer to chapter 7.5.6.2

Name	Description	Type	Direction
SpaceTemp	Present Value of Space Temp (Converted)	AV	read only
SensorFailure		BV	read only

Prefix: VAVcontrol_SpaceTemp_Control_

Server Object Name	Description	Type	Direction
EffectiveControlSetpoint	Current Setpoint of active Cool or Heat Controller	AV	read only
DisplayControlSetpoint	Average Setpoint of Temperature Control for user display	AV	read only
HVACmode	Current HVAC Mode of Temperature Control	MV	read only
OccupiedCoolSetpoint	Space Temperature Cool Setpoint in Occupied Mode	AV	read+write
StandbyCoolSetpoint	Space Temperature Cool Setpoint in Standby Mode	AV	read+write
UnoccupiedCoolSetpoint	Space Temperature Cool Setpoint in Unoccupied Mode	AV	read+write
ProtectionCoolSetpoint	Space Temperature Cool Setpoint in Protection Case	AV	read+write
CoolControlEnabled	Indication if Cool Controller is enabled	BV	read only
CurrentCoolSetpoint	Current Setpoint of Cool Controller	AV	read only

Table 252: BACnet Server Objects of space temperature cooling setpoints

Prefix: VAVcontrol_SpaceTemp_SummerComp_

Server Object Name	Description	Type	Direction
Enable	Enable Summer Compensation of Space Temp Setpoint	BV	read+write
MinimumOutdoorTemperature	Summer Compensation starts if ODT rises above	AV	read+write
MaximumOutdoorTemperature	Summer Compensation max Value if ODT reaches	AV	read+write
MaximumOffset	Summer Compensation max Offset	AV	read+write
SetpointShift	Current Summer Compensation Setpoint Shift	AV	read only

Table 253: BACnet Server Objects of summer compensation

Prefix: VAVcontrol_SpaceTemp_EnergyDemandLimiting_

Server Object Name	Description	Type	Direction
EnergyDemandLimitActive	Current state of the Energy Demand Limiting function (from AHU)	BV	read only
EnergyDemandLimitSpShift	Current cool setpoint shift caused by active Energy Demand Limit	AV	read only
EnergyDemandLimitOffset	Defines offset to cool setpoints if Energy Demand Limit active	AV	read+write

Table 254: BACnet Server Objects of Energy Demand Limiting (EDL)

Prefix: VAVcontrol_ReheatHwMod_HeatControl_ ***)**

Server Object Name	Description	Type	Direction
UnoccupiedHeatSetpoint	Space Temperature Heat Setpoint in Unoccupied Mode	AV	read+write
StandbyHeatSetpoint	Space Temperature Heat Setpoint in Standby Mode	AV	read+write
OccupiedHeatSetpoint	Space Temperature Heat Setpoint in Occupied Mode	AV	read+write
ProtectionHeatSetpoint	Space Temperature Heat Setpoint in Protection Case	AV	read+write
HeatControlEnabled	Indication if Heat Controller is enabled	BV	read only
CurrentHeatSetpoint	Current Setpoint of Heat Controller	AV	read only

Table 255: BACnet Server Objects of space temperature heating setpoints

*): Please note that the prefix for heating is depending on the connected reheat actuator using different folder names:

Hot Water Reheat, modulating folder name: ReheatHwMod_

Hot Water Reheat, floating folder name: ReheatHwFloat_

Electric Reheat, modulating folder name: ReheatElMod_

Electric Reheat, 3 stages folder name: ReheatEl3St_

No Reheat, but heat control folder name: NoReheat_

8.1.3.3 Space Temperature external Setpoint

For functional details, please refer to chapter 7.5.6.3

Prefix: VAVcontrol_SpaceTempSetpoint_

Server Object Name	Description	Type	Direction
ExternalSetpointOffset	Present Value of Space Temp Setpoint Offset from external	AV	read+write
SetpointShiftRange	Present Value of Space Temp ext. Setpoint Shift Range	AV	read+write
OffsetNightReset	Enables reset to 0 of ExternalSetpointOffset in the night	BV	read+write
ExternalSetpoint	Present Value of absolute Space Temp Setpoint from external	AV	read+write

Table 256: BACnet Server Objects of space temperature external setpoint

8.1.3.4 Space Temperature Control

For functional details, please refer to chapter 7.5.6.4

Prefix: VAVcontrol_SpaceTemp_Control_

Server Object Name	Description	Type	Direction
CoolControlEnabled	Indication if Cool Controller is enabled	BV	read only
CurrentCoolSetpoint	Current Setpoint of Cool Controller	AV	read only
CoolControlOutput	Cool control output of temperature controller	AV	read only
HVACmode	Current HVAC Mode of Temperature Control	MV	read only
TerminalLoad	Current Terminal Load of Temperature Control	AV	read only
ProportionalGain	Proportional Gain of PI-Controller Cooling	AV	read+write
IntegralTime	Integral Time of PI-Controller Cooling	AV	read+write
CycleTime	Cycle time valid for cool and heat controller in seconds	AV	read+write
DeadBandControllers	Dead Band of PI-Controllers Cooling and Heating	AV	read+write

Table 257: BACnet Server Objects of space temperature cooling control

Prefix: VAVcontrol_ReheatHwMod_HeatControl_ ***)**

Server Object Name	Description	Type	Direction
HeatControlEnabled	Indication if Heat Controller is enabled	BV	read only
CurrentHeatSetpoint	Current Setpoint of Heat Controller	AV	read only
HeatControlOutput	Heat control output of temperature controller	AV	read+write
HVACmode	Current HVAC Mode of Temperature Control	MV	read only
TerminalLoad	Current Terminal Load of Temperature Control	AV	read only
ProportionalGain	Proportional Gain of PI-Controller Heating	AV	read+write
IntegralTime	Integral Time of PI-Controller Heating	AV	read+write
ChangeOverDelayTime	Delay Time between heating and cooling	AV	read+write

Table 258: BACnet Server Objects of space temperature heating control

*): Please note that the prefix for heating is depending on the connected reheat actuator using different folder names:

Hot Water Reheat, modulating	folder name: ReheatHwMod_
Hot Water Reheat, floating	folder name: ReheatHwFloat_
Electric Reheat, modulating	folder name: ReheatElMod_
Electric Reheat, 3 stages	folder name: ReheatEl3St_
No Reheat, but heat control	folder name: NoReheat_

8.1.3.5 Space Temperature Control Sequences

For functional details, please refer to chapter 7.5.6.5and chapter 8.1.11.

Prefix: VAVcontrol_Core_Temperature_

Server Object Name	Description	Type	Direction
LocalHeatRelease	Local heat release (reheat, periph.heat)	BV	read+write
XmaxFlow	Heat Sequence X-Value (%) for maximum Flow Output	AV	read+write
XstartHeat1	Heat Sequence X-Value (%) for Start Heat-Actuator1 Output	AV	read+write
XmaxHeat1	Heat Sequence X-Value (%) for Maximum Heat-Actuator1 Output	AV	read+write
XstartHeat2	Heat Sequence X-Value (%) for Start Heat-Actuator2 Output	AV	read+write
XmaxHeat2	Heat Sequence X-Value (%) for Maximum Heat-Actuator2 Output	AV	read+write
HeatSequence	Order of Heat-Actuators (0= Reheat/Periph), (1=Periph/Reheat)	BV	read+write
OutdoorTemperature	Current Outdoor Temperature	AV	read only
HeatLockoutState	Current Heat Lockout State	BV	read only
HeatLockoutTemp	Reheat is locked if Outside Air Temp rises above	AV	read+write
UnitHeatActive	Unit Heat is active (0= Heat Params used), (1= UnitHeat Params	BV	read only

Table 259: BACnet Server Objects of reheat / periph. sequence

8.1.3.6 Space Temperature Alarms

For functional details, please refer to chapter 7.5.6.6

Prefix: VAVcontrol_SpaceTemp_CoolAlarm_

Server Object Name	Description	Type	Direction
MaxAlarm	Maximum Alarm of Space Temperature	BV	read only
AlarmLimit	Current Maximum Alarm Limit of Space Temperature	AV	read only
LimitOffsetOcc	Alarm Offset to Occupied Space Temp Setpoint Cool	AV	read+write
LimitOffsetStandby	Alarm Offset to Standby Space Temp Setpoint Cool	AV	read+write
LimitOffsetUnocc	Alarm Offset to Unoccupied Space Temp Setpoint Cool	AV	read+write
AlarmHysteresis	Hysteresis for Space Temp Alarm	AV	read+write
AlarmDelayTime	Time Delay for all Space Temperature Alarms	AV	read+write
AlarmReset	Reset of Space Temperature Alarm	BV	read+write

Table 260: BACnet Server Objects of space temp max alarm

Prefix: VAVcontrol_ReheatHwMod_HeatAlarm_ ***)**

Server Object Name	Description	Type	Direction
SpaceTempMinAlarm	Minimum Alarm of Space Temperature	BV	read only
SpaceTempMinAlarmLimit	Current Minimum Alarm Limit of Space Temperature	AV	read only
SpaceTempLimitOffsetUnocc	Alarm Offset to Unoccupied Space Temp Setpoint Heat	AV	read+write
SpaceTempLimitOffsetStandby	Alarm Offset to Standby Space Temp Setpoint Heat	AV	read+write
SpaceTempLimitOffsetOcc	Alarm Offset to Occupied Space Temp Setpoint Heat	AV	read+write

Table 261: BACnet Server Objects of space temp min alarm

*): Please note that the prefix for heating is depending on the connected reheat actuator using different folder names:

Hot Water Reheat, modulating folder name: ReheatHwMod_

Hot Water Reheat, floating folder name: ReheatHwFloat_

Electric Reheat, modulating folder name: ReheatElMod_

Electric Reheat, 3 stages folder name: ReheatEl3St_

No Reheat, but heat control folder name: NoReheat_

8.1.4 Energy Hold Off

8.1.4.1 Energy Hold Off State

For functional details, please refer to chapter 7.5.7.2

Prefix: VAVcontrol_Window_

Server Object Name	Description	Type	Direction
WindowContact	Present Value of Window Contact	BV	read only
EnergyHoldOffStatus	Current status of Energy Hold Off Function	AV	read only
EnergyHoldOffDelayOn	Time delay to activate Energy Hold Off by opened window	AV	read+write
EnergyHoldOffDelayOff	Time delay to deactivate Energy Hold Off by closed window	MV	read+write

Table 262: BACnet Server Objects of Energy Hold Off

8.1.5 Discharge Air Temperature Control

8.1.5.1 Discharge Air Temperature Setpoint & Control

For functional details, please refer to chapter 7.5.8.2

Prefix: VAVcontrol_DischargeTemp_Control_

Server Object Name	Description	Type	Direction
DischTempControlActive	Indication if the Discharge Temp Control is active	BV	read only
DischargeTempSetpoint	Current Discharge Temperature Setpoint	AV	read only
MinDischargeTempSetpoint	Minimum Discharge Temperature Setpoint	AV	read+write
MaxDischargeTempSetpoint	Maximum Discharge Temperature Setpoint	AV	read+write
StratificationMaxOffset	Maximum allowed difference between space temp and discharge temp	AV	read+write
MaxDischTempSetpointEff	Present value of the effective maximum discharge temperature setpoint	AV	read only
StratificationLimitActive	Present status of stratification limitation	BV	read only

Table 263: BACnet Server Objects of discharge control setpoints

Prefix: VAVcontrol_DischargeTemp_Control_

Server Object Name	Description	Type	Direction
DischTempControlActive	Indication if the Discharge Temp Control is active	BV	read only
DischargeTempSetpoint	Current Discharge Temperature Setpoint	AV	read only
DischargeTemp	Present Value of Discharge Temp (converted)	AV	read only
YdischTempControlOutput	Control output to reheat from disch temp controller	AV	read only
ProportionalGain	Proportional Gain of PI-Controller Discharge	AV	read+write
IntegralTime	Integral Time of PI-Controller Discharge	AV	read+write
DeadBand	Dead Band of PI-Controller Discharge	AV	read+write

Table 264: BACnet Server Objects of discharge control

8.1.5.2 Discharge Temperature Alarms

For functional details, please refer to chapters 7.5.8.3 and 7.5.8.4

Prefix: VAVcontrol_DischargeTemp_Alarm_

Server Object Name	Description	Type	Direction
MaxAlarm	Maximum Alarm of Discharge Temperature	BV	read only
MaxAlarmLimit	Current Maximum Alarm Limit of Discharge Temperature	AV	read only
MinAlarm	Minimum Alarm of Discharge Temperature	BV	read only
MinAlarmLimit	Current Minimum Alarm Limit of Discharge Temperature	AV	read only
MaxLimitOffset	Max Alarm Offset to Discharge Temp Setpoint	AV	read+write
Hysteresis	Hysteresis for Discharge Temp Alarm	AV	read+write
DelayTime	Time Delay for Discharge Temperature Alarms	AV	read+write
Reset	Reset of Discharge Temperature Alarms	BV	read+write
MinLimitOffset	Min Alarm Offset to Discharge Temp Setpoint	AV	read+write
StratificationAlarmLimit	Maximum Alarm limit of the discharge over temperature	AV	read+write
StratificationAlarmDelay	Time delay to trigger a Stratification Alarm	AV	read+write
StratificationAlarm	Present value of Stratification Alarm	BV	read only

Table 265: BACnet Server Objects of discharge temp. alarms and stratification alarm

8.1.6 IAQ Control

8.1.6.1 IAQ Setpoint & Control (Method1)

For functional details, please refer to chapter 7.5.9.2

Prefix: VAVcontrol_IAQ_CO2_SA_

Server Object Name	Description	Type	Direction
CO2concentration	Present value of undamped CO2 concentration	AV	read only
CO2concentration(damped)	Present value of damped CO2 concentration	AV	read only
TimeConstantCO2	Time Constant PT1 for damping the CO2 Value	AV	read+write

Table 266: BACnet Server Objects of IAQ sensor configuration

Prefix: VAVcontrol_IAQ_CO2_SA_CO2control_SA_

Server Object Name	Description	Type	Direction
CO2MinConcentrMinSA	Min CO2 Concentration for Min Supply Air Flow (Curve)	AV	read+write
CO2MinSupplyAirFlow	Minimum Supply Air Flow (CO2 Curve)	AV	read+write
CO2MaxConcentrMaxSA	Max CO2 Concentration for Max Supply Air Flow (Curve)	AV	read+write
CO2MaxSupplyAirFlow	Maximum Supply Air Flow (CO2 Curve)	AV	read+write
SupplyAirFlowDemand	Summary Supply Air Flow demand requested from Group IAQ control	AV	read only
IAQsumSupplyMaxAirFlow	Summary Supply Max Air Flow summarized from the Group	AV	read only
IAQcontrolHVACrelease	IAQ control release by HVAC mode	BV	read only
IAQcontrolOutput	Control output IAQ controller	AV	read only

Table 267: BACnet Server Objects of IAQ supply air demand

Prefix: VAVcontrol_Core_IAQcontrol_

Server Object Name	Description	Type	Direction
IAQlocalMaxFlow	Local Maximum Air Flow of the VAV Box	AV	read only
IAQsetpointLocalSupplyAirFlow	Local Supply Air Flow Setpoint coming from IAQ Control	AV	read only

Table 268: BACnet Server Objects of IAQ control

8.1.6.2 IAQ Setpoint & Control (Method2)

For functional details, please refer to chapter 7.5.9.3

Prefix: VAVcontrol_IAQ_Sensors_OA_

Server Object Name	Description	Type	Direction
CO2concentration(damped)	Present value of damped CO2 concentration	AV	read only
VOCconcentration(damped)	Present value of damped VOC concentration	AV	read only
PeopleCounter(damped)	Present value of damped People Counter	AV	read only
TimeConstantCO2VOC	Time Constant PT1 for damping the CO2 or VOC Value	AV	read+write
IAQsensorSelection	Selection of IAQ Sensor Type	MV	read+write

Table 269: BACnet Server Objects of IAQ sensor configuration

Prefix: VAVcontrol_IAQ_Sensors_OA_IAQcontrol_OA

Server Object Name	Description	Type	Direction
CO2MinConcentrMinOA	Min CO2 Concentration for Min Outdoor Air Flow (Curve)	AV	read+write
IAQminOutdoorAirFlow	Minimum Outdoor Air Flow (IAQ Curve)	AV	read+write
CO2MaxConcentrMaxOA	Max CO2 Concentration for Max Outdoor Air Flow (Curve)	AV	read+write
IAQmaxOutdoorAirFlow	Maximum Outdoor Air Flow (IAQ Curve)	AV	read+write
sumSupplyAirFlowDemand	Summary Supply Air Flow demand requested from Group IAQ control	AV	read only
VOCminConcentrMinOA	Min VOC Concentration for Min Outdoor Air Flow (Curve)	AV	read+write
VOCmaxConcentrMaxOA	Max VOC Concentration for Max Outdoor Air Flow (Curve)	AV	read+write
MinPeopleMinOA	Min Number of People for Min Outdoor Air Flow (Curve)	AV	read+write
MaxPeopleMaxOA	Max Number of People for Max Outdoor Air Flow (Curve)	AV	read+write
sumOutdoorAirFlowDemand	Summary Outdoor Air Flow demand requested from Group IAQ control	AV	read only
AHUoutdoorAirFraction	Outdoor Air Fraction coming from AHU	AV	read only
IAQsumSupplyMaxAirFlow	Summary Supply Max Air Flow summarized from the Group	AV	read only
IAQcontrolOutput	Control output IAQ controller	BV	read only
IAQcontrolHVACrelease	IAQ control release by HVAC mode	AV	read only

Table 270: BACnet Server Objects of IAQ outdoor air demand

Prefix: VAVcontrol_Core_IAQcontrol_

Server Object Name	Description	Type	Direction
IAQsumOutdoorAirFlowDemand	Summary Outdoor Air Flow demand requested from Group IAQ control	AV	read only
IAQlocalMaxFlow	Local Maximum Air Flow of the VAV Box	AV	read only
IAQsetpointLocalSupplyAirFlow	Local Supply Air Flow Setpoint coming from IAQ Control	AV	read only

Table 271: BACnet Server Objects of IAQ control

8.1.6.3 CO2 Max. Alarm (Method1)

For functional details, please refer to chapter 7.5.9.4

Prefix: VAVcontrol_IAQ_CO2_SA_CO2maxAlarm_

Name	Description	Type	Direction
MaxAlarm	Maximum alarm of CO2 Concentration in the Space	BV	read only
MaxAlarmLimit	CO2 Maximum Alarm Limit	AV	read+write
Hysteresis	CO2 Maximum Alarm Hysteresis	AV	read+write
DelayTime	Time Delay for the Max CO2 Alarm	AV	read+write
CO2MaxAlarmReset	Reset of CO2 Maximum Alarm	BV	read+write

Table 272: BACnet Server Objects of CO2 max. alarm

8.1.6.4 IAQ Max. Alarm (Method2)

For functional details, please refer to chapter 7.5.9.5

Prefix: VAVcontrol_IAQ_Sensors_OA_CO2maxAlarm_

Name	Description	Type	Direction
MaxAlarm	Maximum alarm of CO2 Concentration in the Space	BV	read only
MaxAlarmLimit	CO2 Maximum Alarm Limit	AV	read+write
Hysteresis	CO2 Maximum Alarm Hysteresis	AV	read+write
DelayTime	Time Delay for the Max CO2 Alarm	AV	read+write
Reset	Reset of CO2 Maximum Alarm	BV	read+write

Table 273: BACnet Server Objects of CO2 max. alarm

Prefix: VAVcontrol_IAQ_Sensors_OA_VOCmaxAlarm_

Name	Description	Type	Direction
MaxAlarm	Maximum alarm of VOC Concentration in the Space	BV	read only
MaxAlarmLimit	VOC Maximum Alarm Limit	AV	read+write
Hysteresis	VOC Maximum Alarm Hysteresis	AV	read+write
DelayTime	Time Delay for the Max VOC Alarm	AV	read+write
Reset	Reset of VOC Maximum Alarm	BV	read+write

Table 274: BACnet Server Objects of VOC max. alarm

Prefix: VAVcontrol_IAQ_Sensors_OA_PeopleMaxAlarm_

Name	Description	Type	Direction
MaxAlarm	Maximum alarm of People Counter in the Space	BV	read only
MaxAlarmLimit	People Counter Maximum Alarm Limit	AV	read+write
Hysteresis	People Counter Maximum Alarm Hysteresis	AV	read+write
DelayTime	Time Delay for the Max People Counter Alarm	AV	read+write
Reset	Reset of People Counter Maximum Alarm	BV	read+write

Table 275: BACnet Server Objects of People Counter max. alarm

8.1.7 HVAC Modes in the VAV control

8.1.7.1 HVAC Mode Control Status

For functional details, please refer to chapter 7.5.11.1

Prefix: VAVcontrol_Core_HVACmode_

Server Object Name	**Description**	**Type**	**Direction**
HvacModeVAV	Current HVAC mode of VAV controller. E.g. AUTO, HEAT	MV	read only
HvacModeFromAHU	Current HVAC mode from AHU	MV	read only
OnOffFromAHU	On Off Status from AHU	BV	read only
HeatingFromAHU	Heating Mode from the AHU	BV	read only
CoolingFromAHU	Cooling Mode from the AHU	BV	read only
FanOnlyFromAHU	Fan Only Mode from the AHU	BV	read only
ManualValue	Manual output value if is in Manual mode	MV	read+write
WarmupHeatControl	Local heat control in MRNG_WRMUP	BV	read+write
AHUselection	Selection of source of HVAC Mode from AHU	BV	read+write

Table 276: BACnet Server Objects of HVAC Mode control status

8.1.8 Effective Occupancy in the VAV control

8.1.8.1 Effective Occupancy Control and Scheduler

For functional details, please refer to chapter 7.5.12.1

Prefix: VAVcontrol_Core_Occup_

Server Object Name	Description	Type	Direction
EffectiveOccupancy	Effective Occupancy State, Sensor, Man, Sched	MV	read only
AHUoccupOverridePermit	Permission of the Occupancy Override from AHU funct in the group	BV	read+write
AHUoccupOverride	Occupancy Override from AHU	BV	read only
ScheduledOccupancy	Occupancy from Scheduler	MV	read+write
OccSensorAvailable	Indicates if Occupancy Sensor is available	BV	read only
EffectivePresence	Effective Presence Status Sensor	BV	read only
OccOverrideAvailable	Indicates if Occupancy Override Sensor is available	BV	read only
OccOverrideStatus	Occupancy Override Status	BV	read only
OccupAutoMan	Auto or Manual mode of the Occupancy	MV	read+write

Table 277: BACnet Server Objects of Effective Occupancy control status

8.1.8.2 Occupancy Sensor

For functional details, please refer to chapter 7.5.12.2

Prefix: VAVcontrol_Occupancy_

Server Object Name	Description	Type	Direction
EffectivePresence	Effective Presence Status	BV	read only
OccupancyOffDelay	Time Delay to switch off occupancy	AV	read+write

Table 278: BACnet Server Objects of Effective Occupancy sensor

8.1.8.3 Occupancy Override

For functional details, please refer to chapter 7.5.12.3

Prefix: VAVcontrol_Occupancy_

Server Object Name	Description	Type	Direction
OccOverrideStatus	Occupancy Override Status	BV	read only
BypassTimeDuration	Time Duration of the Bypass Mode	AV	read+write

Table 279: BACnet Server Objects of Occupancy Override

8.1.8.4 Optimum Start

For functional details, please refer to chapter 7.5.12.4

Prefix: VAVcontrol_Core_Occup_OptimumStart

Server Object Name	**Description**	**Type**	**Direction**
OsEnable	Enable or disable Optimum Start function	BV	read+write
TempDiffMinHeat	Min temp diff limit to activate Opt Start Heat (<0)	AV	read+write
TempDiffMaxCool	Max temp diff limit to activate Opt Start Cool (>0)	AV	read+write
OsActive	Status of Optimum Start function	BV	read only
OsState	Current State of Optimum Start function	MV	read only
HvacModeOsReq	HVAC Mode requested by Optimum Start to AHU	MV	read only
OsLastHeatFactor	Heat factor of the last optimum start cycle	AV	read only
OsLastCoolFactor	Cool factor of the last optimum start cycle	AV	read only

Table 280: BACnet Server Objects of Optimum Start function

8.1.9 Damper Actuators

8.1.9.1 MP-Bus Damper Actuator

For functional details, please refer to chapter 7.5.13.1

Prefix: VAVcontrol_DamperMP_

Server Object Name	Description	Type	Direction
AutoMan	Auto or Manual mode of the actuator	MV	read+write
ManualValue	Manual output value if is in Manual mode	AV	read+write
ControlDirection	Selection of inverted control direction of the damper	BV	read+write
StartTest	start adaptation, synchronization or a test run	MV	read+write
DamperOutput	Present value of Damper Output	AV	read only
DamperFeedback	Present value of Damper Feedback	AV	read only
DamperMotor	Status of the damper motor	BV	read only
DamperGear	Status of the damper gear	BV	read only
DamperAdaption	Status of the damper adaption	BV	read only

Table 281: BACnet Server Objects of MP-Bus damper actuator

Prefix: VAVcontrol_DamperMP_

Server Object Name	Description	Type	Direction
FeedbackAlarm	Present Value of Damper Feedback Alarm	BV	read only
FeedbackAlarmTolerance	Feedback Alarm Damper Position Tolerance	AV	read+write
FeedbackAlarmDelayTime	Time Delay for the Damper Feedback Alarm	AV	read+write
FeedbackAlarmReset	Damper Feedback Alarm Reset	BV	read+write

Table 282: BACnet Server Objects of MP-Bus damper actuator feedback alarm

8.1.9.2 Modulating Damper Actuator

For functional details, please refer to chapter 7.5.13.3

Prefix: VAVcontrol_DamperMod_

Server Object Name	Description	Type	Direction
AutoMan	Auto or Manual mode of the actuator	MV	read+write
ManualValue	Manual output value if is in Manual mode	AV	read+write

Table 283: BACnet Server Objects of modulating damper actuator

8.1.9.3 Floating Damper Actuator

For functional details, please refer to chapter 7.5.13.4

Prefix: VAVcontrol_DamperFloat_

Server Object Name	**Description**	**Type**	**Direction**
CalcPosition	Calculated Position of the floating Damper Actuator	AV	read only
AutoMan	Auto or Manual mode of the actuator	MV	read+write
ManualValue	Manual output value if is in Manual mode	AV	read+write
RuntimeOpen	Runtime from close to open position	AV	read+write
RuntimeClose	Runtime from open to close position	AV	read+write
DeadBand	Dead Band to reduce Actuator Activity	AV	read+write
CycleTime	Cycle Time of Position Calculation	AV	read+write
PositionSynchrMode	Mode of the Position Synchronization	BV	read+write

Table 284: BACnet Server Objects of floating damper actuator

8.1.10 Fan Actuators

8.1.10.1 Series Fan

For functional details, please refer to chapter 7.5.14.1

Prefix: VAVcontrol_SeriesFan_

Server Object Name	Description	Type	Direction
AutoMan	Auto or ManOff or ManOn mode of the actuator	MV	read+write

Table 285: BACnet Server Objects of series fan

Prefix: VAVcontrol_SeriesFan_FanOffDelay_

Server Object Name	Description	Type	Direction
HeatRequestFan	Heating Request of Fan calculated by the sequence	BV	read only
ReheatActiveMan	Reheat is in Manual Mode and Active	BV	read only
OffDelayFan	Time delay to switch off the series fan	AV	read+write

Table 286: BACnet Server Objects of series fan off delay

8.1.10.2 Parallel Fan

For functional details, please refer to chapter 7.5.14.2

Prefix: VAVcontrol_ParallelFan_

Server Object Name	Description	Type	Direction
AutoMan	Auto or ManOff or ManOn mode of the actuator	MV	read+write

Table 287: BACnet Server Objects of parallel fan

Prefix: VAVcontrol_ParallelFan_FanOffDelay_

Server Object Name	Description	Type	Direction
HeatRequestFan	Heating Request of Fan calculated by the sequence	BV	read only
ReheatActiveMan	Reheat is in Manual Mode and Active	BV	read only
OffDelayFan	Time delay to switch off the series fan	AV	read+write

Table 288: BACnet Server Objects of parallel fan off delay

8.1.11 Reheat Actuators

8.1.11.1 Hot Water Modulating Reheat

For functional details, please refer to chapter 7.5.6.2 and chapter 7.5.6.4

Prefix: VAVcontrol_ReheatHwMod_HeatControl_

Server Object Name	Description	Type	Direction
UnoccupiedHeatSetpoint	Space Temperature Heat Setpoint in Unoccupied Mode	AV	read+write
StandbyHeatSetpoint	Space Temperature Heat Setpoint in Standby Mode	AV	read+write
OccupiedHeatSetpoint	Space Temperature Heat Setpoint in Occupied Mode	AV	read+write
ProtectionHeatSetpoint	Space Temperature Heat Setpoint in Protection Case	AV	read+write

Table 289: BACnet Server Objects of Reheat HW Mod heat setpoints

For functional details, please refer to chapter 7.5.6.4

Prefix: VAVcontrol_ReheatHwMod_HeatControl_

Server Object Name	Description	Type	Direction
HeatControlEnabled	Indication if Heat Controller is enabled	BV	read only
CurrentHeatSetpoint	Current Setpoint of Heat Controller	AV	read only
HeatControlOutput	Heat control output of temperature controller	AV	read only
HVACmode	Current HVAC Mode of Temperature Control	MV	read only
TerminalLoad	Current Terminal Load of Temperature Control	AV	read only
ProportionalGain	Proportional Gain of PI-Controller Heating	AV	read+write
IntegralTime	Integral Time of PI-Controller Heating	AV	read+write
ChangeOverDelayTime	Delay Time between heating and cooling	AV	read+write

Table 290: BACnet Server Objects of Reheat HW Mod heat control

For functional details, please refer to chapter 7.5.6.5and chapter 7.5.15

Prefix: VAVcontrol_ReheatHwMod_HeatSequence_

Server Object Name	Description	Type	Direction
LocalHeatRelease	Local heat release (reheat, periph.heat)	BV	read+write
XmaxFlow	Heat Sequence X-Value (%) for maximum Flow Output	AV	read+write
XstartHeat1	Heat Sequence X-Value (%) for Start Heat-Actuator1 Output	AV	read+write
XmaxHeat1	Heat Sequence X-Value (%) for Maximum Heat-Actuator1 Output	AV	read+write
XstartHeat2	Heat Sequence X-Value (%) for Start Heat-Actuator2 Output	AV	read+write
XmaxHeat2	Heat Sequence X-Value (%) for Maximum Heat-Actuator2 Output	AV	read+write
HeatSequence	Order of Heat-Actuators (0= Reheat/Periph), (1=Periph/Reheat)	BV	read+write
OutdoorTemperature	Current Outdoor Temperature	AV	read only
HeatLockoutState	Current Heat Lockout State	BV	read only
HeatLockoutTemp	Reheat is locked if Outside Air Temp rises above	AV	read+write
UnitHeatActive	Unit Heat is active (0= Heat Params used), (1= UnitHeat Params	BV	read only

Table 291: BACnet Server Objects of Reheat HW Mod heat sequence

For functional details, please refer to chapter 7.5.6.6

Prefix: VAVcontrol_ReheatHwMod_HeatAlarm_

Server Object Name	Description	Type	Direction
SpaceTempMinAlarm	Minimum Alarm of Space Temperature	BV	read only
SpaceTempMinAlarmLimit	Current Minimum Alarm Limit of Space Temperature	AV	read only
SpaceTempLimitOffsetUnocc	Alarm Offset to Unoccupied Space Temp Setpoint Heat	AV	read+write
SpaceTempLimitOffsetStandby	Alarm Offset to Standby Space Temp Setpoint Heat	AV	read+write
SpaceTempLimitOffsetOcc	Alarm Offset to Occupied Space Temp Setpoint Heat	AV	read+write

Table 292: BACnet Server Objects of Reheat HW Mod Space Temp Min Alarm

For functional details, please refer to chapter 7.5.15.1

Prefix: VAVcontrol_ReheatHwMod_

Server Object Name	Description	Type	Direction
AutoMan	Auto or Manual mode of the actuator	MV	read+write
ManualValue	Manual output value if is in Manual mode	AV	read+write

Table 293: BACnet Server Objects of Reheat HW Mod

8.1.11.2 Hot Water Floating Reheat

For functional details, please refer to chapter 7.5.6.2 and chapter 7.5.6.4

Prefix: VAVcontrol_ReheatHwFloat_HeatControl_

Server Object Name	Description	Type	Direction
UnoccupiedHeatSetpoint	Space Temperature Heat Setpoint in Unoccupied Mode	AV	read+write
StandbyHeatSetpoint	Space Temperature Heat Setpoint in Standby Mode	AV	read+write
OccupiedHeatSetpoint	Space Temperature Heat Setpoint in Occupied Mode	AV	read+write
ProtectionHeatSetpoint	Space Temperature Heat Setpoint in Protection Case	AV	read+write

Table 294: BACnet Server Objects of Reheat HW Float heat setpoints

For functional details, please refer to chapter 7.5.6.4

Prefix: VAVcontrol_ReheatHwFloat_HeatControl_

Server Object Name	Description	Type	Direction
HeatControlEnabled	Indication if Heat Controller is enabled	BV	read only
CurrentHeatSetpoint	Current Setpoint of Heat Controller	AV	read only
HeatControlOutput	Heat control output of temperature controller	AV	read only
HVACmode	Current HVAC Mode of Temperature Control	MV	read only
TerminalLoad	Current Terminal Load of Temperature Control	AV	read only
ProportionalGain	Proportional Gain of PI-Controller Heating	AV	read+write
IntegralTime	Integral Time of PI-Controller Heating	AV	read+write
ChangeOverDelayTime	Delay Time between heating and cooling	AV	read+write

Table 295: BACnet Server Objects of Reheat HW Float heat control

For functional details, please refer to chapter 7.5.6.5and chapter 7.5.15

Prefix: VAVcontrol_ReheatHwFloat_HeatSequence_

Server Object Name	Description	Type	Direction
LocalHeatRelease	Local heat release (reheat, periph.heat)	BV	read+write
XmaxFlow	Heat Sequence X-Value (%) for maximum Flow Output	AV	read+write
XstartHeat1	Heat Sequence X-Value (%) for Start Heat-Actuator1 Output	AV	read+write
XmaxHeat1	Heat Sequence X-Value (%) for Maximum Heat-Actuator1 Output	AV	read+write
XstartHeat2	Heat Sequence X-Value (%) for Start Heat-Actuator2 Output	AV	read+write
XmaxHeat2	Heat Sequence X-Value (%) for Maximum Heat-Actuator2 Output	AV	read+write
HeatSequence	Order of Heat-Actuators (0= Reheat/Periph), (1=Periph/Reheat)	BV	read+write
OutdoorTemperature	Current Outdoor Temperature	AV	read only
HeatLockoutState	Current Heat Lockout State	BV	read only
HeatLockoutTemp	Reheat is locked if Outside Air Temp rises above	AV	read+write
UnitHeatActive	Unit Heat is active (0= Heat Params used), (1= UnitHeat Params	BV	read only

Table 296: BACnet Server Objects of Reheat HW Float heat sequence

For functional details, please refer to chapter 7.5.6.6

Prefix: VAVcontrol_ReheatHwFloat_HeatAlarm_

Server Object Name	**Description**	**Type**	**Direction**
SpaceTempMinAlarm	Minimum Alarm of Space Temperature	BV	read only
SpaceTempMinAlarmLimit	Current Minimum Alarm Limit of Space Temperature	AV	read only
SpaceTempLimitOffsetUnocc	Alarm Offset to Unoccupied Space Temp Setpoint Heat	AV	read+write
SpaceTempLimitOffsetStandby	Alarm Offset to Standby Space Temp Setpoint Heat	AV	read+write
SpaceTempLimitOffsetOcc	Alarm Offset to Occupied Space Temp Setpoint Heat	AV	read+write

Table 297: BACnet Server Objects of Reheat HW Float Space Temp Min Alarm

For functional details, please refer to chapter 7.5.15.2

Prefix: VAVcontrol_ReheatHwFloat_

Server Object Name	**Description**	**Type**	**Direction**
AutoMan	Auto or Manual mode of the actuator	MV	read+write
ManualValue	Manual output value if is in Manual mode	AV	read+write
CalcPosition	Calculated position of the actuator	AV	read only
RuntimeOpen	Runtime from close to open position	AV	read+write
RuntimeClose	Runtime from open to close position	AV	read+write
DeadBand	Dead Band to reduce Actuator Activity	AV	read+write
CycleTime	Cycle Time of Position Calculation	AV	read+write
PositionSynchrMode	Mode of the Position Synchronization	BV	read+write

Table 298: BACnet Server Objects of Reheat HW Float

8.1.11.3 Electric Modulating Reheat

For functional details, please refer to chapter 7.5.6.2 and chapter 7.5.6.4

Prefix: VAVcontrol_ReheatElMod_HeatControl_

Server Object Name	Description	Type	Direction
UnoccupiedHeatSetpoint	Space Temperature Heat Setpoint in Unoccupied Mode	AV	read+write
StandbyHeatSetpoint	Space Temperature Heat Setpoint in Standby Mode	AV	read+write
OccupiedHeatSetpoint	Space Temperature Heat Setpoint in Occupied Mode	AV	read+write
ProtectionHeatSetpoint	Space Temperature Heat Setpoint in Protection Case	AV	read+write

Table 299: BACnet Server Objects of Reheat Electric Mod heat setpoints

For functional details, please refer to chapter 7.5.6.4

Prefix: VAVcontrol_ReheatElMod_HeatControl_

Server Object Name	Description	Type	Direction
HeatControlEnabled	Indication if Heat Controller is enabled	BV	read only
CurrentHeatSetpoint	Current Setpoint of Heat Controller	AV	read only
HeatControlOutput	Heat control output of temperature controller	AV	read only
HVACmode	Current HVAC Mode of Temperature Control	MV	read only
TerminalLoad	Current Terminal Load of Temperature Control	AV	read only
ProportionalGain	Proportional Gain of PI-Controller Heating	AV	read+write
IntegralTime	Integral Time of PI-Controller Heating	AV	read+write
ChangeOverDelayTime	Delay Time between heating and cooling	AV	read+write

Table 300: BACnet Server Objects of Reheat Electric Mod heat control

For functional details, please refer to chapter 7.5.6.5and chapter 7.5.15

Prefix: VAVcontrol_ReheatElMod_HeatSequence_

Server Object Name	Description	Type	Direction
LocalHeatRelease	Local heat release (reheat, periph.heat)	BV	read+write
XmaxFlow	Heat Sequence X-Value (%) for maximum Flow Output	AV	read+write
XstartHeat1	Heat Sequence X-Value (%) for Start Heat-Actuator1 Output	AV	read+write
XmaxHeat1	Heat Sequence X-Value (%) for Maximum Heat-Actuator1 Output	AV	read+write
XstartHeat2	Heat Sequence X-Value (%) for Start Heat-Actuator2 Output	AV	read+write
XmaxHeat2	Heat Sequence X-Value (%) for Maximum Heat-Actuator2 Output	AV	read+write
HeatSequence	Order of Heat-Actuators (0= Reheat/Periph), (1=Periph/Reheat)	BV	read+write
OutdoorTemperature	Current Outdoor Temperature	AV	read only
HeatLockoutState	Current Heat Lockout State	BV	read only
HeatLockoutTemp	Reheat is locked if Outside Air Temp rises above	AV	read+write
UnitHeatActive	Unit Heat is active (0= Heat Params used), (1= UnitHeat Params	BV	read only

Table 301: BACnet Server Objects of Reheat Electric Mod heat sequence

For functional details, please refer to chapter 7.5.6.6

Prefix: VAVcontrol_ReheatElMod_HeatAlarm_

Server Object Name	Description	Type	Direction
SpaceTempMinAlarm	Minimum Alarm of Space Temperature	BV	read only
SpaceTempMinAlarmLimit	Current Minimum Alarm Limit of Space Temperature	AV	read only
SpaceTempLimitOffsetUnocc	Alarm Offset to Unoccupied Space Temp Setpoint Heat	AV	read+write
SpaceTempLimitOffsetStandby	Alarm Offset to Standby Space Temp Setpoint Heat	AV	read+write
SpaceTempLimitOffsetOcc	Alarm Offset to Occupied Space Temp Setpoint Heat	AV	read+write

Table 302: BACnet Server Objects of Reheat Electric Mod Space Temp Min Alarm

For functional details, please refer to chapter 7.5.15.3

Prefix: VAVcontrol_ReheatElMod _

Server Object Name	Description	Type	Direction
AutoMan	Auto or Manual mode of the actuator	MV	read+write
ManualValue	Manual output value if is in Manual mode	AV	read+write
ReheatMinFlowDelay	Delay time to block the reheat if the min air flow is not present	AV	read+write
ReheatFlowRelease	Indication if the reheat is released by MinAirFlow or fan	BV	read only

Table 303: BACnet Server Objects of Reheat Electric Mod

8.1.11.4 Electric 3 Stage Reheat

For functional details, please refer to chapter 7.5.6.2 and chapter 7.5.6.4

Prefix: VAVcontrol_ReheatEl3St_HeatControl_

Server Object Name	Description	Type	Direction
UnoccupiedHeatSetpoint	Space Temperature Heat Setpoint in Unoccupied Mode	AV	read+write
StandbyHeatSetpoint	Space Temperature Heat Setpoint in Standby Mode	AV	read+write
OccupiedHeatSetpoint	Space Temperature Heat Setpoint in Occupied Mode	AV	read+write
ProtectionHeatSetpoint	Space Temperature Heat Setpoint in Protection Case	AV	read+write

Table 304: BACnet Server Objects of Reheat Electric 3 Stage heat setpoints

For functional details, please refer to chapter 7.5.6.4

Prefix: VAVcontrol_ReheatEl3St_HeatControl_

Server Object Name	Description	Type	Direction
HeatControlEnabled	Indication if Heat Controller is enabled	BV	read only
CurrentHeatSetpoint	Current Setpoint of Heat Controller	AV	read only
HeatControlOutput	Heat control output of temperature controller	AV	read only
HVACmode	Current HVAC Mode of Temperature Control	MV	read only
TerminalLoad	Current Terminal Load of Temperature Control	AV	read only
ProportionalGain	Proportional Gain of PI-Controller Heating	AV	read+write
IntegralTime	Integral Time of PI-Controller Heating	AV	read+write
ChangeOverDelayTime	Delay Time between heating and cooling	AV	read+write

Table 305: BACnet Server Objects of Reheat Electric 3 Stage heat control

For functional details, please refer to chapter 7.5.6.5and chapter 7.5.15

Prefix: VAVcontrol_ReheatEl3St_HeatSequence_

Server Object Name	Description	Type	Direction
LocalHeatRelease	Local heat release (reheat, periph.heat)	BV	read+write
XmaxFlow	Heat Sequence X-Value (%) for maximum Flow Output	AV	read+write
XstartHeat1	Heat Sequence X-Value (%) for Start Heat-Actuator1 Output	AV	read+write
XmaxHeat1	Heat Sequence X-Value (%) for Maximum Heat-Actuator1 Output	AV	read+write
XstartHeat2	Heat Sequence X-Value (%) for Start Heat-Actuator2 Output	AV	read+write
XmaxHeat2	Heat Sequence X-Value (%) for Maximum Heat-Actuator2 Output	AV	read+write
HeatSequence	Order of Heat-Actuators (0= Reheat/Periph), (1=Periph/Reheat)	BV	read+write
OutdoorTemperature	Current Outdoor Temperature	AV	read only
HeatLockoutState	Current Heat Lockout State	BV	read only
HeatLockoutTemp	Reheat is locked if Outside Air Temp rises above	AV	read+write
UnitHeatActive	Unit Heat is active (0= Heat Params used), (1= UnitHeat Params	BV	read only

Table 306: BACnet Server Objects of Reheat Electric 3 Stage heat sequence

For functional details, please refer to chapter 7.5.6.6

Prefix: VAVcontrol_ReheatEl3St_HeatAlarm_

Server Object Name	Description	Type	Direction
SpaceTempMinAlarm	Minimum Alarm of Space Temperature	BV	read only
SpaceTempMinAlarmLimit	Current Minimum Alarm Limit of Space Temperature	AV	read only
SpaceTempLimitOffsetUnocc	Alarm Offset to Unoccupied Space Temp Setpoint Heat	AV	read+write
SpaceTempLimitOffsetStandby	Alarm Offset to Standby Space Temp Setpoint Heat	AV	read+write
SpaceTempLimitOffsetOcc	Alarm Offset to Occupied Space Temp Setpoint Heat	AV	read+write

Table 307: BACnet Server Objects of Reheat Electric 3 Stage Space Temp Min Alarm

For functional details, please refer to chapter 7.5.15.4

Prefix: VAVcontrol_ReheatEl3St_

Server Object Name	Description	Type	Direction
AutoMan	Auto or Manual mode of the actuator	MV	read+write
ManualValue	Manual output value if is in Manual mode	AV	read+write
ReheatMinFlowDelay	Delay time to block the reheat if the min air flow is not present	AV	read+write
ReheatFlowRelease	Indication if the reheat is released by MinAirFlow or fan	BV	read only
ReheatStageFb	Reheat stage feedback (for display)	MV	read only
ControlOutputReheat	Control output to reheat 0...100%	AV	read only
ReheatMaxStage	Number of the maximum reheat stage	AV	read+write
LimitActiveReheatStage1	Limit of control signal that switches Stage 1 to active	AV	read+write
HysOffReheatStage1	Hysteresis that switches Stage1 to off	AV	read+write
OnDelayReheatStage1	On delay of Stage1	AV	read+write
MinOutputStage1	Minimum analog output of stage1	AV	read+write
LimitActiveReheatStage2	Limit of control signal that switches Stage 2 to active	AV	read+write
HysOffReheatStage2	Hysteresis that switches Stage2 to off	AV	read+write
OnDelayReheatStage2	On delay of Stage2	AV	read+write
MinOutputStage2	Minimum analog output of stage2	AV	read+write
LimitActiveReheatStage3	Limit of control signal that switches Stage 3 to active	AV	read+write
HysOffReheatStage3	Hysteresis that switches Stage3 to off	AV	read+write
OnDelayReheatStage3	On delay of Stage3	AV	read+write
MinOutputStage3	Minimum analog output of stage3	AV	read+write

Table 308: BACnet Server Objects of Reheat Electric 3 Stage

8.1.11.5 No Reheat

For functional details, please refer to chapter 7.5.6.2 and chapter 7.5.6.4

Prefix: VAVcontrol_NoReheat_HeatControl_

Server Object Name	Description	Type	Direction
UnoccupiedHeatSetpoint	Space Temperature Heat Setpoint in Unoccupied Mode	AV	read+write
StandbyHeatSetpoint	Space Temperature Heat Setpoint in Standby Mode	AV	read+write
OccupiedHeatSetpoint	Space Temperature Heat Setpoint in Occupied Mode	AV	read+write
ProtectionHeatSetpoint	Space Temperature Heat Setpoint in Protection Case	AV	read+write

Table 309: BACnet Server Objects of No Reheat heat setpoints

For functional details, please refer to chapter 7.5.6.4

Prefix: VAVcontrol_NoReheat_HeatControl_

Server Object Name	Description	Type	Direction
HeatControlEnabled	Indication if Heat Controller is enabled	BV	read only
CurrentHeatSetpoint	Current Setpoint of Heat Controller	AV	read only
HeatControlOutput	Heat control output of temperature controller	AV	read only
HVACmode	Current HVAC Mode of Temperature Control	MV	read only
TerminalLoad	Current Terminal Load of Temperature Control	AV	read only
ProportionalGain	Proportional Gain of PI-Controller Heating	AV	read+write
IntegralTime	Integral Time of PI-Controller Heating	AV	read+write
ChangeOverDelayTime	Delay Time between heating and cooling	AV	read+write

Table 310: BACnet Server Objects of No Reheat heat control

For functional details, please refer to chapter 7.5.6.5and chapter 7.5.15

Prefix: VAVcontrol_NoReheat_HeatSequence_

Server Object Name	Description	Type	Direction
LocalHeatRelease	Local heat release (reheat, periph.heat)	BV	read+write
XmaxFlow	Heat Sequence X-Value (%) for maximum Flow Output	AV	read+write
XstartHeat1	Heat Sequence X-Value (%) for Start Heat-Actuator1 Output	AV	read+write
XmaxHeat1	Heat Sequence X-Value (%) for Maximum Heat-Actuator1 Output	AV	read+write
XstartHeat2	Heat Sequence X-Value (%) for Start Heat-Actuator2 Output	AV	read+write
XmaxHeat2	Heat Sequence X-Value (%) for Maximum Heat-Actuator2 Output	AV	read+write
HeatSequence	Order of Heat-Actuators (0= Reheat/Periph), (1=Periph/Reheat)	BV	read+write
OutdoorTemperature	Current Outdoor Temperature	AV	read only
HeatLockoutState	Current Heat Lockout State	BV	read only
HeatLockoutTemp	Reheat is locked if Outside Air Temp rises above	AV	read+write
UnitHeatActive	Unit Heat is active (0= Heat Params used), (1= UnitHeat Params	BV	read only

Table 311: BACnet Server Objects of No Reheat heat sequence

For functional details, please refer to chapter 7.5.6.6

Prefix: VAVcontrol_NoReheat_HeatAlarm_

Server Object Name	Description	Type	Direction
SpaceTempMinAlarm	Minimum Alarm of Space Temperature	BV	read only
SpaceTempMinAlarmLimit	Current Minimum Alarm Limit of Space Temperature	AV	read only
SpaceTempLimitOffsetUnocc	Alarm Offset to Unoccupied Space Temp Setpoint Heat	AV	read+write
SpaceTempLimitOffsetStandby	Alarm Offset to Standby Space Temp Setpoint Heat	AV	read+write
SpaceTempLimitOffsetOcc	Alarm Offset to Occupied Space Temp Setpoint Heat	AV	read+write

Table 312: BACnet Server Objects of No Reheat Space Temp Min Alarm

8.1.12 Periph. Heat Actuators

8.1.12.1 Modulating Peripheral Heat

For functional details, please refer to chapter 7.5.16

Prefix: VAVcontrol_PeriphHeatMod_WinterMinPos_

Server Object Name	Description	Type	Direction
WinterMinPosition	Winter minimum position of peripheral heat actuator	AV	read+write
ODTlimitWinterMinPos	Outdoor temperature min limit to enable winter minimum position	AV	read+write
WinterMinPositionStatus	Status of winter minimum position function	BV	read only

Table 313: BACnet Server Objects of Modulating Peripheral Heat Winter Minimum Position

For functional details, please refer to chapter 7.5.16.1

Prefix: VAVcontrol_ PeriphHeatMod_

Server Object Name	Description	Type	Direction
AutoMan	Auto or Manual mode of the actuator	MV	read+write
ManualValue	Manual output value if is in Manual mode	AV	read+write
HeatLockoutState	Current heat lockout state	BV	read only

Table 314: BACnet Server Objects of Modulating Peripheral Heat

8.1.12.2 Floating Peripheral Heat

For functional details, please refer to chapter 7.5.16

Prefix: VAVcontrol_PeriphHeatFloat_WinterMinPos_

Server Object Name	Description	Type	Direction
WinterMinPosition	Winter minimum position of peripheral heat actuator	AV	read+write
ODTlimitWinterMinPos	Outdoor temperature min limit to enable winter minimum position	AV	read+write
WinterMinPositionStatus	Status of winter minimum position function	BV	read only

Table 315: BACnet Server Objects of Floating Peripheral Heat Winter Minimum Position

For functional details, please refer to chapter 7.5.16.2

Prefix: VAVcontrol_ PeriphHeatMod_

Server Object Name	Description	Type	Direction
AutoMan	Auto or Manual mode of the actuator	MV	read+write
ManualValue	Manual output value if is in Manual mode	AV	read+write
HeatLockoutState	Current heat lockout state	BV	read only
CalcPosition	Calculated position of the actuator	AV	read only
RuntimeOpen	Runtime from close to open position	AV	read+write
RuntimeClose	Runtime from open to close position	AV	read+write
DeadBand	Dead Band to reduce Actuator Activity	AV	read+write
PositionSynchrMode	Mode of the Position Synchronization	BV	read+write

Table 316: BACnet Server Objects of Floating Peripheral Heat

8.1.12.3 Peripheral Heat On Off

For functional details, please refer to chapter 7.5.16

Prefix: VAVcontrol_PeriphHeatOnOff_WinterMinPos_

Server Object Name	Description	Type	Direction
WinterMinPosition	Winter minimum position of peripheral heat actuator	AV	read+write
ODTlimitWinterMinPos	Outdoor temperature min limit to enable winter minimum position	AV	read+write
WinterMinPositionStatus	Status of winter minimum position function	BV	read only

Table 317: BACnet Server Objects of On Off Peripheral Heat Winter Minimum Position

For functional details, please refer to chapter 7.5.16.3

Prefix: VAVcontrol_ PeriphHeatOnOff_

Server Object Name	Description	Type	Direction
AutoMan	Auto or Manual mode of the actuator	MV	read+write
ManualValue	Manual output value if is in Manual mode	AV	read+write
HeatLockoutState	Current heat lockout state	BV	read only
CurrCycleOnTime	Current ON time in the cycle of the on off actuator	AV	read only
CurrCycleOffTime	Current OFF time in the cycle of the on off actuator	AV	read only
CyclesPerHour	Number of control cycles of on off actuator	AV	read+write

Table 318: BACnet Server Objects of On Off Peripheral Heat

8.1.13 External Flow Setpoint

8.1.13.1 External Flow Setpoint Configuration

For functional details, please refer to chapter 7.5.17.2

Prefix: VAVcontrol_SeriesFan_FanOffDelay_

Server Object Name	Description	Type	Direction
FlowSetptExternal_Flow%Occ	External Flow Setpoint %Occ from sensor distribution	AV	read only
FlowSetptExternal_Flow%NotOcc	External Flow Setpoint %NotOcc from sensor distribution	AV	read only
FlowSetptExternal_Flow%Eff	External Flow Setpoint % effective for operation	AV	read only
FlowSetpointExt	Present Value of external Flow Setpoint	AV	read only
MinSetptPercentage	If input is <= % then the MinSetpoint is active	AV	read+write

Table 319: BACnet Server Objects of external flow setpoint configuration

8.1.14 VAV communication

8.1.14.1 Configuring an Air Supply Zone

For functional details, please refer to chapter 7.6.1.1

Prefix: VAVcontrol_Core_AHUcommunication_

Server Object Name	Description	Type	Direction
AirSupplyZoneId	ID of Air Supply Zone	AV	read+write
ManagerWatchdog	Indicates if the VAV communicates with the Area manager	BV	read only

Table 320: BACnet Server Objects of AHU communication configuration

8.1.14.2 Enable /Disable Data Aggregation

For functional details, please refer to chapter 7.6.1.2

Prefix: VAVcontrol_Core_AHUcommunication_

Server Object Name	Description	Type	Direction
EnableAggregation	Enabled Data Aggregation for this device	BV	read+write

Table 321: BACnet Server Objects of AHU communication enable configuration

8.1.14.3 Weight Factor Data Aggregation

For functional details, please refer to chapter 7.6.1.3

Prefix: VAVcontrol_Core_AHUcommunication_

Server Object Name	Description	Type	Direction
WeightFactorRoom	Weight factor of the room data for aggregation	AV	read+write

Table 322: BACnet Server Objects of AHU communication weight factor room

8.1.14.4 Values communicated between Manager and VAV controllers

For functional details, please refer to chapter 7.6.1.4

Prefix: VAVcontrol_Core_AHUcommunication_

Server Object Name	Description	Type	Direction
OccupiedModeToAHU	Occupancy Mode to AHU	AV	read only
HvacModeOsReqToAHU	HVAC Mode requested by Optimum Start to AHU	MV	read only
TerminalLoadToAHU	Terminal Load to AHU	AV	read only
SupplyDamperPositionToAHU	Damper Position Supply Air To AHU	AV	read only
ExhaustDamperPositionToAHU	Damper Position Exhaust Air To AHU	AV	read only
CO2toAHU	Indoor Air Quality (CO2) to AHU	AV	read only
SpaceTempToAHU	Space Temperature to AHU	AV	read only
SpaceTempAvailableToAHU	Space Temp Sensor is available To AHU	BV	read only
EffSetpointToAHU	Effective Space temperature Setpoint to AHU	AV	read only
EffSetpointAvailableToAHU	Space Temp Effective Setpoint is available To AHU	BV	read only
SetbackOverrideToAHU	Setback Override to AHU	AV	read only
RelHumidityToAHU	Relative Space Humidity to AHU	BV	read only
RelHumidAvailableToAHU	Relative Humidity Sensor is available To AHU	AV	read only
SupplyAirFlowToAHU	Supply Air Flow To AHU	AV	read only
ExhaustAirFlowToAHU	Exhaust Air Flow To AHU	AV	read only
OutdoorAirFlowDemandToAHU	Outdoor Air Flow Demand to AHU	AV	read only
(AirFlowForcedToAHU)*	Air Flow Forced To AHU	AV	read only
(MinAirFlowForcedToAHU)*	Minimum Air Flow Forced To AHU	BV	read only

Table 323: BACnet Server Objects of AHU communication Values to AHU

)* : not supported in the current version

Prefix: VAVcontrol_Core_AHUcommunication_

Server Object Name	Description	Type	Direction
HvacModeFromAHU	Current HVAC mode from AHU	MV	read+write
OccupOverrideFromAHU	Occupancy Override from the AHU	BV	read+write
OnOffFromAHU	On Off Status from AHU	BV	read+write
HeatingFromAHU	Heating Mode from the AHU	BV	read+write
CoolingFromAHU	Cooling Mode from the AHU	BV	read+write
FanOnlyFromAHU	Fan Only Mode from the AHU	MV	read+write
OudoorAirFractionFromAHU	Outdoor Air Fraction from AHU	AV	read+write
CO2outdoorAirFromAHU	CO2 Concentration of Outdoor Air from AHU	AV	read+write
CO2supplyAirFromAHU	CO2 Concentration of Supply Air from AHU	AV	read+write
SupplyAirTempFromAHU	Current Supply Air temperature from AHU	AV	read+write
EnergyDemandLimitFromAHU	Request of Energy Demand Limiting from the AHU	BV	read+write
BalanceFlowCmdFromAHU	Balance Flow Command from AHU	MV	read+write
BalanceFlowValueFromAHU	Balance Flow Value from AHU (valid on Value_Flow Cmd)	AV	read+write

Table 324: BACnet Server Objects of AHU communication Values from AHU

Prefix: VAVcontrol_Core_AHUcommunication_AHUcommDamper_

Server Object Name	Description	Type	Direction
SupplyAirDamperPositionClass	Class number of Supply Air Damper Demand for Aggregation	AV	read only
ExhaustAirDamperPositionClass	Class number of Exhaust Air Damper Demand for Aggregation	AV	read only

Table 325: BACnet Server Objects of AHU communication Damper Class aggregation to AHU

Prefix: VAVcontrol_Core_AHUcommunication_AHUcommHumidity_

Server Object Name	Description	Type	Direction
HumidificationDemandClass	Class number of Humidification Demand for Aggregation	AV	read only
DehumidificationDemandClass	Class number of Dehumidification Demand for Aggregation	AV	read only

Table 326: BACnet Server Objects of AHU comm Humid/Dehumid Class aggregation to AHU

Prefix: VAVcontrol_Core_AHUcommunication_AHUcommTerminalLoad_

Server Object Name	Description	Type	Direction
TerminalLoadCoolClass	Class number of Terminal Load Cool Demand for Aggregation	AV	read only
TerminalLoadHeatClass	Class number of Terminal Load Heat Demand for Aggregation	AV	read only

Table 327: BACnet Server Objects of AHU comm Terminal Load Class aggregation to AHU

8.1.15 Multi Manager

8.1.15.1 Manager Tiles and Watchdogs

For functional details, please refer to chapter 7.7.1.2

Prefix: VAVmultiManager_Floor_Zone_***)**

Server Object Name	Description	Type	Direction
AirSupplyZoneId	ID of Air Supply Zone	ChStrV	read+write
HighLevelWatchdog	Indicates if Manager communicates with high level devices	BV	read only
LocalLevelWatchdog	Indicates if Manager communicates with local level devices	BV	read only
CurrLocalLevelDevCnt	Current number of local level devices	AV	read only
MaxLocalLevelDevCnt	Maximum number of local level devices	AV	read only

Table 328: BACnet Server Objects of Multi Manager tiles and watchdogs

*): Please note that the prefix is depending on the manager type and number using different folder names. This is valid for all sever objects in the Multi Manager.

Multi Manager	Prefix: VAVmultiManager_Floor_Zone_
Area 1 Manager	Prefix: VAVmultiManager_Area1_Zone_
Area 2 Manager	Prefix: VAVmultiManager_Area2_Zone_
Area 3 Manager	Prefix: VAVmultiManager_Area3_Zone_
Area 4 Manager	Prefix: VAVmultiManager_Area4_Zone_
Area 5 Manager	Prefix: VAVmultiManager_Area5_Zone_

8.1.15.2 Configuring a Manager

For functional details, please refer to chapter 7.7.1.3

Prefix: VAVmultiManager_Floor_Zone_***)**

Server Object Name	Description	Type	Direction
AirSupplyZoneId	ID of Air Supply Zone	ChStrV	read+write
HighLevelWatchdog	Indicates if Manager communicates with high level devices	BV	read only
LocalLevelWatchdog	Indicates if Manager communicates with local level devices	BV	read only
CommFaultSummary	Communication Fault Summary of the local level and lower levels	BV	read only
CurrLocalLevelDevCnt	Current number of local level devices	AV	read only
MaxLocalLevelDevCnt	Maximum number of local level devices	AV	read only

Table 329: BACnet Server Objects of Multi Manager configuring a manager

*): Please note that the prefix is depending on the manager type and number using different folder names. See regarding note in chapter 8.1.15.1.

8.1.15.3 Values to AHU

For functional details, please refer to chapter 7.7.1.4

Aggregation using Method #1:

Prefix: VAVmultiManager_Floor_Zone_***)**

Server Object Name	**Description**	**Type**	**Direction**
AirSupplyZoneId	ID of Air Supply Zone	ChStrV	read+write
OccupiedModeToAHU	Maximum aggregated Occupancy Mode to AHU	MV	read only
MinTerminalLoadToAHU	Minimum aggregated Terminal Load to AHU	AV	read only
MaxTerminalLoadToAHU	Maximum aggregated Terminal Load to AHU	AV	read only
MaxSupDamperPosition	Maximum aggregated Supply Air Damper Position To AHU	AV	read only
MaxExhDamperPosition	Maximum aggregated Exhaust Air Damper Position To AHU	AV	read only
MaxIAQtoAHU	Maximum aggregated Indoor Air Quality (CO2) to AHU	AV	read only
MinSpaceTempToAHU	Minimum aggregated Space Temperature to AHU	AV	read only
MaxSpaceTempToAHU	Maximum aggregated Space Temperature to AHU	AV	read only
AvgSpaceTempLevel	Average Space Temperature on this aggregation level	AV	read only
SumSpaceTempToAHU	Summary of SpaceTemperatures to AHU	AV	read only
NumSpaceTempToAHU	Number of Space Temp Summations to AHU	AV	read only
MinEffSetpointToAHU	Minimum aggregated effective Setpoint to AHU	AV	read only
MaxEffSetpointToAHU	Maximum aggregated effective Setpoint to AHU	AV	read only
AvgEffSetpointLevel	Average effective Setpoint on this aggregation level	AV	read only
SumEffSetpointToAHU	Summation of effective Setpoints to AHU	AV	read only
NumEffSetpointToAHU	Number of effective Setpoint Summations to AHU	AV	read only
SetbackOverrideToAHU	Aggregated Setback Override to AHU	BV	read only
MinHumidityToAHU	Minimum aggregated relative Space Humidity to AHU	AV	read only
MaxHumidityToAHU	Maximum aggregated relative Space Humidity to AHU	AV	read only
AvgRelHumidityLevel	Average relative humidity on this aggregation level	AV	read only
SumHumidityToAHU	Summation of Space Humidities to AHU	AV	read only
NumHumidityToAHU	Number of Space Humidity Summations to AHU	AV	read only
SumSupplyAirFlowToAHU	Summation of Supply Air Flow To AHU	AV	read only
SumExhaustAirFlowToAHU	Summation of Exhaust Air Flow To AHU	AV	read only

SumOutdoorAirFlowDemandToAHU	Outdoor Air Flow Demand to AHU	AV	read only
(SumAirFlowForcedToAHU)**	Summation of Air Flow Forced To AHU	AV	read only
(SumMinAirFlowForcedToAHU)**	Summation of Minimum Air Flow Forced To AHU	AV	read only

Table 330: BACnet Server Objects of Multi Manager values to AHU

*): Please note that the prefix is depending on the manager type and number using different folder names. See regarding note in chapter 8.1.15.1.

**): not supported in the current version

Aggregation using Method #2:

Class Aggregation: Supply Damper Positions:

Prefix: VAVmultiManager_Floor_Zone_***)**.SupDampPosToAHU

Server Object Name	Description	Type	Direction
Class1	Number of devices with Supply Air Damper Positions in Class1 (0…25%)	AV	read only
SupDampPosClass1p	Percentage of devices with Supply Air Damper Positions in Class1 (0…25%)	AV	read only
Class2	Number of devices with Supply Air Damper Positions in Class2 (25…50%)	AV	read only
SupDampPosClass2p	Percentage of devices with Supply Air Damper Positions in Class2 (25…50%)	AV	read only
Class3	Number of devices with Supply Air Damper Positions in Class3 (50…75%)	AV	read only
SupDampPosClass3p	Percentage of devices with Supply Air Damper Positions in Class3 (50…75%)	AV	read only
Class4	Number of devices with Supply Air Damper Positions in Class4 (75…90%)	AV	read only
SupDampPosClass4p	Percentage of devices with Supply Air Damper Positions in Class4 (75…90%)	AV	read only
Class5	Number of devices with Supply Air Damper Positions in Class5 (>90%)	AV	read only
SupDampPosClass5p	Percentage of devices with Supply Air Damper Positions in Class5 (>90%)	AV	read only

Table 331: BACnet Server Objects of Multi Manager values to AHU, Supply Damper Positions

*): Please note that the prefix is depending on the manager type and number using different folder names. See regarding note in chapter 8.1.15.1.

Class Aggregation: Exhaust Damper Positions:

Prefix: VAVmultiManager_Floor_Zone_***)**.ExhDampPosToAHU

Server Object Name	Description	Type	Direction
Class1	Number of devices with Exhaust Air Damper Positions in Class1 (0…25%)	AV	read only
ExhDampPosClass1p	Percentage of devices with Exhaust Air Damper Positions in Class1 (0…25%)	AV	read only
Class2	Number of devices with Exhaust Air Damper Positions in Class2 (25…50%)	AV	read only
ExhDampPosClass2p	Percentage of devices with Exhaust Air Damper Positions in Class2 (25…50%)	AV	read only
Class3	Number of devices with Exhaust Air Damper Positions in Class3 (50…75%)	AV	read only
ExhDampPosClass3p	Percentage of devices with Exhaust Air Damper Positions in Class3 (50…75%)	AV	read only
Class4	Number of devices with Exhaust Air Damper Positions in Class4 (75…90%)	AV	read only
ExhDampPosClass4p	Percentage of devices with Exhaust Air Damper Positions in Class4 (75…90%)	AV	read only
Class5	Number of devices with Exhaust Air Damper Positions in Class5 (>90%)	AV	read only
ExhDampPosClass5p	Percentage of devices with Exhaust Air Damper Positions in Class5 (>90%)	AV	read only

Table 332: BACnet Server Objects of Multi Manager values to AHU, Exhaust Damper Positions

*): Please note that the prefix is depending on the manager type and number using different folder names. See regarding note in chapter 8.1.15.1.

Class Aggregation: Terminal Load Cool Demands:

Prefix: VAVmultiManager_Floor_Zone_***)**.TermLdCoolToAHU

Server Object Name	**Description**	**Type**	**Direction**
Class1	Number of rooms with Terminal Load Cool Demand in Class1 (2…25%)	AV	read only
TermLdCoolClass1p	Percentage of rooms with Terminal Load Cool Demand in Class1 (2…25%)	AV	read only
Class2	Number of rooms with Terminal Load Cool Demand in Class2 (25…50%)	AV	read only
TermLdCoolClass2p	Percentage of rooms with Terminal Load Cool Demand in Class2 (25…50%)	AV	read only
Class3	Number of rooms with Terminal Load Cool Demand in Class3 (50…75%)	AV	read only
TermLdCoolClass3p	Percentage of rooms with Terminal Load Cool Demand in Class3 (50…75%)	AV	read only
Class4	Number of rooms with Terminal Load Cool Demand in Class4 (75…90%)	AV	read only
TermLdCoolClass4p	Percentage of rooms with Terminal Load Cool Demand in Class4 (75…90%)	AV	read only
Class5	Number of rooms with Terminal Load Cool Demand in Class5 (>90%)	AV	read only
TermLdCoolClass5p	Percentage of rooms with Terminal Load Cool Demand in Class5 (>90%)	AV	read only

Table 333: BACnet Server Objects of Multi Manager values to AHU, Terminal Load Cool Demands

*): Please note that the prefix is depending on the manager type and number using different folder names. See regarding note in chapter 8.1.15.1.

Class Aggregation: Terminal Load Heat Demands:

Prefix: VAVmultiManager_Floor_Zone_***)**.TermLdHeatToAHU

Server Object Name	**Description**	**Type**	**Direction**
Class1	Number of rooms with Terminal Load Heat Demand in Class1 (2…25%)	AV	read only
TermLdHeatClass1p	Percentage of rooms with Terminal Load Heat Demand in Class1 (2…25%)	AV	read only
Class2	Number of rooms with Terminal Load Heat Demand in Class2 (25…50%)	AV	read only
TermLdHeatClass2p	Percentage of rooms with Terminal Load Heat Demand in Class2 (25…50%)	AV	read only
Class3	Number of rooms with Terminal Load Heat Demand in Class3 (50…75%)	AV	read only
TermLdHeatClass3p	Percentage of rooms with Terminal Load Heat Demand in Class3 (50…75%)	AV	read only
Class4	Number of rooms with Terminal Load Heat Demand in Class4 (75…90%)	AV	read only
TermLdHeatClass4p	Percentage of rooms with Terminal Load Heat Demand in Class4 (75…90%)	AV	read only
Class5	Number of rooms with Terminal Load Heat Demand in Class5 (>90%)	AV	read only
TermLdHeatClass5p	Percentage of rooms with Terminal Load Heat Demand in Class5 (>90%)	AV	read only

Table 334: BACnet Server Objects of Multi Manager values to AHU, Terminal Load Heat Demands

*): Please note that the prefix is depending on the manager type and number using different folder names. See regarding note in chapter 8.1.15.1.

Class Aggregation: Humidification Demands:

Prefix: VAVmultiManager_Floor_Zone_***)**.HumDemToAHU

Server Object Name	Description	Type	Direction
Class1	Number of rooms with Humidification Demand in Class1 (2…25%)	AV	read only
HumDemClass1p	Percentage of rooms with Humidification Demand in Class1 (2…25%)	AV	read only
Class2	Number of rooms with Humidification Demand in Class2 (25…50%)	AV	read only
HumDemClass2p	Percentage of rooms with Humidification Demand in Class2 (25…50%)	AV	read only
Class3	Number of rooms with Humidification Demand in Class3 (50…75%)	AV	read only
HumDemClass3p	Percentage of rooms with Humidification Demand in Class3 (50…75%)	AV	read only
Class4	Number of rooms with Humidification Demand in Class4 (75…90%)	AV	read only
HumDemClass4p	Percentage of rooms with Humidification Demand in Class4 (75…90%)	AV	read only
Class5	Number of rooms with Humidification Demand in Class5 (>90%)	AV	read only
HumDemClass5p	Percentage of rooms with Humidification Demand in Class5 (>90%)	AV	read only

Table 335: BACnet Server Objects of Multi Manager values to AHU, Humidification Demands

*): Please note that the prefix is depending on the manager type and number using different folder names. See regarding note in chapter 8.1.15.1.

Class Aggregation: Dehumidification Demands:

Prefix: VAVmultiManager_Floor_Zone_***)**.DehumDemToAHU

Server Object Name	Description	Type	Direction
Class1	Number of rooms with Dehumidification Demand in Class1 (2…25%)	AV	read only
DehumDemClass1p	Percentage of rooms with Dehumidification Demand in Class1 (2…25%)	AV	read only
Class2	Number of rooms with Dehumidification Demand in Class2 (25…50%)	AV	read only
DehumDemClass2p	Percentage of rooms with Dehumidification Demand in Class2 (25…50%)	AV	read only
Class3	Number of rooms with Dehumidification Demand in Class3 (50…75%)	AV	read only
DehumDemClass3p	Percentage of rooms with Dehumidification Demand in Class3 (50…75%)	AV	read only
Class4	Number of rooms with Dehumidification Demand in Class4 (75…90%)	AV	read only
DehumDemClass4p	Percentage of rooms with Dehumidification Demand in Class4 (75…90%)	AV	read only
Class5	Number of rooms with Dehumidification Demand in Class5 (>90%)	AV	read only
DehumDemClass5p	Percentage of rooms with Dehumidification Demand in Class5 (>90%)	AV	read only

Table 336: BACnet Server Objects of Multi Manager values to AHU, Dehumidification Demands

*): Please note that the prefix is depending on the manager type and number using different folder names. See regarding note in chapter 8.1.15.1.

Class Aggregation: Occupancy States Count:

Prefix: VAVmultiManager_Floor_Zone_***)**.EffOccCountToAHU

Server Object Name	Description	Type	Direction
NumUnoccAgg	Number of rooms with current occupancy state unoccupied	AV	read only
NumUnoccAggP	Percentage of rooms with current occupancy state unoccupied	AV	read only
NumStbyAgg	Number of rooms with current occupancy state standby	AV	read only
NumStbyAggP	Percentage of rooms with current occupancy state standby	AV	read only
NumBypAgg	Number of rooms with current occupancy state bypass	AV	read only
NumBypAggP	Percentage of rooms with current occupancy state bypass	AV	read only
NumOccAgg	Number of rooms with current occupancy state occupied	AV	read only
NumOccAggP	Percentage of rooms with current occupancy state occupied	AV	read only

Table 337: BACnet Server Objects of Multi Manager values to AHU, Occupancy States Count

*): Please note that the prefix is depending on the manager type and number using different folder names. See regarding note in chapter 8.1.15.1.

Class Aggregation: HVAC Mode Requests Count (from Optimum Start):

Prefix: VAVmultiManager_Floor_Zone_***)**.HVACreqCountToAHU

Server Object Name	Description	Type	Direction
NumWarmUpAgg	Number of aggregated WARMUP requesting rooms	AV	read only
NumWarmUpAggP	Percentage of aggregated WARMUP requesting rooms	AV	read only
NumPreCoolAgg	Number of aggregated PRE_COOL requesting rooms	AV	read only
NumPreCoolAggP	Percentage of aggregated PRE_COOL requesting rooms	AV	read only

Table 338: BACnet Server Objects of Multi Manager values to AHU, Devices and Rooms Count

*): Please note that the prefix is depending on the manager type and number using different folder names. See regarding note in chapter 8.1.15.1.

<u>Class Aggregation: Devices and Rooms Count:</u>

Prefix: VAVmultiManager_Floor_Zone_***)**.DevRmCountToAHU

Server Object Name	**Description**	**Type**	**Direction**
NumDevicesAgg	Aggregated number of devices	AV	read only
NumDevWghtAgg	Aggregated number of devices multiplied with the weight factors	AV	read only
NumSupWghtAgg	Aggregated number of supply air devices multiplied with the weight factors	AV	read only
NumExhWghtAgg	Aggregated number of exhaust air devices multiplied with the weight factors	AV	read only
NumRoomsAgg	Aggregated number of rooms	AV	read only
NumRmWghtAgg	Aggregated number of rooms multiplied with the weight factors	AV	read only

Table 339: BACnet Server Objects of Multi Manager values to AHU, Devices and Rooms Count

*): Please note that the prefix is depending on the manager type and number using different folder names. See regarding note in chapter 8.1.15.1.

8.1.15.4 Values from AHU

For functional details, please refer to chapter 7.7.1.5

Prefix: VAVmultiManager_Floor_Zone_***)**

Server Object Name	**Description**	**Type**	**Direction**
AirSupplyZoneId	ID of Air Supply Zone	ChStrV	read+write
HvacModeFromAHU	Current HVAC mode from AHU	MV	read+write
OccupOverrideFromAHU	Occupancy Override from the AHU	BV	read+write
OnOffFromAHU	On Off Status from AHU	BV	read+write
HeatingFromAHU	Heating Mode from the AHU	BV	read+write
CoolingFromAHU	Cooling Mode from the AHU	BV	read+write
FanOnlyFromAHU	Fan Only Mode from the AHU	BV	read+write
OudoorAirFractionFromAHU	Outdoor Air Fraction from AHU	AV	read+write
CO2outdoorAirFromAHU	CO2 Concentration of Outdoor Air from AHU	AV	read+write
CO2supplyAirFromAHU	CO2 Concentration of Supply Air from AHU	AV	read+write
SupplyAirTempFromAHU	Supply Air Temperature from AHU	AV	read+write
EnergyDemandLimitFromAHU	Energy Demand Limiting request from the AHU	BV	read+write
BalanceFlowCmdFromAHU	Balance Flow Command from AHU	MV	read+write
BalanceFlowValueFromAHU	Balance Flow Value from AHU (valid on Value_Flow Cmd)	AV	read+write
LifeTicks	Life ticks from AirSupplyZone for custom watchdog purposes	BV	read only

Table 340: BACnet Server Objects of Multi Manager values to AHU

*): Please note that the prefix is depending on the manager type and number using different folder names. See regarding note in chapter 8.1.15.1.

8.1.15.5 Local Operation of the Values from AHU

For functional details, please refer to chapter 7.7.1.6

Prefix: VAVmultiManager_Floor_Zone_***)**

Server Object Name	**Description**	**Type**	**Direction**
AirSupplyZoneId	ID of Air Supply Zone	ChStrV	read+write
HvacModeFromAHU	Current HVAC mode from AHU	MV	read+write
ModeHVACmodeFromAHU	Local Mode for VAC Mode from AHU	MV	read+write
OccupOverrideFromAHU	Occupancy Override from the AHU	BV	read+write
ModeOccupOverrideFromAHU	Local Mode of Occupancy Override from AHU	MV	read+write
OnOffFromAHU	On Off Status from AHU	BV	read+write
ModeOnOffFromAHU	Local Mode of Occupancy Override from AHU	MV	read+write
HeatingFromAHU	Heating Mode from the AHU	BV	read+write
ModeHeatingFromAHU	Local Heating Mode from AHU	MV	read+write
CoolingFromAHU	Cooling Mode from the AHU	BV	read+write
ModeCoolingFromAHU	Local Cooling Mode from AHU	MV	read+write
FanOnlyFromAHU	Fan Only Mode from the AHU	BV	read+write
ModeFanOnlyFromAHU	Local Fan Only Mode from AHU	MV	read+write
EnergyDemandLimitFromAHU	Energy Demand Limiting request from the AHU	BV	read+write
ModeEnergyDemandLimitFromAHU	Local Mode of Energy Demand Limit from AHU	MV	read+write

Table 341: BACnet Server Objects of Multi Manager values to AHU

*): Please note that the prefix is depending on the manager type and number using different folder names. See regarding note in chapter 8.1.15.1.

8.1.15.6 Balance Flow Manager

For functional details, please refer to chapter 7.7.1.7

Prefix: VAVmultiManager_Floor_Zone_***)**

Server Object Name	**Description**	**Type**	**Direction**
AirSupplyZoneId	ID of Air Supply Zone	ChStrV	read+write
BalanceFlowCmdFromAHU	Balance Flow Command from AHU	MV	read+write
BalanceFlowValueFromAHU	Balance Flow Value from AHU (valid on Value_Flow Cmd)	AV	read+write
ModeBalanceFlowCmdFromAHU	Local Balance Flow Command Mode from AHU	MV	read+write
ManualBalanceFlowValueFromAHU	Local Manual Balance Flow Value from AHU	AV	read+write

Table 342: BACnet Server Objects of Multi Manager values to AHU

*): Please note that the prefix is depending on the manager type and number using different folder names. See regarding note in chapter 8.1.15.1.

8.1.16 Dedicated Managers

8.1.16.1 Manager Tiles and Watchdogs

For functional details, please refer to chapter 7.7.2.2

Prefix: VAVbuilding_AirSupplyZones_Zone1_***)**

Server Object Name	Description	Type	Direction
AirSupplyZoneId	ID of Air Supply Zone	ChStrV	read+write
HighLevelWatchdog	Indicates if Manager communicates with high level devices	BV	read only
LocalLevelWatchdog	Indicates if Manager communicates with local level devices	BV	read only
CurrLocalLevelDevCnt	Current number of local level devices	AV	read only
MaxLocalLevelDevCnt	Maximum number of local level devices	AV	read only

Table 343: BACnet Server Objects of dedicated Manager tiles and watchdogs

*): Please note that the prefix is depending on the manager type and number using different folder names. This is valid for all sever objects in the Multi Manager.

Building Manager, Zone1	Prefix: VAVbuilding_AirSupplyZones_Zone1_
Building Manager, Zone2	Prefix: VAVbuilding_AirSupplyZones_Zone2_
Building Manager, Zone3	Prefix: VAVbuilding_AirSupplyZones_Zone3_
Building Manager, Zone4	Prefix: VAVbuilding_AirSupplyZones_Zone4_
Floor Manager, Zone1	Prefix: VAVfloor_AirSupplyZones_Zone1_
Floor Manager, Zone2	Prefix: VAVfloor_AirSupplyZones_Zone2_
Floor Manager, Zone3	Prefix: VAVfloor_AirSupplyZones_Zone3_
Floor Manager, Zone4	Prefix: VAVfloor_AirSupplyZones_Zone4_
Area Manager, Zone1	Prefix: VAVarea_AirSupplyZones_Zone1_
Area Manager, Zone2	Prefix: VAVarea_AirSupplyZones_Zone2_
Area Manager, Zone3	Prefix: VAVarea_AirSupplyZones_Zone3_
Area Manager, Zone4	Prefix: VAVarea_AirSupplyZones_Zone4_

8.1.16.2 Configuring a Manager

For functional details, please refer to chapter 7.7.2.3

Prefix: VAVbuilding_AirSupplyZones_Zone1_***)**

Server Object Name	**Description**	**Type**	**Direction**
AirSupplyZoneId	ID of Air Supply Zone	ChStrV	read+write
HighLevelWatchdog	Indicates if Manager communicates with high level devices	BV	read only
LocalLevelWatchdog	Indicates if Manager communicates with local level devices	BV	read only
CommFaultSummary	Communication Fault Summary of the local level and lower levels	BV	read only
CurrLocalLevelDevCnt	Current number of local level devices	AV	read only
MaxLocalLevelDevCnt	Maximum number of local level devices	AV	read only

Table 344: BACnet Server Objects of dedicated Manager configuring a manager

*): Please note that the prefix is depending on the manager type and number using different folder names. See regarding note in chapter 8.1.16.1.

8.1.16.3 Values to AHU

For functional details, please refer to chapter 7.7.2.4

Prefix: VAVbuilding_AirSupplyZones_Zone1_***)**

Server Object Name	**Description**	**Type**	**Direction**
AirSupplyZoneId	ID of Air Supply Zone	ChStrV	read+write
OccupiedModeToAHU	Maximum aggregated Occupancy Mode to AHU	MV	read only
MinTeminalLoadToAHU	Minimum aggregated Terminal Load to AHU	AV	read only
MaxTeminalLoadToAHU	Maximum aggregated Terminal Load to AHU	AV	read only
MaxSupDamperPosition	Maximum aggregated Supply Air Damper Position To AHU	AV	read only
MaxExhDamperPosition	Maximum aggregated Exhaust Air Damper Position To AHU	AV	read only
MaxIAQtoAHU	Maximum aggregated Indoor Air Quality (CO2) to AHU	AV	read only
MinSpaceTempToAHU	Minimum aggregated Space Temperature to AHU	AV	read only
MaxSpaceTempToAHU	Maximum aggregated Space Temperature to AHU	AV	read only
AvgSpaceTempLevel	Average Space Temperature on this aggregation level	AV	read only
SumSpaceTempToAHU	Summation of SpaceTemperatures to AHU	AV	read only
NumSpaceTempToAHU	Number of Space Temp Summations to AHU	AV	read only
MinEffSetpointToAHU	Minimum aggregated effective Setpoint to AHU	AV	read only
MaxEffSetpointToAHU	Maximum aggregated effective Setpoint to AHU	AV	read only
AvgEffSetpointLevel	Average effective Setpoint on this aggregation level	AV	read only
SumEffSetpointToAHU	Summation of effective Setpoints to AHU	AV	read only

NumEffSetpointToAHU	Number of effective Setpoint Summations to AHU	AV	read only
SetbackOverrideToAHU	Aggregated Setback Override to AHU	BV	read only
MinHumidityToAHU	Minimum aggregated relative Space Humidity to AHU	AV	read only
MaxHumidityToAHU	Maximum aggregated relative Space Humidity to AHU	AV	read only
AvgRelHumidityLevel	Average relative humidity on this aggregation level	AV	read only
SumHumidityToAHU	Summation of Space Humidities to AHU	AV	read only
NumHumidityToAHU	Number of Space Humidity Summations to AHU	AV	read only
SumSupplyAirFlowToAHU	Summation of Supply Air Flow To AHU	AV	read only
SumExhaustAirFlowToAHU	Summation of Exhaust Air Flow To AHU	AV	read only
SumOutdoorAirFlowDemandToAHU	Outdoor Air Flow Demand to AHU	AV	read only
(SumAirFlowForcedToAHU)**	Summation of Air Flow Forced To AHU	AV	read only
(SumMinAirFlowForcedToAHU)**	Summation of Minimum Air Flow Forced To AHU	AV	read only

Table 345: BACnet Server Objects of dedicated Manager values to AHU

*): Please note that the prefix is depending on the manager type and number using different folder names. See regarding note in chapter 8.1.16.1.

)**: not supported in the current version

8.1.16.4 Values from AHU

For functional details, please refer to chapter 7.7.2.5

Prefix: VAVbuilding_AirSupplyZones_Zone1_***)**

Server Object Name	**Description**	**Type**	**Direction**
AirSupplyZoneId	ID of Air Supply Zone	ChStrV	read+write
HvacModeFromAHU	Current HVAC mode from AHU	MV	read+write
OccupOverrideFromAHU	Occupancy Override from the AHU	BV	read+write
OnOffFromAHU	On Off Status from AHU	BV	read+write
HeatingFromAHU	Heating Mode from the AHU	BV	read+write
CoolingFromAHU	Cooling Mode from the AHU	BV	read+write
FanOnlyFromAHU	Fan Only Mode from the AHU	BV	read+write
OudoorAirFractionFromAHU	Outdoor Air Fraction from AHU	AV	read+write
CO2outdoorAirFromAHU	CO2 Concentration of Outdoor Air from AHU	AV	read+write
CO2supplyAirFromAHU	CO2 Concentration of Supply Air from AHU	AV	read+write
SupplyAirTempFromAHU	Supply Air Temperature from AHU	AV	read+write
BalanceFlowCmdFromAHU	Balance Flow Command from AHU	MV	read+write
BalanceFlowValueFromAHU	Balance Flow Value from AHU (valid on Value_Flow Cmd)	AV	read+write
LifeTicks	Life ticks from AirSupplyZone for custom watchdog purposes	BV	read only

Table 346: BACnet Server Objects of dedicated Manager values to AHU

*): Please note that the prefix is depending on the manager type and number using different folder names. See regarding note in chapter 8.1.16.1.

8.1.16.5 Local Operation of the Values from AHU

For functional details, please refer to chapter 7.7.2.6

Prefix: VAVbuilding_AirSupplyZones_Zone1_***)**

Server Object Name	**Description**	**Type**	**Direction**
AirSupplyZoneId	ID of Air Supply Zone	ChStrV	read+write
HvacModeFromAHU	Current HVAC mode from AHU	MV	read+write
ModeHVACmodeFromAHU	Local Mode for VAC Mode from AHU	MV	read+write
OccupOverrideFromAHU	Occupancy Override from the AHU	BV	read+write
ModeOccupOverrideFromAHU	Local Mode of Occupancy Override from AHU	MV	read+write
OnOffFromAHU	On Off Status from AHU	BV	read+write
ModeOnOffFromAHU	Local Mode of Occupancy Override from AHU	MV	read+write
HeatingFromAHU	Heating Mode from the AHU	BV	read+write
ModeHeatingFromAHU	Local Heating Mode from AHU	MV	read+write
CoolingFromAHU	Cooling Mode from the AHU	BV	read+write
ModeCoolingFromAHU	Local Cooling Mode from AHU	MV	read+write
FanOnlyFromAHU	Fan Only Mode from the AHU	BV	read+write
ModeFanOnlyFromAHU	Local Fan Only Mode from AHU	MV	read+write

Table 347: BACnet Server Objects of dedicated Manager values to AHU

*): Please note that the prefix is depending on the manager type and number using different folder names. See regarding note in chapter 8.1.16.1.

8.1.16.6 Balance Flow Manager

For functional details, please refer to chapter 7.7.2.7

Prefix: VAVbuilding_AirSupplyZones_Zone1_***)**

Server Object Name	**Description**	**Type**	**Direction**
AirSupplyZoneId	ID of Air Supply Zone	ChStrV	read+write
BalanceFlowCmdFromAHU	Balance Flow Command from AHU	MV	read+write
BalanceFlowValueFromAHU	Balance Flow Value from AHU (valid on Value_Flow Cmd)	AV	read+write
ModeBalanceFlowCmdFromAHU	Local Balance Flow Command Mode from AHU	MV	read+write
ManualBalanceFlowValueFromAHU	Local Manual Balance Flow Value from AHU	AV	read+write

Table 348: BACnet Server Objects of dedicated Manager values to AHU

*): Please note that the prefix is depending on the manager type and number using different folder names. See regarding note in chapter 8.1.16.1.

9 Firmware Update

The process of Firmware Update using the WebUI or the LINX-Configurator is described in the LOYTEC Device User Manual [1].

The process of Firmware Update using LWEB-900 is described in the LWEB-900 User Manual [4].

10 Troubleshooting

10.1 Technical Support

LOYTEC offers free telephone and e-mail support for the LIOB-AIR product series. If none of the above descriptions solves your specific problem, please contact us at the following address:

LOYTEC electronics GmbH
Blumengasse 35
A-1170 Vienna
Austria / Europe

e-mail :	***support@loytec.com***
Web :	***http://www.loytec.com***
tel :	***+43/1/4020805-100***
fax :	***+43/1/4020805-99***

or

LOYTEC Americas Inc.
N27 W23957 Paul Road
Suite 103
Pewaukee, WI 53072
USA

e-mail:	***support@loytec-americas.com***
Web:	***http://www.loytec-americas.com***
tel:	***+1 (512) 402 5319***
fax:	***+1 (262) 408 5238***

11 Specifications

11.1 Specification for LIOB-AIR Models

Types	LIOB-AIR1	LIOB-AIR2	LIOB-AIR13
Dimensions [mm]	260 x 120 x 68 (L x W x H)	260 x 120 x 68	208 x 120 x 68
Operating Temperature (ambient)	0°C to +50°C		
Storage Temperature	-10°C to +85°C		
Humidity (non condensing) operating / storage	10 to 90 % RH @ 50°C		
Environmental Protection	IP 40 (enclosure); IP 20 (screw terminals)		
Power Supply	24 VDC / 24 VAC ±10 % 85-240VAC 50-60Hz	24 VDC / 24 VAC ±10 %	24 VDC / 24 VAC ±10 %
Installation	mountable on the corresponding volume flow actuator	mountable on the corresponding volume flow actuator	mountable via oblong holes
Power Consumption [W]	8.0 (all Relays on)	5.8	5.8
Universal Input (UI)	10	10	10
Digital Input (DI)	-	-	-
Analog Output (AO)	3	3	3
Digital Output (DO)	9 (3 x Relay 16A, 3 x Relay 6A, 2 x Triac 0.5A)	6 (3 x Relay 6A, 2 x Triac 0.5A)	6 (3 x Relay 6A, 2 x Triac 0.5A)
Digital output specification	Relay:16 A, 6 A Triac: 0.5 A @ 24-230 VAC	Relay:6 A Triac: 0.5 A @ 24-230 VAC	Relay:6 A Triac: 0.5 A @ 24-230 VAC
Differential Pressure sensor	0 – 250 Pa	0 – 250 Pa	0 – 250 Pa
Internal shunt available for current measurement	UI5 & UI6, UI7 & UI8	UI5 & UI6, UI7 & UI8	UI5 & UI6, UI7 & UI8

Table 349: Specification of LIOB-AIR models

11.1.1 I/O Specification

11.1.1.1 UI - Universal Input

UIs are universal inputs for four different input types. They have an input voltage range of 0 to 10V, and can withstand up to 30V. The UIs correspond to class 1 with a relative accuracy of +/-1% (of measured value) between 1V and 10V, and an absolute accuracy of +/-10mV between 0V and 1V. The ADC resolution is 16 bits. Galvanically isolated sensors resp. switches must be connected. Universal inputs can be configured as:

- **Binary Input (Digital Input):** input impedance > 20kΩ, sampling period 10ms.
    - In voltage mode, the threshold values are < 0.8V for low level and > 2V for high level.
    - In resistance mode, the threshold values are < 1.9kΩ for low level and > 6.7kΩ for high level.

    Between the threshold values, the resulting level of the UI is not defined.

- **Voltage Metering 0-10V**: input impedance > 20kΩ, sampling period < 1s.
- **Current Loop 4-20mA**: input impedance 249Ω, sampling period < 1s. An internal shunt of 249Ω is available for some universal inputs. Otherwise, an external resistor of 249Ω must be used as a shunt.
- **Resistance Measurement**: input impedance 10kΩ, sampling period < 1s. Resistors in the range of 1kΩ to 100kΩ can be measured.

The average sampling period *p* of analog inputs depends on the number of active (non-disabled) universal inputs *n* that are configured in analog mode. The formula for *p* is:

$$p = n * 125ms$$

This means if e.g. only two UIs are configured as analog inputs, a new sample is taken every 250ms (on average) for each of the two inputs. The UIs configured as digital inputs are unaffected (sampling period always 10ms) by this formula.

11.1.1.2 AO - Analog Output

AOs are analog outputs with a signal range of 0 to 10V (up to 12V), a resolution of 10 bits, and a maximum output current of 10mA (short circuit proof). The accuracy over the whole range is +/-100mV.

11.1.1.3 DO - Digital Output

The following digital outputs are available:

- Relay 6A Output: Switching capacity 6A, 250VAC resp. 30VDC.
- Relay 16A Output: Switching capacity 16A, 250VAC resp. 30VDC.
- TRIAC Output: Switching capacity 1A, 24 to 230VAC.

When connecting an air gap switch to a L-IOB relay, a quenching circuit like a varistor or RC element must be used.

11.1.1.4 PRESS - Pressure Sensor

These inputs represent differential pressure sensors which measure pressures from 0 - 250 Pascal. They are equipped with two 3/16” (4.8 mm) hose connectors.

11.1.2 Internal Translation Tables

The LIOB_AIR devices offer fixed internal translation tables for easy configuration of some temperature sensors. The xin/xout values of these tables are listed in Table 350.

xout: Temp. [°C]	xin: Resistance [Ω]			
	PT1000	NTC10K	NTC1K8	Ni1000
-30	882.2	176680	24500	842
-20	921.6	96970	14000	893
-10	960.9	55300	8400	946
0	1000.0	32650	5200	1000
10	1039.0	19900	3330	1056
20	1077.9	12490	2200	1112
25	1097.4	10000	1800	1141
30	1116.7	8060	1480	1171
40	1155.4	5320	1040	1230
50	1194.0	3600	740	1291
60	1232.4	2490	540	1353
70	1270.0	1750	402	1417
80	1308.9	1260	306	1483
90	1347.0	920	240	1549
100	1385.0	680	187	1618
120	1460.6	390	118	1760

Table 350: Internal translation table values

11.2 Resource Limits

11.2.1 LIOB-AIR Models

Table 351 specifies the resource limits of the different LIOB-AIR models.

Limits \ Model	LIOB-AIR1	LIOB-AIR13	LIOB-AIR2
Total number of data points	30,000	30,000	30,000
OPC Tags	10,000	10,000	10,000
User Registers	10,000	10,000	10,000
NVs (static, dynamic)	2,000	2,000	2,000
External NVs	2,000	2,000	2,000
Alias NVs (ECS and legacy mode)	2,000	2,000	2,000
Address table entries/legacy	1,000/ 15	1,000/ 15	1,000/ 15
LONMARK Calendar objects	1 (25 calendar patterns)		
LONMARK Scheduler objects	100 (max. AST configuration size 384KB, 64 data points per scheduler)		
LONMARK Alarm Servers	1	1	1
BACnet objects (analog, binary, multi-state)	2,000	2,000	2,000
BACnet client mappings	1,000	1,000	1,000
BACnet scheduler objects	100	100	100
BACnet calendar objects	25	25	25
BACnet notification classes	32	32	32
BDT max recommended	100	100	100
Trend Logs	512	512	512
Total trended data points	1000	1000	1000
Total aggregated size	60MB	60MB	60MB
E-mail templates	100	100	100
Math objects	100	100	100
Alarm Logs	10	10	10
Modbus data points	4,000	4,000	4,000
EnOcean data points	1,000	1,000	1,000
Connections (local)	4,000	4,000	4,000
Connections (global)	250	250	250
L-WEB Clients (concurrent)	32	32	32
L-IOB Modules	1	1	1

Table 351: Resource limits of different LIOB-AIR models

12 References

[1] LOYTEC Device User Manual, LOYTEC electronics GmbH, Document № 88086501, March 2016.

[2] LINX Configurator User Manual, LOYTEC electronics GmbH, Document № 88086701, March 2016.

[3] LWEB-802/803 User Manual 2.3, LOYTEC electronics GmbH, Document № 88074213, February 2016.

[4] LWEB-900 User Manual 2.1, LOYTEC electronics GmbH, Document № 88081504, April 2015.

[5] L-VIS User Manual 5.1, LOYTEC electronics GmbH, Document № 88068519, February 2015.

[6] L-STAT User Manual 1.2, LOYTEC electronics GmbH, Document № 88085803, May 2016.

13 Revision History

Date	Version	Author	Description
2016-11-16	2.1.2	JOW	Initial version
2016-11-25	2.1.2	JOW	Fixed some broken cross-references
2017-07-17	2.1.3	JOW	Release version