

## **Description**

### **JOY BACnet**

Subject to technical alteration

## 1 Revision

Revision	Date	Description
2	03.12.2020	From software version 2.6.0++ <ul style="list-style-type: none"><li>- Overtemperature protection with underfloor heating</li><li>- Implementation of a 2<sup>nd</sup> control loop</li><li>- Introducing rH-Types (integrated humidity sensor)</li></ul>
1	21.09.2020	First draft

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### 3 Device Type Overview

#### Fan coil types

JOY Fancoil 5DO BACnet	(3 fan coil stages, 230V)
JOY Fancoil EC AO2DO BACnet	(EC-fan coil 0-10V, 230V)
JOY Fancoil EC 3AO BACnet	(EC-fan coil 0-10V, 230V)
JOY rH Fancoil 5DO BACnet	(3 fan coil stages, 230V, temperature, humidity)
JOY rH Fancoil EC AO2DO BACnet	(EC- fan coil 0-10V, 230V, temperature, humidity)
JOY rH Fancoil EC 3AO BACnet	(EC- fan coil 0-10V, 24V, temperature, humidity)

#### HC types

JOY HC AO2DO BACnet	(6-way valve, 230V)
JOY HC 3AO BACnet	(6-way valve, 24V)
JOY rH HC AO2DO BACnet	(6- way valve, 230V, temperature, humidity)
JOY rH HC 3AO BACnet	(6- way valve, 24V, temperature, humidity)

## 4 General

### 4.1 Introduction

This documentation applies to all JOY BACnet device variants!

### 4.2 Device description

Modern design, flush mounting room thermostat for individual temperature control in residential, commerce and business buildings. Depending on the version, the Fan Coil type is used to control a 3-stage fan or an EC fan coil (0-10V). This type is designed for two-pipe and four-pipe fan coil units with two-wire electric valves. The HC type is a pure thermostat. The rH variant provides measurement and display of a humidity value.

The valves are controlled with relays (two-level controller or PWM of a PI controller) in the 230V types and by a continuous 0...10V signal in the 24V types. Alternatively, with the HC type, a 6-way valve (Sauter or Belimo) can be actuated at the third 0...10 V output. Operation is via touch-sensitive buttons. The device combines a modern design with a 2,5" LCD and a touch sensitive surface.



Fan coil type



HC (Heating/Cooling) type

### 4.3 Hardware Installation RS-485

The RS485 interface is connected to the higher-level building management system via a twisted pair cable (line resistance 120 Ohm). For detailed information on commissioning and assembly, please refer to the product data sheet.

### 4.4 RS485 Transceiver

Maximum number of bus participants without use of repeater is defined by the RS485 transceiver. The transceiver used in JOY enables a maximum of 32 devices per bus segment. This constraint is not a timing matter but only for current drive ability of the hardware!

The maximum cable length per line should not exceed 1,200 meters. The last device in a line must be terminated with a 120 Ohm resistor to avoid signal reflections from the BUS. The RS485 specification requires the use of terminating resistors (120 - 150 Ohm, 0.25 W) at both ends. Please make sure, that both resistors are properly connected to the terminals. The terminating resistor is not included in the delivery of the devices.

The room operating units load the BUS with a standard BUS load (1/1 unit load according to the RS485 standard). This allows up to 32 room operating units to be operated on one single BUS line.

Please also note that RS485 does NOT support star topologies and no stub line connection!

If no signals are present on the BUS, it must be ensured that the signal levels (voltage) are fixed. This can be done through pull-up / pull-down resistors on the drivers. These form a voltage divider with the installed BUS termination

resistors. It must be ensured, that there is at least a differential voltage of 200mV detectable for the receiver between the data lines A and B.

## 4.5 Protocol

The protocol used is the internationally standardized BACnet MS/TP protocol. This enables connection to corresponding remote stations, such as an automation station or a BMS that support the BACnet MS/TP protocol. According to the BACnet standard, the transmission parameters are set to 8N1 (8 data bits, no parity, 1 stop bit). The baud rate can be freely selected (9600, 19200, 38400, 57600, 76800, 115200).

## 4.6 SD-Card

MicroSD cards can be used to import a new application or a device configuration. The SD card slot is located in the front part. This must be removed in order to insert the SD card. Only MicroSD cards that are formatted in the FAT file system can be used! NTFS and exFAT file systems are not supported

## 4.7 Factory reset

In the last submenu of menu *General Settings* the possibility to reset the device to delivery state can be found.

## 4.8 Configuration software

The configuration software uConfig is available free of charge and can be downloaded from the Thermokon website. This software can be used to create parameter files that can be transferred to the respective device types by using a SD card or via BACnet file object. Only parameter that match the current or lower firmware version of the device files can be uploaded! The start screen shows if an invalid parameter file was found on the SD card. The configuration file must be named **confJoy.bin!**

The uConfig configuration software names the file accordingly when it is saved. At the same time, if the SD card is inserted, a configuration file is saved on the SD card after approx. 10 seconds. The file name consists of the prefix JOY\_ and the MAC address of the device. Please note: **The microSD card must then be removed!** All updated parameters are available after next cold start! When transmitting via BACnet, an error message is generated if the parameter file is invalid.

## 4.9 Bootloader

Because of an integrated bootloader a new application (update) can be uploaded by means of a SD. To insert the SD card, the housing cover must be removed.

On Thermokon website you can find the corresponding files. The zip archives contain the corresponding firmware versions, a small README file (short info on firmware names, device types, etc.) and the software specification belonging to the version number. The sd-card update files have the extension \*.s19. In case of a downgrade it is strongly recommended to copy a configuration file suitable for the firmware version to the SD card in addition to the firmware file. This ensures that the appropriate configuration file is automatically loaded directly after firmware downgrade has been completed. This avoids instability due to incompatible firmware and configuration file versions.

If the boot loader is running, the ring illumination blinks in a 1s cycle, while display is not triggered! After detection of a SD card with a valid application, the update process is started. Ring illumination blinks in a 300ms cycle. After a successful update process (Duration approx. 20-30 seconds), the new application is started automatically.

**Afterwards, MicroSD card shall be removed!**

## 4.10 Start screen

After power-up or switching from standby to normal mode (button ON/OFF) a start screen is faded in for about 5s, showing information about device type and application firmware version.



Picture 1: View main screen

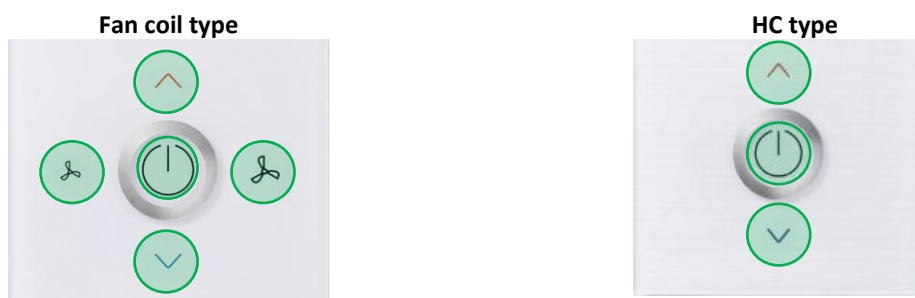
### Custom Logo in Start Screen

There is one logo available. The size of the logo is set to 190x50 pixels. Thermokon creates from the template of the customer a file that can be loaded via SD card.

## 5 Operation

### 5.1 Main menu

Keys



Single key actuation releases an action. A long keypress causes a cyclic value change in a 0,5s cycle.

### Configuration

Name	Type	Unit	Value range	Factory default
Special function ON/OFF Button		--	0: no special function (ON/OFF active) 1: toggle occupancy 2: occupied 3: unoccupied 4: toggle ECO mode 255 (=0xFF): key locked (ON/OFF locked)  The configured function is triggered by briefly pressing the key. A long key press continues to trigger the ON / OFF function. When using a keycard switch, the OFF (= standby) key function (long key press) is not possible. Linking the key to the occupancy state excludes the use of a digital input as a occupancy detector!	no special function



## BACnet objects

Object type	Instance	Name	Type	Unit	Value range	Factory default	COV
MV	4	Release of keys			1: all keys released 2: all keys locked 3: fan coil keys locked  The keys are always released after a power-on reset!	1	--

## 5.2 Parameter Menu

### Enter Parameter Menu

Simultaneous actuation of marked keys for at least 3s. The key combination can be locked by parameter *Lock parameter menu*, so that a user cannot modify parameters at run time.

#### Fan coil type



Picture 2 Key combination Fan coil type for invoking parameter menu

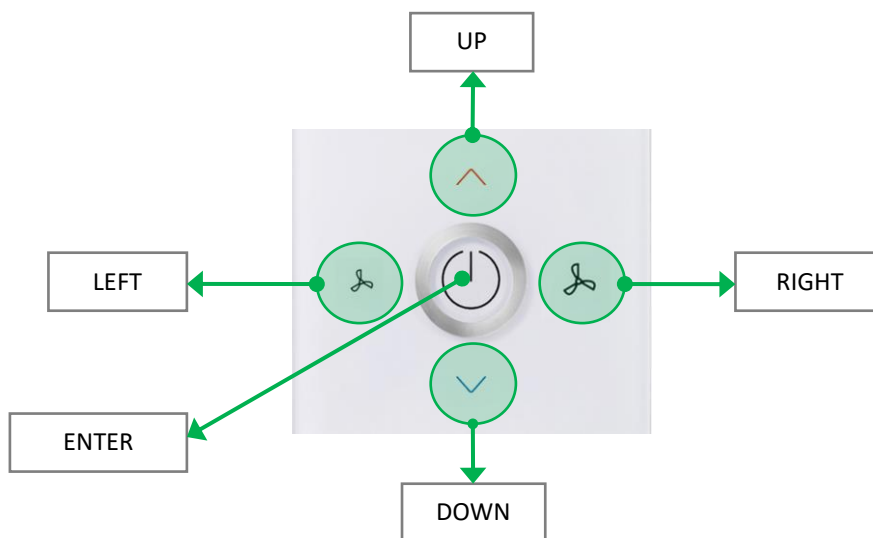
#### HC type



Picture 3 Key combination HC type for invoking parameter menu

### Keys

The device is operated in parameter mode with keys specified below:

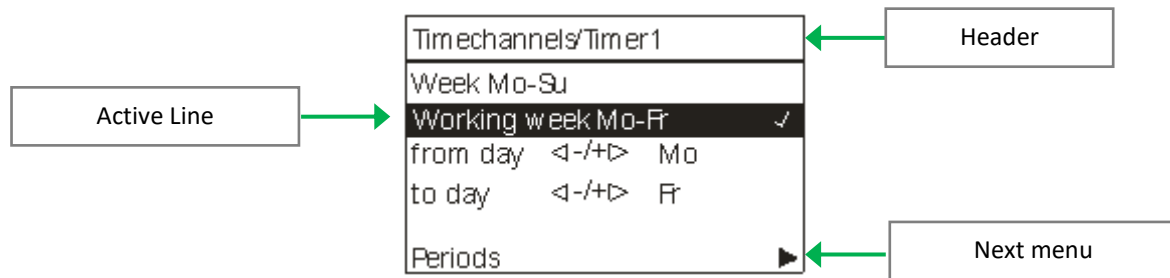


Picture 4 Keys in parameter menu

## Navigation

Navigation in menus is made via the keys UP, DOWN, LEFT, RIGHT and ENTER. The menus are build-up hierarchically. Highest level is the main menu. From main menu the user can jump to different submenus. From there, further submenus can be entered. **To return to previous level, the header must be selected and key LEFT must be actuated afterwards.**

The keys UP/DOWN are used for selection of a menu line. The currently selected menu line is displayed inverted. A modification of a value can only be made in the selected menu line.



Picture 5: Menu page example

The following icons are used in the menu and enable a better orientation during navigation through the menus:

### Value Change



The value can be changed by means of keys LEFT(-)/RIGHT(+). No selection via ENTER key necessary.

### Invoke next Menu



The next menu can be invoked by means of key RIGHT.

### Selection of Display Value



The icon is faded-in if corresponding value is selected. Parameters for which no icon <-/+> for value change is shown can be selected with key ENTER.

## Leaving the parameter menu

The parameter menu can be left by selecting the header in main window of the parameter menu and then pressing the LEFT key. An automatic return to the main menu occurs after 10 minutes without user action.

## Configuration

Name	Type	Unit	Value range	Factory default
Lock parameter menu		--	0: invocation released 1: invocation locked	invocation released

### 5.3 User-Defined Keys

After pressing a user-defined key, the assigned icon is shown in the display and a value for a short or long key press is provided via BACnet.

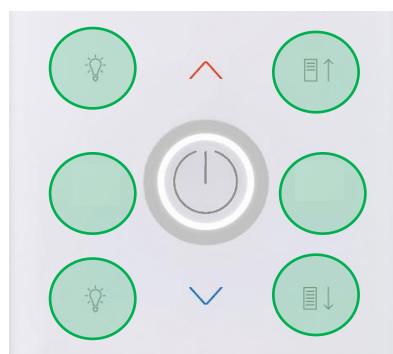
In addition to internally available functions, such as light, blinds, controller mode, etc., there are also four freely definable user graphics available, which can be loaded via SD card.

**Fan coil type**



Picture 6 Freely definable keys Fan coil type

**HC type**



Picture 7 Freely definable keys HC type

#### Icon display

When a special function button (except center button) is pressed, an icon will appear in the main screen

#### Icons

Funktion	Icons	
No special function	--	
Light toggle		
Light on/off		
Light on/off Group 1-3		
Blind up/down		
Blind up/down Group 1-3		
Controller mode heating auto	 HEAT	
Controller mode cooling auto	 COOL	
Controller mode Auto	AUTO	

Picture 8 Fix icons

### Freely definable user graphics

There are four graphics available. The size of each graphic is set to 120x80 pixels. Thermokon creates from the template provided by the customer a file that can be loaded via SD card.

### Configuration

Name	Type	Unit	Value range	Factory default
Special function top left			0: no special function 17: Light toggle 18: Light on 19: Light off	no special function
Special function top right			20: Blind up 21: Blind down	
Special function center left	HC AO2DO HC 3AO		22: Controller mode toggle 23: Controller mode heat/cool/auto 24: Controller mode heat 25: Controller mode cool 26: Switch unit	
Special function center right	HC AO2DO HC 3AO		27: User defined graphic 1 28: User defined graphic 2 29: User defined graphic 3 30: User defined graphic 4	
Special function bottom left			40: Light on Group 1 41: Light off Group 1 42: Light on Group 2 43: Light off Group 2 44: Light on Group 3 45: Light off Group 3	
Special function bottom right			50: Blind up Group 1 51: Blind down Group 1 52: Blind up Group 2 53: Blind down Group 2 54: Blind up Group 3 55: Blind down Group 3	

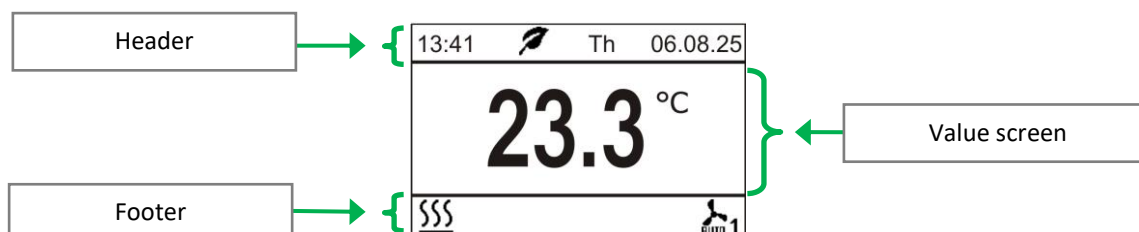
### BACnet objects

Object type	Instance	Name	Type	Unit	Value range	Factory default	COV
BI	10	Top left			0: inactive 1: active		Change of value
BI	11	Top right					
BI	12	Center left	HC AO2DO HC 3AO				
BI	13	Center right	HC AO2DO HC 3AO				
BI	14	Bottom left					
BI	15	Bottom right					

## 6 Screen

### 6.1 Main Screen

The main screen is divided in three fields: header, value screen and footer.



Picture 9: View main screen

#### Header

The header is designed for displaying time, weekday and date. In addition an info icon is displayed upon requirement or depending on certain states/modes. The positions are pre-defined and cannot be changed.



Picture 10: Main screen header

#### Info Icons

ECO-Mode

Alarm



#### Value Screen

As default the value screen shows the room temperature measured by an integrated sensor. If an external temperature sensor is connected and the input is configured accordingly, this value will be indicated in the display. It can be parameterized if room temperature, absolute set point or set point offset shall be displayed.

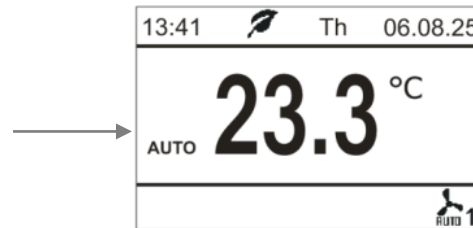


Picture 11: Temperature display in value range

Upon actuation of any arrow key the display of the value screen changes and shows the associated sub menu. The display switches back to standard screen after 3s without key actuation.

### Fade in controller mode

The active controller mode can be additionally faded in in main screen.



Picture 12 Controller mode faded in

This display refers to the default setting of the controller mode through the parameter *Controller mode after device reset* and/or the object *Preset Controller*. The control modes Heating Auto, Cool Auto and Auto (heating/cooling) are displayed. Other possible controller modes are not displayed.

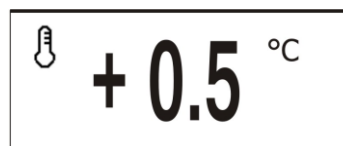
Note: As soon as a controller state is heating or cooling, the corresponding icon will be displayed in the footer, if configured.

### Icons

**AUTO**



### Display of Set point



Picture 13 Display of set point adjustment

After actuation of the arrow keys for set point adjustment, the display screen changes to the set point adjustment screen. The following actuation of one of the two arrow keys modifies the value.

There are five options available for the adjustment mode of the set point. It can be displayed as the offset value with unit °C / °F, as absolute value (= basic setpoint), in integer stages, with Kelvin or as offset value without unit. When displaying in steps, the values -3, -2, -1, 0, 1, 2, 3 are displayed.

### Display of fan coil stages (Only Fancoil types)



Picture 14 Display of fan coil stage adjustment

After actuation of any arrow key for fan coil stage adjustment, the indication of the value screen changes to fan coil stage adjustment screen. The following actuation of any arrow key switches the fan stage.

### Footer

In the footer, icons for process-oriented states such as heating, cooling, room occupancy, window contact etc. are displayed. The icons are divided into icon groups. Only one icon per group can be displayed at the same time. The icons can be optionally switched on or off.

### Icon Groups

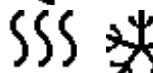
Occupancy



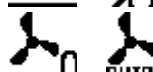
Window contact/dew point



Heating/cooling



Fan coil stage



Active time channel



For the symbols five fields in the footer are available. Moreover, the positions of the icons can be freely chosen.



Picture 15: Main screen footer example

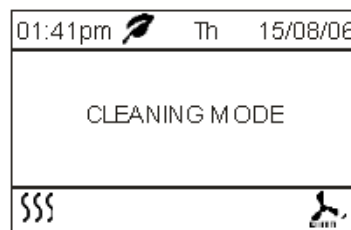
### Configuration

Name	Type	Unit	Value range	Factory default
Display main screen		--	0: room temperature 1: absolute set point 2: set point offset with °C/°F 3: fan stage 4: set point offset in integer stages (e.g. -3,-2, -1, 0, +1, +2, +3) 5: offset value without unit 6: offset value with Kelvin 7: Temperature with humidity (only rH-version)	room temperature
Footer icon 1		--	0: no icon 1: heating/cooling 2: occupancy 3: window contact/dew point 4: fan coil stage 5: time channel	no icon
Footer icon 2				
Footer icon 3				
Footer icon 4				
Footer icon 5				
Display set point adjustment		--	0: set point offset with °C/°F 1: base set point 2: set point offset in integer stages (e.g. -3,-2, -1, 0, +1, +2, +3) 3: set point offset with Kelvin 4: set point offset without unit	set point offset with °C/°F
Fade in controller mode		--	0: not faded in 1: faded in	not faded in

## 6.2 Cleaning mode



You can switch to cleaning mode with the two hidden keys at the bottom left and bottom right. For this, the key combination must be pressed for at least 3s. The cleaning mode will last for 20s. The elapsed time is shown in the display. During this time, all buttons are locked.



Picture 16: Cleaning mode screen



## 7 BACnet settings

### 7.1 Communication parameter

The menu for setting the BACnet communication parameters is entered by simultaneously pressing the keys marked below for at least 3s. The key combination has to be actuated directly from the main screen. The LEDs of the ring light up when the key combination has been recognized by the device.

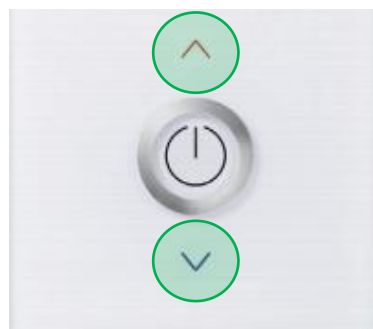
**The menu is enabled for the first 60 minutes after switching on the supply voltage!**

Fan coil type



Picture 17 Key combination Fan coil type for invoking BACnet settings menu

HC type



Picture 18 Key combination HC type for invoking BACnet settings menu

Afterwards the following menu appears:

BACnet settings		
Address	◀-/+▶	32
Baudrate	◀-/+▶	38400

Picture 19 BACnet settings menu

Parameter	Value range
Address	1-127 Default: 1
Baudrate	9600Bd 19200Bd 38400Bd (Default) 57600Bd 76800Bd 115200Bd

**To save the settings, select the header and exit the menu with the Left key. When you exit the menu, the set values are saved.**

With the keys in the corners, the address can be changed by + -10 for faster setting.

## 7.2 Device object

### Device

Name	Access	Range	Default
Offset Identifier (Device ID)	R	0...4194302	Offset Device ID + MAC-address
Object name	R		MAC-address_Offset deviceID_ModelName E.g.: „2_100_JOY_EC_AO2DO_BACnet“
Object type	R		Device
Description	R/W	31 chars max.	
Location	R/W	31 chars max.	
System status	R		Operational
Vendor name	R		Thermokon Sensortechnik
Model name	R		xxx BACnet E.g.: EC AO2DO BACnet
Protocol version	R		1
Protocol revision	R		12
Max. APDU length	R		480
Segmentation support	R		No
APDU timeout	R		3000ms
Number of APDU retries	R		3
Max. Master	R/W	1-127	127
Max. info frames	R/W	1-4	1

## 7.3 File object

Object type	Instance	Name	Type	Unit	Value range	Factory default	COV
FIL	0	confJoy.bin			For transmission of configuration data.  The configuration and creation of a "Configuration file" is created with the uConfig software. The Property <i>Modification Date</i> shows the creation date of the file.		--

## 7.4 Offset Device ID

This value plus the set MAC address (0-127) corresponds to the Device ID (Writeable 0 - 4194302).

### BACnet objects

Object type	Instance	Name	Type	Unit	Value range	Factory default	COV
AV	100	Offset Device ID			0-4194200	100*	--

\*Default values depending on the configured parameter value

## 7.5 ChangeOfValue

The Data Sharing COV Unsubscribed-B service can be disabled or set up as a local or global service. For the analog objects there are corresponding COV increment values, which can be configured directly in the configuration software as well as in the corresponding BACnet objects. Binary Inputs and Multistate Inputs are automatically transferred with every value change.

Attention: Values set directly in the object will be overwritten by importing a configuration file!

### Configuration

Name	Type	Unit	Value range	Factory default
COV Increment Set point base(AI-1)		°C	0-100,0	0
COV Increment Set point offset (AI-2)		°C	0-100,0	0
COV Increment Set point heating (AI-3)		°C	0-100,0	0
COV Increment Set point cooling (AI-4)		°C	0-100,0	0
COV Increment Int. Temperature sensor (AI-5)		°C	0-100,0	0
COV Increment Ext. temperature sensor (AI-6)		°C	0-100,0	0
COV Increment Manipulated variable controller (AI-7)		%	0-100,0	0
COV Increment output heat (AI-8)	HC 3AO EC 3AO	%	0-100,0	0
COV Increment output cool (AI-9)	HC 3AO EC 3AO	%	0-100,0	0
COV Increment output 6-way valve (AI-10)	HC AO2DO HC 3AO	%	0-100,0	0
COV Increment output fan coil (AI-11)	EC AO2DO EC3AO	%	0-100,0	0

### BACnet objects

Object type	Instance	Name	Type	Unit	Value range	Factory default
MV	4183	COV mode		1: off 2: local 3: global  <b>local:</b> The COV is sent as a local broadcast command only to the network where the device is located. <b>global:</b> The COV is sent as a global broadcast command to all networks.	2*	--

\*Default values depending on the configured parameter value

## 8 Functions

### 8.1 Common settings

#### Configuration

Name	Type	Unit	Value range	Factory default
Lock parameter menu		--	0: invocation of menu released 1: invocation of menu locked	invocation of menu released
Language		--	0: german 1: english	german
Brightness background illumination LCD		%	0-100 = 0-100%	90%
Brightness ring		%	0-100 = 0-100%	20%
Device state after Power ON		--	0: standby 1: last state (standby/Device ON) 2: Device ON	Device ON
Device values after Power ON		--	0: keep last values 1: reset values Occupancy, Set point offset and Fan coil	Keep last values

#### BACnet objects

Object type	Instance	Name	Type	Unit	Value range	Factory default	COV
BI	1	Device state			0: Device on 1: standby (off)	Device on*	Change of value
BV	1	Device state overwrite			0: Device on 1: standby (off)	0	--

\*Default values depending on the configured parameter value

## 8.2 Operating modes

### Standby

Triggering via bus or key. In standby mode, the controller is not active and the display is off. The keys, except the ENTER key, are locked. Frost and heat protection remain active! It can only be switched to standby mode if no keycard function is used!

### ECO

In ECO mode, the dead band between heating and cooling is automatically set to the configured ECO deadband (default 10K) and the PWM time is doubled when using the controller in PI mode. If ECO mode is active, the ECO icon is displayed in the header of the main screen.

When the ECO mode is active, the value of the setpoint offset is not taken into account as long as the occupancy mode is not used. If the occupancy function is used in parallel, it can be configured (136, *Occupancy/ECO override*) that the OCCUPIED state overrides an active ECO (Overtime function). When occupancy mode is used, the behavior of the setpoint offset depends on parameter *Behavior setpoint offset at occupancy change*.

The ECO mode can be activated / deactivated by the time channels by center key or via BACnet! The last modified value determines the state.

### Keycard

The operation of the keys is disabled, the display is switched off and the controller regulates to the setpoints of the "room unoccupied" status (reduction of setpoint heating by parameter *Set point adjustment occupancy* and increase setpoint cooling by corresponding value).

### Occupancy

When occupancy mode is used, a distinction is made between OCCUPIED/UNOCCUPIED. OCCUPIED is the comfort mode. In state UNOCCUPIED, the setpoint is lowered (heating) or increased (cooling) by value of parameter *Set point adjustment occupancy*.

### Comfort

In comfort mode, the controller works with the heating and cooling setpoint calculated from the *Set point base* and *deadband comfort*.

## Overview

**Comfort (Device ON)**

Control in normal operation

Switching is done via:  
 ON/OFF button  
 (long key press)  
 BACnet default

**(Device OFF) Standby**

Controller OFF  
 Keys locked (Exception ON/OFF)  
 Display OFF  
 Frost und Heat protection active

When returning to comfort mode, all states  
 are restored

From comfort to ECO mode is switched  
 via time channels  
 ECO can also be set directly via BACnet

**ECO****Timed lowering operation  
(e.g., night setback)***Factory default*

*ECO dead band +10 corresponds to:  
 Set point Heating -5 K | Cooling +5 K  
 PWM cycle x2 (PI-controller)*

ECO mode can be switched directly on or off  
 via BACnet.

Set point offset is reset to 0

Presence state "OCCUPIED" can override ECO mode (address136)

The presence change takes place via:  
 Digital input  
 (configured as presence contact)  
 keystroke  
 BACnet default

**Occupancy  
(occupied/unoccupied)**

→ Set point adjustment occupancy

*Factory default**Set point Heating -2K | Cooling +2K*

Behavior set point offset configurable

The presence change takes place via:  
 Digital input  
 (configured as keycard switch)

**Keycard (Occupancy +)  
(occupied/unoccupied)**

→ Set point adjustment occupancy

**+ Display OFF****+ Keys locked (Exception ON/OFF Button)***Factory default**Set point Heating -2K | Cooling +2K*

Behavior set point offset configurable

Standby is not possible in interaction  
 with the key card function (Presence +)

## 8.3 Time and date

### Overview

JOY has a real-time clock, which calculates time and date automatically. Time and date can be updated during operation by a supervisory system via BACnet.

### Configuration

Name	Type	Unit	Value range	Factory default
Format time		--	0: 24h(pm) 64 (=0x40): 12h(am) 255 (=0xFF): not displayed	24h
Format date		--	0: DD.MM.YY 1: YY/MM/DD 255 (=0xFF): not displayed	TT.MM.JJ
Daylight saving		--	0: deactivated 1: activated (CET)	deactivated

## 8.4 Time channel

### Overview

There are 3 time channels available including 4 sections, which can be freely programmed. For each time channel a set of weekdays can be selected. Start time, set point, fan coil stage and ECO mode can be parameterized for every period. HC type has no fan stages!

Table 1: Structure of a Time Channel

Weekday mask	Periods	Parameter
Complete week Mo-So	1 - 4	Start time
Working week Mo-Fr		Fan coil stage
From day to day		Set point heating
		ECO mode

A section is switched to active if the time and weekday match the configured start time and weekday mask. A section remains active until the conditions of another section are fulfilled. **Attention: If no time channel is assigned to a day, the time channel function is deactivated on this day and the controller works with the default values.** Via BACnet it is possible to override the setpoint via the object *base setpoint* and the time channel is deactivated until the value -1 is written into the object.

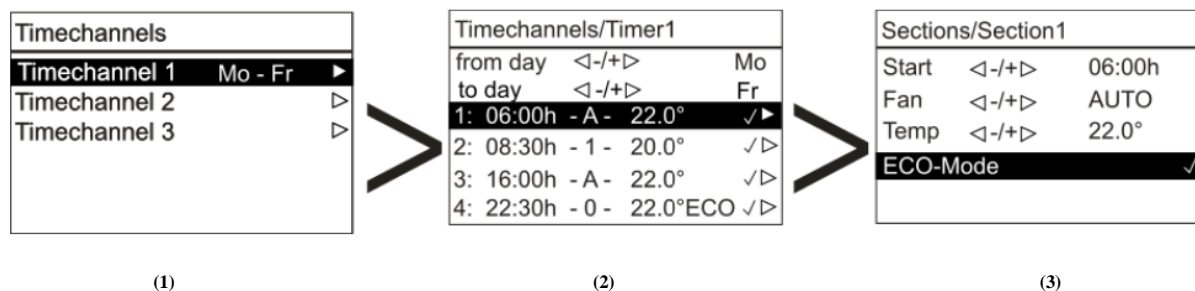
The time channels are prioritised. Channel 3 has the highest priority.

A time channel is active as soon as weekdays are set! By setting the weekdays, the first time channel section is automatically activated. The following time channel sections are not active as long as they are initialized with the values:

Time: 00: 00h **and**  
 Fan speed: 0 **and**  
 Set point: 21.0 ° C **and**  
 ECO: Off

By changing any value, the corresponding section is activated.

## Menu time channel



Picture 20: Menu "Selection of Time Channel"

- (1) Timechannel selection  
 (2) Weekday selection and  
     Selection of timechannel section  
         *Index time period / start time / fan coil stage / set point/ info ECO-Mode*  
 (3) Configuration of timechannel section

Changes of the time channel are stored by return from menu (2) to menu (1) actuating key LEFT. Only after saving, active time channels and sections are marked as active (time channel with weekday display, see (1), sections with check mark, see (3))

## Configuration

Name	Type	Unit	Value range	Factory default
Timechannel 1 weekdays		--	Bit0: monday Bit1: tuesday Bit2: wednesday Bit3: thursday Bit4: friday Bit5: saturday Bit6: sunday  Example: 7 $\triangleq$ 0x0F <sub>hex</sub> = monday, tuesday, wednesday, thursday	0
Timechannel 1 start hour period 1		h		0
Timechannel 1 start minute period 1		min		0
Timechannel 1 set point period 1		°C	0-500 $\triangleq$ 0,0 – 50,0°C	21
Timechannel 1 fan coil stage period 1	5DO	--	0: off 1: stage 1 2: stage 2 3: stage 3 4: automatic	off
	EC AO2DO, EC 3AO	--	0: off 1: automatic	off
	HC AO2DO, HC3AO	--	not used	--
Timechannel 1 ECO mode period 1		--	0: ECO mode OFF 1: ECO mode ACTIVE	0
Timechannel 1 period 2		..	..	..
Timechannel 1 period 3		..	..	..
Timechannel 1 period 4		..	..	..
Timechannel 2		..	..	..
Timechannel 3		..	..	..



## 8.5 Temperature

### Overview

By default the value of the internal sensor is used as actual value for the internal controller. The universal input can be parameterized as a sensor input for an external temperature sensor. In this case, the external sensor value is used as actual value and is displayed on main screen. The measuring range of the sensors is 0...50 °C, with a resolution of 0.1 °. For both sensors a calibration to compensate self-heating is available.

### Configuration

Name	Type	Unit	Value range	Factory default
Offset internal sensor		°C	-15,0 - 15,0°C For temperature compensation of the self-heating of the internal temperature sensor	0
Offset external sensor		°C	-15,0 - 15,0°C For temperature compensation of the self-heating of the external NTC10K	0
Unit temperature		--	1: °Celsius 2: °Fahrenheit When modifying the unit, please note that all temperature parameters (setpoints, frost/heat protection, Xp controller, etc.) must be converted and parameterised to the corresponding unit!	°C

### BACnet objects

Object type	Instance	Name	Type	Unit	Value range	Factory default	COV
AI	5	Internal temperature sensor		°C °F	0 - 50,0°C 0 - 90,0°F		COV-Increment
AI	6	External temperature sensor		°C °F	0 - 50,0°C 0 - 90,0°F		COV-Increment

## 8.6 Feuchte

The humidity value can be read out via BACnet or shown in the display (*Display main screen*). The value is not processed internally! The measuring range of the sensor goes from 0...100%, with a resolution of 0.1%. The sensor can be calibrated to correct the measured value.

### Configuration

Name	Type	Unit	Value range	Default
Offset internal sensor	rH	%	-15,0 - 15,0% Zur Kompensation des Feuchtesensors	0

## BACnet objekts

Object type	Instance	Name	Type	Unit	Value range	Factory default	COV
AI	12	Internal humidity sensor	rH	%	0 - 100,0% For variants without humidity sensor, the object outputs -0.1% as value		COV- Increment

## 8.7 Inputs

### Overview

There are 2 inputs available. Input 1 is a universal input for connecting potential-free contacts or an NTC10K sensor (low voltage). On units with 230V supply, input 2 is a 230V input (**Caution!! Please observe the wiring diagram!**), on units with 24V supply, a low voltage input for connecting potential-free contacts.

The internal input states are OR-linked with the associated BACnet objects when configured as window, dew point and occupancy contacts. With Change-Over Configuration the corresponding BACnet object overrides the internal status!

### Configuration

Name	Type	Unit	Value range	Factory default
Input 1 universal (low voltage)		--	0: Not used 1: External temperature sensor (NTC10k) 2: Change-Over sensor (NTC10k) 4: External temperature sensor FBH (NTC10k) - Heating output switch-off (JOY) 6: External temperature sensor FBH (NTC10k) – 2nd control loop  16: Change-Over NO (normally open) 17: Window contact NO 18: Occupancy contact NO 19: Dew point contact NO 20: Keycard switch NO 21: Alarm feedback NO  48: Change-Over NC (normally closed) 49: Window contact NC 50: Occupancy contact NC 51: Dew point contact NC 52: Keycard switch NC 53: Alarm feedback NC  Connection of a NTC10K or of a potential-free contact	Not used
Input 2 (230V input for 230V types, low voltage for 24V types)		--	0: Not used 16: Change-Over NO (normally open) 17: Window contact NO 18: Occupancy contact NO 19: Dew point contact NO 20: Keycard switch NO 21: Alarm feedback NO 48: Change-Over NC (normally closed) 49: Window contact NC 50: Occupancy contact NC 51: Dew point contact NC 52: Keycard switch NC 53: Alarm feedback NC  Connection of a potential-free contact. <b>ATTENTION 230V! Observe connection diagram!</b>	Not used

## BACnet objects

Object type	Instance	Name	Type	Unit	Value range	Factory default	COV
BI	6	State input 1			0: open 1: closed		Change of value*
BI	7	State input 2			0: open 1: closed		Change of value*

\* Only sent if the COV increment for object AI-6, *Temperature sensor ext.* = 0. If greater than 0, it is assumed that the input is used as an analogue input!

## 8.8 Outputs

### Overview

The outputs are assigned fixed functions. Depending on the device type, these can be manually overridden in various ways. For example, the digital outputs can only be manually overridden in conjunction with the controller mode (see chapter Controller). In contrast, the analogue outputs for heating and cooling can be used freely. No icon is displayed automatically.

The output or outputs for the fan stages can only be used in conjunction with the fan stage. If a fan icon is assigned in the footer, the specified value by the BMS is displayed as manual level.

### Configuration

Name	Type	Unit	Value range	Factory default
Type 6-way valve	HC AO2DO, HC 3AO, EC 3AO	--	0 – 0-10V steady signal heating and cooling = 6-way valve deactivated  20 – 2-10V (e.g. BELIMO) 21 – 2-10V inverted (e.g. BELIMO) 22 – 0-10V DN15 (e.g. SAUTER) 23 – 0-10V DN15 inverted (e.g. SAUTER) 24 – 0-10V DN20 e.g. (e.g. SAUTER) 25 – 0-10V DN20 inverted (z.B. SAUTER) 26 – 0-10V steady signal heating 26 – 0-10V steady signal cooling 28 – 10-0V steady signal heating 29 – 10-0V steady signal cooling 30 – 0-10V Danfoss CO6 (HCAO2DO only!) 31 – generic 6-way valve  In addition to various 6-way valve types, you can select whether the control value of the heating or cooling controller is also output on the 6-way valve output as a continuous 0-10V signal in parallel to the heating or cooling output. If 0: 0-10V steady signal for heating and cooling is selected, the 6-way valve output also runs as a 0-10V signal in both cases!  If a 6-way valve type is selected for the EC-3AO type, the two heating and cooling outputs simultaneously provide the signal converted to the configured 6-way valve type!	0 – 0-10V steady signal heating and cooling
Heating 100% - generic 6-way valve	HC AO2DO, HC 3AO, EC 3AO	--	0-100 $\triangleq$ 0-10V	0
Heating 0% - generic 6-way valve		--		
Cooling 100% - generic 6-way valve		--		
Cooling 0% - generic 6-way valve		--		
Maximum load heating	5DO EC AO2DO HC AO2DO	--	0: <2A 1: <4A 2: <6A	<2A

Maximum load cooling	5DO EC AO2DO HC AO2DO	--	0: <2A 1: <4A 2: <6A	<2A
Effective direction of relay heating	5DO EC AO2DO HC AO2DO	--	0: Normally open 1: Normally closed	Normally open
Effective direction of relay cooling	5DO EC AO2DO HC AO2DO	--	0: Normally open 1: Normally closed	Normally open
Effective direction of analog output heating	EC 3AO, HC 3AO	--	0: 0-10V 1: 10-0V	0-10V
Effective direction of analog output cooling	EC 3AO, HC 3AO	--	0: 0-10V 1: 10-0V	0-10V

## BACnet objects

Object type	Instance	Name	Type	Unit	Value range	Factory default	COV
AI	8	Output heating	EC 3AO HC 3AO	V	0-10V		COV-Increment
AI	9	Output cooling	EC 3AO HC 3AO	V	0-10V		COV-Increment
AI	10	Output 6-way valve	HC AO2DO HC 3AO	V	0-10V		COV-Increment
AV	8	Output heating overwrite	EC 3AO HC 3AO	V	0-10V  The outputs are decoupled from the internal controller when specified and can be controlled by the higher-level system (BMS). No icon is displayed.	-1	
AV	9	Output cooling overwrite	EC 3AO HC 3AO	V	To display a icon (heating/cooling) with the output, manual mode must be activated via the data point Default controller mode (0xFF01=heating or 0xFF02=cooling).	-1	
AV	10	Output 6- way valve output overwrite	HC 3AO HC AO2DO	V	The value -1 deactivates the preset by object and the internal value, preset by the controller, is active	-1	
BI	8	Output heating	5DO EC AO2DO		0: open 1: closed		
BI	9	Output cooling	HC AO2DO		0: open 1: closed		

\* Description of output fan stage (ECAO2DO, EC3AO) in chapter Fan stages

## 8.9 Alarm

### Overview

It's possible to fade-in an alarm icon in the header line of the display. This icon is at the same position as the ECO icon. As the alarm icon has a higher priority, the ECO icon is overridden. If an alarm is active, the background illumination of the LCD is blinking. An alarm can be triggered by BACnet or by a digital input.

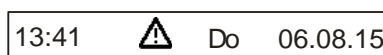


Figure 21: Header with faded-in alarm icon

## BACnet objects

Object type	Instance	Name	Type	Unit	Value range	Factory default	COV
BV	6	Default alarm			0: alarm inactive 1: alarm active	0	

## 8.10 Set point

### Overview

The active setpoint is determined via the *Setpoint after reset* parameter, the specification via BACnet via the *Set point base* object (*AI-1*) or, in the case of an active time channel, by the setpoint parameterised in the time channel section. It can be changed by the user within defined limits by changing the setpoint offset.

### Configuration

Name	Type	Unit	Value range	Factory default
Set point after reset		°C	0-500 $\triangleq$ 0,0 – 50,0°C After a restart of the unit this value is used as set point until a new set point is activated by a time channel or default value via Bus	21
Adjustment range of set point		°C	0-100 $\triangleq$ 0,0 – 10,0°C Determines the limits of the setpoint offset adjustment by the user. If the display Setpoint adjustment is selected as <i>set point offset in integer stages</i> , e.g. -3 ... +3, this parameter must be set to the value of the set point offset of step 3! Example: Step size 1K => step 3 corresponds to 3K => enter here! Note scaling!	3
Set point step range		°C	0-100 $\triangleq$ 0,0 – 10,0°C	0,5
Dead band comfort		°C	0-150 $\triangleq$ 0,0 – 15,0°C	2
Dead band ECO mode		°C	0-150 $\triangleq$ 0,0 – 15,0°C	10
Set point adjustment occupancy		°C	0-150 $\triangleq$ 0,0 – 15,0°C In the UNOCCUPIED state, the value configured here is automatically subtracted from the heating setpoint or added to the cooling setpoint. The <i>Occupied/ECO override</i> parameter can be used to parameterise the effect of the occupancy state when the controller is in ECO mode.	2
Frost protection		°C	0-150 $\triangleq$ 0,0 – 15,0°C	7
Heat protection		°C	0-500 $\triangleq$ 0,0 – 50,0°C	35
Behaviour of set point offset at occupancy change		--	0: keep value 1: reset value 2: reset value while unoccupied, restore on return to occupied	keep value

## BACnet objects

Object type	Instance	Name	Type	Unit	Value range	Factory default	COV
AI	1	Set point base		°C °F	0 - 50,0°C 0 - 90,0°F  Output of the active heating setpoint/cooling setpoint. Depends on the specification of the basic setpoint (time channel, BACnet), the setpoint offset (user, BACnet) and the mode (Comfort/ECO, Occupied/Unoccupied).		COV-Increment
AI	2	Set point offset		°C °F	-15,0 - 15,0°C -30,0 - 30,0°F  As soon as the KEYCARD or the occupancy function is used, the behaviour of the set point offset depends on the parameter <i>Behaviour of set point offset at occupancy change</i> . The ECO mode has no influence on the set point offset. If neither of the two functions is used, the set point offset is reset when the ECO mode is activated.		COV-Increment
AI	3	Set point heating		°C °F	0 - 50,0°C 0 - 90,0°F  The output of the active heating/cooling setpoint. Is dependent on the specification of the basic setpoint (time channel, BACnet), the setpoint offset (user, BACnet) and the mode (Comfort/ECO, Occupied/Unoccupied)		COV-Increment
AI	4	Set point cooling		°C °F			COV-Increment
AV	1	Set point base overwrite		°C °F	0 - 50,0°C 0 - 90,0°F  Can be used to override the internal setpoint setting (time channel, setpoint after reset). Values outside the specified range deactivate the preset by a higher-level-system and the internal value is active.	-1	
AV	2	Set point offset overwrite	--	°C °F	-15,0 - 15,0°C -30,0 - 30,0°F  Values outside the specified range are not accepted internally	0	

## 8.11 Fan stages

### Types

#### Three fan stages (5DO)

Three outputs for controlling up to three fan stages. The switch-on and switch-off behaviour of the stages depends on the operating mode of the active controller. If the controller operates as a two-point controller, the stages are switched depending on the parameterised threshold values for the fan stages 1/2/3.

With the PI controller, the stages are output as a function of the manipulated variable of the controller:

3 stages	2 stages	1 stage
Stage 3: $y > 66\%$	-	-
Stage 2: $y > 33\%$	Stage 2: $y \geq 50\%$	-
Stage 1: $y > 0\%$	Stage 1: $y > 0\%$	Stage 1: $y > 0\%$

The fan control is coupled to the controller in automatic mode. If the fan stage is switched off manually, the controller is deactivated and the outputs are switched off.

#### EC fan (EC AO2DO, EC 3AO)

A 0-10V output is used to control an EC fan. The speed of the fan can be changed manually via the keys. The number of steps to adjust the speed between 0 and 100% is configurable. If the fan stage is switched off manually, the controller is deactivated and the outputs are switched off.

#### HC version (HC AO2DO, HC 3AO)

To display a fan icon, a stage can be set via BACnet. For this purpose, the fan icon in the footer must be activated.

### Behavior of fan levels on mode change

The behavior of the fan levels during a mode change depends on the set function of the keys in the parameter Keys fan level with/without AUTO.

	From	Eco Keycard Unoccupied Standby	Comfort	Comfort
	to	Comfort	Eco Keycard Unoccupied	Standby
Key fan stage with/without AUTO	With Auto	Auto	Auto	Auto
	Without Auto	Off	Auto	Auto
	With Auto, without OFF	Auto	Auto	Auto
	Without Auto, without OFF	Stage 1	Stage 1	Auto

Table 1 Behavior of fan levels on mode change

In energy saving mode there is never the state OFF, so that the frost and heat protection is always guaranteed.

## Configuration

Name	Type	Unit	Value range	Factory default
Number of fan coil stages	5DO	--	1: 1 stage 2: 2 stages 3: 3 stages	3
Threshold stage 1 on	5DO	°C	0-150 $\pm$ 0,0 – 15,0°C	0
Threshold stage 2 on	5DO	°C	The value parameterised here determines the threshold between setpoint and actual value at which the individual fan stages normally switch on. For example, fan level 1 in the basic setting ( <i>threshold stage 1 on</i> = 0) starts directly with the occurrence of the control request. Please note that an internal hysteresis is active (+/- 0.3°C) for switching the fan stages on and off to prevent the outputs from flickering!	1,5
Threshold stage 3 on	5DO	°C	<i>Only valid for two-point controllers!</i> 0-150 $\pm$ 0,0 – 15,0°C	3
Maximum fan coil value (100%) at temperature deviation	EC AO2DO EC 3AO	°C	If the <b>two-step controller</b> is active, the value parameterised here is the deviation of the set point from the actual value at which the output of the fan control reaches 100% (referred to the configured maximum value). Below this value, the output value is calculated linearly to the deviation and output in the parameterised steps. <i>Only valid for two-point controller!</i>	4
Fan coil assignment	5DO EC AO2DO EC 3AO		0: heating/cooling 1: heating 2: cooling	heating/ cooling
Steps fan coil control	EC AO2DO EC 3AO		1: 1 step 2: 2 steps 3: 3 steps 4: 4 steps 5: 5 steps	5 steps
Fan coil minimum	EC AO2DO EC 3AO	V	0-100 $\pm$ 0-10V  Special case: 0x8xxxhex = the minimum value corresponds to stage 1. The step size of the control is calculated from the number of stages, the minimum and the maximum. <i>Example:</i> Number of steps: 3 Minimum: 5V, Maximum: 7V OFF=0V, step1=5V, step2=6V, step3= 7V	0
Fan coil maximum	EC AO2DO EC 3AO	V	0-100 $\pm$ 0-10V	0
Start-up time fan coil	5DO EC AO2DO EC 3AO	s	0-30s $\pm$ 0 – 300	1
Fan start with manipulated variable > x	5DO EC AO2DO EC 3AO	%	0-40 $\pm$ >0%->40%  With a value >0, the fan only runs if the heating or cooling valve is actively controlled and the manipulated value has exceeded the value parameterised here. <i>Example:</i> 20% => Fan starts at a control value of >20%.	0
Key fan stage with/without AUTO	5DO EC AO2DO EC 3AO	--	0: with AUTOMATIC 1: without AUTOMATIC 2: with AUTOMATIC/without MANUAL OFF 3: without AUTOMATIC/without MANUAL OFF	with AUTOMATIC
Fan follow-up time	5DO EC AO2DO EC 3AO	s	0-600 $\pm$ 0-600s  The fan follow-up time becomes active when the controller switches from an active controller state (heating/cooling) to the idle state when a user manually switches off the fan or switches off the unit.	0



## BACnet objects

Object type	Instance	Name	Type	Unit	Value range	Factory default	COV
AI	11	Output Fan coil EC-type	EC AO3 EC AO2DO	V	0-10V		COV-Increment
AV	11	Output fan coil value overwrite	EC AO3 EC AO2DO		0-10V  The value -1 deactivates the default and activates the automatic mode of the fan level	-1	
MI	2	State fan coil	5DO		1: off 2: stage 1 3: stage 2 4: stage 3 5: Auto Off 6: Auto stage 1 7: Auto stage 2 8: Auto stage 3		
MV	2	Fan coil value overwrite	HC AO2DO HC 3AO		1: off 2: stage 1 3: stage 2 4: stage 3	0	
			5DO		1: off 2: stage 1 3: stage 2 4: stage 3 5: AUTO	5	

## 8.12 Keycard Switch

When the card is not inserted, the device is switched to the power saving mode. Operation of the keys is disabled, the display is switched off and the controller regulates to the setpoints of the "room unoccupied" state (reduction of setpoint heating and increase of setpoint cooling by corresponding value by value in parameter *Set point adjustment occupancy*).

If the keycard is not inserted, the unit can be switched on and the comfort mode can be activated with the middle key INPUT.

## 8.13 Occupancy

### Overview

The occupancy function can be activated via the configuration of a digital input, the ON/OFF key or via a BACnet object. If the key and the BACnet preset are used simultaneously, the last changed preset determines the output value. The digital input has a higher priority. When the occupancy function is activated, the occupancy icon is automatically displayed if a position in the footer has been assigned to the occupancy icon.

The behavior of the set point offset on occupancy change can be configured (keep, restore, reset). See the Set point chapter.

### Configuration

Name	Type	Unit	Value range	Factory default
Occupied/ ECO overwrite		--	0: Occupancy state without effect on ECO mode 1: OCCUPIED state overrides ECO mode  The occupancy state OCCUPIED can overwrite an active ECO mode, i.e. the controller deactivates the ECO mode and operates in normal mode. In the UNOCCUPIED state the ECO mode is enabled. In the other case, the occupancy state has no effect when the ECO mode is active.	Occupancy state without effect on ECO mode

## BACnet objects

Object type	Instance	Name	Type	Unit	Value range	Factory default	COV
BI	2	Occupancy state			0: room unoccupied 1: room occupied		Change of value
BV	2	Occupancy state overwrite			0: room unoccupied 1: room occupied	0	--

## 8.14 ECO-Mode

## Overview

In ECO mode, the dead band between the heating and cooling setpoint corresponds to the parameter *Dead band ECO mode*. An active ECO mode can be overwritten by the occupancy state OCCUPIED (*Occupied/ECO overwrite* parameter).

## BACnet objects

Object type	Instance	Name	Type	Unit	Value range	Factory default	COV
BI	5	ECO mode			0: ECO mode inactive 1: ECO mode active		Change of value
BV	5	ECO mode overwrite			0: deactivate ECO mode 1: activate ECO mode	0	--

## 8.15 Dew point

## Overview

An active dew point contact blocks the cooling controller. The dew point function is activated via the configuration of a digital input or via bus specification. The setting via bus is OR-linked to the internal status.

When the dew point is active, the dew point icon "Dew point active" is automatically displayed if a position in the footer has been assigned to the icon.

## BACnet objects

Object type	Instance	Name	Type	Unit	Value range	Factory default	COV
BI	3	Dew point state			0: dew point inactive 1: dew point active		Change of value
BV	3	Dew point state overwrite			0: dew point inactive 1: dew point active	0	--

## 8.16 Window contact

## Overview

When the window contact is active (window open = energy lock active), the setpoints for heating and cooling are automatically set to frost protection or heat protection. The fan switches to automatic mode and returns to the previous state after leaving the energy lockout. The window contact/energy lock function is activated via the configuration of the digital input or via bus. The last changed value determines the state.

When the function is activated, the window icon is automatically displayed in the "window open" state if the icon has been assigned a position in the footer and heating and cooling controllers control to the frost protection or heat protection setpoint.

## BACnet objects

Object type	Instance	Name	Type	Unit	Value range	Factory default	COV
BI	4	Window state			0: window closed 1: window open		Change of value
BV	4	Window state overwrite			0: window closed 1: window open	0	--

## 8.17 Change-Over

In a 2-pipe system, the controller is set to heating or cooling mode via a change-over contact. The change-over function is activated via the configuration of a digital input or specified via bus. An input configured as a change-over contact deactivates the default via bus!

If the input is configured as a make contact, the heating mode is enabled when the input is open and the cooling mode is enabled when the input is closed. If a change-over sensor is selected, the cooling mode is enabled <22° and the heating mode from a temperature of >25°C. Between these temperature the mode is undefined!

**Attention:** When using the change-over function the outputs heating (terminal 5) and cooling (terminal 4) are controlled in parallel!

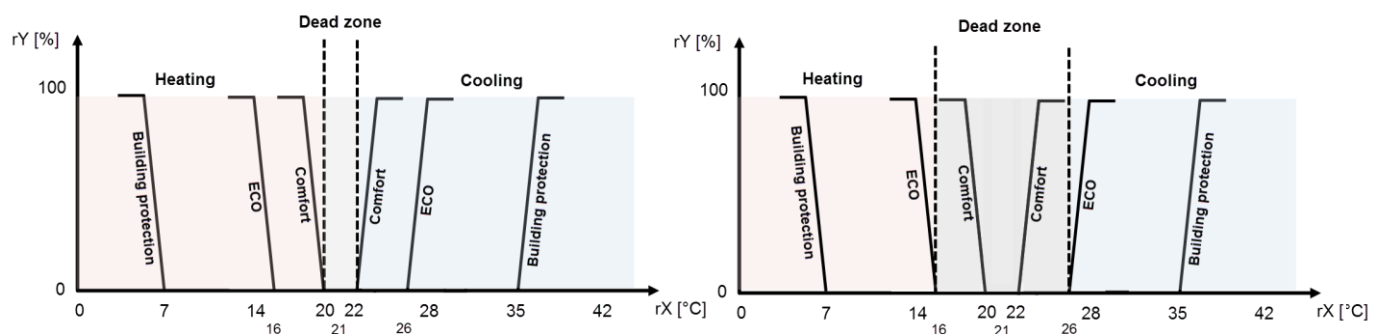
## BACnet objects

Object type	Instance	Name	Type	Unit	Value range	Factory default	COV
MI	1	Change-over state			1: heating mode (cooling locked) 2: cooling mode (heating locked) 3: Data point inactive		Change of value
MV	1	Change-over overwrite			1: heating mode (cooling locked) 2: cooling mode (heating locked) 3: mode not defined → Only relevant for change-over by external sensor! 4: Data point inactive	4	--

## 8.18 Controller

### Overview

The JOY has a PI or two-point controller for heating and cooling. The manipulated variable is output via the outputs.



Picture 22: Two-step control with hysteresis

The controller starts with a 30-second delay after a cold start (voltage on) of the unit.

#### PI controller

The time response of the PI-controller is determined by parameters  $X_p$  and  $T_n$ . Due to the proportional component, the manipulated variable reacts immediately to any control deviation, while the integral component only takes effect over time. The resulting manipulated variable is output as a pulse width modulated, continuous signal (3AO) or as an analogue signal adapted to the corresponding 6-way valve type.

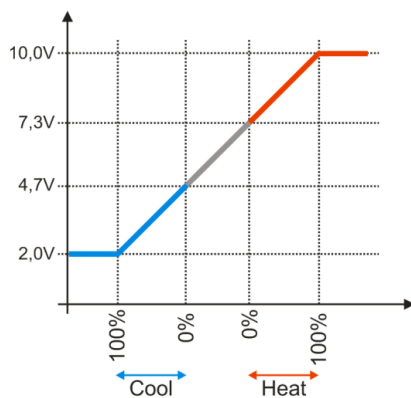
#### Two-point controller

If the temperature falls below the heating setpoint minus half the hysteresis, the controller switches the heating output on, and if it exceeds the heating setpoint plus hysteresis threshold, it switches it off. In cooling mode it behaves accordingly.

#### 6-Way valve

##### 2-10V (e.g. BELIMO® 6-Way valve)

The control variable of the integrated PI controller is converted into the voltage values shown below according to the characteristic curve of the valve.



#### Standard

100...0% cooling  $\Rightarrow$  2,0...4,7V

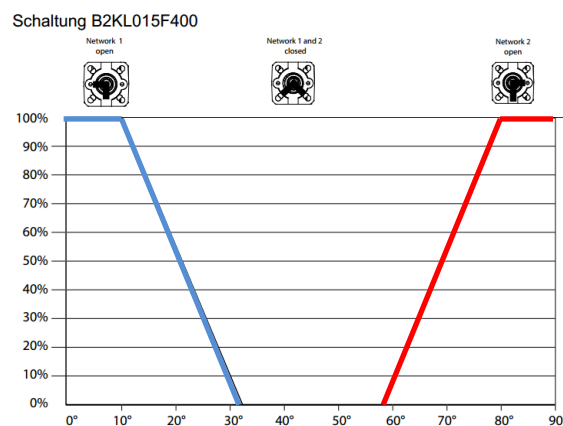
0...100% heating  $\Rightarrow$  7,3...10,0V

#### Inverted

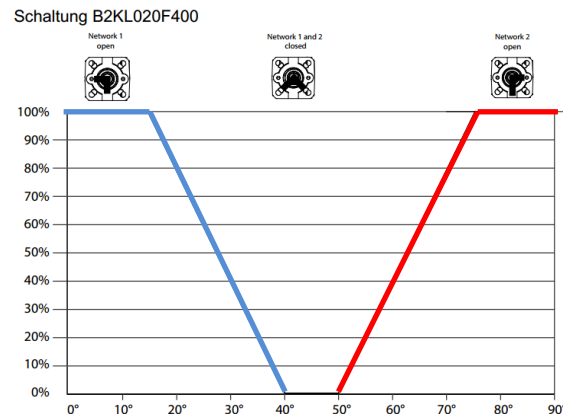
Heating/cooling sequence inverted

##### 0-10V (e.g. SAUTER 6-Way valve)

The manipulated variable of the integrated PI controller is converted into the voltage values shown below according to the characteristic curve of the valve. The characteristic curves of the output are designed for the two nominal sizes DN15 and DN20. The output characteristic curve is calculated according to the characteristic curve B2KL015F400 for the valve with nominal diameter DN15 resp. the characteristic curve B2KL020F400 for the valve with nominal diameter DN20. Please see SAUTER datasheet 58.001, B2KL: 6-way-ball valve with male thread, PN16).



Picture 23 Characteristic curve for nominal width DN15 (extract from SAUTER product data sheet 58.001)



Picture 24 Characteristic curve for nominal width DN20 (extract from SAUTER product data sheet 58.001)

When the inverted types are selected, heating and cooling are reversed.

#### 0-10V Danfoss CO6 (HC AO2DO-type)

The control variable is output as 0-10V signal for heating and cooling. In parallel, both digital outputs are used as a changeover signal for controlling the CO6 actuator. **A coupling relay (230VAC-> 24VAC) must be used!!**

#### Generic 6-way valve 0-10V

The limit values for heating and cooling of the valve used can be parameterized. The values can be found in the data sheet of the valve and.

**Example:**

- 100% cooling  $\triangleq$  2,0V  $\Rightarrow$  20
- 0% cooling  $\triangleq$  4,7V  $\Rightarrow$  47
- 0% heating  $\triangleq$  7,3  $\Rightarrow$  73
- 100% heating  $\triangleq$  10,0V  $\Rightarrow$  100

See parameters *heating 100% - Generic 6-way valve to cooling* | *0% - Generic 6-way valve*.

#### Heat pump function

The heat pump function can be activated using the two parameters *Minimum runtime controller output* and *Delay time controller mode change* (5DO, EC AO2DO, HC AO2DO).

#### Overheating protection underfloor heating

An external temperature sensor at the universal input can be used to protect underfloor heating. If a configurable temperature is exceeded (*Maximum temperature underfloor heating*) the heating output of the JOY is switched off and the 6-way valve output is moved to the rest position.

#### 2nd Control loop

An external temperature sensor at the universal input can be parameterized as a sensor for a second control loop. Both control loops must be 2-pipe systems with common change-over!

The heating output is assigned to the 1st control loop (=main control loop), whose mode of operation is configured with the existing parameters. The set points for heating and cooling correspond to the internal set points and can be adjusted by the user on the device. The actual temperature is determined via the internal temperature sensor. The fan stages (fan coil types) and the 6-way valve output (HC type) are permanently assigned to the main control loop. The second control loop is controlled with the cooling output. It operates as a pure two-step controller, whose hysteresis is configured with the parameter *Controller hysteresis*. The set point is linked to the set point of the first control loop, but can be shifted via a constant offset, parameter 140: *Offset 2nd control loop*.

Occupancy and ECO mode as well as the window and dew point contact states affect both control loops.

## Configuration

Name	Type	Unit	Value range	Factory default
Controller hysteresis		°C	0,0 – 15,0°C  Determines the on/off behaviour of the two-point controller. The heating controller is switched ON if value falls below set point less half of the hysteresis and heats until actual value of set point plus half of hysteresis is exceeded. The hysteresis prevents the “flickering” of the actuator if actual value is within the value of set point. <i>Not used with PI-controller</i>	1
Controller mode after device reset		--	0: off 1: heating auto 2: cooling auto 3: auto (heating/cooling) 17: auto heating using both digital outputs 18: auto cooling using both digital outputs  With selection 1: <i>heating auto</i> , the controller can only assume the OFF and HEATING states, with selection 2: <i>cooling auto</i> accordingly OFF and COOLING.	Auto
Valve protection release		--	0: locked 1: released  The valve protection is only started if the corresponding valve (heating or cooling) has not been activated for more than 96 hours. The time is set to Friday 11:00h (heating valve) or 11:15h (cooling valve). The respective valve is then switched on for 5 minutes.	released
Mode selection manipulating variable		--	0 - minimum control value remains until mode change E.g.: Ymin = 20%  <div style="text-align: center;"> <p>1 – correcting variable is only output when minimum manipulated variable is reached</p> </div> <div style="text-align: center;"> </div>	minimum control value remains until mode change
PWM cycle time		min	0-600  The switch-on/switch-off time of the digital outputs is calculated depending on the manipulated variable. Example: PWM time=30min, manipulated variable y=50% -> T <sub>on</sub> =15min, T <sub>off</sub> =15min <i>Only relevant when using the PI controller and existing digital valve switching outputs.</i>	30
Heating controller type		--	0 - PI controller 1 - Two-point controller  No two-point controller can be configured with the 3AO variants	PI-Regler

Cooling controller type		--	0 - PI controller 1 - Two-point controller	PI-Regler
			No two-point controller can be configured with the 3AO variants 0,0 – 10,0°C	
Proportional band Xp heating		°C	The proportional band indicates the deviation at which the controller outputs the maximum manipulated variable (100%). A small Xp leads to a stronger control intervention of the proportional component at small deviations, but increases the tendency of the control loop to oscillate. <i>Only relevant when using the PI controller.</i> 0-1000 $\triangleq$ 0-1000min	2
Reset time Tn heating		min	The time that elapses until the I-component produces the same amplitude as that which immediately results from the P-component. To increase the integral component of the controller, the reset time must be reduced. <i>Only relevant when using the PI controller.</i> 0-1000 $\triangleq$ 0-1000min	30
Minimum manipulating variable heating		%	0-100 = 0-100%	0
Maximum manipulating variable heating		%	0-100 = 0-100%	100
			0-100 $\triangleq$ 0,0 – 10,0°C	
Proportional band Xp cooling		°C	The proportional band indicates the deviation at which the controller outputs the maximum manipulated variable (100%). A small Xp leads to a stronger control intervention of the proportional component at small deviations, but increases the tendency of the control loop to oscillate. <i>Only relevant when using the PI controller.</i> 0-1000 $\triangleq$ 0-1000min	2
Reset time Tn cooling		min	The time that elapses until the I-component produces the same amplitude as that which immediately results from the P-component. To increase the integral component of the controller, the reset time must be reduced. <i>Only relevant when using the PI controller.</i> 0-1000 $\triangleq$ 0-1000min	30
Minimum manipulating variable cooling		%	0-100 = 0-100%	0
Maximum manipulating variable cooling		%	0-100 = 0-100%	100
			0-60 = 0-60 min	
Minimum runtime controller output	5DO EC AO2DO HC AO2DO	min	After switching on, the heating or cooling output remains in the ON state for the minimum runtime, independent of the controller's request/control variable. If a switch-over of the controller mode between heating/cooling occurs during the active monitoring of the minimum running time, the outputs are switched directly and the monitoring of the minimum running time is restarted.	0
Delay time controller mode change	5DO EC AO2DO HC AO2DO	s	0-600 = 0-600 s Delay time between the change of the two control sequences heating and cooling. The opposite direction is only enabled after the time has expired.	0
Maximum temperature underfloor control		°C	150..500 $\triangleq$ 15,0 – 50,0°C	35
Offset 2 <sup>nd</sup> Control loop		K	-150..+150 $\triangleq$ -15,0..+15,0K	0

## BACnet objects

Object type	Instance	Name	Type	Unit	Value range	Factory default	COV
AI	7	Manipulated variable		%	0 – 100%		COV-Increment
MI	3	Controller state			0: off 1: heating 2: cooling		Change of value

Object type	Instance	Name	Type	Unit	Value range	Factory default	COV
MV	3	Preset Controller			1: off 2: heating AUTO 3: cooling AUTO 4: AUTO  5: heating AUTO, both outputs (heating and cooling) are triggered in parallel 6: cooling AUTO, both outputs (heating and cooling) are triggered in parallel 7: outputs OFF (manual mode), frost- and heatprotection disabled! 8: output heating ON (MANUAL Mode), icon heating is faded-in <i>Output control only for SDO, HC AO2DO, EC AO2DO</i> 9: output cooling ON (MANUAL Mode) icon cooling is faded-in <i>Output control only for SDO, HC AO2DO, EC AO2DO</i> 10: heating MANUAL, both outputs (heating and cooling) switched ON in parallel, icon heating is faded-in <i>Output control only for SDO, HC AO2DO, EC AO2DO</i> 11: cooling MANUAL, both outputs (heating and cooling) switched ON in parallel, icon cooling is faded-in <i>Output control only for SDO, HC AO2DO, EC AO2DO</i>  The specifications of the manual modes (7-10) only control the icon for both 3AO variants!		



## 9 BACnet Object list reference

### 9.1 Objects

#### Analog inputs

Function group	Object type	Instance	Name	Type	Unit	Value range	Factory default	COV
Set point	AI	1	Set point base		°C   °F	0 - 50,0°C   0 – 90,0°F		COV-Increment
	AI	2	Set point offset		°C   °F	-15,0 - 15,0°C   -30,0 - 30,0°F		
	AI	3	Set point heating					
	AI	4	Set point cooling					
Sensors	AI	5	Internal temperature sensor		°C   °F	0 - 50,0°C   0 – 90,0°F		
	AI	6	External temperature sensor					
Controller	AI	7	Manipulated variable		%	0 – 100%		
Outputs	AI	8	Output heating	EC 3AO HC 3AO	V	0-10V		
	AI	9	Output cooling	EC 3AO HC 3AO				
	AI	10	Output 6-way valve	HC AO2DO HC 3AO				
Fan coil	AI	11	Output Fan coil EC-type	EC AO3 EC AO2DO				
Humidity	AI	12	Internal humidity sensor	rH	%	0-100%		

#### Analog values

Function group	Object type	Instance	Name	Type	Unit	Value range	Factory default
Set point	AV	1	Set point base overwrite		°C   °F	0 - 50,0°C   0 – 90,0°F	-1
	AV	2	Set point offset overwrite	--	°C   °F	-15,0 - 15,0°C   -30,0 - 30,0°F	0
Outputs	AV	8	Output heating overwrite	EC 3AO	V	0-10V	-1
	AV	9	Output cooling overwrite	HC 3AO			-1
				HC 3AO			-1
	AV	10	Output 6- way valve output overwrite	HC AO2DO			-1

## JOY BACnet

Function group	Object type	Instance	Name	Type	Unit	Value range	Factory default
Fan coil	AV	11	Output fan coil value overwrite	HC 3AO HC AO2DO EC AO3 EC AO2DO			-1
Device	AV	100	Offset Device ID			0-4194200	100*

\* Default values depending on the parameter

## Binary inputs

Function group	Object type	Instance	Name	Type	Unit	Value range	Factory default	COV
Controller	BI	1	Device state			0: Device on 1: standby (off)		Change of value
	BI	2	Occupancy state			0: room unoccupied 1: room occupied		
	BI	3	Dew point state			0: dew point inactive 1: dew point active		
	BI	4	Window state			0: window closed 1: window open		
	BI	5	ECO mode			0: ECO mode inactive 1: ECO mode active		
Inputs	BI	6	State input 1			0: open 1: closed		
	BI	7	State input 2			0: open 1: closed		
Outputs	BI	8	Output heating	5DO EC AO2DO HC AO2DO		0: open 1: closed		
	BI	9	Output cooling			0: open 1: closed		
Keys	BI	10	Top left			0: inactive 1: active		
	BI	11	Top right					
	BI	12	Center left	HC AO2DO HC 3AO				
	BI	13	Center right	HC AO2DO HC 3AO				
	BI	14	Bottom left					
	BI	15	Bottom right					

## Binary values

Function group	Object type	Instance	Name	Type	Unit	Value range	Factory default
Controller	BV	1	Device state overwrite			0: Device on 1: standby (off)	0
	BV	2	Occupancy state overwrite			0: room unoccupied 1: room occupied	0
	BV	3	Dew point state overwrite			0: dew point inactive 1: dew point active	0
	BV	4	Window state overwrite			0: window closed 1: window open	0
	BV	5	ECO mode overwrite			0: deactivate ECO mode 1: activate ECO mode	0
Alarm	BV	6	Default alarm			0: alarm inactive 1: alarm active	0

## Multi state inputs

Function group	Object type	Instance	Name	Type	Unit	Value range	Factory default	COV
Controller	MI	1	Change-over state			1: heating mode (cooling locked) 2: cooling mode (heating locked) 3: Data point inactive		Change of value
Fan coil	MI	2	State fan coil	5DO		1: off 2: stage 1 3: stage 2 4: stage 3 5: Auto Off 6: Auto stage 1 7: Auto stage 2 8: Auto stage 3		
Controller	MI	3	Controller state			0: off 1: heating 2: cooling		

## Multi state values

Function group	Object type	Instance	Name	Type	Unit	Value range	Factory default
Controller	MV	1	Change-over overwrite			1: heating mode (cooling locked) 2: cooling mode (heating locked) 3: mode not defined 4: Data point inactive	4
Fan coil	MV	2	Fan coil value overwrite	HC AO2DO HC 3AO		1: off 2: stage 1 3: stage 2 4: stage 3	0
				5DO		1: off 2: stage 1 3: stage 2 4: stage 3 5: AUTO	5
Controller	MV	3	Preset Controller			1: off 2: heating AUTO 3: cooling AUTO 4: AUTO  5: heating AUTO, both outputs (heating and cooling) are triggered in parallel 6: cooling AUTO, both outputs (heating and cooling) are triggered in parallel 7: outputs OFF(manual mode), frost- and heatprotection disabled 8: output heating ON (MANUAL Mode) , icon heating is faded-in <i>Output control only for 5DO, HC AO2DO, EC AO2DO</i> 9: output cooling ON (MANUAL Mode) , icon cooling is faded-in <i>Output control only for 5DO, HC AO2DO, EC AO2DO</i> 10: heating MANUAL, both outputs (heating and cooling) switched ON in parallel, icon heating is faded-in <i>Output control only for 5DO, HC AO2DO, EC AO2DO</i> 11: cooling MANUAL, both outputs (heating and cooling) switched ON in parallel, icon cooling is faded-in <i>Output control only for 5DO, HC AO2DO, EC AO2DO</i>  The specifications of the manual modes (7-10) only control the symbol for the 3AO variants!	4*
Keys	MV	4	Release of keys			1: all keys released 2: all keys locked 3: fan coil keys locked	1
Device	MV	4183	COV mode			1: off 2: local 3: global	2*

\* Default values depending on the parameter

## 10 PICS

### BACnet Protocol Implementation Conformance Statement

Date:	03.12.2020
Vendor Name:	Thermokon Sensortechnik GmbH (Vendor ID: 396)
Product Name:	JOY FC5 DO BACnet JOY EC AO2DO BACnet JOY HC AO2DO BACnet JOY EC 3AO BACnet JOY HC 3AO BACnet  JOY rH FC5 DO BACnet JOY rH EC AO2DO BACnet JOY rH HC AO2DO BACnet JOY rH EC 3AO BACnet JOY rH HC 3AO BACnet
Firmware Revision:	1.0.0
Application Software Version:	2.6.0
BACnet Protocol Revision:	1.12
Product Description:	Multi-function Room Operating Panel with interface BACnet MS/TP RS485 for temperature detection, integrated operation and controlling of HVAC for single room control.
BACnet Standardized Device Profile:	BACnet Smart Sensor (B-SS)

### BIBBs Supported:

Supported BIBBS	BIBB Name
DS-RP-B	Data Sharing-Read Property-B
DS-RPM-B	Data Sharing-Read Property Multiple-B
DS-WP-B	Data Sharing-Write Property-B
DS-COVU-B	Data Sharing-COV Unsubscribed-B
DM-DDB-B	Device Management – Dynamic Device Binding–B
DM-DOB-B	Device Management – Dynamic Object Binding–B
DM-DCC-B	Device Management – Device Communication Control–B
DM-TS-B	Device Management – Time Synchronization–B

**BACnet Standard Application Services Supported:**

ReadProperty  
 ReadPropertyMultiple  
 WriteProperty  
 UnconfirmedCOVNotification  
 I-Am  
 I-Have  
 DeviceCommunicationControl  
 Time Synchronization

**Standard Object Types Supported:**

Object-Type	Dynamically Creatable Deleteable	Optional Properties supported	Writable Properties	Property Range Restrictions
Device	<input type="checkbox"/>	Description Location Max-Master Max-Info-Frames LocalTime LocalDate	Description Location Max_Master Max-Info-Frames	31 characters 31 characters 0-127 1-4
Analog Input	<input type="checkbox"/>	COV_Increment Description	COV_Increment	
Analog Output	<input type="checkbox"/>	COV_Increment Description	Present_Value COV_Increment	
Analog Value	<input type="checkbox"/>	Description	Present_Value	
Binary Input	<input type="checkbox"/>	Description Inactive_Text Active_Text		
Binary Output	<input type="checkbox"/>	Description Inactive_Text Active_Text	Present_Value	
Binary Value	<input type="checkbox"/>	Description Inactive_Text Active_Text	Present_Value	
Multi-state Input	<input type="checkbox"/>	Description State Text		
Multi-state Output	<input type="checkbox"/>	Description State Text	Present_Value	
Multi-state Value	<input type="checkbox"/>	Description State_Text	Present_Value	
File	<input type="checkbox"/>			

**Data Link Layer Option:**

MS/TP master. Baud rate(s): [9600, 19200, 38400, 57600, 76800, 115200]

**Device Address Binding:**

Is static device binding supported?

Yes

☐

No

☒**Character Sets Supported:**

UTF-8

**Special Functionality:**

Maximum APDU size in octets: 480