thermokon®

HOME OF SENSOR TECHNOLOGY

Description

JOY
Room controller

valid from firmware revision 4

Subject to technical alteration

1 Revision

Revision	Date	Description
44	01.09.2026	Corrections From version 4.3.5 - EnOcean send profile A5-09-04 – Air quality sensor
43	12.03.2026	From version 4.3++ New: - LoRaWAN® added (see chapter 9) - Controller mode switching at digital input supplemented - BACnet: Device Object->object name changeable and non-volatile
42	25.02.2026	Corrections - Mode after incorrect changeover measurement
41	30.01.2026	From version 4.2++ - Option CO2 offset adjustment
40	07.01.2026	Corrections From version 4.1— - Option district cooling
39	18.07.2025	From version 4.0++ - Fan: Limitation of the max. automatic level - EnOcean: New profile A5-09-04, CO2 sensor - Changeover: configurable measuring cycles when using a changeover sensor - 2nd control loop: Mode selection and minimum control value configurable - Main screen: Advanced display options - Advanced options middle button - Party mode - New set point display possible (basic set point)

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3 Device Type Overview

This document refers to the following variants:

Hardware output configuration

Outputs	5DO (230V, 24V)	ECAO2DO (230V, 24V)	HCAO2DO (230V, 24V)	EC3AO (24V)	HC3AO (24V)
Fan (Relay)	3x	-	-	-	-
EC Fan (0..10V)	-	1x	-	1x	1x
Heating/cooling (Relay)	2x	2x	2x	-	-
Heating/cooling (0..10V)	-	-	-	2x	-
6-Way valve (0..10V)	-	-	1x	-	1x
Inputs	**5DO (230V, 24V)**	**ECAO2DO (230V, 24V)**	**HCAO2DO (230V, 24V)**	**EC3AO (24V)**	**HC3AO (24V)**
Universal (configurable)	3x / Bus: 2x	3 / Bus: 2x	3 / Bus: 2x	3 / Bus: 2x	3 / Bus: 2x

Options/Extensions

Radio variants
SR - EnOcean
LRW – LoRaWAN®
(only one of the two options is possible at the same time)

Measured variables
CO2 - air quality
rH - Humidity

Communication
RS-485 - Modbus
Without - Additional digital input
(only one of the two options is possible at the same time)

4 General

4.1 Introduction

This documentation applies to all device models with Modbus and without a bus system, as well as the optional EnOcean and LoRaWAN® wireless extensions. The chapter *Configuration parameter* list parameters that apply to all device types. Parameters/data points that are only intended for the Modbus types are marked accordingly!

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 SR version provides an additional EnOcean interface, the rH variant the 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

JOY can be connected by means of twisted pair cables (line resistance 120 Ohm). Detailed information on installation and mounting can be obtained in the JOY 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

JOY is a Slave bus participant which is only allowed to send data upon request of the Master. The protocol corresponds to the defaults of:
- MODBUS application protocol specification V1.1
- MODBUS over Serial Line Specification & Implementation guide V1.0

4.6 SD-Card

MicroSD cards can be used to upload a new application or a new device configuration. The SD card slot is located in the housing cover. This must be removed to insert the MicroSD card.
Only cards formatted in FAT-file system are supported. NTFS and exFat are not supported!

4.7 Factory reset

In the last submenu of the Common settings menu you will find the option to reset the device to the factory settings. More information about the menus can be found in the datasheet.

4.8 Configuration software

Thermokon provides the configuration software **uConfig** free of charge which can be downloaded from Thermokon website. This software enables the user to create parameter files for the different available device types, which can be stored on a SD card. Remove housing cover from device, insert SD card and after power-on the device reads and stores a valid parameter file from SD card. Only configuration parameters are transferred to the device. At the same time, if an SD card is inserted, a configuration is read from the device and saved to the SD card as a .bin file after approximately 10 seconds. This file is named JOY_xxx.bin, where xxx represents the Modbus address. For a device without a bus, the file name is JOY_999.bin. **Afterwards, MicroSD card shall be removed!** All updated parameters are only available after a device reset. Start screen indicates if a valid parameter file is found on plugged-in MicroSD card! Only parameter files that match the current or lower firmware version of the device can be loaded! The configuration file must be named **confJoy.csv**! The configuration software uConfig names the file accordingly when saving.
Devices with integrated Modbus-interface can also be parameterized by using the Modbus interface.

4.9 Bootloader

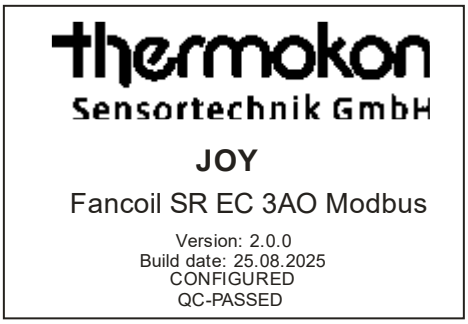
A bootloader is integrated in the device, which makes it possible to install a new application (update, upgrade, downgrade) via SD card or Modbus. To insert the SD card, the housing cover must be removed.

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 update files for the SD card have the extension *.s19 for the version 2.x and version 4.x units, for the version 3.x units it is a *.bin file. The files for a Modbus update of all versions (2.x and 3.x) have the extension *.bin. 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 activated, the ring illumination blinks in a 1s cycle, while display is not triggered! After recognition of a SD card with a valid application the update process is started. Now, ring illumination blinks in a 300ms cycle. After a successful update process (Duration circa 20-30 seconds), the new application is started automatically. **Afterwards, MicroSD card shall be removed!**

For an update via Modbus interface Thermokon provides a Thermokon Bootloader which is available on request.

4.10 Start screen

After power-up a start screen is faded in for about 5s, showing information about device type and application firmware version.



Picture 1: View main screen

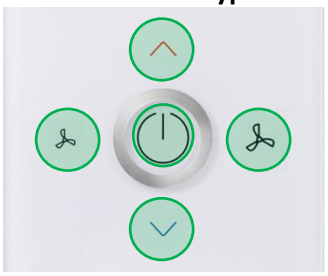
Custom Logo in Start Screen
There is one logo available. The size of the logo is set to 190x50 pixels. Thermokon creates from the template of the customer a file that can be loaded via SD card.

5 Operation

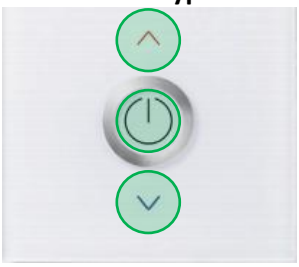
5.1 Main Menu

Keys

Fan coil type



HC type



Single key actuation releases an action. A long keypress causes a cyclic value change in a 0,5s cycle. Pressing a button automatically activates the backlight, which switches off automatically after 20 seconds of inactivity.

Configuration parameter

Special function ON/OFF Button

The center key can be configured with different functionalities. A short key press triggers the special function. A long key press still triggers the ON/STANDBY (Off) (See Chapter 7.2, Standby) function, except if function *Locked* is set. In this case the key is completely locked. When using a keycard switch, the ON / OFF (Standby) function via button is not possible.
Linking the key to the occupancy state excludes the use of a digital input as a occupancy detector!

Modbus

Holding register

Release of keys

Keys can be locked/unlocked via Modbus at runtime.

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* (address 124, See Chapter 9.1).

Fan coil type



Picture 2 Key combination Fan coil type for invoking parameter menu

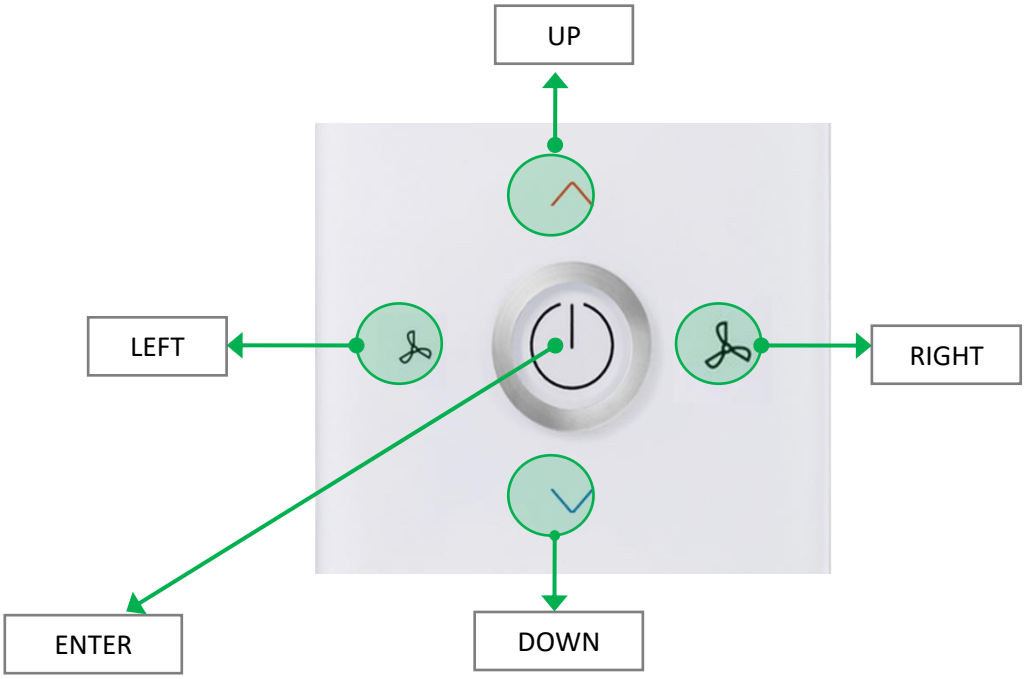
HC type



Picture 3 Key combination HC type for invoking parameter menu

Keys

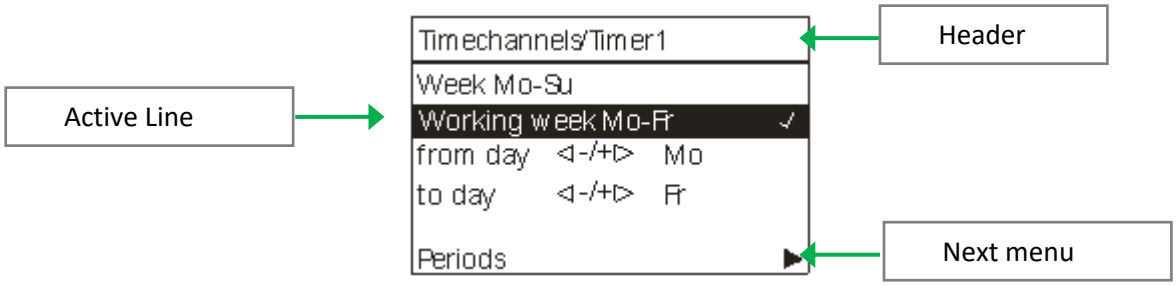
The device is operated in parameter mode with keys specified below:



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 symbols 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 symbol is faded-in if corresponding value is selected. Parameters for which no symbol ◁-/+▷ 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.

5.3 JOY Custom – User-Defined Keys

With software version 2.3.0 Modbus types have the possibility to define custom keys. After pressing such a key, the assigned symbol is shown in the display and a value for a short or long key press is provided via Modbus. Short key presses are incremented until the next request, long key presses (> 200ms) are displayed with the value 101, see Modbus register description.
As of version 2.3.3, EnOcean telegrams are automatically sent for the functions light ON / OFF and blinds UP / DOWN and the user-defined keys when pressed. Further information can be found in Chapter 8.8.
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



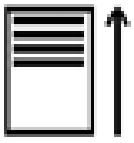
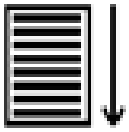
Picture 7 Freely definable keys HC type

Symbol display

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

Symbols

Funktion	Symbol	
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		
Controller mode cooling auto		
Controller mode Auto	AUTO	

Picture 8 Fix symbols

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.

Custom logo

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

5.4 Modbus settings

The menu for setting the Modbus parameters is invoked by simultaneously pressing the keys marked below for at least 3s. The key combination must be called directly from the main screen. The LEDs of the ring light up when the key combination has been detected by device.

The menu is enabled during the first 60 minutes after the supply voltage is switched on, as long as the device is not actively integrated in a Modbus communication. As soon as the device receives a valid Modbus telegram addressed to the device, access to the menu is blocked. Without valid communication, the access will be blocked after 60 minutes!

Fan coil type



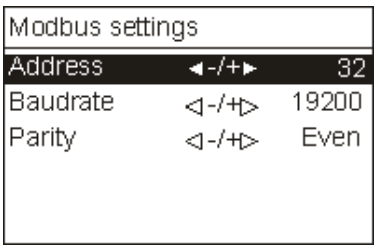
Picture 9 Key combination Fan coil type for invoking modbus settings menu

HC-Variante



Picture 10 Key combination HC type for invoking modbus settings menu

Following menu appears:



Picture 11 Modbus settings menu

Parameter	Value range
Address	1-247 Default: 32
Baudrate	9600Bd 19200Bd (Default) 38400Bd 57600Bd
Parity	None Odd Even (Default)

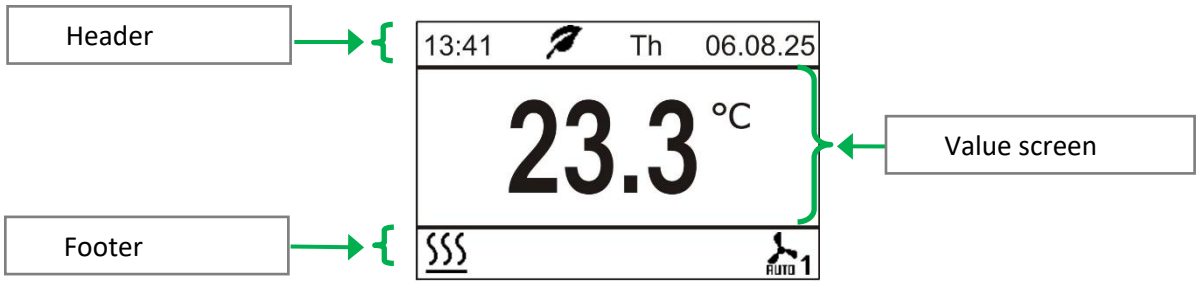
To save the settings, the header must be selected and the Key LEFT must be used to exit the menu. When leaving the menu, the set values are stored.

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

6 Screen

6.1 Main Screen

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



Picture 12: View main screen

Header

The header is designed for displaying time, weekday and date. In addition an info symbol is displayed upon requirement or depending on certain states/modes.



Picture 13: Main screen header

The positions are pre-defined and cannot be changed.

Info Symbols

ECO-Mode

Alarm

6.2 Value Screen

Unit temperature Selection °C/°F

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. Various options are available for display in the value screen (10, Display main screen), such as room temperature, absolute (= base) set point or set point shift.



Picture 14: 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/Humidity/CO2

The active controller mode, humidity and/or the CO2 value (EnOcean or internal sensor) can be shown as an additional display in the values screen. can be additionally faded in in main screen. The positioning is based on the following scheme:



Picture 15 Display of controller mode and humidity or CO2 value



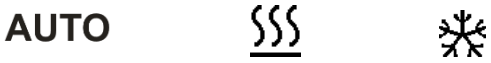
Picture 16 Display of humidity and CO2

Controller mode: This display refers to the specification of the controller mode via the register *Controller mode after device restart (29)* and/or *Default controller (269).* The controller modes Heating Auto, Cooling Auto and Auto (heating/cooling) are displayed. Other possible controller modes are not displayed.
Note: As soon as the control request (heating or cooling) is present, the corresponding symbol is displayed in the footer.

Humidity: The value of the internal humidity sensor is displayed

CO2: The CO2 value of a taught-in wireless sensor (SR variant) or the value of the internal sensor can be displayed.

Symbols



Display of Set point





Picture 17 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. Another actuation of one of the two arrow keys modifies the value.

There are different options available for the adjustment mode of the set point. E.g. 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 fan coil types)





Picture 18 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. Another actuation of any arrow key switches the fan stage.

Footer symbol

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

Symbol Groups

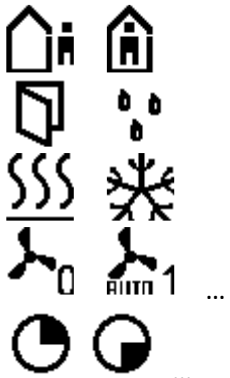
Occupancy

Window contact/dew point

Heating/cooling

Fan coil stage

Active time channel



Five fields are available.



Picture 19: Main screen footer example

Moreover, the positions of the symbols can be freely chosen.
A frost protection Default received via EnOcean (Profile A5-20-12, DB0.1…DB0.0 Enumeration value = 3) is indicated by a snowflake symbol at the position of the Heating / Cooling icon.

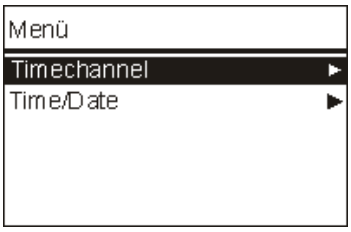
There are special symbols , and for heating/cooling and depending on the configuration. An explanation can be found in the Controller chapter.

Configuration parameters

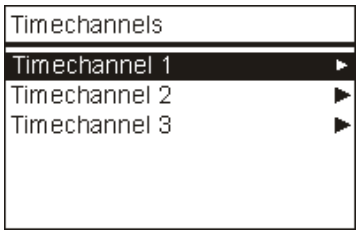
- Display main screen
- Display footer symbol 1-5
- Display set point adjustment
- Fade in controller mode

6.3 Parameter screen

The following menu description refers to the Modbus type. A more detailed explanation of the menus of versions without Modbus can be found in the corresponding data sheets!



Picture 20 Overview parameter menu of modbus type



Picture 21 Menu „Timechannel selection“

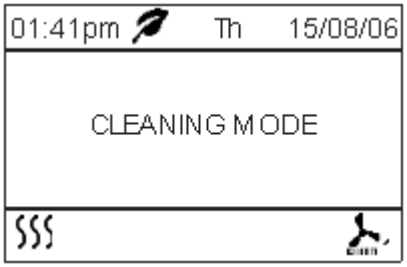
6.4 Diagnostic menu

To access the diagnostics menu, select the header in the startscreen of the parameter menu, and press the ENTER key. Here you will find various information, such as device type, software version, state of the inputs and outputs and controller state (current manipulated variable). The Modbus types indicate whether the Joy communicates via Modbus.

6.5 Cleaning mode



You can switch to cleaning mode with the two hidden buttons 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 22: Cleaning mode screen

7 Functions

7.1 Common settings

Configuration parameters

Lock parameter menu
Invocation of the parameter menu can be locked

Language
Selection German/English

Brightness background illumination LCD/ Brightness ring
Device state after Power ON (Standby or Device ON)

Start up state of the device after power on (STANDBY/ON/last state).
If *last state* is selected, the previous operating state, STANDBY or ON is restored

Device values after Power ON
Select whether occupancy, set point offset and fan stage will resume their last value or be reset after power on.

Maximum load heating/cooling
Serves to optimize the self-heating compensation when the load is switched. When selecting the value, the maximum possible load current in amperes due to the heating/cooling valve and the fan level must be taken into account.

Modbus

Holding Register

Device ON/OFF(=Standby)
Standby mode can be activated by key or via Modbus.

7.2 Operating modes

Standby

Triggered by Modbus 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 dead band (default 10K) and the PWM time is doubled when using the controller in PI mode. If ECO mode is active, the ECO symbol is displayed in the header of the main screen.
When ECO mode is active, the value of the set point offset is not taken into account if the occupancy function is not used at the same time. 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 set point offset depends on parameter *Behavior set point offset during occupancy change (135).*
The ECO mode can be activated / deactivated by the time channels, by center key or with the Modbus devices via Modbus! The last modified presetting determines the state.

Keycard

The operation of the keys is disabled, the display is switched off and the controller regulates to the set points of the UNOCCUPIED status (reduction of set point heating by parameter *Set point adjustment occupancy (25)* and increase set point 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 set point is lowered (heating) or increased (cooling) by value of parameter *Set point adjustment occupancy (25).* In UNOCCUPIED state, the buttons for setpoint and fan speed control cannot be operated.

Comfort

In comfort mode, the controller works with the heating and cooling set point calculated from *the basic set point and dead band comfort.*

Overview

Comfort (Device ON)

Control in normal operation

Switching takes place via:
ON / OFF button
(long press)

Modbus 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 Modbus

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 Modbus.
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
Modbus default

Occupancy

(occupied/unoccupied)

→ Set point adjustment occupancy
Factory default
Set point Heating -2K | Cooling +2K
Behavior set point offset configurable
Keys locked (Exception ON/OFF Button)

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 +)

7.3 Time and Date

Overview

The room thermostat has a real-time clock, which calculates time and date automatically. Time and date can be updated during operation by a supervisory system via Modbus.

Configuration

Format time
Display in 24h-, 12h- (am / pm) mode or display OFF.

Format date
Display OFF or in german or english mode.

Daylight saving
Activation / deactivation of automatic daylight saving time.

Modbus

Holding Register
Hour, minute, day, month and year can be updated via Modbus.

7.4 Time Channel

Overview

There are 3 time channels available including 4 periods, 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

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

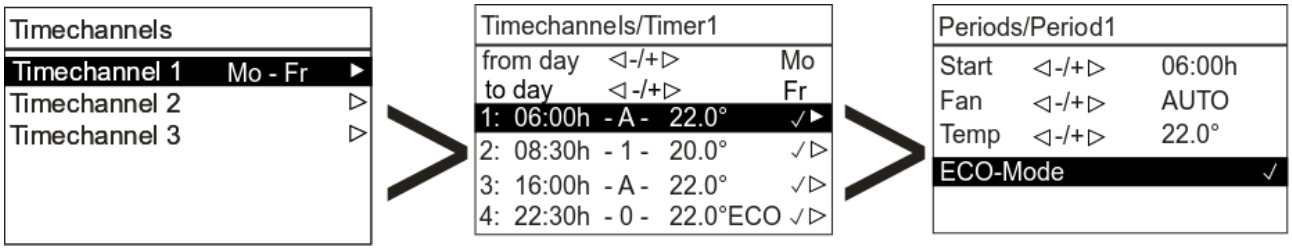
A period is activated, if start time and weekday are in conformance with the parameterized start time and weekday mask. A period remains active until conditions of another period are fulfilled. **Attention: It is strongly recommended to define the time channels without gaps over the entire week (Mon-Sun) to avoid undesired or unexpected behavior.** Active set point can be overriden over Modbus by means of register *Basic set point* (255). The time channel is deactivated until the value -1 is written to the register.
Time channels are prioritized. 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

Changing any value activates the corresponding section.

Menu time channel



(1) **(2)** **(3)**

(1) Time channel selection
(2) Weekday selection and
Selection of time channel period
Index time period / start time / fan coil stage / set point/ info ECO-Mode
(3) Configuration of time channel period
(4)

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 hooks, see (3))

Configuration parameter

Start
The start time can be changed in 15-minute steps.

Fan
Fan coil stage selection between OFF, Stage 1, Stage 2, Stage 3 and AUTOMATIC (5DO type) resp. between OFF and AUTOMATIC (EC fan coil-type).

Set Point
The set point can be adjusted in the range 0°C to 50°C.
ECO-Mode

7.5 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 possible.

Configuration parameter

Offset internal sensor
Temperature compensation of self-heating of the internal temperature sensor

Offset external sensor
Temperature compensation of self-heating of the external NTC10K

Unit temperature
Selection °C/°F
When switching the unit, please note that all temperature parameters (set points, frost / heat protection, Xp of controller, etc.) must be converted to the corresponding unit and parameterized!

Modbus

Input Register

Internal temperature sensor

External temperature sensor

7.6 Humidity

Overview

The humidity value can be read out via Modbus or shown in the display (see parameter 10, *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

Offset Humidity
For compensation of constant measurement value deviations

Modbus

Input Register
Humidity value

7.7 Air quality

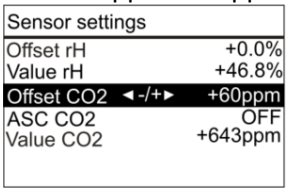
Overview

The air quality can be measured and transmitted using an internal CO2 sensor or via a taught-in EnOcean CO2 sensor. The value can be read out via Modbus and/or shown on the display (see parameter 162, *Display CO2 value*). The value is not processed internally!

Internal sensor
The measuring range of the sensor is from 0...2000ppm, with a resolution of 1ppm. The sensor can be calibrated by manual correction of the measured value or for automatic self-calibration (default).

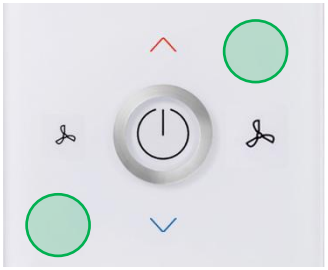
Automatic self-calibration (ASC)
The ASC function sets the lowest recorded CO2 value (7-day period) as the reference value (400ppm) for the measured value recording. A sufficient supply of fresh air within this period is required to ensure a perfect measurement result.

Offset adjustment
An offset can be set in the range -1000ppm – 1000ppm in 10ppm increments.



Picture 23 CO2 settings menu

Factory setting
Deletes the history of the recorded values of the manual or automatic calibration and restores the factory settings.



Picture 24 Key combination for resetting to factory settings SCD41

Attention: CO2 sources (e.g. breathing air) or CO2 sinks (e.g. concrete) influence the measured value recording!

Configuration

CO2-alarm treshold
If the threshold is exceeded, an alarm is issued in the Modbus register

Altitude above sea level
Compensates the influence of the installation location depending on the altitude above sea level on the measured value.

ASC-Activation
The ASC logic can be activated/deactivated.

Modbus

Input Register
CO2 value

CO2 alarm

7.8 Inputs

Overview

The Modbus type of the device has 2 inputs, the type without Modbus 3 inputs. Input 1 is a universal input for connecting potential-free contacts or an NTC10K sensor (low voltage). For 230V powered devices, input 2 is a 230V input (**Caution !! Please pay attention to the connection diagram!**), for devices with 24V power supply it is a low voltage input for connecting potential-free contacts. The additional input of the devices without Modbus (input 3) is also a low-voltage input for potential-free contacts. Internal input states are OR-linked with the associated Modbus registers when configured as window, dew point and occupancy contact. In change-over configuration, the corresponding Modbus register overrides the internal change-over state!

Please note that some functions can only be assigned to a single input (Occupancy, Change-Over, Keycard), while the other functions can be used on more than one input in parallel.

Configuration parameter

Input 1 universal input (low voltage)
NTC10K or a potential-free contact

Input 2 (AO2DO=230V, 3AO=low voltage)
Potential-free contact. **ATTENTION 230V! Note connection diagram!**

Input 3 (low voltage), only types without modbus!
Potential-free contact

Modbus

Input Register

State input 1 universal
Only relevant if used as digital input

State input 2

7.9 Outputs

Overview

The outputs are assigned with fixed functions. Depending on the device type, these can be manually overridden in different ways. Thus, the digital outputs can only be manually overridden combined with the controller mode or the fan stage. The analog outputs can be used freely.

Configuration parameter

Effective direction of relay heating/cooling *(5DO-, EC/HC AO2DO-type!)*
Effective direction can be changed for the two relay heating and cooling to adapt to the existing actuator (normally open or normally closed).

Effective direction of analog output heating/cooling *(EC 3AO-, HC 3AO-type!)*
Effective direction can be changed for the two analog outputs heating and cooling to adapt to the existing actuator (normally open or normally closed).

Type 6-way valve
In addition to various 6-way valve types, it can be selected whether the control value of the heating or cooling controller is additionaly output on the 6-way valve output as a steady 0-10V signal. When selecting *0: 0-10V steady signal heating and cooling*, the 6-way valve output runs in heating and cooling state as 0-10V signal! If a 6-way valve type is selected for the EC 3AO type, the two outputs heating and cooling simultaneously output the signal converted to the configured 6-way valve type!

Modbus

Holding Register

Default output heating/cooling *(EC 3AO-, HC 3AO-type)*
The outputs are decoupled from the internal controller and can be controlled by the higher-level system (BMS). In order to display a symbol (heating/cooling) with the output, the manual mode must be activated (0xFF01 = heating or 0xFF02 = cooling) via Register *Default controller mode*.

Default output 6-way valve *(HC 3AO-, HC AO2DO-type)*
The output is decoupled from the internal controller and can be controlled by the higher-level system (BMS) as a 0-10V steady signal output. In order to display a symbol (heating / cooling) with the output, the manual mode must be activated via the tab Default controller mode (0xFF01 = heating or 0xFF02 = cooling). Possible application is the control of a volumetric flow controller.

Input Register

Output heating/cooling/6-way valve
State of relays (on/off) resp. value 0..100% as 0..10V

7.10 Alarm

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



Picture 25: Header with faded-in alarm symbol

Modbus

Holding Register

Default Alarm
Turn alarm on/off signal in the display.

7.11 Set point

Overview

The active set point is determined by the parameter *Set point after reset* (20), by Modbus default (255, *Default base set point*) or by an active time channel. It can be changed by the user within defined limits by changing the set point offset. During operation, it is possible to set the set point from a higher level (Modbus).

Calculation of heating and cooling setpoints

Two calculation concepts are available for determining the set points for heating and cooling:

Variant 1 - Symmetrical set point formation around the base set point:
Comfort:
Heating set point = base set point - (dead zone comfort / 2)
Cooling set point = base set point + (dead zone comfort / 2)
ECO:
Heating set point = base set point - (dead zone ECO / 2)
Cooling set point = base set point + (dead zone ECO / 2)

The base set point represents the center of the dead zone. If the absolute (base) set point display is activated, this middle value is shown on the display.

Variant 2 - Heating set point as reference value (base set point):
Comfort:
Heating set point = Base set point
Cooling set point = base set point + dead zone comfort
ECO:
Heating set point = base set point – (dead zone ECO / 2)
Cooling set point = base set point + dead zone comfort + (dead zone ECO / 2)

In this variant, the base set point value corresponds to the heating set point value. The absolute (base) set point display therefore always shows the heating set point, regardless of the current operating mode. In cooling mode, this correlation must be taken into account accordingly.

Configuration Parameter

Set point after reset
After a restart of the device this value is used as set point until a new set point via time channel or Modbus default is activated.

Adjustment range of set point
Determines the limits of the set point adjustment range. When selecting the display of the set point adjustment (data address 114) as stage display – 3…+3 this parameter must be set to the value of the set point offset of stage 3!
Example: *Set point step range* = 1K and Stage 3 is equivalent to 3K => enter this value!! Take care of the scaling!

Set point step range
Determines the step size of the set point offset upon changes at the device by a user.

Dead band comfort/Dead band ECO-mode
Determines the dead band in comfort mode respectively in ECO-mode.

Set point adjustment occupancy
When using the occupancy function by a digital input or via Modbus, the configured value is in UNOCCUPIED state automatically deducted from the heating set point or added to the cooling set point.
The *Occupancy/Eco override* parameter can be used to parameterize how the occupancy state affects when the controller is in ECO mode.

Frost Protection/Heating Protection
The monitoring of the two limit values is always active and cannot be deactivated. Only the limit values can be adjusted.
By use of the window function (reduction of energy consumption) through a digital input or via Modbus, in case “Window open” the heating and cooling set points are set to the configured values for energy saving.
A frost protection Default received via EnOcean (Profile A5-20-12) is indicated by a snowflake symbol at the position of the Heating / Cooling icon.

Behavior of set point offset at occupancy change
Behavior of the set point offset value when occupancy state changes. Select whether the offset is (1) retained, (2) reset or (3) restored at occupancy change. If set point offset value should be restored, value is set to zero during UNOCCPIED state and previous value is restored after switching to the OCCPUPIED state.

Set point calculation
Selection between *Variant 1* - Symmetrical set point formation around the base set point und *Variant 2* - Heating set point as reference value (basic set point)

Modbus

Holding Register

Basic Set point
This register is designed for the set point default by a supervisory system. Cooling and heating set points are calculated internally from this basic set point and the dead band depending on the mode (Comfort / ECO). With the value -1 (factory setting), this data point is deactivated and the internal value (set point after reset or set point of the active time channel section) determines the set point.

Set point offset
External default for override of internal set point offset.

Input Register

Set point heating/cooling
Output of the active heating set point / cooling set point. It depends on the specification of the basic set point (Time channel, Modbus), the set point offset (user, Modbus) and the mode (Comfort/ECO, occupied /unoccupied, Keycard). The value changed at last determines the set point, that means if the time channel is active, the set point changes if a new value is written via the register Basic set point (255) or if a new time channel period becomes active.

Set point offset
Output of the internal offset specified by the user setting at JOY or via the *Set point offset* register (256). The value changed at last determines the set point, e.g. an offset set by the user would be overwritten with the next update of the *set point offset* register.
If the KEYCARD or occupancy function is used, the behavior of the set point offset depends on the parameter *Behavior set point offset during occupancy change* (135). The ECO mode triggered by Modbus or key has no influence on the set point offset, an ECO mode triggered by a time channel resets the offset to 0. If neither function is used, the set point offset will be reset when ECO mode is activated.

Absolute setpoint
Output of the currently effective average absolute setpoint of the controller. This value corresponds to the absolute setpoint displayed on the screen. It can be the setpoint parameter after reset, the setpoint specified via Modbus, or the setpoint of the active time channel section including the associated offset.

7.12 Fan stages

Types

Three fan stages *(5DO)*
Three outputs for controlling up to three fan stages. The switching on and off behavior 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 as a function of the parameterized threshold values for fan levels 1/2/3.

With the PI controller, the stages are output in dependence on the manipulating variable of the controller:

3 stages	2 stages	1 stage
Stage 3: y > 66%	-	-
Stage 2: y > 33%	Stage 2: y >= 50%	-
Stage 1: y > 0%	Stage 1: y > 0%	Stage 1: y > 0%

If the fan level is switched off manually, the controller is deactivated and the outputs heating/cooling 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 10V is configurable. If the fan is switched off manually, the controller is deactivated and the outputs are switched off.

HC version (HC AO2DO, HC 3AO)
To display a fan symbol, a stage can be specified via Modbus. For this purpose the fan symbol 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	Off	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 standby there is never the state MANUAL OFF, so that the frost and heat protection is always guaranteed.
ATTENTION: If you select "Without Auto," the valve will still be activated even if the fan is set to MANUAL OFF !!!

Configuration parameter

Number of fan coil stages *(5DO-type!)*

3 outputs to control up to 3 fan stages

Threshold stage 1/2/3 *(5DO-type!)*

The value configured determines the threshold between set point and actual value at which the individual fan stages are switched on when controller is active. For example using the default setting (*threshold value fan stage 1* = 0), fan stage 1 is started instantly if a control deviation occurs. It has to be considered that a hysteresis for the on/off switching of the fan stages is activated (+/-0.3°C) to prevent flickering of the outputs!
Only two-point controller!

Maximum fan coil value (100%) at temperature deviation *(EC AO2DO-type!)*

If a two-point controller is activated the parameterized value is the deviation of set point from actual value at which the output of the fan coil unit has reached 100% (related to configured maximum value). Below this value the output value is calculated linear to the deviation and is output in the configured stages.
Only two-point controller!

Steps fan coil control (EC AO2DO-, EC 3AO-type!)

Determines the number of steps and thus the step size of the fan stage control.
Fan coil minimum, Fan coil maximum *(EC AO2DO-, EC 3AO-type!)*
The calculation of the stages is made between minimum and maximum value. A minimum value greater than 0 will allow the fan to run even if there is no heating or cooling request.

Fan minimum, Fan maximum (EC AO2DO, EC 3AO type!)

Minimum and maximum values for the fan control output. The steps are calculated between the minimum and maximum values. A minimum value greater than 0 keeps the fan running even when there is no heating or cooling demand.

Fan coil assignment
Optionally, the fan can optionally be allocated to heating or cooling controller or to both at the same time.
Start-up time fan coil

Fan start-up time
To guarantee a save start-up of the fan, a period of time can be configured in which the fan starts with the highest possible stage available. If the value is 0, the function is disabled.

Fan start with manipulated variable > x (>0% - 40%)
When set, the fan only runs if the heating or cooling valve is activated and the manipulating variable has exceeded the value parameterized here.
Example: 20% => Fan starts with a manipulating variable >20%.

Keys Fan stage with / without AUTO
Selection, which fan stages the user can select on the device. Attention: If "1: without AUTOMATIC" is selected, the heating or cooling valve is also controlled if the fan speed is set to MANUAL OFF!

Fan follow-up time (parameter)
The follow-up time of the fan becomes active when the controller switches from an active controller state (heating / cooling) to standby mode, when a user manually switches off the fan or the device.

Limitation of max. fan speed in automatic mode
In manual mode, the level can still be changed up to the maximum fan speed.

Modbus

Holding Register
Fan coil stage

Input Register
State fan coil stage

7.13 Keycard Switch

If Keycard is not inserted the device is set into the ECO-mode. The operation of the keys is locked, the display is switched-off and the controller uses set point defaults of UNOCCUPIED-state (lowering set point heating by value of register *Set point adjustment standby* (25) and increasing set point cooling accordingly). If no keycard is inserted, the key ENTER can be used to switch on the unit and activate the comfort mode.

7.14 Occupancy

Overview

The occupancy function can be activated via the configuration of a digital input, the ENTER key or via Modbus or EnOcean. If the key and Modbus and/or EnOcean are used at the same time, the last modified value determines the output value. The digital input has a higher priority. When the occupancy function is activated, the occupancy symbol is automatically displayed if the symbol has been assigned a position in the footer.
The behavior of the set point offset on occupancy change can be configured (keep, restore, reset). See the Set point chapter. In UNOCCUPIED state, the buttons for setpoint and fan speed control cannot be operated.

Configuration parameter

Occupied/ ECO override

The occupancy state OCCUPIED may override an active ECO mode. The controller disables ECO mode and operates in OCCUPIED state as long as the occupancy state is OCCUPIED. By switching back to state UNOCCUPIED, the ECO mode is restored.
In the other case, the occupancy state has no influence with the ECO mode active.

Party mode

If the middle button is configured accordingly, pressing the button activates comfort mode for a configurable period of time.

Modbus

Holding Register

Default Occupancy
Occupied/Unoccupied

Input Register

Occupancy state

7.15 ECO-Mode

Overview

In ECO mode, the dead band between the heating and cooling setpoint corresponds to the parameter *Dead band ECO mode (24)*. An active ECO mode can be overridden by the occupancy status OCCUPIED (*Occupied/ ECO override parameter, 136*).

Modbus

Holding Register
Default ECO-Mode
off/active

Input Register
State ECO-Mode
off/active

7.16 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 Modbus default. The specification via Modbus is OR-linked with the internal status.
When the dew point is active, the dew point symbol is automatically displayed if the symbol has been assigned a position in the footer.

Modbus

Holding Register

Default dewpoint

Input Register

State dewpoint

7.17 Window Contact

Overview

When the window contact is active (window open = reduction of energy consumption active), the set points for heating and cooling are automatically set to frost- respectively heat-protection. The fan state changes to automatic mode and, after exiting the energy lock mode, resumes the previous state.
The window contact function is activated via configuration of a digital input or via Modbus or via EnOcean. The default via Modbus is linked by an OR-function to the internal state. The last changed value determines the state.
When the function is activated, the window symbol is automatically displayed in the "window open" state if a position has been assigned to the icon in the footer line. Heating and cooling controllers control the frost protection or heat protection setpoint.

Modbus

Holding Register

Default window contact

Input Register

State window contact

7.18 Change-Over

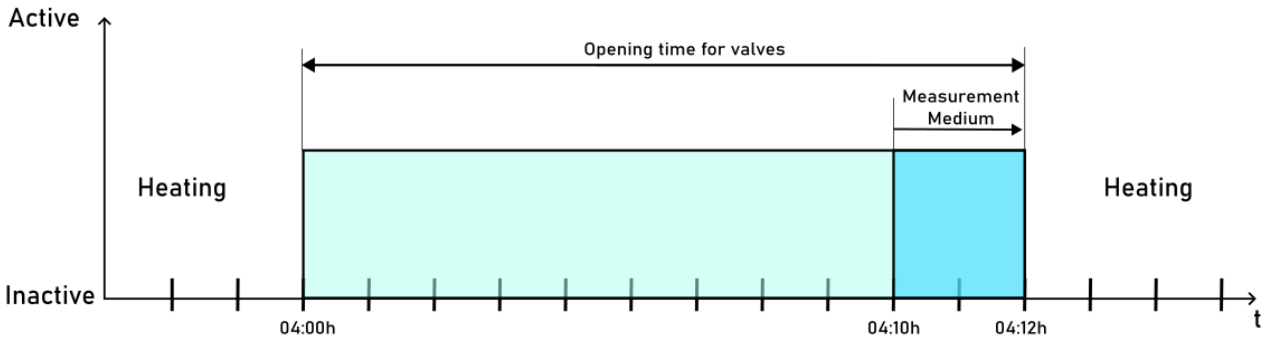
Overview

A change-over contact/sensor is used to specify the heating or cooling mode for the controller in a 2-pipe system. The change-over function is activated via the configuration of an input (digital/sensor) or specified via Modbus or EnOcean.

Digital input
If the digital input is configured as a normally open contact, heating mode is enabled when the input is open and cooling mode is enabled when the input is closed. A digital input activated as a change-over contact deactivates the setting via Modbus/EnOcean!

EnOcean sensor VFG
The changeover function is automatically activated when an EnOcean VFG sensor is learned in. The configured limit temperatures apply as limit values (parameter: *Changeover limit value for cooling & Changeover limit value for heating*). The value received is the default value.

Sensor
If the universal input is configured as a changeover sensor, the measurement of the medium temperature can be controlled via various parameters. Up to two measurements can be carried out per day, for which the opening time of the valves and the start and subsequent duration of the medium temperature measurement can be configured. Furthermore, the limit temperatures for heating and cooling can be configured.



Picture 26 Medium measurement sequence

Example: Start of measurement at 4:00h, duration of opening time 12min and start of medium measurement after 10min opening time.

During active opening time, the controller mode display, if activated, alternates between the heating and cooling symbols (parameter: controller mode display). After an incorrect medium measurement (invalid temperature), the previous mode is retained.
The opening time must be configured to be longer than the start of the measurement! The difference is the duration of the measurement in which an averaged temperature value of the medium is determined.

Attention: When using the change-over function, the heating and cooling outputs are controlled in parallel, except when using the second control circuit (see chapter Controller).

Modbus

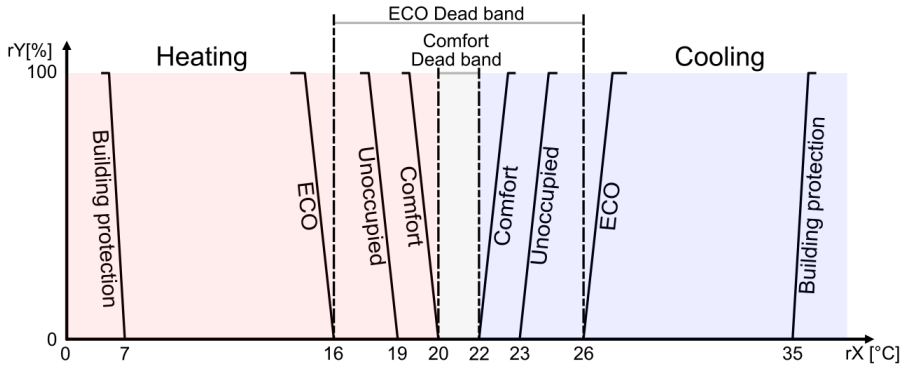
Holding Register

Default change-over
Heating, cooling or not used

7.19 Controller

Overview

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



Picture 27: PI control with dead band

The controller starts after a cold start (power supply on) of the device with a 30-second delay.

PI-controller

The time response of the PI-controller is determined by parameters Xp and Tn. Due to the proportional band, the control variable reacts instantly on a control deviation while the integral portion is only occurring with the time of action. The resulting manipulated variable is output as a pulse width modulated, as a continuous signal (3AO) or as an analog signal adapted to the corresponding 6-way valve type.

Two-point controller

If value goes below set point less half of hysteresis treshold, the controller switches-on the heating output. In case value exceeds set point plus hysteresis threshold, the controller switches-off the heating output. As for cooling, it acts accordingly.

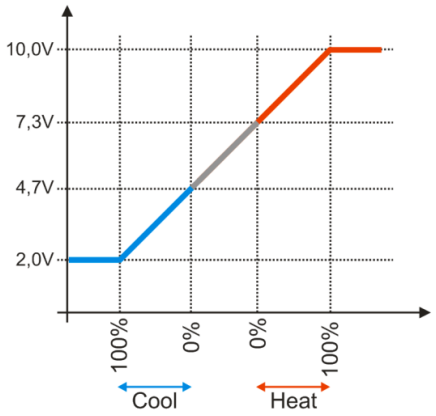
Valve Protection Function

In order to guarantee that the valves are also fully functional when not in use for a longer period of time, the room thermostat has a valve protection function. The valve protection is only started, when corresponding valve (heating or cooling) has not been triggered for more than 96 hours. The time is fixed to Friday at 05:00am (heating valve) and 05:20am (cooling valve). The corresponding valve is switched on for 5 minutes. The valve protection function can be disabled.

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.

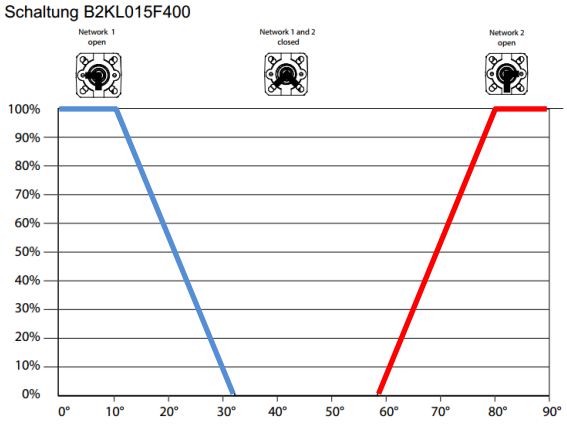


Standard
100…0% cooling ⇒ 2,0…4,7V
0…100% heating ⇒ 7,3…10,0V

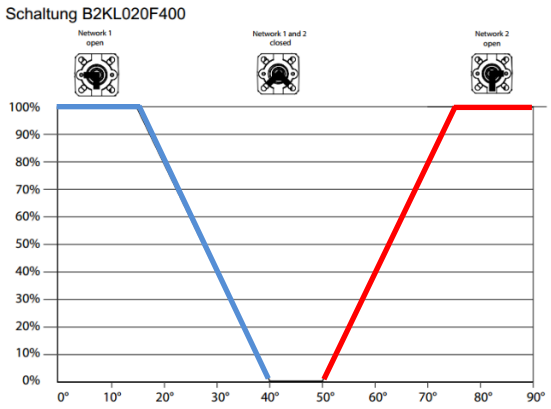
Inverted
Heating/cooling sequence inverted

0-10V (e.g. SAUTER 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. 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 28 Characteristic curve for nominal width DN15 (extract from SAUTER product data sheet 58.001)



Picture 29 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)*

A Danfoss 6-way valve with the NovoCon® digital actuator can be implemented by selecting Generic 6-way valve 0-10V.

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 ≙ 2,0V => 20

0% cooling ≙ 4,7V => 47

0% heating ≙ 7,3 => 73

100% heating ≙ 10,0V => 100

See parameters *heating 100% - Generic 6-way valve* to *coolingl 0% - Generic 6-way valve* (152-155).

Overheating protection underfloor heating (UFH)

An external temperature sensor on the universal input can be used to protect an underfloor heating system. The limit for the switch-off can be configured with parameter *159: Maximum temperature UFH*.

JOY outputs

Universal input = *4: External temperature sensor UFH (NTC10k)* - Switching off the heating output (JOY)

The heating output of the JOY is switched off and the 6-way valve output is moved to the idle position

SR variant

Universal input = *5: External temperature sensor UFH (NTC10k)* - Switching off EnOcean actuators

Actuators taught in via profile A5-20-01 are moved to the off position.

For more information on how the EnOcean option works, please refer to the EnOcean chapter.

2nd Control loop (wired)

A prerequisite for proper function is that both control loops are 2-pipe systems with a common change-over!

An external temperature sensor at the universal input must be configured as a sensor for a second control circuit (see parameter *18: Input 1 universal input (low voltage) => 6: External temperature sensor (NTC10k) - 2nd control circuit*). This automatically activates the second control circuit.

Main control loop

Control via heating output

- Freely configurable (PI/two-point, Xp heating/cooling, Tn heating/cooling, etc.)
- The setpoints for heating and cooling correspond to the internal setpoints and can be adjusted by the user via the adjustment on the device. The actual temperature is determined via the internal temperature sensor. The fan stages (fan coil variants) and the 6-way valve output (HC variant) are permanently assigned to the main control circuit.

Second control loop

Control via cooling output

- P-controller with Xp=2K
- The setpoint is linked to the setpoint of the first control circuit, but can be shifted via a constant offset, parameter *140 Offset 2nd control circuit*.
- The temperature of the second control circuit is recorded via the external temperature sensor.
- The assigned mode (heating and cooling/heating only/cooling only) and a minimum manipulating variable can be configured
- The digital outputs are controlled with a PWM signal at 20-minute intervals

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

District cooling

Monitoring of a configurable treshold for the return flow temperature of the cooling medium.
If the temperature falls below this value, the control variable for the cooling valve is decoupled from the cooling controller and the valve is controlled using a P-control algorithm (hereinafter referred to as DC controller) depending on the temperature deviation, continuously in the 3AO variants or via PWM control in the DO variants. The fan output (FC/EC variants) continues to run independently of the control variable of the district cooling control with the control variable calculated by the cooling controller, which remains active. It is possible to switch off the fan manually while district cooling control is active.

Required parameter setting

Configuring the universal input (*input 1 universal input* (18)) as a *district cooling sensor* (value 7) activates monitoring. The function of the DC controller is defined using the *parameters threshold district cooling* (175) and *Xp district cooling* (176).

Control of the cooling valve

If the return temperature falls below the setpoint, a proportional controller (DC controller) is activated to control the valve output.

Properties of the FK controller

Proportional behavior (Xp):

Two-point operation is possible with a small proportional bandwidth (low Xp).

Hysteresis:

A fixed value of ±0.2 K results in a total switching difference of 0.4 K between switching on and off.

Behavior when the return limit value is undershot:

The cooling valve is closed when the return flow temperature falls below the treshold value (see Pict. 31 District cooling control diagram).

Controller release conditions

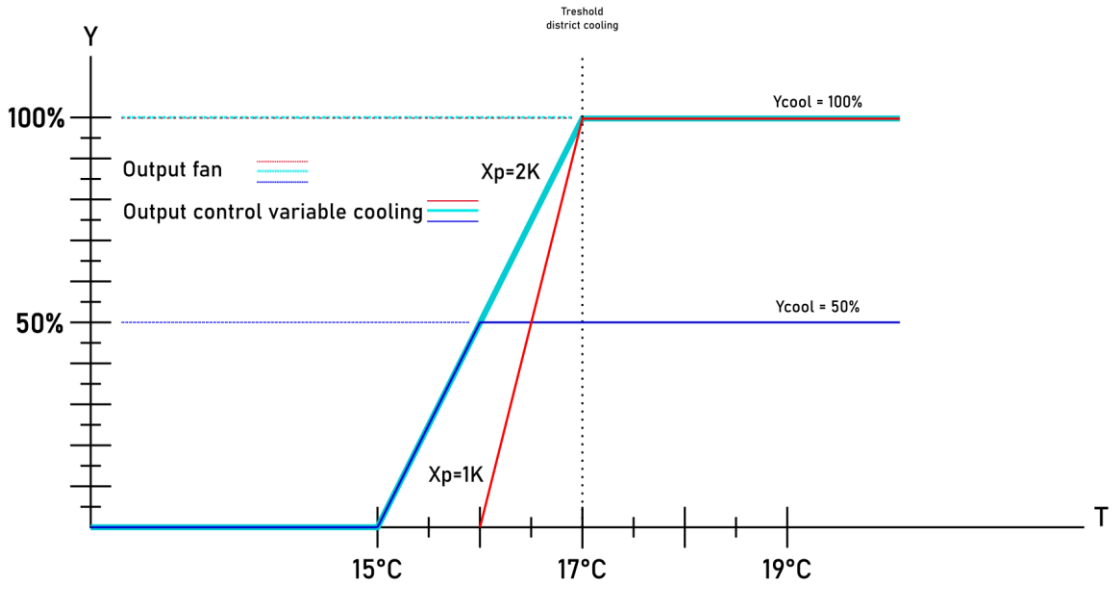
The DC controller (= closing of the cooling valve) only becomes active when the standard controller is in cooling mode.

Control algorithm

Condition: Sensor temperature < limit value parameter AND the cooling valve is open
Consequence: Override of the cooling valve is required

Behavior of the control variable (Xp):

The calculated proportional band (Xp) acts in the opposite direction to the control direction of the cooling controller.
The Y value can never be greater than the control variable calculated by the cooling controller.



Picture 30 District cooling control diagram

Configuration parameter

Controller hysteresis

Determines the ON/OFF behavior 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.

Not used with PI-controller

Controller mode after device reset

Determines the startup mode of controller after restart. With selection *1: heating*, the controller can only work in states OFF and HEAT, with option *2: cooling* in OFF and COOL.

Valve protection release

Release/Lock of the valve protection

Proportional band Xp heating/cooling

The proportional band determines the deviation at which the controller outputs the maximum control variable (100%). A small Xp relates to a stronger controller intervention of the proportional band with lower deviations, but increases the tendency to oscillate.

Only relevant when using the PI controller.

Reset time Tn heating/cooling

Time passing by until the Integral-part produces the same control amplitude as produced directly in case of the Proportional band. To increase the integral part of the controller the reset time must be reduced.

Only relevant when using the PI controller.

Minimum manipulating variable

Minimum value in percent.

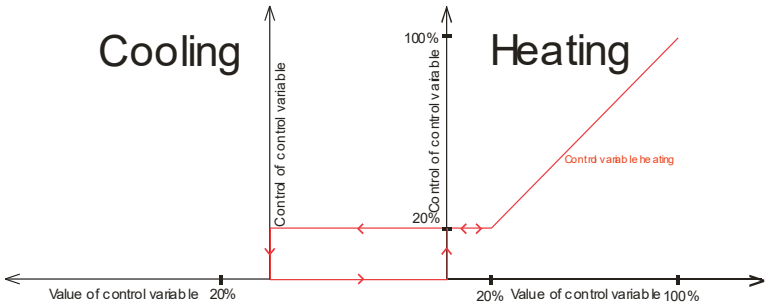
Maximum manipulating variable

Maximum value in percent.

Mode Selection manipulating variable

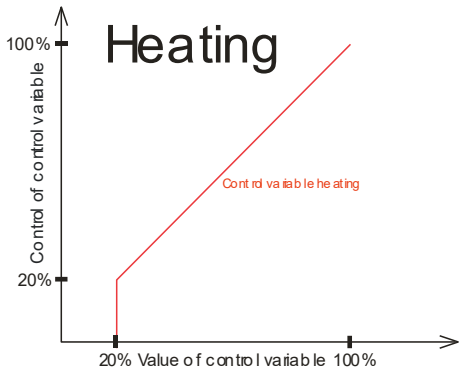
a) Mode selection manipulating variable = 0

Ymin = 20%



The minimal control variable at the output remains unchanged until the controller changes the operating mode

b) Mode selection manipulating variable = 1
Ymin = 20%



The control variable is only sent to the output, if the calculated value of the control variable is bigger than the minimal control variable

PWM cycle time
Cycle time of the PI-controller output signal. The ON/OFF time of the digital outputs is calculated as a function of the manipulating variable.
Example: PWM time = 30min, manipulating variable y = 50% => T_{on} = 15min, T_{off} = 15min
Only relevant when using the PI controller and existing digital outputs (device types FC and HC).

Heating controller type
Heating controller can be configured as PI- or Two-point-controller.

Cooling controller type
Cooling controller can be configured as PI- or Two-point-controller.

Minimum runtime controller output (5DO, EC AO2DO, HC AO2DO-type)
After switching on, the heating or cooling output always remains in the ON-state for the minimum runtime, regardless of the controller's request / manipulated variable.
If the controller mode switches between heating and cooling during active monitoring of the minimum runtime, the outputs are switched directly and the monitoring of the minimum runtime is restarted.
If the minimum runtime is active without a controller request, the symbols or are displayed.

Delay time controller mode change (5DO, EC AO2DO, HC AO2DO-type)
Delay time between the change of the two controller modes heating and cooling. The output of the new mode will be released only after the time has expired.
The symbol is displayed when the delay time is active.

Maximum temperature underfloor control (UFH)
If this temperature threshold is exceeded, the heating output is deactivated if the overheating protection underfloor heating function is active. The value of parameter *Controller hysteresis* is used for deactivating/reactivating the heating output.

Offset 2nd Control loop
An offset can be configured for the 2nd Control loop which will be added to the effective set point for controlling of the second control loop.

Mode 2nd control loop
heating and cooling/heating only/cooling only

Minimum manipulating variable 2nd control loop
Minimum value of the manipulated variable in percent. Applies to every enabled mode

Threshold temperature monitoring for district cooling
Monitoring of the return temperature of the cooling medium

Proportional band Xp controller for district cooling
The cooling valve is continuously adjusted using a P-control algorithm based on the temperature deviation

Modbus

Holding Register

Default controller mode
In controller mode “Automatic”, the controller controls the heating and cooling set point. In mode *only heating*, the controller operates in automatic mode and only controls the heating set point. Cooling is deactivated. In cooling mode vice versa. In addition, it is possible to override the two controller outputs manually (not with the 3AO version! See the description of register *Default output heating / cooling*). If one of the outputs is set to manual mode the corresponding symbol in display is faded-in and internal controller is deactivated.

Input Register

Manipulating variable of controller
Unit %

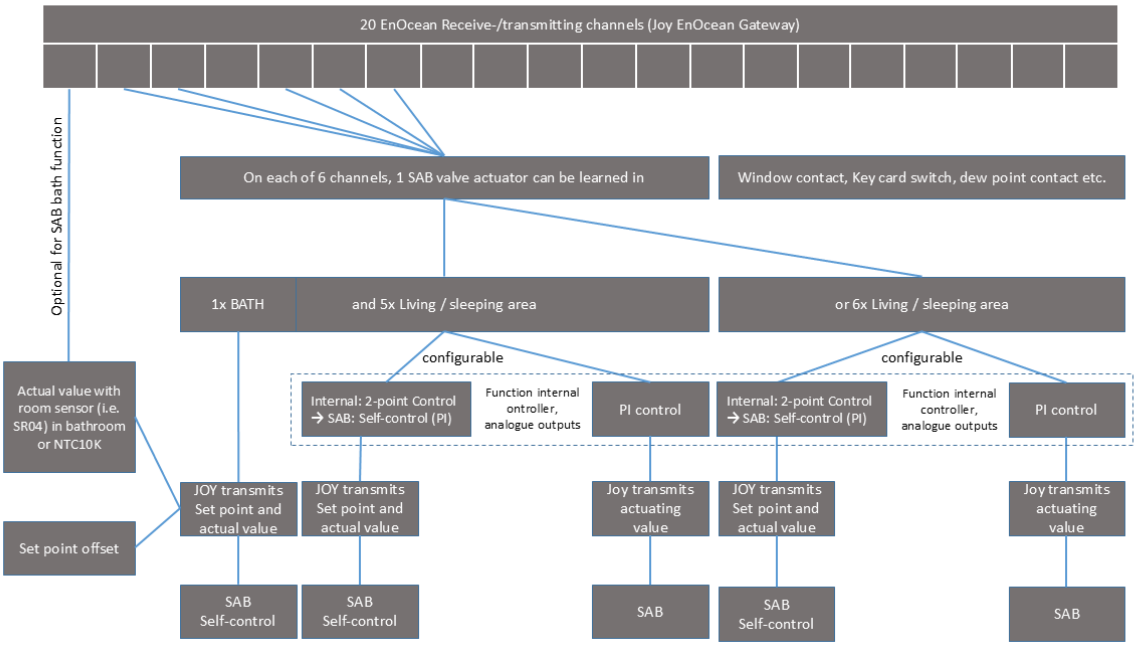
Controller mode feedback
Active controller mode

8 EnOcean

Attention: chapter only concerns SR variants.

8.1 Overview

With Joy SR up to 20 radio channels with different functions can be used. A channel can be configured as a receive channel, as a send channel or as a message server (for bidirectional SAB communication).

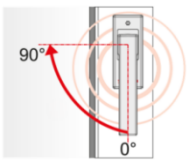


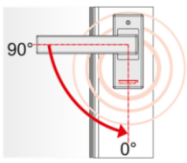
Picture 31 Function overview

8.2 Functional groups

The profiles used are divided into functional groups.

SRW/SRG Window contact and window handle. Up to five sensors can be learned-in. Both act on the window contact function (reduction of energy consumption) and are linked to the digital inputs or the Modbus default.
Attention: To learn-in the window handle, the handle must be turned from the closed position to the open position and back again!





VFG Wireless sensor for changeover specification. As an alternative to the digital input, a radio changeover sensor can be learned-in.

EXT/WRF Receive channel: Room temperature Default by an external room temperature sensor. Overrides the internal temperature sensor and is used by the controller as actual value. Max. one sensor is possible. The temperature is displayed in the main screen instead of the internal sensor value. Via Modbus, the value can be read out in register 567 as long as the sensor is used for internal control. If the sensor is assigned to the SAB bath, the value can be read out in register 568.
Send channel: The associated WRF profile will be transmitted.

OCC Up to three motion sensors can be learned-in and affect the room occupancy function. The last modified value of the configured Defaults (Modbus, EnOcean, key on the JOY) is accepted. If several EnOcean motion sensors have been learned-in, the "ROOM UNOCCUPIED" value will only be accepted once all sensors have signaled "ROOM UNOCCUPIED".

CO2 Receive channel: A CO2 sensor can be taught in. The value can be shown on the display and/or read out for further processing in the Modbus version.
Send channel: CO2-, temperature and humidity value will transmitted.

KEY Controls the internal keycard feature. When learning-in a key card switch, it should be noted that the card must not be plugged in AND pulled during the learn-in process, but that after inserting or removing the card it is necessary to wait **at least 5 seconds** until the second action is performed with the card. Only then the switch is assigned to the key card function (function group display switches to KEY), otherwise it is learned-in as a radio switch (function group RPS).

SUP A higher-level controller that overrides the internal functions.

SAB Up to six valve actuators (SAB) can be learned-in, one of these channel can be used with the bath function. The other channels can be used for heating. For each SAB channel, an offset for the set point can be configured via Modbus. Further information see chapter EnOcean configuration.

OUT These are telegrams sent by Joy. The function can be used to map an EnOcean temperature controller.

RPS Feedback from an EnOcean push button via Modbus. No internal function is linked to this.

8.3 Supported Profiles

Receive profiles

EnOcean-EEP	Type	Direction	Description	Thermokon Device	Max. Number of	Abbreviation LCD/ funktional group
F6-02-01	RPS	Rx	EnOcean Rocker switch	Diverse	1	RPS
D5-00-01	1BS	Rx	Window contact	SRW01	12	SRW
F6-10-00	RPS	Rx	Window handle	SRG02		SRG
A5-02-06	4BS	Rx	Temperature sensor 10-50°C	SR65 VFG, SR65 TF, SR65 AKF, SR65	1	VFG
A5-02-16	4BS	Rx	Temperature sensor 0-80°C			VFG
A5-02-05	4BS	Rx	Temperature sensor 0-40°C	SR04, LC-SR04, SR07, SR65	1	EXT
A5-10-03	4BS	Rx	Temperature, set point	SR07P, SR04P, SR06 2T/2T+		WRF
A5-07-01	4BS	Rx	Occupancy sensor (Occ)	SR-MDS Solar, SR-MOC Solar, SR-MOW Solar	3	OCC
A5-08-01	4BS	Rx	Occupancy sensor (Occ, light, temperature)	SR-MDS		OCC
A5-09-04	4BS	Rx	Air quality room sensor	NOVOS 3 SR CO2 Temp/Temp_rH	1	CO2
F6-04-01	RPS	Rx	Keycard switch	SR-KCS02, SR-KCS	1	KEY
A5-20-01	4BS	Rx/Tx	Valve actuator	SAB+, SAB05	6	SAB
A5-20-12	4BS	Rx	Higher level controller (Fan, set point offset, controller, energy hold-off/dewpoint, Occup)		1	SUP

Sender profiles

Overview

The sender channels transmit after a value change or cyclically every 15 minutes. After sending a value, sending is disabled for 5s so as not to send any fast value change.

EnOcean-EEP	Type	Direction	Description	Thermokon Device	Max. Number of	Abbrev. LCD
A5-10-02	4BS	Tx	Room operating unit (Fan,temperature, set point, occupancy)		1	WRF
A5-10-06	4BS	Tx	Room operating unit (Temperature, set point, occupancy)			WRF
A5-11-02	4BS	Tx	Temperature controller (Fan, set point, alarm, controller state, energy hold-off, occupancy)		1	OUT
A5-20-01	4BS	Rx/Tx	SAB		max. 6	SAB

Profile description

A5-10-02

EnOcean Byte	Information/Data
ORG	A5
Data byte 3	Fan stage 255: Auto 200: Stage 0 175: Stage 1 155: Stage 2 70: Stage 3
Data byte 2	Set point offset Depends on parameter Adjustment range of set point 0…255 = Set point range-…+
Data byte 1	Temperature 255…0 = 0-+40°C
Data byte 0	Bit 3 -> Learn bit (0=key pressed) Bit 0 -> Occupancy (unoccupied = 0/occupied = 1)*

A5-10-06

EnOcean Byte	Information/Data
ORG	A5
Data byte 3	Not used
Data byte 2	Set point Offset Depends on parameter Adjustment range of set point 0…255 = Set point range -…+
Data byte 1	Temperature 255…0 = 0-+40°C
Data byte 0	Bit 3 -> Learn bit (0=key pressed) Bit 0 -> Occupancy (Unoccupied = 0/Occupied = 1)*

A5-11-02

EnOcean Byte	Information/Data
ORG	A5
Data byte 3	Manipulating variable Y of controller 0…255 = 0…100%
Data byte 2	Fan stage 0: Stage 0 Manual 1: Stage 1 Manual 2: Stage 2 Manual 3: Stage 3 Manual 16: Stage 0 Automatic 17: Stage 1 Automatic 18: Stage 2 Automatic 19: Stage 3 Automatic 255: Not used
Data byte 1	Set point effective Basic set point + set point offset 0…255 = 0-51,2°C
Data byte 0	Bit 7 -> Alarm Bit 6-5 -> Controller mode (1:Heating, 2:Cooling, 3:Off) Bit 4 -> Controller state (0:Automatic,1:Manual) Bit 3 -> Learn bit (0=key pressed) Bit 2 -> Reduce energy consumption (1:Window contact/Dewpoint active,0:not active) Bit 1-0 ->Occupancy (0:Occupied, 1:unoccupied, 3:frost protection)*

* If the JOY occupancy function is not used, an OCCUPIED is always sent!

A5-20-01

EnOcean Byte	Information/Data
ORG	A5
Data byte 3	Manipulating variable Y of controller (Heating/Cooling with PI-controller) 0…255 = 0…100% Set point (Bath-function, Heating/Cooling with two-point controller) 0…255 = 0…40°C
Data byte 2	Temperature 255…0 = 0-+40°C Heating/Cooling function: internal sensor Bath function: Default by assigned receive channel, internal sensor JOY, external sensor JOY
Data byte 1	Bit 7 -> not used Bit 6 -> not used Bit 5 -> not used Bit 4 -> not used Bit 3 -> Reduction of energy consumption ON/OFF Bit 2 -> Set point selection: Manipulating variable/Temperature set point Bit 1 -> Heating/cooling Bit 0 -> RCU
Data byte 0	Bit 3 -> Learn bit (0=key pressed)

Note: A5-20-1 is the profile for a battery-powered actuator. In this case, the JOY does not transmit cyclically; instead, as specified, it responds only to messages from the actuator.

A5-09-04

EnOcean Byte	Information/Data
ORG	A5
Data byte 3	Humidity 0..200 = 0 - 100%
Data byte 2	CO2 0..255 = 0 – 2550ppm
Data byte 1	Temperature 0..255 = 0 - +51°C
Data byte 0	Bit 3 -> Learn bit (0=key pressed) Bit 2 -> Humidity sensor available Bit 1 -> Temperature senor available

F6-02-01

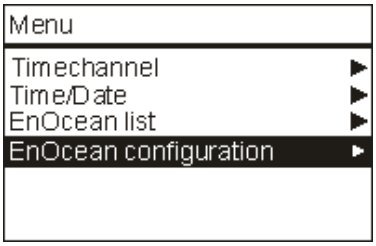
EnOcean Byte	Information/Data
ORG	A5
Data byte 0	0x50 – Off/Down 0x70 – On/Up

This profile can only be used in conjunction with use of the custom keys. Please see chapter 8.9 for more detailed description.

8.4 Comissioning

Menu

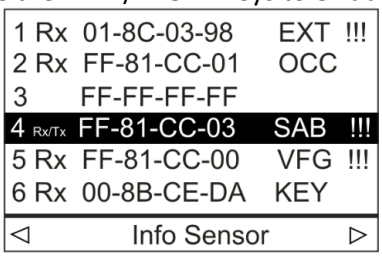
Two additional menu items appear with SR-type. The EnOcean list is a simple list representation of the EnOcean devices that have been learned-in. In addition to the list you can find more information about the channels as described below. EnOcean configuration is a password-protected area in which sensors and actuators can be learned-in/-out.



Picture 32 Main menu SR-type

EnOcean list

All learned-in sensors/actuators are listed. In addition, the info menu of a channel with information about profile, ID, errors, RSSI, etc. can be called. Use the UP / DOWN keys to select the channel. The ENTER key calls up the info menu of the channel. Use the LEFT / RIGHT keys to exit the list.

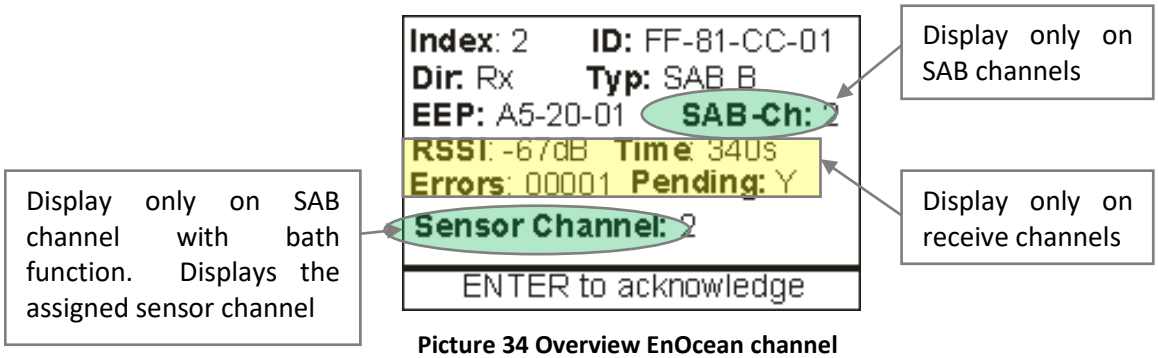


Picture 33 EnOcean list

The information about the individual channels is shown in short form in the following order from left to right:

Index channel / direction / EnOcean-ID/ functional group/ error indication

The exclamation mark **!!!** indicates an error which has not yet been acknowledged. The error handling is explained in more detail in chapter 8.5.



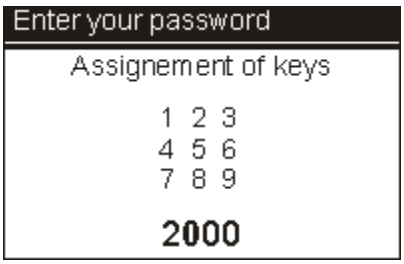
Picture 34 Overview EnOcean channel

ID	For a receive channel/message server the ID of the sensor, for a transmission channel the base ID plus index of the transmission channel
Dir	Channel direction. Rx=Receive channel, Tx=Transmission channel, Rx/Tx=Message Server
Type	Corresponds to the function group from chap. 8.2. For the SAB type, the selected mode of operation is shown with a letter behind it: H-heating, K-cooling, B-bath.
EEP	EnOcean Equipment Profile.
SAB-Ch	Displays the SAB channel for assigning the Modbus registers
RSSI	Signal strength
Time	Time since last radio telegram received
Errors	Number of errors
Pending	Indicates a pending sensor failure

If the energy saving mode of the corresponding SAB function is active, an E is displayed in the bottom line. In the case of a SAB channel, the words "**BAT !!!**" will flash in the lower right corner if the corresponding SAB reports that a battery replacement is required! If the SAB reports a obstructed actuator, the words "**VALVE !!!**" flash in the lower right corner.
Which items are displayed depends on the type of the channel.

8.5 EnOcean configuration

Login menu

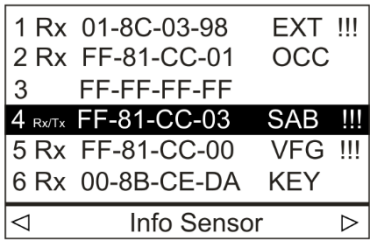


Picture 35 Login screen

The assignment of the keys is displayed and the number to be entered next is displayed in bold. If an incorrect password is entered, the display returns to the main menu. After entering the correct password, the display jumps to the EnOcean submenu. The login remains unlocked until 10 minutes after the last key press. The password must not contain any zeros. Exception: The default password is 0000. There is no password prompt here!

Channel list

After successful login, the channel list is displayed.



Picture 36 Channel list

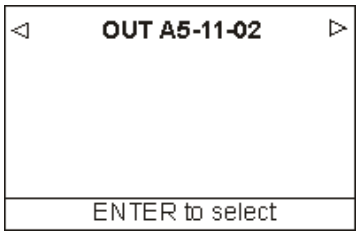
In the footer, various menu items can be selected with the LEFT / RIGHT keys. The corresponding menu item is selected with the ENTER key.

Learn sensor

The selected channel is set to learn mode. The displayed ID is 00-00-00-00 and blinks. After receiving a valid learn-in telegram from a supported sensor, the fields direction, ID and functional group are automatically filled in. The learning mode can be aborted with the ENTER key or is aborted after receiving an unauthorized learn-in telegram.

Set actor

Under this item, the selected channel can be set up as a send channel or as a message server for embedding an SAB.



Picture 37 Set actor channel

With the keys LEFT / RIGHT the options can be selected and accepted with the ENTER key.

OUT/WRF (Send channel Tx)

Triggering a learn telegram with the ENTER key. Exit with UP / DOWN / LEFT / RIGHT. Supported profiles:

- OUT A5-11-02
- WRF A5-10-06
- WRF A5-10-02

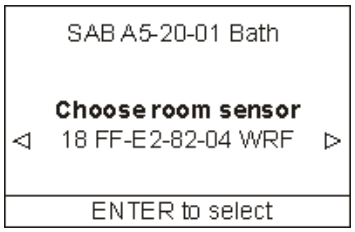
SAB (Message Server)

For controlling a SAB valve actuator. There are three functions to choose from.

Bath

With the bath function, the JOY can be used as a gateway between a wireless temperature sensor or externally connected sensor (universal input JOY) and a SAB to control a second room in addition to the control of its own control loop. Example application is a hotel room with bath. The JOY controls the room and the SAB controls the bathroom radiator.

The SAB works in self-controlled mode and receives set point and temperature from JOY. An EnOcean room sensor from the channel list (must be learned-in before!) or an wired external sensor (connected to the universal input of the JOY, configured as external temperature sensor EnOcean (NTC10k)) can be selected as temperature sensor:



Picture 38 Select room sensor for SAB with bath-function

Following profiles are allowed as EnOcean-sensor:

A5-02-05	Room sensor (Temperature 0-40°C)	SR04, LC-SR04, SR07, SR65	EXT
A5-10-03	(ROP) Temperature, set point	SR07P, SR04P, SR06 2T/2T+	WRF

If an error occurs with an assigned EnOcean room sensor, the SAB is put into self-controlled mode. If the values of an assigned external sensor are invalid, the temperature value of the internal JOY sensor is sent!

For an EnOcean room sensor with set point adjuster, the received value is adapted to the set point adjustment range of the JOY and offset to the heating set point of the JOY.

Example:

Heating set point JOY: 22°C (Basic set point – half dead band).

Set point adjustment range JOY: +-3K

Set point at EnOcean-room sensor: Maximum position = +3K

=> SAB set point setting = 22°C + 3K = 25°C

If the external sensor (connected to the universal input of the JOY) is selected, the set point value of the JOY control loop is used.

An offset can be configured which is added to the SAB set point to set a higher set point in the bath than in the room.

If the assigned EnOcean room sensor fails, the JOY sends a manipulating variable of 10% to the SAB once the failure has been detected. Subsequently, an error is generated for the SAB channel and the following telegrams are no longer responded in order to put the SAB channel into self-controlled mode. Once the fault of the EnOcean room sensor has been eliminated, the function is restored.

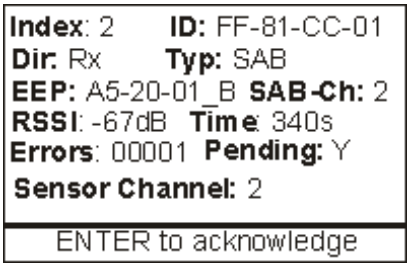
Heating/cooling

The SAB gets the manipulating variable from devices with PI controller. If a two-point controller is configured, it gets set point and actual temperature value and works in self-controlled mode.

SAB's, separated by function (heating / cooling / bath), can be put into energy-saving mode (1 hour wake-up interval for SAB05, 8 hours for SAB+) via Modbus. Register Disable Hardware Outputs (150) allows the hardware outputs of the JOY to be disabled when a SAB has been learned with the appropriate function, e.g. when using a SAB with the heating function deactivates the relay output heating. The same applies to the cooling case.

After selecting the profile respectively the room sensor, the system returns to the list display. The corresponding channel now flashes to indicate readiness for learning. After receiving a SAB learn-in telegram, the channel is updated. When a learn-in message is received which does not correspond to the SAB profile, the learning process is aborted.

Show channel



Picture 39 Menu Show channel

The descriptions of the individual points can be found in the chapter EnOcean List. Occurred or pending errors can be acknowledged with the ENTER key.

Exit

Return to the parameter menu overview.

Delete channel

Deleting a channel must be confirmed with the ENTER key. Any other key exits the menu without deleting.

8.6 Error handling

Error detection

Errors are generated after 90 minutes without receiving a radio telegram from a learned-in sensor. Exception are SAB channels in reduction of energy consumption-mode. Errors are only triggered after 16.5 hours. No errors are generated for senders with ORG byte 0xF6.

Error management

Error types

Errors are stored internally and divided into:

(1) no error	(2) pending error	(3) error gone, not acknowledged

The error display is active if one of the conditions of 2) and 3) is fulfilled. State 3) is set automatically with 2) and remains until the error is acknowledged.

Error counter

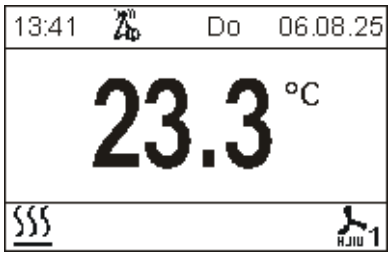
The error counter is incremented for each error that has occurred. It is always counted when the status changes from "no error" to "pending error". This means that an error that persists permanently remains at 1 until the maximum timeout time has been reached (currently 65535s = 18h). Then the error counter is set to 65535 (signed = -1).

Error display

Currently existing errors are displayed in the main screen. As soon as the error no longer exists, the display is deactivated again. In the list views, the display with the three exclamation marks remains until the error has been acknowledged.

Main screen

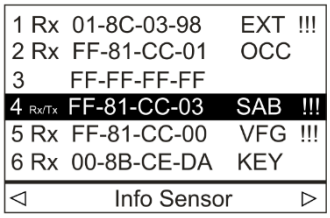
The main screen will display a pending error with the symbol  in the header!



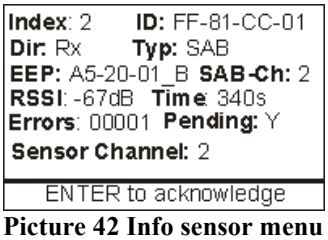
Picture 40 Error display

Parameter menu

In the parameter menu, the list of learned-in sensors/actuators can be selected. Sensors in error state will be marked in the list with 3 exclamation marks at the end of the line. The acknowledgment of an error is only possible in the password-protected area *EnOcean configuration*. A pending error is acknowledged in the *Info Sensor* menu with the ENTER key.



Picture 41 EnOcean list



Picture 42 Info sensor menu channel

Modbus

Register 538, Error list EnOcean

When reading out the register, if there is no error, the value -1 = 0xFFFF is output. In the case of pending errors, an encoding following the scheme specified below is output and the error is subsequently reset internally (reading is equalized with acknowledgment by the user).

Error coding:

Bit 0-7 – channel
Bit 8-14 – type identification
Bit 15 – error pending=1/gone=0

Type identification:

Index	Abbreviation
0	SRW
1	SRG
2	VFG
3	EXT
4	WRF
5	KEY
6	OCC
7	SAB
8	SUP
9	OUT
A	RPS
B	JEX
C	JOY

Example:
Error message for channel 1, type: EXT with pending error: 0x8301 = 0b1000 0011 0000 0001
Error message for channel 5, type: VFG with outgoing error: 0x0205 = 0b0000 0010 0000 0101

In addition, the error counter of the associated channel is buffered. The value must be read out via register 539 directly afterwards.
The next read access to the register returns the next existing error.

Register 539, Error counter EnOcean

Error counter of the last error read out via register 538. The register must be read immediately following register 538.

Acknowledgement

Manual

A manual acknowledgment of the error is possible in the *Info Sensor* submenu of the password-protected *EnOcean configuration* menu. If there is an error, the user gets the option "ENTER to acknowledge" in the footer.

Modbus

Reading out the register 538, *Error list EnOcean*, automatically acknowledges the error read out before.

Error handling

The internal reaction to a sensor failure depends on the profile used.

EXT – Reset to internal temperature sensor value
WRF - Reset to internal temperature sensor value
VFG – The changeover mode is deactivated until the next radio telegram is received
OCC – If all of the learned-in sensors (up to 3) are in error state, the occupancy mode is deactivated. Comfort mode is active.
SUP - All default values are reset. Controller and fan coil stage are switched to automatic mode. Comfort mode is active.
SRW/SRG – The last state is retained until acknowledgment or error correction.

8.7 EnOcean Configuration file SD-Card

Overview

The SD card can be used to read a configuration from the JOY. The SD card can be plugged in during configuration or it can be inserted after completing the configuration. If an SD card is inserted during the configuration, each learn-in / learn-out process is stored directly in the file. If the SD card is inserted after configuration, the configuration file is automatically created on the card after restart (file name: confEo_b.csv). **Attention: There must not be a file named confEo.csv on the SD card. In this case, the device configuration is deleted and the data from the found file is adopted.**

Only the configuration of the receive channels can be done with a SD card. This allows sensors to be learned-in without using the LRN buttons of the respective sensors.

Note: It is not possible to set up Tx- or Rx/Tx-connections automatically. For this, the usual learn-in process with sending a learn telegram is still necessary !!

Configuration file structure

The configuration file is structured according to the following scheme and is saved in csv-format:

- Name: confEo.csv
- EnOcean-configuration file header:
  - JOY;EnOcean;Version_0200
- List:

Channel	EnOcean-ID	EEP	Direction	SAB sensor channel	SAB offset	SAB channel
1-20	i.e. FF051290	**Tx:** A5-11-02 A5-10-02 A5-10-06 **Rx/Tx:** A5-20-01_H (Rx/Tx) A5-20-01_C (Rx/Tx) A5-20-01_B (Rx/Tx) **Rx:** F6-02-01 F6-04-01 F6-10-00 D5-00-01 A5-02-05 A5-02-06 A5-02-16 A5-07-01 A5-08-01 A5-10-03 A5-10-05 A5-20-12	Rx, Tx, Rx/Tx	1-20 21 = Ext. 0xFF	-10 - +10	1-6

Note: In the file all numbers are encoded in hex format !!!

Channel	EnOcean channel index
EnOcean-ID	ID of the learned-in sensor (in Rx and Rx/Tx direction), or the ID of the send channel of the JOY (Tx)
EEP	Profile identifier of the sensor / actuator. Special feature of the SAB channels: The appendix _H for the heating function, _C for the cooling function and _B for the bath function indicates the mode of operation.
Direction	Rx-, Tx- or bidirectional (Rx/Tx) channel
SAB sensor channel	Valid only when using a channel with the SAB bath function. Assigns a sensor to the SAB that provides it with the required values (temperature, setpoint). The types WRF and EXT (see table type identification) can be assigned as external EnOcean sender on channels 1-20, as well as on channel 21 the external sensor of the JOY (analog input). 0xFF means that no sensor is assigned.
SAB offset	Valid only when using a SAB channel implementing the bath function. Offset, which is calculated on the set point value of the JOY. Exception: Default values by internal sensor.
SAB channel	Assigned SAB Modbus channel (*137-143*).

8.8 Enocean data points

Configuration

SAB offset

Only for the bath function. For each SAB channel, an offset can be configured, which is added to the set point default of the JOY.

Disable hardware outputs

If one or more SABs are used, the digital output assigned to the heating or cooling function used can be deactivated. Example: A SAB is used for heating. With option 1: *Hardware outputs disabled when using a SAB*, the digital output heating is deactivated. The digital output cooling remains activated.

EnOcean Menu Password

A password can be assigned to access the EnOcean menu. With the default value 0000 the password query is deactivated and the menu can be called directly. Attention: The password must not contain any zeros since only the keys 1-9 are available for input.

Modbus

Holding register

EnOcean-Wake-Up

Sets the send interval of the broadcast channels.

Heating/cooling/bath reduction of energy consumption

The SABs can be put into energy-saving mode. The send interval of the SABs is set to 60 minutes.

Input Register

SAB channel 1-6 value of manipulating variable
Feedback of the internal SAB manipulating variable value

SAB Kanal 1-6 temperature
Feedback of the internal SAB temperature value

SAB Battery status
Feedback on whether the battery has to be replaced soon

SAB Actuator obstructed
Feedback on whether the actuator is obstructed

8.9 User-defined keys

As of version 2.3.3, user-defined keys that are assigned a light or blind function or a user-defined graphic are automatically sent as an EnOcean telegram when pressed. With light and the user-defined graphics, a distinction can be made as to whether a toggle function is formed with one button or a group of two buttons

Configuration	Function	Profile	Send value	Long press detection
17: Light Toggle	Toggle	F6-02-01	0x50 0x70	--
27: User defined graphic 1	Toggle	F6-02-01	0x50 0x70	--
18: Light on 19: Light off	ON	F6-02-01	0x50 0x00	Yes
	OFF		0x70 0x00	Yes
20: Blind up 21: Blind down	UP	F6-02-01	0x50 0x00	Yes
	DOWN		0x70 0x00	Yes
28: User defined graphic 2	Toggle	F6-02-01	0x50 0x70	--
29: User defined graphic 3	Toggle	F6-02-01	0x50 0x70	--
30: User defined graphic 4	Toggle	F6-02-01	0x50 0x70	--
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	ON	F6-02-01	0x50 0x00	Yes
	OFF		0x70 0x00	Yes
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	UP	F6-02-01	0x50 0x00	Yes
	DOWN		0x70 0x00	Yes
60: User defined graphic 1 Group 1/2 61: User defined graphic 2 Group 1/2	ON/UP	F6-02-01	0x50 0x00	Yes
	ON/UP		0x70 0x00	Yes
62: User defined graphic 3 Group 3/4 63: User defined graphic 4 Group 3/4	ON/UP	F6-02-01	0x50 0x00	Yes
	ON/UP		0x70 0x00	Yes

8.10 Overheating protection underfloor heating (UFH)

Reaching a parameterizable upper temperature limit leads to an adjustment of the heating set point, the manipulated variable or the controller mode; the values of which are transmitted to EnOcean actuators via the profiles implemented in the JOY. For profiles that use the set point offset value, the byte value 0 is transferred for the lower offset limit; for profiles that use the effective set point, the set point sent is reduced by the amount of the configured set point adjustment range (= lower offset limit). The internal heating set point, which is used to control the device-internal heating output and is output via register 512, *set point heating*, is not changed.

The overheating protection for EnOcean actuators is automatically activated if the universal input is parameterized Ext. Sensor temperature underfloor control monitoring EnOcean profile.

- Parameters:
  - Parameter 159*, Maximum temperature underfloor control*
    - Setting the upper temperature limit (range: 15 ° C - 50 ° C)
  - Extension of parameter 18, *input 1 universal input*
    - Ext. Sensor temperature underfloor control monitoring EnOcean profile
- Profile
  - A5-10-02
    - Set point offset = 0
  - A5-10-06
    - Set point offset = 0
  - A5-11-02
    - The set point is reduced by the maximum set point adjustment range
    - Manipulated variable = 0
    - Controller mode = OFF
  - A5-20-01
    - Heating function
      - PI -Controller
        - Manipulated variable = 0
      - Two-position controller
        - The effective set point is reduced by the maximum set point adjustment range
    - Bathroom function heating
      - The effective set point is reduced by the maximum set point adjustment range
      - If the assigned sensor fails, temperature monitoring is deactivated

9 LoRaWAN ®

Attention: Chapter only applies to LRW variants. JOY LoRaWAN variants do not have an RS485 Modbus interface.

9.1 General

The LoRaWAN® interface is used to
- Transmission of process data
- Adaptation of the device configuration

9.2 Structure

A Thermokon LoRaWAN® data package always consists of one or more data sets. A data set consists of
- identifier
- data

The identifier corresponds to the **register number (=protocol address + 1),** the data is always 2 bytes long.
All of the following examples are given in hexadecimal format

Example: Transmission of temperature, fan speed and heating output
0x 0203 00DF 0205 0001 0207 FF03

Up to 10 data sets will be sent in one telegram.

9.3 Data types

All values are always transmitted as UINT16 or INT16.

9.4 LoRaWAN® messages

JOY LRW supports different types of messages:
Uplink
- Heartbeat - cyclical messages with the most important process data
- COV - Automatically triggered messages when values change

Downlink
- Forced Uplink - query of any process data
- Update - writing LoRaWAN® parameters, general configuration parameters and process data

Uplink

Heartbeat

Heartbeats are used to send selected process data in one message. The heartbeat message is made up of a preceding identifier consisting of two words and the following fixed data sets consisting of identifier **(protocol address+1)** and value pairs.
The second word of the preceding identifier contains information on the device type, see register 1 (=protocol address 0).

Prefixed identifier
0x C000 06xx

The following data sets are sent in the heartbeat message:

Register	Data type	Identification
0x0200	UINT16	Set point heating
0x0201	UINT16	Set point cooling
0x0202	UINT16	Set point offset
0x022A	UINT16	Set point base
0x0203	UINT16	Internal temperature sensor
0x0207	UINT16	State fan coil stage / Output 6-way valve
0x023A*	UINT16	Humidity
0x023B**	UINT16	Air quality CO2
0x0204	UINT16	External temperature sensor
0x0205	UINT16	Output Heating
0x0206	UINT16	Output Cooling
0x020D	UINT16	Manipulating variable controller
0x020E	UINT16	Controller mode
0x020A	UINT16	State occupancy
0x020B	UINT16	State dew point
0x020C	UINT16	State window contact
0x0229	UINT16	ECO Mode
0x0236	UINT16	State Change-over

*only for rH variant
**onlyNur bei CO2-Variante

Send format

Example

ECAO2DO
Set point heating = 21°C
Set point cooling = 23°C
Set point offset = 1K
Set point base = 22.0°C
Internal temperature sensor = 22.2°C

0x C000 0601 0200 00D2 0201 00E6 0202 000A 022A 00DC 0203 00DE

A confirmation can be activated for the heartbeat to check whether there is a connection to a remote station. If there is no response to the confirmation request, 5 repetitions are sent. A missing confirmation starts a new join process.
If confirmation is activated, information on the status is displayed in the diagnostics menu.

Forced uplink

Up to 10 different registers can be **queried**. The order and type of register is arbitrary. The request must be preceded by the identifier 0xC230, the response begins with the same identifier.
Communication takes place via LoRaWAN® port

Send format
Command: Identifier | address x | address r ...
Response: Identifier | address x | value x | address r | value r ...

Example:

- Heating setpoint = 20°C
- Heating output = On
- Fan status = Automatic level 1
- Parameter Hysteresis transmission behavior = 1 - large hysteresis

Command: 0x C230 0200 0205 0207 0091 C106
Response: 0x C230 0200 00C8 0205 0001 0207 FF01 C106 0001

COV

The output registers are sent when the value changes.

The following data points are sent via COV:

Register	Data type	Identification	Unit	Description
0x0200	UINT16	Set point heating	°C	0-500 ≙ 0-50,0°C
0x0201	UINT16	Set point cooling	°C	
0x0202	UINT16	Set point offset	K	-150-150 ≙ -15-+150K
0x0203	UINT16	Internal temperature sensor	°C	0-500 ≙ 0-50,0°C
0x0204	UINT16	External temperature sensor		
0x0205	UINT16	Output heating	-	0: Off 1: On
0x0206	UINT16	Output cooling	-	
0x0207	INT16	HC-type: output 6-way valve EC-type: output EC-Fan	V	0-100 ≙ 0-10V manual -256..-156 (=0xFF00$_{hex}$-0xFF64$_{hex}$): automatic with value in V
	INT16	FC-type: output Fan	-	0: off 1: stage 1 2: stage 2 3: stage 3 -255 (=0xFF01$_{hex}$): auto stage 1 -254 (=0xFF02$_{hex}$): auto stage 2 -253 (=0xFF03$_{hex}$): auto stage 3
0x020A	UINT16	Occupancy state	-	0: unoccupied 1: occupied
0x020B	UINT16	Dewpoint state	-	0: inactive 1: active
0x020C	UINT16	Window state	-	0: close 1: open
0x020E	UINT16	Controller state	-	0: off 1: heating 2: cooling
0x0229	UINT16	Eco state	-	0: off 1: on
0x022A	UINT16	Set point base	°C	0-500 ≙ 0-50,0°C
0x0236	UINT16	Changeover state	-	0: off 1: on
0x0237*	UINT16	Internal humidity sensor	% rH	0-1000 ≙ 0-100,0%
0x023B**	UINT16	Internal CO2 sensor	ppm	0-2000ppm
0x023C**	UINT16	CO2 alarm	-	0: inactive 1: active

*only for rH variant
**only for CO2 variant
Status: Version 4.0.2

Send format

The identifier (=register address) and the value are sent. Up to 10 data records can be sent in one message.
Example FC 5DO

- Internal temperature sensor = 21°C
- Heating output = On
- Fan stage = Automatic 2

0x 0203 00DE 0205 0001 0207 FF02

Downlink

The register address **(=protocol address + 1)**, not the protocol addresses, apply for access to the process data and parameters (LoRaWan®-specific and standard). The configuration registers (see Table in Section 10.1 and Table 3) and holding registers (see Table in Section 10.2) can be written to using the register address

Updating the configuration parameters

Up to 10 parameters can be modified via their identifier (=register address). The modified parameters and their new values are sent back in response.
Communication takes place via LoRaWAN® port

Send format

Command: Identifier x | Value x | Identifier y | Value y | Identifier z | Value z | ...
Response: Identifier x | Value x | Identifier y | Value y | Identifier z | Value z | ...

Example:

- FC 5DO
- Language = English
- Main screen = Setpoint adjustment display
- Fan stages = 3
- Set point after reset Reset = 22°C

Command : 0x 0004 0001 000B 0001 0009 0003 0014 00DC
Response: 0x 0004 0001 000B 0001 0009 0003 0014 00DC

Updating the Process data

Up to 10 values can be modified via their identifier (=Modbus register). The modified parameters and their new values are returned in the response.
Communication takes place via the LoRaWAN® port

Transmission format

Command: Identifier x | Value x | Identifier y | Value y | Identifier z | Value z | …
Response: Identifier x | Value x | Identifier y | Value y | Identifier z | Value z | …

Example:

Name	Range	Data type	Modbus-protocol-address	Register
Vorgabe Präsenz	0: room unoccupied 1: room occupied -1 ≙ 0xFFFF: data point inactive	INT16	257	258

Command: 0x 0102 0001
Response: 0x 0102 0001

If an invalid value is transmitted, the value will not be accepted and the response will show the old value.

Updating the LoRaWAN® parameters

The parameters can be modified individually via their identifier (=register address) in accordance with the LoRaWAN® interface description in chapter 9.5. The identifier and the new value are returned as a response. Communication takes place via the LoRaWan® port.

Send format

Command: Identifier | Value
Response: Identifier | Value

Example:

- Data rate = DR2

Command: 0x C218 0002
Response: 0x C218 0002

The values of the parameters can be queried via a forced uplink.

9.5 LoRaWAN® configuration

General device configuration					
Identifier	*Data type*	*Designation*	*Unit*	*Default*	*Description*
0xC106	UINT16	Heartbeat interval	min	5	

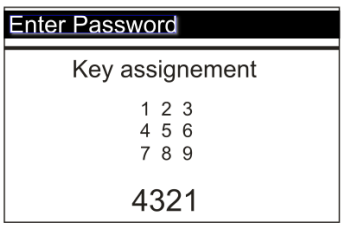
Configuration LoRaWAN®					
Identifier	*Data type*	*Designation*	*Unit*	*Default*	*Description*
0xC216	UINT16	Uplink/Downlink Port		2	Valid ports: 1 - 223
0xC217	UINT16	Adaptive data rate (ADR)		1	0= disabled; 1=enabled
0xC218	UINT16	Data rate (DR) default		0	1=DR1/spreading factor 11 2=DR2/Spreading factor 10 3=DR3/Spreading factor 9 4=DR4/Spreading factor 8 5=DR5/Spreading factor 7
0xC21D	UINT16	Confirmation Activation (for Heartbeat)		0	0= disabled; 1=enabled

9.6 Menu

Parameter menu

Password protection

The configuration menu can be password-protected via register 152 (protocol address 151).

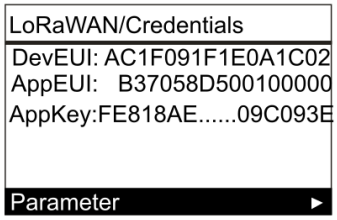


Picture 43 Password menu

The selected password must not contain a zero. Exception: The password menu is deactivated with the default password 0000. **Default password upon delivery is 4321.**

Info screen

The first screen shows information about the DevEUI, AppEUI and the AppKey. Neither value can be changed in the menu. This is only possible via the SD card configuration file.

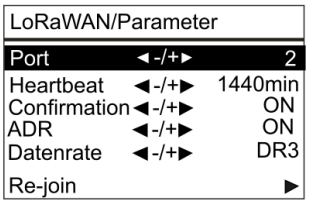


Picture 44 Display LoRaWAN credentials

The DevEUI can be found on a label on the inside of the device (after removing the top part).

Modifiable parameters

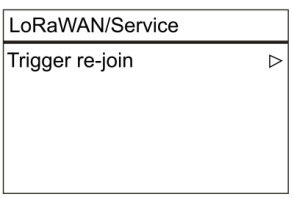
LoRaWAN® specific parameters can be modified in the second screen.



Picture 45 Modifiable parameters

Trigger re-join

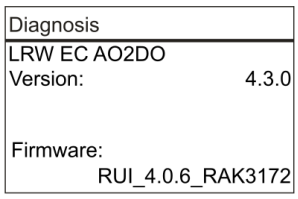
To manually reconnect. Select the line and press KEY RIGHT.



Picture 46 Trigger re-join

Diagnosis menu

The firmware version information about the LoRaWAN® module is displayed in the diagnosis menu.



Picture 47 Software version in diagnosis menu

9.7 uConfig

When saving the configuration data, uConfig creates the file with the process parameters (**confJoy.csv**) and the file with the LoRaWAN® parameters (**conflrw.csv**) mentioned in chapter 9.8. Both files must then be transferred to the device via SD card for configuration.



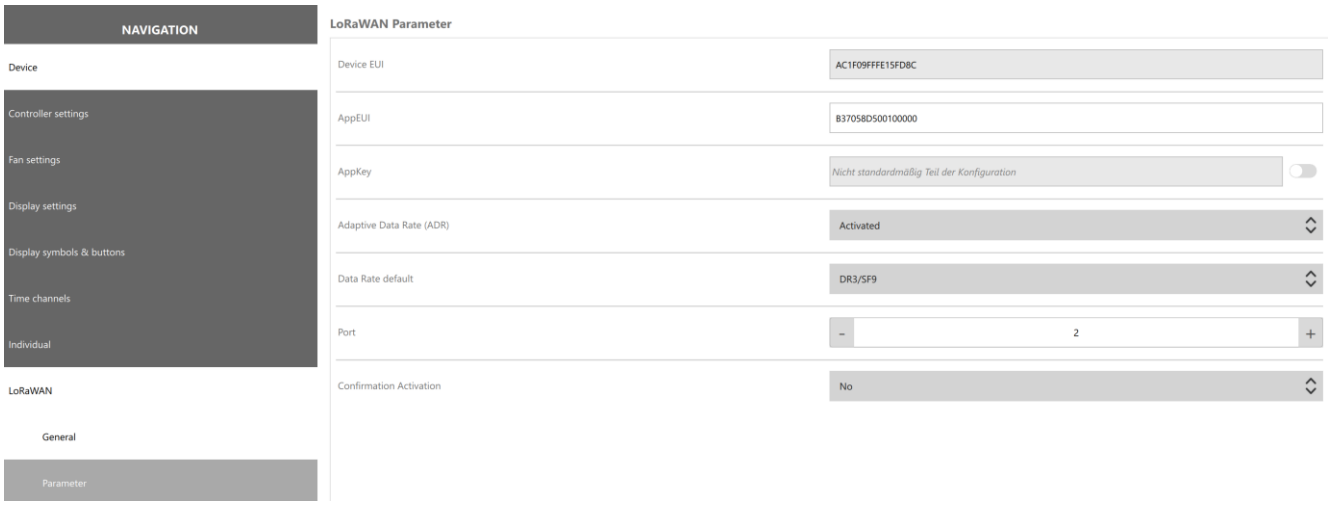
Picture 48 Saving the configuration files confJoy.csv and conflrw.csv with uConfig

Loading device files from SD card

The configuration (standard parameters and LoRaWAN parameters) can be read back from the device using an SD card. Both configurations are stored in separate files (standard = bin-format, LoRaWAN = csv-format) and can be imported into uConfig. To load the LoRaWAN® parameters (see Chapter 9.7) read from the device via SD card into uConfig, the **confLrwb.csv** file must be loaded.



Picture 49 Loading the LoRaWAN® parameters



Picture 50 uConfig LoRaWAN®-mask

9.8 SD card

An SD card can be used to configure the LoRaWAN®-specific parameters. If an SD card is inserted, the existing configuration is written to the SD card after approx. 20 seconds. The display shows: “LRW File written”. The csv format is used as the format for the configuration file. A configuration file can be created or read out with uConfig.

confLrw.csv for the file that configures the function
confLrwb.csv for the file that is read out

Structure of the configuration file
The configuration file is structured according to the following scheme and is saved in csv format:

- File name:
  - *confLrw.csv* for the file that is created with uConfig Function configured
  - *confLrwb.csv* for the file that is read from the device
- Header of the EnOcean configuration file:
  - JOY;LRW;Version_0400
- List:

JOY	Lrw	Version_0400
Identifier	Value	Description
C106	1440	Heartbeat
C107		Not used
C216	2	Port
C21D	0	Confirmation
C217	1	ADR
C218	4	Datarate
C200	FFFF	DevEui(1/2)
C201	FFFF	DevEui(3/4)
C202	FFFF	DevEui(5/6)
C203	FFFF	DevEui(7/8)
C204	70B3	AppEui(1/2)
C205	D558	AppEui(3/4)
C206	1000	AppEui(5/6)
C207	0000	AppEui(7/8)
C208	81FE	AppKey(1/2)
C209	EC8A	AppKey(3/4)
C20A	C2C9	AppKey(5/6)
C20B	EB39	AppKey(7/8)
C20C	EC57	AppKey(9/10)
C20D	3116	AppKey(11/12)
C20E	9C90	AppKey(13/14)
C20F	3E09	AppKey(16/15)

The fields for the DevEUI are irrelevant in the file created with uConfig, as the DevEUI cannot be changed and are therefore displayed with FFFF. In the file read out, the DevEUI corresponds to that of the device. The AppKey is optional. In uConfig, you can choose whether to include the AppKey in the configuration file. By default, this option is disabled.
Please note: The values for the EUIs and the keys are displayed in hexadecimal format, the other parameters in decimal format.

10 Modbus register reference

10.1 Parameters (all device types)

Configuration parameters are saved in EEPROM. They shall be written only during configuration of the device and not at runtime!

Function group	Parameter	Device types	Factory setting	Min	Max	Unit	Description	Data type	Modbus protocol address
Keys	Special function ON/OFF Button		no special function	0	255	--	0: no special function (ON/OFF active) 1: toggle occupancy 2: occupied 3: unoccupied 4: toggle ECO mode 5: occupancy party mode w/o standby 6: toggle occupancy w/o standby 7: occupied w/o standby 8: unoccupied w/o standby 9: toggle ECO mode w/o standby 255 (=0xFF): key locked (ON/OFF locked)	UINT8	115
	Special function top left			0	30	--	0: no special function 17: Light toggle 18: Light on 19: Light off 20: Blind up 21: Blind down 22: Controller mode toggle 23: Controller mode heat/cool/auto 24: Controller mode heat 25: Controller mode cool 26: Switch unit 27: User defined graphic 1	UINT8	116
	Special function top right								118
	Special function center left	HC AO2DO HC 3AO							119
	Special function center right	HC AO2DO HC 3AO							120
	Special function bottom left								121

Function group	Parameter	Device types	Factory setting	Min	Max	Unit	Description	Data type	Modbus protocol address
	Special function bottom right						28: User defined graphic 2 29: User defined graphic 3 30: User defined graphic 4 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 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 Only relevant for EnOcean variants: 60: User defined graphic 1 Group 1/2 61: User defined graphic 2 Group 1/2 62: User defined graphic 3 Group 3/4 63: User defined graphic 4 Group 3/4		123
Main screen	Display main screen		room temperature	--	--	--	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 with Kelvin 6: offset value without unit	UINT8	10
	Footer symbol 1		no symbol	--	--	--	0: no symbol 1: heating/cooling 2: occupancy 3: window contact/dew point 4: fan coil stage 5: time channel	UINT8	11
	Footer symbol 2			--	--	--			12
	Footer symbol 3			--	--	--			13
	Footer symbol 4			--	--	--			14
	Footer symbol 5			--	--	--			15
	Display set point adjustment		set point offset	--	--	--	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	UINT8	114

Function group	Parameter	Device types	Factory setting	Min	Max	Unit	Description	Data type	Modbus protocol address
	Fade in controller mode		not faded in	0	1	--	0: not faded in 1: faded in	UINT8	156
	Display humidity		Keine Anzeige	0	1	--	0: not faded in 1: faded in	UINT8	161
	Display CO2 value		Keine Anzeige	0	1	--	0: not faded in 1: faded in	UINT8	162
Common settings	Lock parameter menu		invocation released	--	--	--	0: invocation released 1: invocation locked	UINT8	124
	Language		german	--	--	--	0: german 1: english	UINT8	3
	Brightness background illumination LCD		90%	0	100	%	0-100 = 0-100%	UINT8	16
	Brightness ring		20%	0	100	%	0-100 = 0-100%	UINT8	17
	Device state after Power ON		Device ON	--	--	--	0: standby 1: last state (standby/Device ON) 2: Device ON	UINT8	130
	Device values after Power ON		Last values	--	--	--	0: last values 1: reset values	UINT8	131
Time/Date	Format time		24h	--	--	--	0: 24h(pm) 64 (=0x40): 12h(am) 255 (=0xFF): not displayed	UINT8	7
	Format date		TT.MM.JJ				0: DD.MM.YY 1: YY/MM/DD 255 (=0xFF): not displayed	UINT8	8
	Daylight saving		deactivated	0	1	--	0: deactivated 1: activated (CET)	UINT8	97
Time channel	Time channel 1 weekdays		0	0	0x7F	--	Bit0: monday Bit1: tuesday Bit2: wednesday Bit3: thursday Bit4: friday Bit5: saturday Bit6: sunday Example: 7 ≙ $0x0F_{hex}$ = monday, tuesday, wednesday, thursday	UINT8	34
	Time channel 1 start hour period 1		0	0	23	h		UINT8	35
	Time channel 1 start minute period 1		0	0	59	min		UINT8	36
	Time channel 1 set point period 1		21	0	50	°C	0-500 ≙ 0,0 – 50,0°C	UINT16	37

Function group	Parameter	Device types	Factory setting	Min	Max	Unit	Description	Data type	Modbus protocol address
	Time channel 1 fan coil stage period 1	5DO	4	0	4	--	0: off 1: stage 1 2: stage 2 3: stage 3 4: automatic	UINT8	38
		EC AO2DO, EC 3AO	1	0	1	--	0: off 1: automatic	UINT8	
		HC, HC3AO	--	--	--	--	not used	--	
	Time channel 1 ECO mode period 1		0	0	1	--	0: ECO mode OFF 1: ECO mode ACTIVE	UINT8	39
	Time channel 1 period 2								40-44
	Time channel 1 period 3							--	45-49
	Time channel 1 period 4							--	50-54
	Time channel 2							--	55-75
	Time channel 3							--	76-96
Temperature	Offset internal sensor		0	-15	15	°C	-150..150 ≙ -15,0 - 15,0°C	SINT16	4
	Offset external sensor		0	-15	15	°C	-150..150 ≙ -15,0 - 15,0°C	SINT16	5
	Unit temperature		°C	--	--	--	1: °Celsius 2: °Fahrenheit	UINT8	6
Humidity	Offset humidity		0	-15%	+15%		-150...150 ≙ -15% - +15%	INT16	158
Set point	Set point after reset		21	0	50	°C	0-500 ≙ 0,0 – 50,0°C	UINT16	20
	Adjustment range of set point		3	0	10	°C	0-100 ≙ 0,0 – 10,0°C	UINT8	21
	Set point step range		0,5	0	10	°C	0-100 ≙ 0,0 – 10,0°C	UINT8	22
	Dead band comfort		2	0	15	°C	0-150 ≙ 0,0 – 15,0°C	UINT8	23
	Dead band ECO mode		10	0	15	°C	0-150 ≙ 0,0 – 15,0°C	UINT8	24
	Set point adjustment occupancy		2	0	15	°C	0-150 ≙ 0,0 – 15,0°C	UINT8	25
	Frost protection		7	0	15	°C	0-150 ≙ 0,0 – 15,0°C	UINT8	26
	Heat protection		35	0	50	°C	0-500 ≙ 0,0 – 50,0°C	UINT16	27
	Behaviour of set point offset at occupancy change		keep value	--	--	--	0: keep value 1: reset value 2: reset value while unoccupied, restore on return to occupied	UINT8	135
	Set point calculation		Symmetrical set point	--	--	--	0: Symmetrical set point formation around the basic set point 1: Heating set point as reference value (basic set point)	UINT8	141
Controller	Controller hysteresis		1	0	15	°C	0-150 ≙ 0,0 – 15,0°C	UINT8	28

Function group	Parameter	Device types	Factory setting	Min	Max	Unit	Description	Data type	Modbus protocol address
	Controller mode after device reset		auto	--	--	--	0: off 1: heating auto 2: cooling auto 3: auto (heating/cooling) 17 (=0x11): auto heating using both digital outputs 18 (=0x12): auto cooling using both digital outputs	UINT8	29
	Valve protection release		released	--	--	--	0: locked 1: released	UINT8	33
	Mode selection manipulating variable		minimum manipulating variable remains until mode change	--	--	--	0 - minimum manipulating variable remains until mode change 1 – the manipulating variable is not output until the minimum manipulating variable has been reached	UINT8	106
	PWM cycle time		30	5	60	min		UINT8	107
	Heating controller type		PI controller	--	--	--	0 - PI controller 1 - two-point-controller	UINT8	108
	Cooling controller type		PI controller	--	--	--	0 - PI controller 1 - two-point-controller	UINT8	109
	Proportional band Xp heating		2	0	10	°C	0-100 ≙ 0,0 – 10,0°C	UINT8	102
	Reset time Tn heating		30	1	1000	min	0-1000 ≙ 0-1000min	UINT16	103
	Minimum manipulating variable heating		0	0	100	%	0-100 = 0-100%	UINT8	104
	Maximum manipulating variable heating		100	0	100	%	0-100 = 0-100%	UINT8	105
	Proportional band Xp cooling		2	0	10	°C	0-100 ≙ 0,0 – 10,0°C	UINT8	125
	Reset time Tn cooling		30	1	1000	min	0-1000 ≙ 0-1000min	UINT16	126
	Minimum manipulating variable cooling		0	0	100	%	0-100 = 0-100%	UINT8	127
	Maximum manipulating variable cooling		100	0	100	%	0-100 = 0-100%	UINT8	128
	Minimum runtime controller output	5DO EC AO2DO HC AO2DO	0	0	60	min	0-60 = 0-60 min	UINT8	146
	Delay time controller mode change	5DO EC AO2DO HC AO2DO	0	0	600	s	0-600 = 0-600 s	UINT16	147
	Maximum temperature underfloor control		35	15	50	°C	150..500 ≙ 15,0 – 50,0°C	UINT16	159
	Offset 2nd Control loop		0	-15	15	K	-150..+150 ≙ -15,0..+15,0K	INT16	140
	Mode 2nd control loop		Heating/cooling	--	--	--	0 – heating/cooling 1 – heating 2 – cooling	UINT8	169
	Minimum manipulating variable 2nd control loop		0	0	100	%	0-100 = 0-100%	UINT8	170
	Treshold district cooling		17°C	0	30	°C	0-300 ≙ 0,0 – 30,0°C	UINT16	175
	Xp district cooling		2	0	10	°C	0-100 ≙ 0,0 – 10,0°C	UINT16	176

Function group	Parameter	Device types	Factory setting	Min	Max	Unit	Description	Data type	Modbus protocol address
	Changeover limit cooling		24	10	25	°C	100-250 ≙ 10,0 – 25,0°C	UINT16	163
	Changeover limit heating		26	20	35	°C	200-350 ≙ 20,0 – 35,0°C	UINT16	164
	Start of changeover first measurement cycle		disabled	0	99	h	0 – 23 99 – disabled	UINT8	165
	Start of changeover second measurement cycle		disabled	0	99	h	0 – 23 99 – disabled	UINT8	166
	Valve opening time		12	5	15	min	5-15 ≙ 5-15min	UINT8	167
	Changeover start measurement		10	5	15	min	5-15 ≙ 5-15min	UINT16	168
Outputs	Type 6-way valve	HC AO2DO, HC 3AO, EC 3AO	0-10V steady signal heating and cooling	--	--	--	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 27 – 0-10V steady signal cooling 28 – 10-0V steady signal heating 29 – 10-0V steady signal cooling 31 –Generic	UINT8	2
	Heating 100% - generic 6-way valve	HC AO2DO, HC 3AO, EC 3AO	0	0	100	-	0-100 ≙ 0-10V	UINT8	152
	Heating 0% - generic 6-way valve		0	0	100	-		UINT8	153
	Cooling 100% - generic 6-way valve		0	0	100	-		UINT8	154
	Cooling 0% - generic 6-way valve		0	0	100	-		UINT8	155
	Maximum load heating	5DO EC AO2DO HC AO2DO	<2A	0	2	--	0: <2A 1: <4A 2: <6A	UINT8	99
	Maximum load cooling	5DO EC AO2DO HC AO2DO	<2A	0	2	--	0: <2A 1: <4A 2: <6A	UINT8	100
	Effective direction of relay heating	5DO EC AO2DO HC AO2DO	make contact	--	--	--	0: make contact 1: break contact	UINT8	132
	Effective direction of relay cooling	5DO EC AO2DO HC AO2DO	make contact	--	--	--	0: make contact 1: break contact	UINT8	133
	Effective direction of analog output heating	EC 3AO, HC 3AO	0-10V	0	1	--	0: 0-10V 1: 10-0V	UINT8	148
	Effective direction of analog output cooling	EC 3AO, HC 3AO	0-10V	0	1	--	0: 0-10V 1: 10-0V	UINT8	149

Function group	Parameter	Device types	Factory setting	Min	Max	Unit	Description	Data type	Modbus protocol address
Fan	Number of fan coil stages	5DO	3	1	3	--	1: 1 stage 2: 2 stages 3: 3 stages	UINT8	9
	Maximum fan coil value (100%) at temperature deviation	EC AO2DO EC 3AO	4	0	15	°C	0-150 ≙ 0,0 – 15,0°C	UINT8	30
	Treshold stage 1 on	5DO	0	0	15	°C	0-150 ≙ 0,0 – 15,0°C	UINT8	30
	Treshold stage 2 on	5DO	1,5	0	15	°C	0-150 ≙ 0,0 – 15,0°C	UINT8	31
	Treshold stage 3 on	5DO	3	0	15	°C	0-150 ≙ 0,0 – 15,0°C	UINT8	32
	Fan coil assignment	5DO EC AO2DO EC 3AO	heating/cooling	0	2		0: heating/cooling 1: heating 2: cooling	UINT8	98
	Steps fan coil control	EC AO2DO EC 3AO	20% steps	1	5		1: 1 step 2: 2 steps 3: 3 steps 4: 4 steps 5: 5 steps	UINT8	110
	Fan coil minimum	EC AO2DO EC 3AO	0	0	100	%	0-100 ≙ 0-10V Special case: $0x8xxx_{hex}$ = the minimum value corresponds to step 1. The step size of the control is calculated from the number of steps of the fan level control, the minimum and the maximum. Example: Steps fan coil control: 3 minimum: 5V, Maximum:7V off=0V, stage1=5V, stage2=6V, stage3= 7V	UINT16	111
	Fan coil maximum	EC AO2DO EC 3AO	0	0	100	%	0-100 ≙ 0-10V	UINT8	112
	Start-up time fan coil	5DO EC AO2DO EC 3AO	1	0	30	s	0-30s ≙ 0 – 300	UINT8	113
	Fan start with manipulated variable > x	5DO EC AO2DO EC 3AO	0	0	40		0-40 ≙ >0%->40%	UINT8	129
	Key fan stage with/without AUTO	5DO EC AO2DO EC 3AO	with AUTOMATIC	--	--	--	0: with AUTOMATIC 1: without AUTOMATIC 2: with AUTOMATIC,without MANUAL OFF 3: without AUTOMATIC&without MANUAL OFF	UINT8	134
	Fan follow-up-time	5DO EC AO2DO EC 3AO	0	0	600	s	0-600 ≙ 0-600s	UINT16	157

Function group	Parameter	Device types	Factory setting	Min	Max	Unit	Description	Data type	Modbus protocol address
	Limitation of max. fan speed in automatic mode	EC AO2DO EC 3AO	0	0	100	%	0-100 ≙ 0-100%	UINT16	160
		5DO	0	3	3	-	1: stage 1 2: stage 2 3: stage 3		
Occupancy	Occupied/ ECO override		Occupancy state without effect on ECO mode	--	--	--	0: Occupancy state without effect on ECO mode 1: OCCUPANCY state overrides ECO mode	UINT8	136
	Party mode		0	0	240	min	0-240 ≙ 0-240min	UINT16	174
Inputs	Input 1 universal (low voltage)		Not used	--	--	--	0: Not used 1: External temperature sensor (NTC10k) 2: Change-Over sensor (NTC10k) 3: External temperature sensor EnOcean(NTC10k) 4: External temperature sensor UFH (NTC10k) - Heating output switch-off (JOY) 5: External temperature sensor UFH (NTC10k) – switch-off actuators via EnOcean (only SR types!) 6: External temperature sensor (NTC10k) – 2nd control loop 7: External temperature sensor return flow(NTC10k) – district cooling 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	UINT8	18

Function group	Parameter	Device types	Factory setting	Min	Max	Unit	Description	Data type	Modbus protocol address
	Input 2 (230V input for 230V types, low voltage for 24V types)		Not used	--	--	--	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	UINT8	19
	Input 3 (low voltage)	all devices without Modbus-interface	Not used	--	--	--	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	UINT8	--
CO2	CO2 alarm threshold	CO2	1200	400	1200	ppm	400-2000 ≙ 400-2000ppm	UINT16	171
	Altitude above sea level	CO2	200	0	3000	m	0-3000 ≙ 0-3000m	UINT16	172
	ASC activation (automatic self calibration)	CO2	enabled	--	--	--	0 – disabled 1 – enabled	UINT8	173
	CO2 Offset		0	-1000	1000	ppm	CO2 Offset	INT16	177

10.2 Modbus Register

Info Register (read only, only Modbus types)

<table>
<tr><th>Function group</th><th>Name</th><th>Type</th><th>Factory setting</th><th>Min</th><th>Max</th><th>Unit</th><th>Description</th><th>Data type</th><th>Modbus Protocol adress</th></tr>
<tr><td rowspan="2">Info</td><td>Device type</td><td></td><td>--</td><td>--</td><td>--</td><td>--</td><td>0x0600 JOY Fancoil 5DO
0x0601 JOY Fancoil EC AO2DO
0x0602 JOY HC AO2DO
0x0604 JOY Fancoil EC 3AO
0x0605 JOY HC 3AO
0x0612 JOY SR HC AO2DO
0x0614 JOY SR Fancoil EC 3AO
0x0615 JOY SR HC 3AO
… …

Bit encoding<table><tr><td>JOY</td><td>0x0600</td></tr><tr><td>No radio</td><td>0x0000</td></tr><tr><td>SR</td><td>0x0010</td></tr><tr><td>LoRaWan</td><td>0x0080</td></tr><tr><td>CO2</td><td>0x0040</td></tr><tr><td>rH</td><td>0x0020</td></tr><tr><td>FC 5DO</td><td>0x0000</td></tr><tr><td>EC AO2DO</td><td>0x0001</td></tr><tr><td>HC AO2DO</td><td>0x0002</td></tr><tr><td>N/A</td><td>0x0003</td></tr><tr><td>EC 3AO</td><td>0x0004</td></tr><tr><td>HC 3AO</td><td>0x0005</td></tr><tr><td>HC AO2DO 24V</td><td>0x0006</td></tr><tr><td>HC 1DO</td><td>0x0007</td></tr><tr><td>EC AO2DO 24V</td><td>0x0008</td></tr><tr><td>FC 5DO 24V</td><td>0x0009</td></tr></table>
Example:
JOY SR CO2 rH EC AO2DO = 0x0671
= 0x600 + 0x0010 + 0x0040 + 0x0020 + 0x0001</td><td>UINT16</td><td>0</td></tr>
<tr><td>Firmware</td><td></td><td>--</td><td>--</td><td>--</td><td>--</td><td>0xAABB –> AA = Major version, BB = Minor version
Beispiel:
Version 2.0 => 0x0200</td><td>UINT16</td><td>1</td></tr>
</table>

Modbus Holding Register (Modbus types only)

Function group	Parameter	Device types	Factory setting	Min	Max	Unit	Description	Data type	Modbus protocol address
Set point	Basic set point		data point inactive	-1	50	°C	0-500 ≙ 0,0 - 50,0°C 0xFFFF = -1 data point inactive	INT16	255
	Set point offset		0	-15	15	°C	-150-150 ≙ -15,0 - 15,0°	INT8	256
--	Default occupancy		data point inactive	-1	1	--	0: room unoccupied 1: room occupied -1 ≙ 0xFFFF: data point inactive	INT16	257
--	Default dew point		data point inactive	-1	1	--	0: dew point inactive 1: dew point active -1 ≙ 0xFFFF: data point inactive	INT16	258
--	Default window contact/ reduction of energy consumption		data point inactive	-1	1	--	0: window closed 1: window open -1 ≙ 0xFFFF: data point inactive	INT16	259
--	Default Change-Over		data point inactive	-1	1	--	0: heating mode (cooling locked) 1: cooling mode (heating locked) -1 ≙ 0xFFFF: data point inactive	INT16	260
--	Device On/standby (Off)		On	0	1	--	0: Device on 1: standby (off)	UINT8	261
--	Release of keys		all keys released	0	2	--	0: all keys released 1: all keys locked 2: fan coil keys locked	UINT8	262
--	Default alarm		alarm inactive	0	1	--	0: alarm inactive 1: alarm active	UINT8	263
Time/Date	Time hour		12	0	23	h		UINT8	264
	Time minute		0	0	59	min		UINT8	265
	Date day		1	1	31	--		UINT8	266
	Date month		1	1	12	--		UINT8	267
	Date year		15	15	99	--		UINT8	268

Controller	Default Controller		AUTO	--	--	--	0: off 1: heating AUTO 2: cooling AUTO 3: AUTO 17 (=0x11): heating AUTO, both outputs (heating and cooling) are triggered in parallel *Control output only with 5DO, HC AO2DO, EC AO2DO* 18 (=0x12): cooling AUTO, both outputs (heating and cooling) are triggered in parallel *Control output only with 5DO, HC AO2DO, EC AO2DO* -256 (=0xFF00): outputs OFF(manual mode), frost- and heatprotection disabled -255 (=0xFF01): output heating ON (MANUAL Mode*)* , symbol heating is faded-in *Control output only with 5DO, HC AO2DO, EC AO2DO* -254 (=0xFF02): output cooling ON (MANUAL Mode) , symbol cooling is faded-in *Control output only with 5DO, HC AO2DO, EC AO2DO* -239 (=0xFF11 heating MANUAL, both outputs (heating and cooling) switched ON in parallel, symbol heating is faded-in *Control outputs only with 5DO, HC AO2DO, EC AO2DO* -238 (=0xFF12): cooling MANUAL, both outputs (heating and cooling) switched ON in parallel, symbol cooling is faded-in *Control outputs only with 5DO, HC AO2DO, EC AO2DO* 3AO types (EC 3AO, HC 3AO): The specifications of the manual modes (-255, -254, -239, -238) only control the symbol not the ouputs, see register 271 and 272	INT16	269

Fan coil	Default Fan coil	EC AO2DO EC 3AO	AUTO	--	--	--	0-100 ≙ 0-10V MANUAL -256 (=0xFF00$_{hex}$) = AUTO	INT16	270
		HC AO2DO HC 3AO	off	0	3	--	0: off 1: stage 1 2: stage 2 3: stage 3	UINT8	
		5DO	AUTO	0	4	--	0: off 1: stage 1 2: stage 2 3: stage 3 4: AUTO	UINT8	
Outputs	Default output heating	EC 3AO HC 3AO	data point inactive	--	--	--	0-100 (=0x00-0x64) ≙ 0-10V, no symbol -1(=0xFFFF): data point inactive, output is controlled by controller	INT16	271
	Default output cooling	EC 3AO HC 3AO	data point inactive	--	--	--	0-100 (=0x00-0x64) ≙ 0-10V, no symbol -1 (=0xFFFF): data point inactive, output is controlled by controller	INT16	272
	Default 6- way valve output	HC 3AO HC AO2DO	data point inactive	--	--	--	0-100 (=0x00-0x64) ≙ 0-10V, no symbol -1(=0xFFFF): data point inactive, output is controlled by controller	INT16	273
	Default ECO mode		deactivate ECO mode	0	1	--	0: deactivate ECO mode 1: activate ECO mode	UINT8	274

Modbus Input Register (Modbus types only)

Function group	Parameter	Device types	Factory setting	Min	Max	Unit	Description		Modbus protocol address
Set point	Set point heating		--	0	50	°C	0-500 ≙ 0-50,0°C	UINT16	511
	Set point cooling		--	0	50	°C	0-500 ≙ 0-50,0°C	UINT16	512
	Set point offset		--	-15	15	°C	-150-150 ≙ -15,0 - 15,0°	INT8	513
	Absolute set point		--	0	50	°C	0-500 ≙ 0-50,0°C	UINT16	553
Temperature	Internal temperature sensor		--	0	50	°C	0-500 ≙ 0-50,0°C	UINT16	514
	External temperature sensor		--	0	50	°C	0-500 ≙ 0-50,0°C 600 – no sensor detected	UINT16	515
Outputs	Output heating	5DO EC AO2DO HC AO2DO	--	0	1	--	0: open 1: closed	UINT8	516

Function group	Parameter	Device types	Factory setting	Min	Max	Unit	Description		Modbus protocol address
		EC 3AO HC 3AO	--	0	100	%	0-100 (=0x00-0x64) ≙ 0-10V	UINT8	
	Output cooling	5DO, EC AO2DO HC AO2DO	--	0	1	--	0: open 1: closed	UINT8	517
		EC 3AO, HC 3AO	--	0	100	%	0-100 (=0x00-0x64) ≙ 0-10V	UINT8	
Fan coil	State fan coil stage	5DO	--	--	--	--	0: off 1: stage 1 2: stage 2 3: stage 3 -255 (=0xFF01$_{hex}$): Auto stage 1 -254 (=0xFF02$_{hex}$): Auto stage 2 -253 (=0xFF03$_{hex}$): Auto stage 3	INT16	518
		EC AO2DO EC 3AO	--	--	--	--	0-100 ≙ 0-10V Manual -256..-156 (=0xFF00$_{hex}$-0xFF64$_{hex}$): Automatic with value in volt	INT16	
Outputs	Output 6-way valve	HC AO2DO HC 3AO	--	--	--	--	0-100 (=0x00-0x64) ≙ 0-10V	UINT8	
Inputs	State input 1		--	0	1	--	0: open 1: closed	UINT8	519
	State input 2		--	0	1	--	0: open 1: closed	INT16	520
---	State occupancy		--	-1	1	--	0: room unoccupied 1: room occupied -1 ≙ 0xFFFF: data point inactive	INT16	521
---	State dew point		--	-1	1	--	0: dew point inactive 1: dew point active -1 ≙ 0xFFFF: data point inactive	INT16	522
---	State window contact/reduction of energy consumption		--	-1	1	--	0: window closed 1: window open -1 ≙ 0xFFFF: data point inactive	INT16	523
Controller	Manipulating variable controller		--	0	100	%	0-100 (=0x00-0x64) ≙ 0-10V	UINT8	524
	Controller mode		--	0	2	--	0: off 1: heating 2: cooling	UINT8	525
	Feedback Change-Over state			-1	1	--	0: Heating (Cooling disabled) 1: Cooling (Heating disabled) 2: Error -1 ≙ 0xFFFF: data point inactive	INT16	565
	Manipulating variable 2nd control loop			0	100	%	0-100 (=0x00-0x64) entspr. 0-10V	UINT8	572

Function group	Parameter	Device types	Factory setting	Min	Max	Unit	Description		Modbus protocol address
---	ECO mode		--	0	1	--	0: ECO mode inactive 1: ECO mode active	UINT8	552
Keys	Top left			0	101	--	0: no operation since last read-out 1++: number of operations since last read-out 101: continuous pressure (> 200ms)	UINT8	556
	Top center								557
	Top right								558
	Center left								559
	Center center								560
	Center right								561
	Bottom left								562
	Bottom center								563
	Bottom right								564
Humidity	Internal humidity sensor	rH		0	100	%	0-1000 ≙ 0-100,0%	UINT16	566
CO2	Internal CO2 Sensor		--	0	2000	ppm	0-2000	UINT16	570
	CO2 Alarm		--	0	1	-	0 – No alarm 1 – Alarm threshold reached	UINT16	571

10.3 EnOcean enhancement

Configuration Register

Function group	Parameter	Device types	Factory setting	Min	Max	Unit	Description		Modbus protocol address
EnOcean	SAB offset Kanal 1	SR	0	-10	10	K	-100..+100 ≙ -10,0..+10,0°C	INT16	139
	EnOcean-Wake-up		15	1	60	min	1..+60 ≙ 1..60 minutes	UINT8	145
	Deactivation Hardware outputs	FC5DO ECAO2DO HCAO2DO SR	0	0	1	--	0: Hardware outputs are controlled in parallel to SAB 1: Hardware outputs are deactivated when a SAB is used	UINT8	150
	EnOcean menu password	SR	0000	0000	9999	--	0000: Password deactivated >=1111 Password activated Attention: The password must not contain any zeros.	UINT16	151

Modbus Holding Register

Function group	Parameter	Device types	Factory setting	Min	Max	Unit	Description		Modbus protocol address
EnOcean	Heating reduction of energy consumption	SR	deactivated	0	1	--	0: deactivated 1: activated	UINT8	275
	Cooling reduction of energy consumption		deactivated	0	1	--	0: deactivated 1: activated	UINT8	276
	Bath reduction of energy consumption		deactivated	0	1	--	0: deactivated 1: activated	UINT8	277

Modbus Input Register

Function group	Parameter	Device types	Factory setting	Min	Max	Unit	Description		Modbus protocol address
SAB	SAB channel 1 value manipulating variable	SR	--	0	100	%	0..+100 ≙ -0..100%	UINT8	526
	SAB channel 1 temperature		--	0	40	°C	0..+255 ≙ -0,0..+40,0°C	UINT8	527
	SAB channel 2 value manipulating variable		--	0	100	%	0..+100 ≙ -0..100%	UINT8	528
	SAB channel 2 temperature		--	0	40	°C	0..+255 ≙ -0,0..+40,0°C	UINT8	529
	SAB channel value manipulating variable		--	0	100	%	0..+100 ≙ -0..100%	UINT8	530
	SAB channel 3 temperature		--	0	40	°C	0..+255 ≙ -0,0..+40,0°C	UINT8	531
	SAB channel 4 value manipulating variable		--	0	100	%	0..+100 ≙ -0..100%	UINT8	532
	SAB channel 4 temperature		--	0	40	°C	0..+255 ≙ -0,0..+40,0°C	UINT8	533
	SAB channel value manipulating variable		--	0	100	%	0..+100 ≙ -0..100%	UINT8	534
	SAB channel 5 temperature		--	0	40	°C	0..+255 ≙ -0,0..+40,0°C	UINT8	535
	SAB channel 6 value manipulating variable		--	0	100	%	0..+100 ≙ -0..100%	UINT8	536
	SAB channel 6 temperature		--	0	40	°C	0..+255 ≙ -0,0..+40,0°C	UINT8	537
	SAB channel 1 ID High Word		--	0	65535	--		UINT16	540
	SAB channel 1 ID Low Word		--	0	65535	--		UINT16	541
	SAB channel 2 ID High Word		--	0	65535	--		UINT16	542
	SAB channel 2 ID Low Word		--	0	65535	--		UINT16	543
	SAB channel 3 ID High Word		--	0	65535	--		UINT16	544
	SAB channel 3 ID Low Word		--	0	65535	--		UINT16	545
	SAB channel 4 ID High Word		--	0	65535	--		UINT16	546
	SAB channel 4 ID Low Word		--	0	65535	--		UINT16	547
	SAB channel 5 ID High Word		--	0	65535	--		UINT16	548
	SAB channel 5 ID Low Word		--	0	65535	--		UINT16	549
	SAB channel 6 ID High Word		--	0	65535	--		UINT16	550
	SAB channel 6 ID Low Word		--	0	65535	--		UINT16	551

Function group	Parameter	Device types	Factory setting	Min	Max	Unit	Description		Modbus protocol address
	SAB Battery status		--	0	0x3F	--	0: no error 1: Battery has to be replaced soon Bit coding: Bit0: SAB-Channel 1 … Bit5: SAB-Channel 6	UINT8	554
	SAB Actuator obstructed		--	0	0x3F	--	0: no error 1: Actuator obstructed Bit coding: Bit0: SAB-Channel 1 … Bit5: SAB-Channel 6	UINT8	555
Error management	Error list EnOcean		--	--	--	--	Bit 0-7 – channel Bit 8-14 – type identification Bit 15 – error pending=1/gone=0	UINT8	538
	Error counter EnOcean		--	0	65535	--		UINT16	539
Temperature	EXT EnOcean sensor			0	50	°C	0-500 ≙ 0-50,0°C Feedback of the external EnOcean sensor learned-in under EXT/WRF	UINT16	567
	EXT EnOcean sensor SAB bath			0	50	°C	0-500 ≙ 0-50,0°C Feedback of the external EnOcean sensor learned-in under EXT/WRF, which is assigned to an SAB Bad control loop.	UINT16	568
CO2	EXT EnOcean sensor CO2		--	0	2000	ppm	0-2000	UINT16	569
Rocker switch	Feedback EnOcean Rocker Switch RPS profile		-	-	-	-	Bit 4 – Left OFF (Left top), 4 Rocker PTM100 and PTM200 Bit 5 – Left ON (Left bottom), 4 Rocker PTM100 and PTM200 Bit 6 – Right OFF (Right top),4 Rocker PTM200 resp. OFF (top button),2 Rocker PTM200 Bit 7 – Right ON (Right bottom), 4 Rocker PTM200 resp. ON (bottom button), 2 Rocker PTM200	UINT8	1023

11 Appendix

11.1 Device coding

Device offset	JOY	0b0000 0110 0000 0000	0x0600
Hardware type	FC 5DO	0b0000 0000 0000 **0000**	0x0000
	EC AO2DO	0b0000 0000 0000 **0001**	0x0001
	HC AO2DO	0b0000 0000 0000 **0010**	0x0002
	ROP	0b0000 0000 0000 **0011**	0x0003
	EC 3AO	0b0000 0000 0000 **0100**	0x0004
	HC 3AO	0b0000 0000 0000 **0101**	0x0005
	HC AO2DO 24V	0b0000 0000 0000 **0110**	0x0006
	HC 1DO	0b0000 0000 0000 **0111**	0x0007
	EC AO2DO 24V	0b0000 0000 0000 **1000**	0x0008
	FC 5DO 24V	0b0000 0000 0000 **100**	0x0009
Sensors	rH	0b0000 0000 0010 0000	0x0020
	CO2	0b0000 0000 0100 0000	0x0040
Radio variant	No radio	0b0000 0000 0000 0000	0x0000
	SR (EnOcean)	0b0000 0000 0001 0000	0x0010
	LRW	0b0000 0000 1000 0000	0x0080

11.2 Register list sorted numerically

11.3 Holding Register

Modbus Holding Register (R/W)		
Protocol address	**Description**	**Device type only**
0	(#)	
1	(#)	
2	(#) 6-way valve type	HC AO2DO, HC 3AO, EC 3AO
3	(#) Language	
4	(#) Offset internal sensor	
5	(#) Offset external sensor	
6	(#) Unit temperature	
7	(#) Format time	
8	(#) Format date	
9	(#) Number of fan coil stages	5DO
10	(#) Display main screen	
11	(#) Footer symbol 1	
12	(#) Footer symbol 2	
13	(#) Footer symbol 3	
14	(#) Footer symbol 4	
15	(#) Footer symbol 5	
16	(#) Brightness background illumination LCD	
17	(#) Brightness ring	
18	(#) Input 1 universal input	
19	(#) Input 2 230V input	
20	(#) Set point after reset	
21	(#) Set point adjustment	
22	(#) Set point stepping	

Modbus Holding Register (R/W)		
Protocol address	**Description**	**Device type only**
23	(#) Deadband comfort mode	
24	(#) Deadband ECO mode	
25	(#) Set point adjustment standby	
26	(#) Frost protection	
27	(#) Heating protection	
28	(#) Controller hysteresis	
29	(#) Controller mode after device restart	
30	(#)Maximum fan coil value (100%) at temperature deviation	EC AO2DO EC 3AO
30	(#) Threshold fan coil stage 1 On	5DO
31	(#) Threshold fan state 2 On	
32	(#) Threshold fan coil stage 3 On	
33	(#) Release valve protection	
34	(#) Time channel 1 weekday	
35	(#) Time channel 1 start time hour period 1	
36	(#) Time channel 1 start time minute period 1	
37	(#) Time channel 1 set point period 1	
38	(#) Time channel 1 fan coil stage period 1	5DO EC AO2DO, EC 3AO
39	(#) Time channel 1 ECO mode period 1	
40	(#) Time channel 1 start time hour period 2	
41	(#) Time channel 1 start time minute period 2	
42	(#) Time channel 1 set point period 2	
43	(#) Time channel 1 fan coil stage period 2	5DO EC AO2DO EC 3AO
44	(#) Time channel 1 ECO Mode period 1	
45	(#) Time channel 1 start time hour period 3	
46	(#) Time channel 1 start time minute period 3	
47	(#) Time channel 1 set point period 3	
48	(#) Time channel 1 fan coil stage period 3	5DO EC AO2DO EC 3AO
49	(#) Time channel 1 ECO mode period 3	
50	(#) Time channel 1 start time hour period 4	
51	(#) Time channel 1 start time minute period 4	
52	(#) Time channel 1 set point period 4	
53	(#) Time channel 1 fan coil stage period 4	5DO EC AO2DO EC 3AO
54	(#) Time channel 1 ECO mode period 4	
55	(#) Time channel 2 weekdays	
56	(#) Time channel 2 start time hour period 1	
57	(#) Time channel 2 start time minute period 1	
58	(#) Time channel 2 set point period 1	
59	(#) Time channel 2 fan coil stage period 1	5DO EC AO2DO EC 3AO
60	(#) Time channel 2 ECO mode period 1	
61	(#) Time channel 2 start time hour period 2	
62	(#) Time channel 2 start time minute period 2	
63	(#) Time channel 2 set point period 2	
64	(#) Time channel 2 fan coil stage period 2	5DO EC AO2DO EC 3AO
65	(#) Time channel 2 ECO mode period 1	
66	(#) Time channel 2 start time hour period 3	
67	(#) Time channel 2 start time minute period 3	

Modbus Holding Register (R/W)		
Protocol address	**Description**	**Device type only**
68	(#) Time channel 2 set point period 3	
69	(#) Time channel 2 fan coil stage period 3	5DO EC AO2DO EC 3AO
70	(#) Time channel 2 ECO mode period 3	
71	(#) Time channel 2 start time hour period 4	
72	(#) Time channel 2 start time minute period 4	
73	(#) Time channel 2 set point period 4	
74	(#) Time channel 2 fan coil stage period 4	5DO EC AO2DO EC 3AO
75	(#) Time channel 2 ECO mode period 4	
76	(#) Time channel 3 weekdays	
77	(#) Time channel 3 start time hour period 1	
78	(#) Time channel 3 start time minute period 1	
79	(#) Time channel 3 set point period 1	
80	(#) Time channel 3 fan coil stage period 1	5DO EC AO2DO EC 3AO
81	(#) Time channel 3 ECO mode period 1	
82	(#) Time channel 3 start time hour period 2	
83	(#) Time channel 3 start time minute period 2	
84	(#) Time channel 3 set point period 2	
85	(#) Time channel 3 fan coil stage period 2	5DO EC AO2DO EC 3AO
86	(#) Time channel 3 ECO mode period 1	
87	(#) Time channel 3 start time hour period 3	
88	(#) Time channel 3 start time minute period 3	
89	(#) Time channel 3 set point period 3	
90	(#) Time channel 3 fan coil stage period 3	5DO EC AO2DO EC 3AO
91	(#) Time channel 3 ECO mode period 3	
92	(#) Time channel 3 start time hour period 4	
93	(#) Time channel 3 start time minute period 4	
94	(#) Time channel 3 set point period 4	
95	(#) Time channel 3 fan coil stage period 4	5DO EC AO2DO EC 3AO
96	(#) Time channel 3 ECO mode period 4	
97	(#) Daylight saving	
98	(#) Fan coil assignment	5DO EC AO2DO EC 3AO
99	(#) Max heating load	5DO EC AO2DO HC AO2DO
100	(#) Max cooling load	
101	(#)	
102	(#) Proportional band Xp	
103	(#) Reset time Tn	
104	(#) Minimum actuating variable	
105	(#) Maximum actuating variable	
106	(#)Mode Selection Control Variable	
107	(#) PWM cycle time	
108	(#)Heating controller type	
109	(#)Cooling controller type	
110	(#) Steps fan coil control	EC AO2DO EC 3AO
111	(#) Fan coil minimum	

Modbus Holding Register (R/W)		
Protocol address	**Description**	**Device type only**
112	(#) Fan coil maximum	
113	(#) Startup-time fan coil	5DO EC AO2DO EC 3AO
114	(#) Display set point adjustment	
115	(#) Special function key ON/OFF	
116	(#) Special function top left	
118	(#) Special function top right	
119	(#) Special function center left	HC AO2DO HC 3AO
120	(#)Special function center right	
121	(#)Special function bottom left	
123	(#)Special function bottom right	
124	(#) Lock parameter menu	
125	(#) Proportional band Xp cooling	
126	(#) Reset time Tn cooling	
127	(#) Minimum actuating variable cooling	
128	(#) Maximum actuating variable cooling	
129	(#) Switch/control behavior fan stages	5DO EC AO2DO EC 3AO
130	(#) Device state after reset	
131	(#) Device values after reset	
132	(#) Effective direction of output heating	5DO EC AO2DO HC AO2DO
133	(#) Effective direction of output cooling	
134	(#)Key fan stage with/without AUTO	5DO EC AO2DO EC 3AO
135	(#) Behavior setpoint offset	
136	(#) Occupied- / ECO-override	
137	(#) not used	
138	(#) not used	
139	(#) SAB-Offset Bad-Funktion	SR-type
140	(#)Offset 2nd Control loop	
141	(#) not used	
142	(#) not used	
143	(#) not used	
144	(#) not used	
145	(#) EnOcean-Wake-up	
146	(#) Minimum runtime controller output	5DO EC AO2DO
147	(#) Delay time controller mode change	
148	(#) Effective direction of analog output heating	EC 3AO, HC 3AO
149	(#) Effective direction of analog output cooling	
150	(#) Deactivation Hardware outputs	
151	(#) EnOcean menu password	
152	(#) Heating 100% - generic 6-way valve	HC AO2DO HC 3AO EC 3AO
153	(#) Heating 0% - generic 6-way valve	
154	(#) Cooling 100% - generic 6-way valve	
155	(#) Cooling 0% - generic 6-way valve	
156	(#) Fade in controller mode	
157	(#) Fan follow-up-time	5DO EC AO2DO EC 3AO
158	(#) Offset humidity	rH- type
159	(#) Maximum temperature underfloor control	
160	(#) Limitation of max. fan speed in automatic mode	EC AO2DO EC 3AO
161	(#) Display humidity	rH type
162	(#) Display CO2	CO2 type

Modbus Holding Register (R/W)		
Protocol address	**Description**	**Device type only**
163	(#) Changeover limit cooling	
164	(#) Changeover limit heating	
165	(#) Start of changeover first measurement cycle	
166	(#) Start of changeover second measurement cycle	
167	(#) Valve opening time	
168	(#) Changeover start measurement	
169	(#) Mode 2nd control loop	
170	(#) Minimum manipulating variable 2nd control loop	
171	(#) CO2 alarm threshold	CO2 type
172	(#) Altitude above sea level	CO2 type
173	(#) ASC activation (automatic self calibration)	CO2 type
174	(#) Party mode	
175	(#) Treshold district cooling	
176	(#) Xp district cooling	
177	(#) CO2 offset	CO2 type
Protocol address	**Description**	**Device type only**
255	Basic set point	
256	Set point offset	
257	Default presence	
258	Default dew point	
259	Default window contact/energy hold off	
260	Default change-over	
261	Device On/Off	
262	Release keys	
263	Default alarm	
264	Time hour	
265	Time minute	
266	Date day	
267	Date month	
268	Date year	
269	Default controller	
270	Fan coil stage	
271	Default output heating	EC 3AO HC 3AO
272	Default output cooling	
273	Default 6- way valve output	HC 3AO HC AO2DO
274	Default ECO mode	
275	Heating reduction of energy consumption	SR- type
276	Cooling reduction of energy consumption	
277	Bath reduction of energy consumption	

The registers marked with # are stored in the EEPROM. They may only be written during configuration of the unit and not during operation!

11.4 Input Register

Modbus Input Register (R)		
Protocol address	**Description**	**Device type only**
511	Set point heating	
512	Set point cooling	
513	Set point offset	
514	Internal temperature sensor	
515	External temperature sensor	
516	Output heating	
517	Output cooling	
518	State fan coil stage	
519	State input 1	
520	State input 3	
521	State presence	
522	State dew point	
523	State window contact/energy off	
524	Actuating variable controller	
525	Controller mode feedback	
526	SAB channel 1 value manipulating variable	SR- type
527	SAB-channel 1 temperature	
528	SAB channel 2 value manipulating variable	
529	SAB-channel 2 temperature	
530	SAB channel 3 value manipulating variable	
531	SAB-channel 3 temperature	
532	SAB channel 4 value manipulating variable	
533	SAB-channel 4 temperature	
534	SAB channel 5 value manipulating variable	
535	SAB-channel 5 temperature	
536	SAB channel 6 value manipulating variable	
537	SAB-channel 6 temperature	
538	Error list EnOcean	
539	Error counter EnOcean	
540	SAB-Kanal 1 ID High Word	
541	SAB-Kanal 1 ID Low Word	
542	SAB-Kanal 2 ID High Word	
543	SAB-Kanal 2 ID Low Word	
544	SAB-Kanal 3 ID High Word	
545	SAB-Kanal 3 ID Low Word	
546	SAB-Kanal 4 ID High Word	
547	SAB-Kanal 4 ID Low Word	
548	SAB-Kanal 5 ID High Word	
549	SAB-Kanal 5 ID Low Word	
550	SAB-Kanal 6 ID High Word	
551	SAB-Kanal 6 ID Low Word	
552	ECO-Mode	
553	Basic set point	
554	SAB Battery status	SR- type
555	SAB Actuator obstructed	
556	Top left	
557	Top center	
558	Top right	
559	Center left	
560	Center center	
561	Center right	
562	Bottom left	
563	Bottom center	
564	Bottom right	
565	Feedback Change-Over state	

Modbus Input Register (R)		
Protocol address	**Description**	**Device type only**
566	Internal humidity sensor	rH- type
567	EXT EnOcean sensor	
568	EXT EnOcean sensor SAB bath	
569	EXT EnOcean CO2 sensor	
570	CO2 sensor	CO2
571	CO2 alarm	
572	Manipulating variable 2nd control loop	

11.5 Supported Control Commands

The following MODBUS control commands are supported:

Description	Function Code	
Read Holding Register	03 (hex)	3 (dez)
Read Input Register	04 (hex)	4 (dez)
Write single Register	06 (hex)	06 (dez)
Write multiple registers	10 (hex)	16 (dez)

Table 2 Supported Modbus Commands

11.6 Data Transmission

Master/Slave Protocol

One Master and one or more slaves are connected to the serial bus. Communication between Master and Salve is solely regulated by the Master. The Slaves are only allowed to transmit if they were addressed by the Master before. Slaves are only transmitting back to the Master, never to another slave.

Data Frame

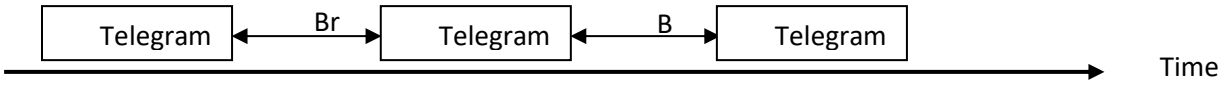
Data packets are transmitted according to strictly defined defaults:

Address	Control	Data	Checksum

In general a MODBUS telegram is started with the address of the slave, following a control command (e.g. read out registers) and the data. By means of the checksum at the telegram-end the bus participants can recognize transmission errors.

Transmission Mode RTU

In transmission mode RTU telegrams are separated from each other by means of transmission breaks.



The time of the transmission breaks for the separation of telegrams is depending on the adjusted baud rate and amounts to 3,5 * Word-Transmission Time (11 Bit). With 9600 baud at least 4ms and with 19200 baud at least 2ms between both telegrams must pass by.

Telegram Structure

Address 1 Byte	Control Command 1 Byte	Data 0 - 100 Byte	Checksum	
			Low	

Calculation of CRC-Checksum

The CRC–checksum (Cyclical Redundancy Check) is calculated by the sender from all bytes transmitted and attached to the message. The receiver calculates the CRC checksum again and compares the same with the checksum received. If values do not match, a transmission error is assumed and the received data packet is rejected. The low-order byte of the 16 bit checksum is sent in the telegram at the next to last position and the high-order byte at last position.

Calculation of checksum (programming example in C):

```
crc = 0xFFFF;                                   // CRC-Check, Init
for(i = 0; i < telegram_length-2; i++)
        crc = crc_calc(crc, telegram_data[i]);

crc_low  = crc & 0x00FF;                        // Low-Byte
crc_high = (crc & 0xFF00) >> 8;                 // High-Byte

// Calculate CRC
unsigned int crc_calc(unsigned int crc_temp, unsigned int data)
{
        unsigned int    Index_CC=0;
        unsigned int    LSB=0;
        crc_temp = ( ( crc_temp ^ data) | 0xFF00) & (crc_temp | 0x00FF) ;
        for(Index_CC = 0; Index_CC<8; Index_CC++)
        {
            LSB = (crc_temp & 0x0001);
            crc_temp        >>= 1;
            if(LSB)
            crc_temp = crc_temp ^ 0xA001;       // calculation polynominal for CRC16
        }
        return(crc_temp);
}
```