thermokon®

HOME OF SENSOR TECHNOLOGY

Description

JOY
Thermostat

Subject to technical alteration

1. Revision

Revision	Date	Description
35	09.01.2024	Corrections Adapted example for error code EnOcean channel
34	24.11.2023	Corrections Incorrect register specification Feedback Rocker Switch: new=1023 Device type overview: Added missing device types
33	11.07.2023	Corrections From version 3.0.14: Changed behavior of the "Fan speed with/without Auto" parameter.
32	27.02.2023	Corrections Chap. 8.5 Error detection: ORG-Byte D5 generate errors
31	14.12.2022	From software version 2.6.10++ & 3.0.11++ Description 2nd control loop Two EnOcean sensor register added
30	14.09.2022	Corrections Added numeric sorted register list
29	26.07.2022	Corrections
28	03.12.2021	Corrections
27	01.07.2021	Corrections
26	24.02.2021	Corrections
25	03.12.2020	From software version 2.6.0++ - Overtemperature protection with underfloor heating - Implementation of a 2nd control loop - Correction in documentation: Keycard possible for all digital inputs - Introducing rH-Types (integrated humidity sensor)
24	08.06.2020	- Modbus address can be adjusted by + -10
23	04.05.2020	From software version 2.4.0++ - EnOcean functionality for user-defined keys - New function Center key: activate/deactivate ECO-mode - New function keys fan stage: without AUTO and without manual OFF
22	10.12.2019	From software version 2.3.1 ++ - Further display options in the main screen and in the set point adjustment screen Corrections

21	22.11.2019	From software version 2.3.0 ++
		- JOY Custom:
		  - Custom graphics and logo reloadable via SD card
		  - User-defined key functions including feedback (Modbus devices only!)
		- Extended menu for Modbus devices
		- Feedback changeover status (Modbus devices !)
		- Changed buttons for calling the "Cleaning Mode"
		- Fan coil follow-up-time
		- Alarm feedback via digital input
		- Configuration files for lower firmware versions can be loaded via SD card

20	12.08.2019	From software version 2.2.0++ - Generic 6-way valve (Modbus protocol address 152-155) - Fan stages as main screen (Modbus protocol address 10) - Fade in controller mode in main screen (Modbus protocol address 156) - EC versions Output of the 0-10V signal as a continuous signal in AUTOMATIC mode
19	27.03.2019	Corrections/additions - Note on inactive time channel added - fan coil specifications in volt, not in percent From software version 2.1.1++ - Tx-profiles A5-10-01 and A5-10-05 are replaced by profiles A5-10-02 and A5-10-06 - Support for Danfoss CO6 valve

18	13.02.2019	Corrections: - Chapter 8.5 Error Handling From software version 2.1.0++ - Feedback SAB battery capacity - Feedback SAB actuator obstructed - Fan stage expansion: Fan stage selection configurable without MANUAL OFF - 2 inputs can be used in parallel as a keycard switch - Digital outputs can be deactivated when using an SAB
17	19.12.2018	Corrections: - Value range offset external and internal sensor
15	05.12.2018	From software version 2.0 Fancoil and HC variants merged into one document EnOcean type added

2. Table of contents

3. Device Type Overview

Fan Coil types

JOY Fan coil 5DO	(3 fan coil stages, 230V, Temperature)
JOY Fan coil 5DO Modbus	(3 fan coil stages, 230V, Temperature)
JOY Fan coil EC AO2DO	(EC-fan coil 0-10V, 230V, Temperature)
JOY Fan coil EC AO2DO Modbus	(EC-fan coil 0-10V, 230V, Temperature)
JOY Fan coil EC 3AO	(EC-fan coil 0-10V, 24V, Temperature)
JOY Fan coil EC 3AO Modbus	(EC-fan coil 0-10V, 24V, Temperature)
JOY rH Fan coil 5DO	(3 fan coil stages, 230V, Temperature, Humidity)
JOY rH Fan coil 5DO Modbus	(3 fan coil stages, 230V, Temperature, Humidity)
JOY rH Fan coil EC AO2DO	(EC-fan coil 0-10V, 230V, Temperature, Humidity)
JOY rH Fan coil EC AO2DO Modbus	(EC-fan coil 0-10V, 230V, Temperature, Humidity)
JOY rH Fan coil EC 3AO	(EC-fan coil 0-10V, 24V, Temperature, Humidity)
JOY rH Fan coil EC 3AO Modbus	(EC-fan coil 0-10V, 24V, Temperature, Humidity)

HC types

JOY HC AO2DO	(6-way valve, 230V, Temperature)
JOY HC AO2DO Modbus	(6- way valve, 230V, Temperature)
JOY HC 3AO	(6- way valve, 24V, Temperature)
JOY HC 3AO Modbus	(6- way valve, 24V, Temperature)
JOY rH HC AO2DO	(6-way valve, 230V, Temperature, Humidity)
JOY rH HC AO2DO Modbus	(6- way valve, 230V, Temperature, Humidity)
JOY rH HC 3AO	(6- way valve, 24V, Temperature, Humidity)
JOY rH HC 3AO Modbus	(6- way valve, 24V, Temperature, Humidity)

SR types

JOY SR Fan coil 5DO Modbus	(3 fan coil stages, 230V, Temperature)
JOY SR Fan coil EC AO2DO Modbus	(EC-fan coil 0-10V, 230V, Temperature)
JOY SR Fan coil EC 3AO Modbus	(EC-fan coil 0-10V, EnOcean, 24V, Temperature)
JOY SR HC 3AO Modbus	(6- way valve, EnOcean, 24V, Temperature)
JOY SR HC AO2DO Modbus	(6- way valve, EnOcean, 230V, Temperature)
JOY SR rH Fan coil 5DO Modbus	(3 fan coil stages, 230V, Temperature, Humidity)
JOY SR rH Fan coil EC AO2DO Modbus	(EC-fan coil 0-10V, 230V, Temperature, Humidity)
JOY SR rH Fan coil EC 3AO Modbus	(EC-fan coil 0-10V, EnOcean, 24V, Temperature, Humidity)
JOY SR rH HC 3AO Modbus	(6- way valve, EnOcean, 24V, Temperature, Humidity)
JOY SR rH HC AO2DO Modbus	(6- way valve, EnOcean, 230V, Temperature, Humidity)

4. General

4.1. Introduction

This documentation applies to all device types with Modbus integrated and without any bus system! The chapters *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. **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

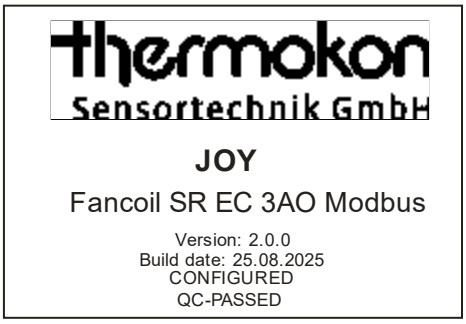
A bootloader is integrated in the device, which makes it possible to install a new application (update, upgrade, downgrade) via SD card or Modbus. To insert the SD card, the housing cover must be removed.

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 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 (from version 2.0.0), 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

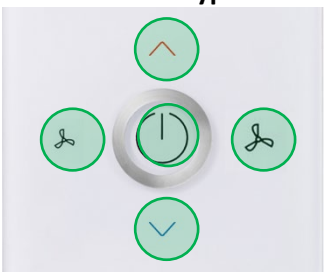
Custom Logo in Start Screen
There is one logo available. The size of the logo is set to 190x50 pixels. Thermokon creates from the template of the customer a file that can be loaded via SD card.

5. Operation

5.1. Main Menu

5.1.1. 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.

5.1.2. 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!

5.1.3. Modbus

Holding register

Release of keys

Keys can be locked/unlocked via Modbus at runtime.

5.2. Parameter Menu

5.2.1. 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

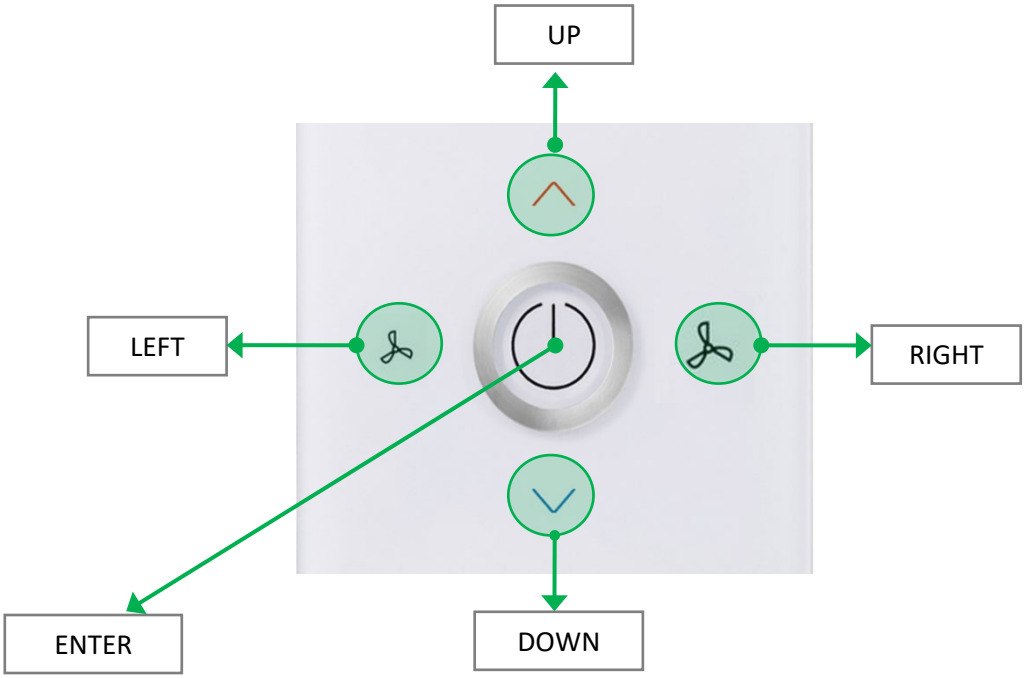
Picture 2 Key combination Fan coil type for invoking parameter menu

HC type

Picture 3 Key combination HC type for invoking parameter menu

5.2.2. Keys

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

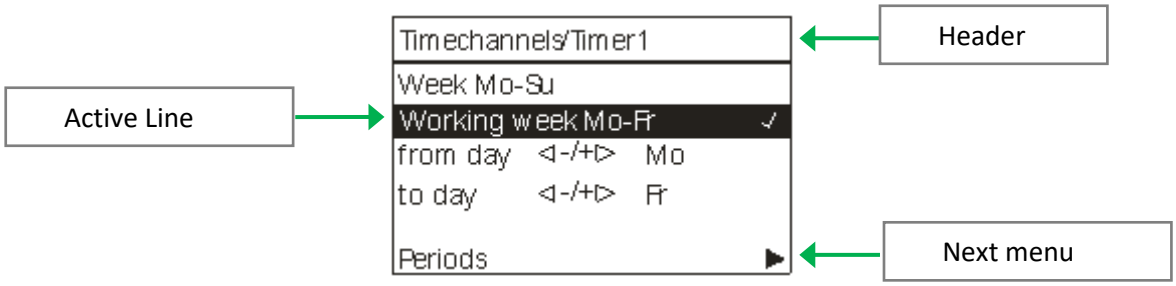


Picture 4 Keys in parameter menu

5.2.3. 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.

5.2.4. 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

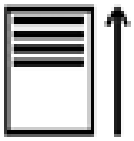
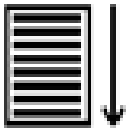
Picture 7 Freely definable keys HC type

5.3.1. 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	 [INDEX]	 [INDEX]
Blind up/down		
Blind up/down Group 1-3	 [INDEX]	 [INDEX]
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!

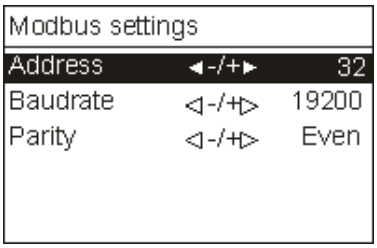
Fan coil type

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)

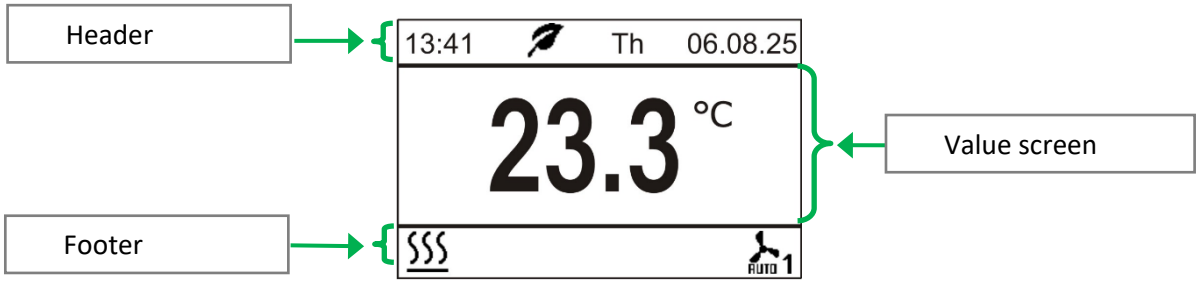
To save the settings, the header must be selected and the Key LEFT must be used to exit the menu. When leaving the menu, the set values are stored.

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

6.1.1. Value Screen

Unit temperature Selection °C/°F

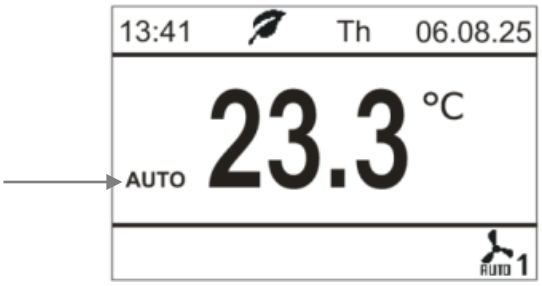
As default the value screen shows the room temperature measured by an integrated sensor. If an external temperature sensor is connected and the input is configured accordingly, this value will be indicated in the display. Various options are available for display in the value screen (10, *Display main 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

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



Picture 15 Controller mode faded in

This display refers to the default setting of the controller mode through the *Controller mode after device reset (29)* and/or the *Default Controller (269)* register. The control modes *Heating Auto*, *Cooling Auto* and *Auto* (heating/cooling) are displayed. Other possible controller modes are not displayed.
Note: As soon as a controller state is heating or cooling, the corresponding symbol will be displayed in the footer.

Symbols

AUTO

Display of Set point

Picture 16 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 17 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

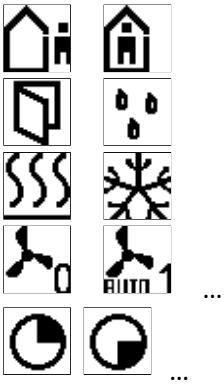
Occupancy

Window contact/dew point

Heating/cooling

Fan coil stage

Active time channel



Five fields are available.

Picture 18: 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.

6.1.2. Configuration parameters

Display main screen

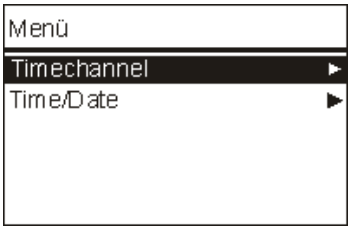
Display footer symbol 1-5

Display set point adjustment

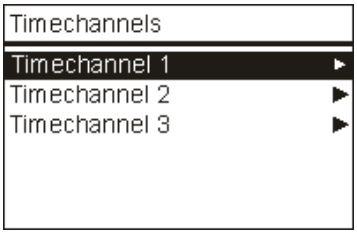
Fade in controller mode

6.2. 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 19 Overview parameter menu of modbus type



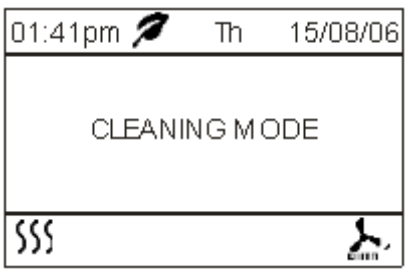
Picture 20 Menu „Timechannel selection“

6.3. 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.

6.4. 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 21: Cleaning mode screen

7. Functions

7.1. Common settings

7.1.1. 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.

7.1.2. 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).*

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

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

7.3.1. 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.

7.3.2. Konfiguration

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.

7.3.3. Modbus

Holding Register

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

7.4. Time Channel

7.4.1. 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

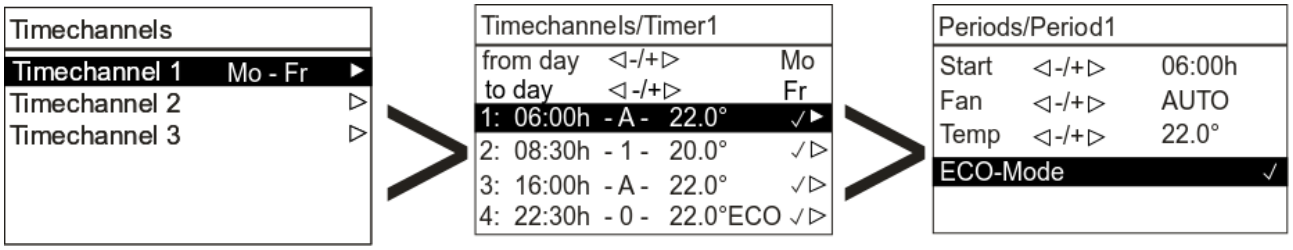
A period is activated, if start time and weekday are in conformance with the parameterized start time and weekday mask. A period remains active until conditions of another period are fulfilled. **Attention: If no time channel is assigned to a day, the time channel function is deactivated on this day and the controller works with the default values.** 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.

7.4.2. 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))

7.4.3. 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

7.5.1. 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.

7.5.2. 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!

7.5.3. Modbus

Input Register

Internal temperature sensor

External temperature sensor

7.6. Humidity

7.6.1. 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.

7.6.2. Configuration

Offset Humidity
For compensation of constant measurement value deviations

7.6.3. Modbus

Input Register
Humidity value

7.7. Inputs

7.7.1. 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.

7.7.2. 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

7.7.3. Modbus

Input Register

State input 1 universal

State input 2

7.8. Outputs

7.8.1. 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.

7.8.2. 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!

7.8.3. 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

7.9. 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 22: Header with faded-in alarm symbol

7.9.1. Modbus

Holding Register

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

7.10. Set point

7.10.1. 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).

7.10.2. 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
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.
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.

7.10.3. 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.

7.10.4. 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.

Basic set point
Current set point of the controller. Can be the internal set point after reset, the Modbus Default (255, *basic set point*) or the set point of the active time channel period.

7.11. Fan stages

7.11.1. 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.

7.11.2. 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.

7.11.3. 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 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
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.

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.

7.11.4. Modbus

Holding Register

Fan coil stage

Input Register

State fan coil stage

7.12. 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.

7.13. Occupancy

7.13.1. 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.

7.13.2. 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.

7.13.3. Modbus

Holding Register

Default Occupancy
Occupied/Unoccupied

Input Register

Occupancy state

7.14. ECO-Mode

7.14.1. 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*).

7.14.2. Modbus

Holding Register

Default ECO-Mode
off/active

Input Register

State ECO-Mode
off/active

7.15. Dew point

7.15.1. 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.

7.15.2. Modbus

Holding Register

Default dewpoint

Input Register

State dewpoint

7.16. Window Contact

7.16.1. 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.

7.16.2. Modbus

Holding Register

Default window contact

Input Register

State window contact

7.17. Change-Over

7.17.1. Overview

Via a change-over contact heating or cooling mode is forced with a 2-pipe system. The change-over function is activated via configuration of a digital input, via Modbus or via EnOcean. A digital input activated as a change-over contact deactivates Modbus value/EnOcean.

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

Attention: When using the change-over function, the outputs heating (terminal 5) and cooling (terminal 4) are controlled in parallel with the exception when using the second control circuit (see chapter Controller)!

7.17.2. Modbus

Holding Register

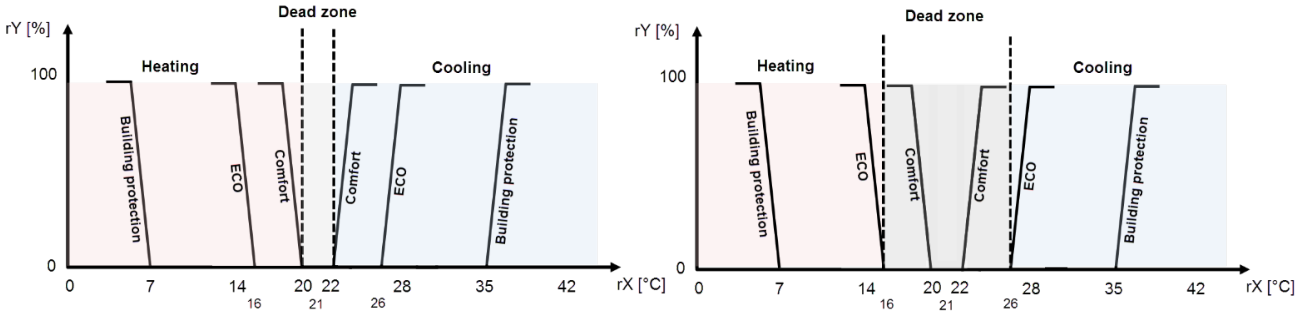
Default change-over

Heating, cooling or not used

7.18. Controller

7.18.1. Overview

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



Picture 23: 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.

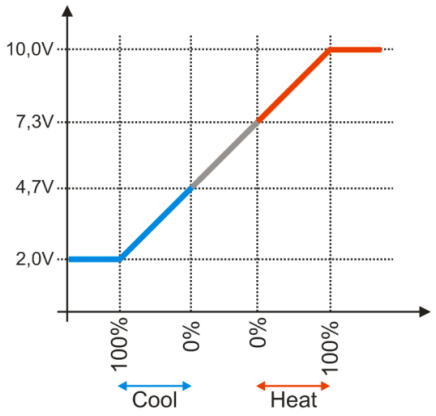
Valve Protection Function

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 11:00am (heating valve) and 11:15am (cooling valve). The corresponding valve is switched on for 5 minutes.
The valve protection function can be disabled.

7.18.2. 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.

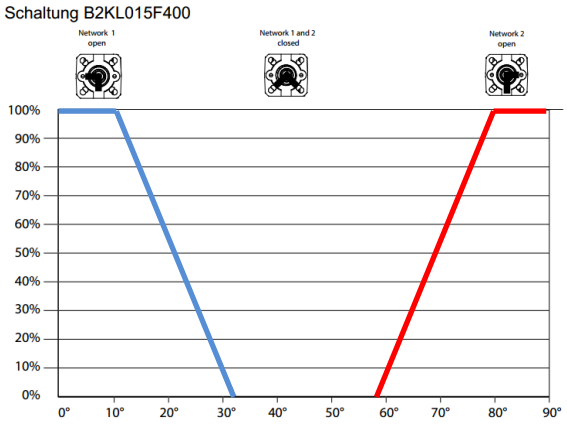


Standard
100…0% cooling ⇒ 2,0…4,7V
0…100% heating ⇒ 7,3…10,0V

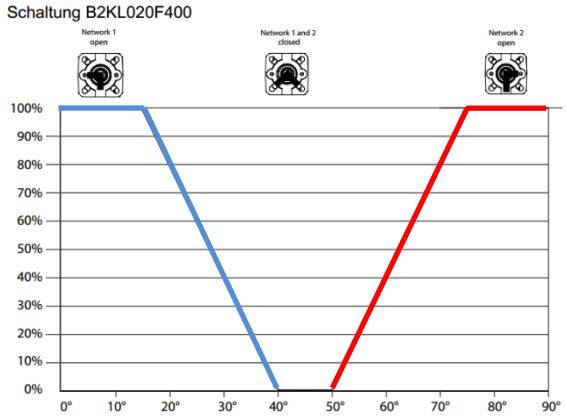
Inverted
Heating/cooling sequence inverted

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



Picture 25 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).

7.18.3. Heat pump function

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

7.18.4. Overheating protection underfloor heating (UFH)

An external temperature sensor at the universal input can be used to protect underfloor heating. With selection of the universal input as *4: External temperature sensor FBH (NTC10k) - Heating output switch-off (JOY)* or *5: External temperature sensor FBH (NTC10k) – switch-off via EnOcean (only SR types!)* the overheating protection UFH is automatically activated.
If a configurable temperature is exceeded (159: *Maximum temperature underfloor heating*), either a) the heating output of the JOY is switched off and the 6-way valve output is moved to the rest position or b), in the case of the EnOcean variant, EnOcean wireless actuators are influenced via the corresponding transmission profiles (18: *Input 1 universal input (low voltage)*).
More information on the functionality of the EnOcean option can be found in the EnOcean chapter.

2nd Control loop
An external temperature sensor at the universal input can be parameterized as a sensor for a second control loop (*6: External temperature sensor (NTC10k) - 2nd control loop*). Prerequisite for proper function is that both control loops are 2-pipe systems with common change-over!
The heating output is assigned to the 1st control loop (=main control loop), whose mode of operation is configured with the existing parameters. The set points for heating and cooling correspond to the internal set points and can be adjusted by the user on the device. The actual temperature is determined via the internal temperature sensor. The fan stages (fan coil types) and the 6-way valve output (HC type) are permanently assigned to the main control loop.
The second control loop is controlled with the cooling output. It operates as a pure two-step controller, whose hysteresis is configured with the parameter *Controller hysteresis*. The set point is linked to the set point of the first control loop, but can be shifted via a constant offset, parameter 140: *Offset 2nd control loop*. The temperature of the second control loop is recorded via the external temperature sensor.
Occupancy and ECO mode as well as the window and dew point contact states affect both control loops.

7.18.5. 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

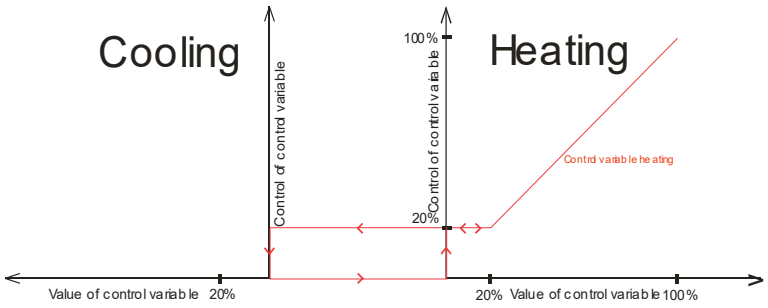
Proportional band Xp heating/cooling
The proportional band determines the deviation at which the controller outputs the maximum control variable (100%). A small Xp relates to a stronger controller intervention of the proportional band with lower deviations, but increases the tendency to oscillate.
Only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

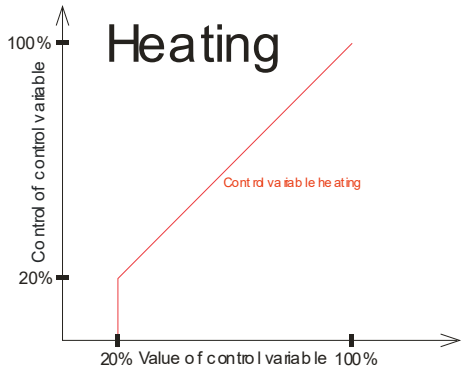
Maximum manipulating variable
Maximum value in percent.

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.

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.

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.

7.18.6. 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).

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 is sent.

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".

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.

8.3. Supported Profiles

8.3.1. Receive profiles

EnOcean-EEP	Type	Direction	Description	Thermokon Device	Max. Number of	Abbreviation LCD/ funktional group
F6-02-01	RPS	Rx	EnOcean switch	Diverse	1	RPS
D5-00-01	1BS	Rx	Window contact	SRW01	max.5	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	max. 3	OCC
A5-08-01	4BS	Rx	Occupancy sensor (Occ, light, temperature)	SR-MDS		OCC
F6-04-01	RPS	Rx	Keycard switch	SR-KCS02, SR-KCS	1	KEY
A5-20-01	4BS	Rx/Tx	Valve actuator	SAB+, SAB05	max. 6	SAB
A5-20-12	4BS	Rx	Higher level controller (Fan, set point offset, controller, energy hold-off/dewpoint, Occup)		1	SUP

8.3.2. 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!

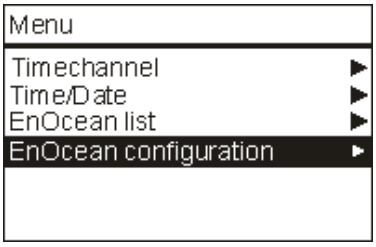
A5-20-01

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)

8.4. Comissioning

Menu

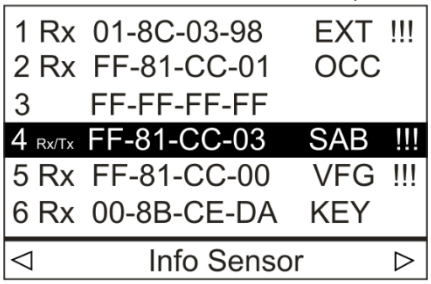
Two additional menu items appear with SR-type. The EnOcean list is a simple list representation of the EnOcean devices that have been learned-in. In addition to the list you can find more information about the channels as described below. EnOcean configuration is a password-protected area in which sensors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



Picture 26 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.

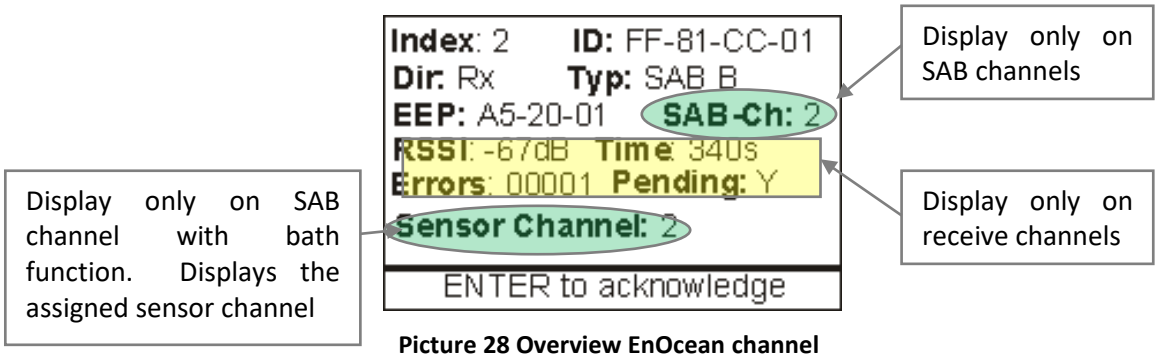


Picture 27 EnOcean list

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.



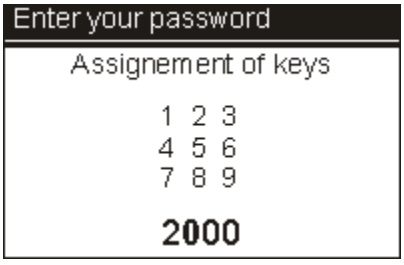
Picture 28 Overview EnOcean channel

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.

8.4.1. EnOcean configuration

Login menu

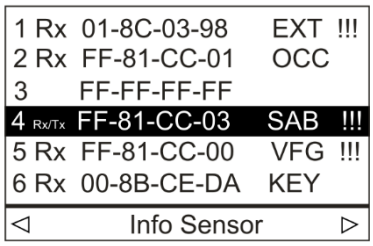


Picture 29 Login screen

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 30 Channel list

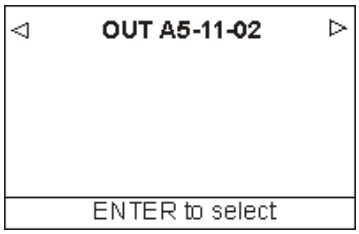
In the footer, various menu items can be selected with the LEFT / RIGHT keys. The corresponding menu item is selected with the ENTER key.

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 31 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

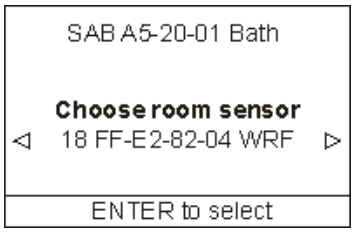
SAB (Message Server)

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 32 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.

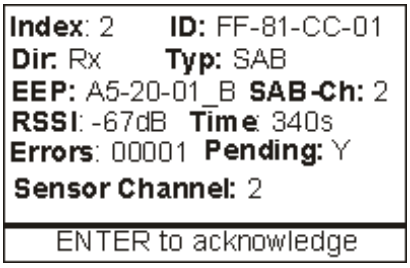
Heating/cooling

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 (60 minutes wake-up interval) 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 33 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.

8.5. Error handling

8.5.1. Error detection

Errors are generated after 45 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.

8.5.2. 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

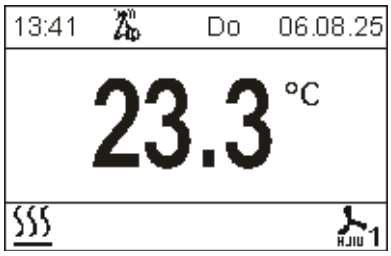
The error counter is incremented for each error that has occurred. It is always counted when the status changes from "no error" to "pending error". This means that an error that persists permanently remains at 1 until the maximum timeout time has been reached (currently 65535s = 18h). Then the error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

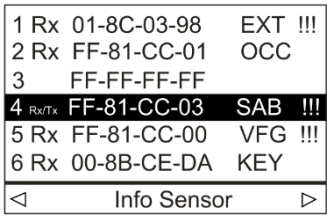
The main screen will display a pending error with the symbol  in the header!



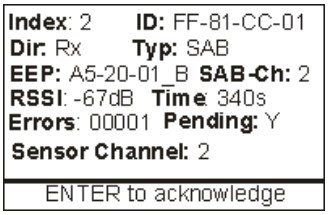
Picture 34 Error display

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 35 EnOcean list



Picture 36 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.

8.6. EnOcean Configuration file SD-Card

8.6.1. 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 !!

8.6.2. 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*).

8.7. Enocean data points

8.7.1. 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.

8.7.2. 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

8.8. 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

8.9. 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. Modbus register reference

9.1. 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		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 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

	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 7: Temperature with humidity (only rH-version)	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

	Fade in controller mode		not faded in	0	1	--	0: not faded in 1: faded in	UINT8	156
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
	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
Controller	Controller hysteresis		1	0	15	°C	0-150 ≙ 0,0 – 15,0°C	UINT8	28
	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	0	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	0	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
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
Fan	Number of fan coil stages	5DO	3	1	3	--	1: 1 stage 2: 2 stages 3: 3 stages	UINT8	9
	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
	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
	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
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
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 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
	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	--

9.2. Modbus Register

9.2.1. Info Register (read only, only Modbus types)

Function group	Name	Type	Factory setting	Min	Max	Unit	Description		Modbus Protocol adress
Info	Device type		--	--	--	--	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	UINT16	0
	Firmware		--	--	--	--	0xAABB –> AA = Major version, BB = Minor version Example: Version 2.0 => 0x0200	UINT16	1

9.2.2. Modbus Holding Register (Modbus types only)

Function group	Parameter	Device types	Factory setting	Min	Max	Unit	Description		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)		Ein	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

9.2.3. 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
	Basic 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
		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) -1 ≙ 0xFFFF: data point inactive	INT16	565
---	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

9.3. EnOcean enhancement

9.3.1. 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	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

9.3.2. 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

9.3.3. 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
	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
Rocker switch	Feedback Rocker Switch		-	-	-	-	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

10. Appendix

10.1. Register list sorted numerically

10.1.1. 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	
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	
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	
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	
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!

10.1.2. 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	
566	Internal humidity sensor	rH- type

10.2. Supported Control Commands

The following MODBUS control commands are supported by JOY:

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

Table 2 Supported Modbus Commands

10.3. 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

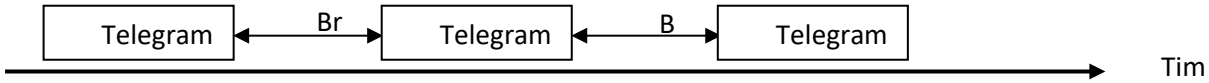
Data packets are transmitted according to strictly defined defaults:

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	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);
}
```