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Description

JOY
Fan Coil Thermostat

Introduction

Revision

Revision	Date	Description
3	09.12.2015	Issued
4	19.01.2016	Valid with Software version 1.0.12++ - Fan coil assignment to controller mode - Locking of fan coil keys - Override heating/cooling outputs - Cleaning mode - °C/°F display switching - ON/OFF delay - Max heating and coolin loads configurable
5	19.07.2016	Valid with Software version 1.0.14++ - Added hint: Only output heating is active when using change-over - Additional controller modes: - Manual heat respectively cool mode triggering both outputs - Auto heat mode triggering both outputs - Auto cool mode triggering both outputs
6	06.09.2016	Correction of register 6-8 order in chapter 4.1
7	14.11.2016	Valid with application firmware version 1.1.0++ Added PI-controller Added EC-fan coil type Added Startup time fan coil Added Display set point adjustment Added Keycard mode Added Display of controller mode Added Input register “Controller mode“ Added Display automatic mode in Input Register “State fan coil“ Configuration software version 1.2.0.0++

1 Device Types Overview

JOY Fancoil 3DI	Ord.-Nr. 614757	(3 fan coil stages)
JOY Fancoil Modbus	Ord.-Nr. 614771	(3 fan coil stages)
JOY Fancoil_EC 3DI	Ord.-Nr. 649889	(EC-fan coil 0-10V)
JOY Fancoil_EC Modbus	Ord.-Nr. 648363	(EC-fan coil 0-10V)

2 General

2.1 Device Description

Modern design, flush mounting fan coil room thermostat. Used for individual control of temperature in commercial, industrial and residential buildings. It is tailored for two-pipe and four-pipe fan coil units with two-wire electric valves. The device combines a modern design with a 2,5” LCD and a touch sensitive surface, 3 time channel options each with 4 time periods options.

2.2 Configuration software

Thermokon provides a configuration software free of charge which can be downloaded from our website. This software enables the user to create parameter files for the different available device types (3DI and Modbus), which can be stored on a SD card. Remove front panel from device, insert SD card and after reset device reads and stores a valid parameter file from SD card. Subsequently SD card has to be removed! Devices with intergrated Modbus-interface can also be parameterized by using the Modbus interface.
Further information about the configuration software can be found in chapter 6.

2.3 Hardware Installation

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 and the data sheet wiring_rs485_network.pdf.

2.4 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!

2.5 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

2.6 SD-Card

Micro SD cards can be used to upload a new application or a new device configuration. Further information on uploading process can be found in chapter **Bootloader**. With the corresponding PC configuration tool a configuration file can be created and uploaded via SD card. Read more in chapter **Configuration Software**.
SDHC-cards cannot be used!

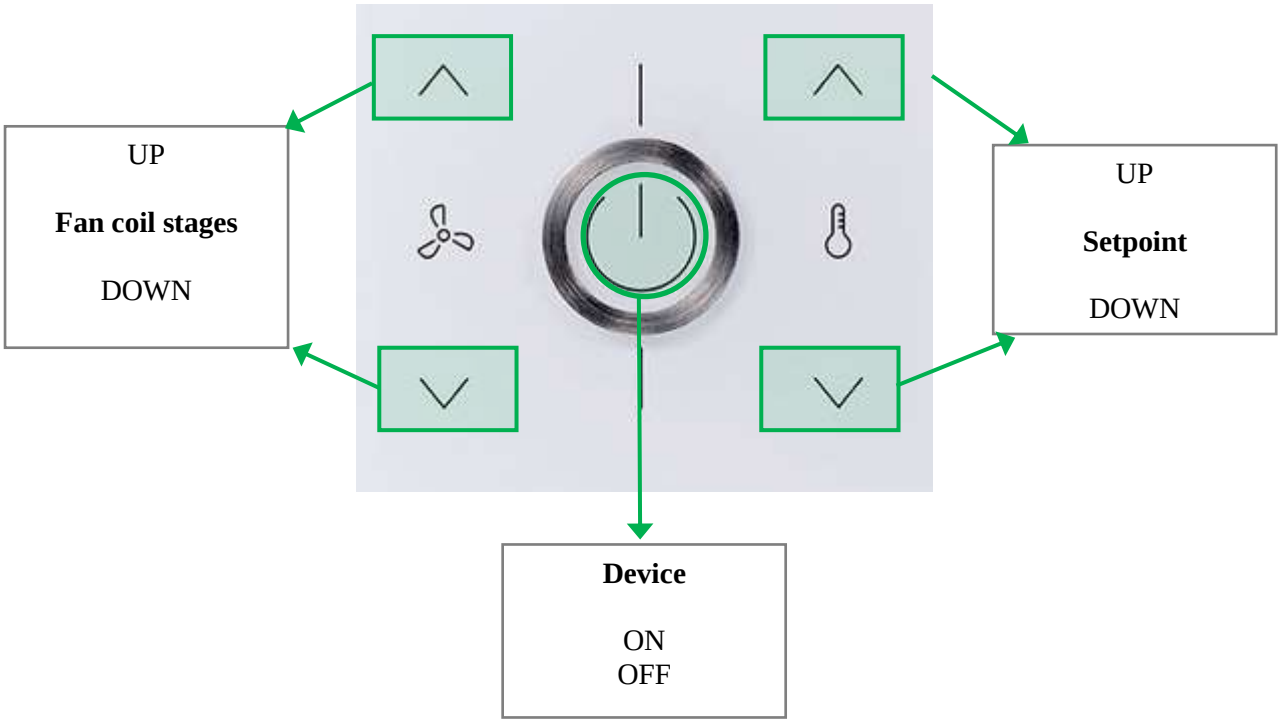
2.7 Boot Loader

Because of an integrated bootloader a new application (update) can be uploaded by means of a SD card. To insert the SD card, the upper part must be removed. 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 2-3 minutes!) the new application is started automatically. **Afterwards, SD card shall be removed!**

3 Menu Guidance

3.1 Main Menu

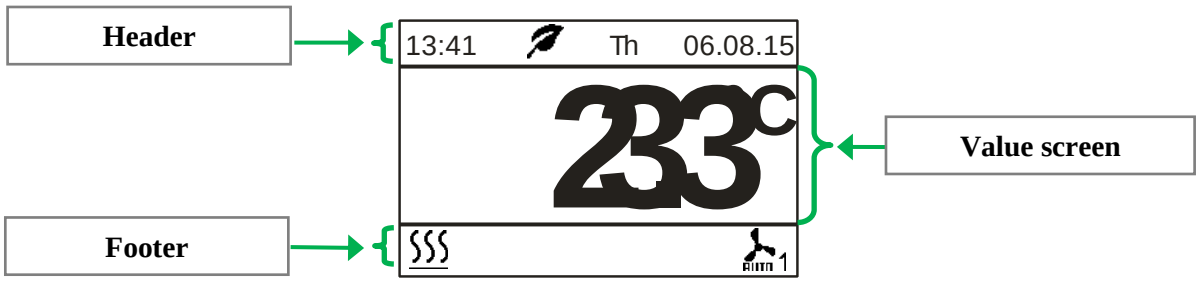
3.1.1 Keys



Single key actuation releases an action. A longer key actuation enables a cyclical change of the value in 1s cycle. After having pressed the key for approx. 3s, the cycle time is decreased. Standby mode can be enabled by actuating key ON/OFF for at least 2s. In standby mode display and outputs are switched off (controller deactivated). Frost and heat protection remain active. Switching to standby mode is only possible if no digital input is configured as keycard switch.

3.1.2 Main Screen

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



Picture 1: 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 2: Main screen header

The positions are pre-defined and cannot be changed.

Info Symbols

- ECO Mode
- Alarm

Value Screen

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

Picture 3: Temperature display in value range

Upon actuation of any arrow key the display of the value screen changes and shows the associated value. The arrow keys above and under the set point symbol are leading to the set point adjustment screen - the arrow keys above and under the fan coil stage symbol to the fan coil stage adjustment screen. The display switches back to standard screen after 20s without key actuation.

Display of Setpoint

Picture 4: Display of set point adjustment

After actuation of the arrow keys for set point adjustment, the display screen changes to the set point adjustment screen. The set point symbol and the set point offset value are displayed. Another actuation of one of the two arrow keys modifies the value. There are three options available for the adjustment mode of the set point. It is possible to adjust the same as a pure offset value, as an effective value or in stages. As for the display in stages, the values -3, -2, -1, 0, 1, 2, 3 are indicated. Which set point jump corresponds to the individual stages can be set by means of the parameter set point step size (register 21). The parameter

of the set point adjustment range (register 21) has to be adjusted in this way that the value corresponds to stage 3.
See chapter Setpoint.

Display of fan coil stages

Picture 5: 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. Fan coil stage symbols and the current fan coil stage are displayed. Another actuation of any arrow key switches the fan coil stage.

Footer
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.

Symbol Groups

Occupancy

Window contact/dew point

Heating/cooling

Fan coil stage

Active time channel

Five fields are available.

Picture 6: Main screen footer example

Moreover, the positions of the symbols can be freely choosen.

Picture 6 shows a possible configuration. The symbol group fan coil stage is always faded-in, the symbols of group Heating/Cooling only when the controller is in the corresponding mode. The groups Window Contact/Dew Point and Occupancy are only faded-in, if the corresponding mode is configured via an input or set via Modbus. Refer to chapter Inputs. The symbol “Active time channel“ is only displayed if a channel is active and no set points are indicated via Modbus.

3.1.3 Holding Register

Modbus Holding Register	
Register Data Address	**Description**
10	(#) Display main screen Default: $0x00_{hex}$: Room temperature display Value range: $0x00_{hex}$: Room temperature display $0x01_{hex}$: Set point display
11	(#) Footer symbol 1 Default: $0x00_{hex}$: No symbol Value range: $0x00_{hex}$: No symbol $0x01_{hex}$: Heating/cooling $0x02_{hex}$: Occupancy $0x03_{hex}$: Window contact/dew point $0x04_{hex}$: Fan coil stage $0x05_{hex}$:Active time channel
12	(#) Footer symbol 2 Default: $0x00_{hex}$: No symbol Value range: See symbol 1
13	(#) Footer symbol 3 Default: $0x00_{hex}$: No symbol Value range: See symbol 1

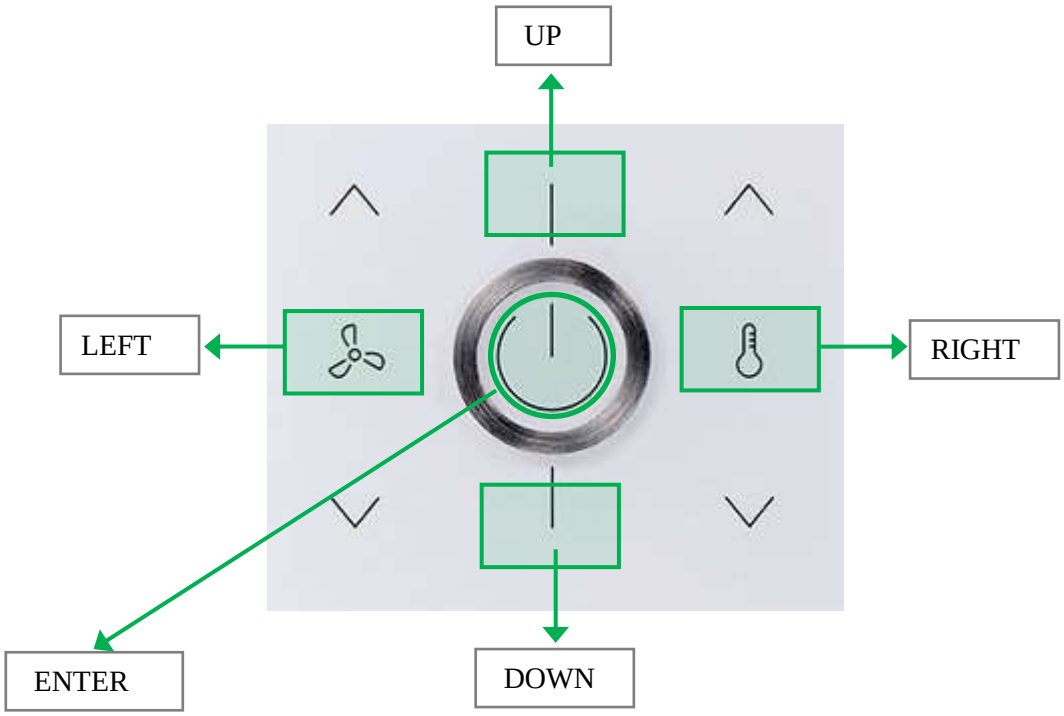
14	(#) Footer symbol 4 Default: $0x00_{hex}$: No symbol Value range: See symbol 1
15	(#) Footer symbol 5 Default: $0x00_{hex}$: No symbol Value range: See symbol 1
114	(#) Display setpoint adjustment Default: $0x00_{hex}$: Setpoint offset Value range: $0x00_{hex}$: Setpoint offset $0x01_{hex}$: Setpoint effective $0x02_{hex}$: Setpoint stages (-3,-2, -1, 0, +1, +2,+3)

The registers marked with # are saved in EEPROM. They shall be written only during configuration of the device and not at runtime !

3.2 Parameter Menu

3.2.1 Keys

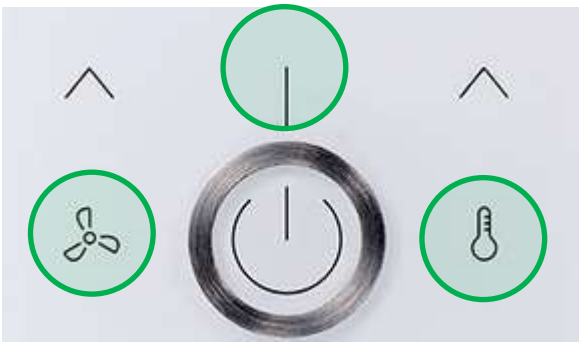
Parameter mode is entered by the key combination shown in picture 7. The parameter mode enables the user to adapt the time channel parameter to own requirements directly at the device. In an additional menu the Modbus parameters can be modified by installer/system integrator.



Picture 7: Keys in parameter menu

3.2.2 Enter Parameter Menu

Simultaneous actuation of marked keys for at least 5s.



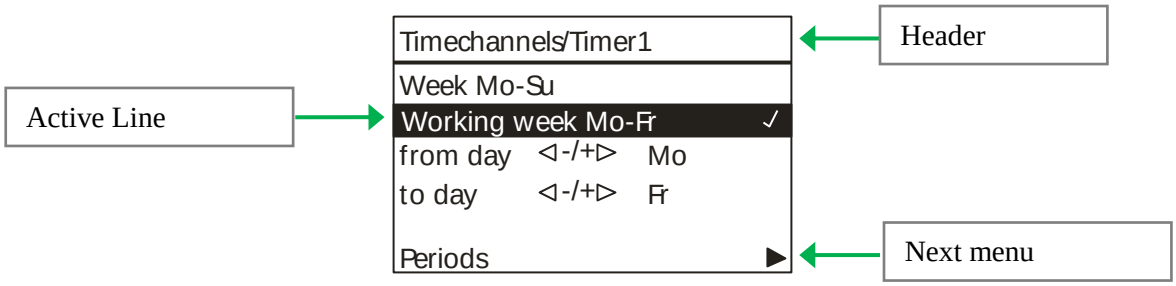
Picture 8: Key combination to invoke parameter menu

3.2.3 Exit Parameter Menu

The parameter menu can be left by choosing the header in the main screen of the parameter menu and a key “LEFT“ press afterwards. An automatic return to main menu is effected if no key is actuated in parameter menu for 30s.

3.2.4 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 (if existing) 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 9: Example of a menu page

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.

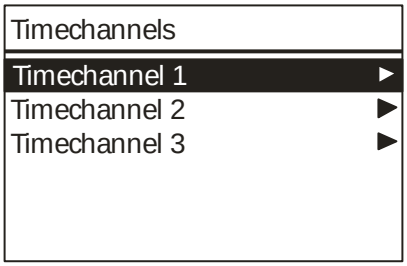
Selection of Display Value

✓ The symbol is faded-in if corresponding value is selected accordingly. Parameters for which no symbol for value change ◁-/+▷ is shown can be selected with key ENTER.

3.2.5 Overview Parameter Menu

3.2.5.1 Menu time channel

After actuation of the key combination mentioned earlier in chapter **Enter Parameter Menu** the following menu is shown:



Picture 10 Menu „Choose time channel“

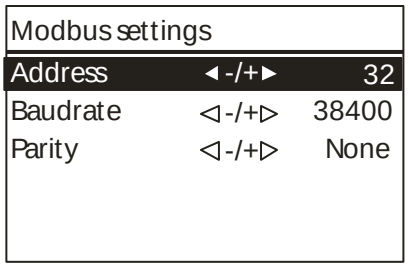
Further information on the parameterization of the time channels can be found in chapter **Time channel**. Up to three time channels with four periods each can be parameterized.

3.2.5.2 Overview Parameter Menu

The menu for Modbus parameter setting is invoked by a simultaneous actuation of the keys marked below for at least 5s. To access the menu for Modbus settings by means of the mentioned key combination, the header must be activated in the main menu of the time channels!!

Picture 11 Key combination for call of parameter menu Modbus

Afterwards the following Menu appears:



Picture 12: Overview parameter menu modbus

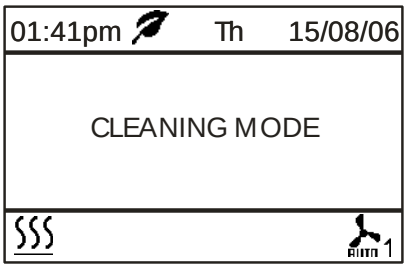
Address
Address of the room thermostat in Modbus network. Adjustable addresses 1-247.

Baud Rate
9600Bd
19200Bd
38400Bd
57600Bd

Parity
None
Odd
Even

3.3 Cleaning mode

By actuating key  for at least 3s, cleaning mode can be entered. All keys are locked. Cleaning mode remains active for 60s.



Picture 13: Cleaning mode screen

3.4 °C/°F diplay switching

By actuating key  for at least 3s, the temperature unit displayed on screen can be switched between °C and °F. Only screen display is affected! The temperature unit of parameter and process data maintain the unit parameterized in register 6 (UNIT TEMPERATURE).

4 Functions

4.1 General Settings

A code for device location identification can be configured. Also brightness of background illumination for LCD and ring can be configured in the range of 0-100%. Furthermore, all keys or fan coil keys can be locked via Modbus and the device can be switched off. In standby mode controller is not active and display is off. Moreover, all outputs are switched off and the keys are locked (except for ENTER). Switching to standby mode is only possible if no digital input is configured as keycard switch.

4.1.1 Holding Register

Max heating load
Designed to optimize self-heating compensation with switched load. When stating the value, the load of the fan must be considered in addition to the occurred load of the heating valve, if a triggering of the fan in the heating phase is feasible.

Max cooling load
The same applies here.

Modbus Holding Register (R/W)	
Register Data Address	**Description**
2	(#) Device location identification Default: $0x00_{hex}$ Value range: $0x0000_{hex}$ - $0xFFFF_{hex}$
3	(#) Language Default: $0x00_{hex}$: German Value range: $0x00_{hex}$: German $0x01_{hex}$: English
16	(#) Brightness background illumination LCD Default: 90_{dez} = 90% Value range: $0\text{-}100_{dez}$ = 0-100%

17	(#) Brightness ring Default: 20_{dez} = 20% Value range: 0-100_{dez} = 0-100%
99	(#) Max heating load Default: $0x00_{hex}$ = <2A Value range: $0x00_{hex}$ = <2A $0x01_{hex}$ = <4A $0x02_{hex}$ = <6A
100	(#) Max cooling load Default: $0x00_{hex}$ = <2A Value range: $0x00_{hex}$ = <2A $0x01_{hex}$ = <4A $0x02_{hex}$ = <6A
261	Device On/Off Default: $0x00_{hex}$: On Value range: $0x00_{hex}$: On $0x01_{hex}$: Off
262	Release of keys Default: $0x00_{hex}$: Released Value range: $0x00_{hex}$: Released $0x01_{hex}$: Lock all keys $0x02_{hex}$: Lock fan coil keys

The registers marked with # are saved in EEPROM. They shall be written only during configuration of the device and not at runtime !

4.2 Time and Date

4.2.1 Overview

The room thermostat has a real-time clock, which calculates time and date automatically. Daylight saving is made automatically. Besides daylight saving the presentation formats of time and date can be freely configured. The real time clock is a battery buffered, i.e. time and date are kept even in case of longer power failures.
Time and date can be updated during operation by a supervisory system via Modbus.

4.2.2 Holding Register

Modbus Holding Register (R/W)	
Register Data-Address	**Description**
7	(#) Format time Default: $0x00_{hex}$: 24h(pm) Value range: $0x00_{hex}$: 24h(pm) $0x40_{hex}$: 12h(am)
8	(#) Format date Default: $0x00_{hex}$: TT.MM.JJ Value range: $0x00_{hex}$: TT.MM.JJ $0x01_{hex}$: JJ/MM/TT
97	(#) Daylight saving Default: $0x01_{hex}$: Central european time (CET) Value range: $0x00_{hex}$: disabled $0x01_{hex}$: CET
264	Time hour Default: 12 Adjustable range 0 - 23

265	Time minute Default: 00 Adjustable range 0 - 59
266	Date day Default: 01 Adjustable range 1 - 31
267	Date month Default: 01 Adjustable range 1 - 12
268	Date year Default: 15 Adjustable range 15 - 99

The registers marked with # are saved in EEPROM. They shall be written only during configuration and not at runtime !

4.3 Time Channel

4.3.1 Overview

There are 3 time channels with 4 periods available, 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.

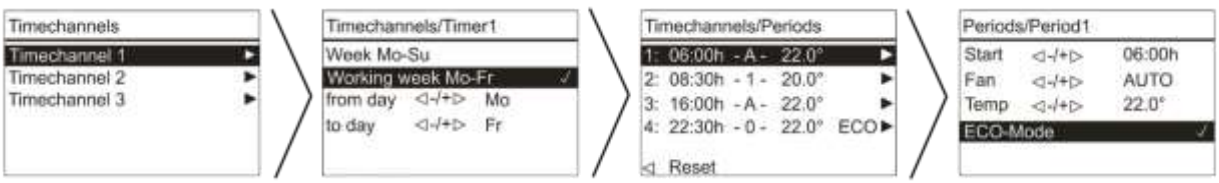
Table 1: Structure of a Time Channel

Time Channel		
Weekday mask	**Periods**	**Parameters**
Complete week Mo-So Working week Mo-Fr From day to day	1	Start time
		Fan coil stage
		Setpoint heating
		ECO mode
	2	Start time
		Fan coil stage
		Setpoint heating
		ECO mode
	3	Start time
		Fan coil stage
		Setpoint heating
		ECO mode
	3	Start time
		Fan coil stage
		Setpoint heating
		ECO mode

A period is activated, if 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. Active setpoint can be overriden over Modbus by means of holding register 255. For further information see chapter Setpoint.
Time channels are prioritized. Channel 3 has the highest priority.
Parameterization of the thermostat type is made in parameter menu or, for types with bus connection (Modbus), via a configuration tool for PC, which transmits the parameter to the device via bus.

4.3.2 Menu time channel

Up to three time channels, each with 4 periods, can be parameterized. For every period start time, setpoint, fan coil stage and ECO-mode can be set.



Picture 14: Menu "Selection of Time Channel"

After having selected the line of the time channel that shall be processed, next submenu "Weekday Mask" is invoked actuating key RIGHT. In the first two lines the complete week from Monday to Friday or the

working week from Monday to Friday is chosen. Alternatively, any period within a week can be adjusted in lines 3 and 4. The selected time period is marked with symbol ✓ .
In the lower line menu “Selection of Periods“ can be invoked (key RIGHT). Here an overview of all 4 periods of the corresponding time channels is shown first. The adjusted parameters of the corresponding period are displayed in shortened form in the following sequence from left to right.

Index time period / start time / fan coil stage / setpoint/ info ECO-Mode

After selection of the period that shall be processed, the corresponding submenu can be invoked by key RIGHT. In the lowest line the adjustments of the time channel can be reset (key LEFT). ATTENTION: A reset deletes all settings and cannot be cancelled anymore!
To return to the corresponding previous menu the cursor must be on the top line. Afterwards, the key LEFT must be actuated. **Changes of the time channel are stored by return from menu (2) to menu (1) actuating key LEFT**.

4.3.3 Holding register

Start
The start time can be changed in 15 minutes step.

Fan
3 stages fan coil type (3 relays)
Fan coil stage selection between OFF, Stage 1, Stage 2, Stage 3 and AUTOMATIC.
EC fan coil type (0-10V)
Fan coil selection between OFF and AUTOMATIC

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

ECO-Mode
In addition, ECO mode can be set (key INPUT). In ECO mode, the dead zone between heating and cooling is set automatically to the configured ECO dead band (standard 10K). Also the pwm cycle time is doubled. If a period with ECO Mode is activated, the ECO symbol is faded-in at the main screen.

Modbus Holding Register (R/W)	
Register Data Address	**Description**
34	(#) Time channel 1 weekdays Display process value: $0x0F_{hex}$ = Monday, Tuesday, Wednesday, Thursday Default: $0x00_{hex}$ Adjustable range $0x00_{hex}$-$0x7F_{hex}$ Bit0: Monday Bit1: Tuesday Bit2: Wednesday Bit3: Thursday Bit4: Friday Bit5: Saturday Bit6: Sunday
35	(#)Time channel 1 period 1: Start time hour Display process value: $0x0D_{hex}$ = 13h Default: 0h Adjustable range: 0 – 23h
36	(#)Time channel 1 period 1: Start time minute Display process value: $0x3B_{hex}$ = 59m Default: 0m Adjustable range: 0 – 59m

37	(#)Time channel 1 period 1: Set point Display process value: 21,0°C = $0x15_{hex}$ Default: 0,0°C Adjustable range: 0,0 – 50,0°C
3 stages fan coil type (3 relays)	
38	(#)Time channel 1 period 1: Fan coil stage Display process value : $0x04_{hex}$ = Automatic Default: $0x00_{hex}$: Off Value range: $0x00_{hex}$: Off $0x01_{hex}$: Stage 1 $0x02_{hex}$: Stage 2 $0x03_{hex}$: Stage 3 $0x04_{hex}$: Automatic
EC-fan coil type (0-10V)	
38	(#)Time channel 1 period 1: Fan coil stage Display process value : $0x01_{hex}$ = Automatic Default: $0x00_{hex}$: Off Value range: $0x00_{hex}$: Off $0x01_{hex}$: Automatic
39	(#)Time channel 1 period 1: ECO mode Display process value $0x01_{hex}$ = ECO Mode active Default: $0x00_{hex}$: ECO Mode off Value range: $0x00_{hex}$: ECO Mode off $0x01_{hex}$: ECO Mode active
40-44	(#) Time channel 1 period 2
45-49	(#) Time channel 1 period 3
55-75	(#) Time channel 2

76-96	(#) Time channel 3

The registers marked with # are saved in EEPROM. They shall be written only during configuration of the device and not at runtime!

The segments of time channels 2 and 3 are following with corresponding register offsets. A complete register list can be found in chapter **Modbus Register Reference**.

4.4 Temperature

4.4.1 Overview

The room temperature has an integrated temperature sensor. By default this value is used as actual value for the internal controller. As described in chapter **Inputs** the universal input can be parameterized as a sensor input for an external sensor. In this case, the external sensor value is used as actual value and additionally is indicated as temperature display. Measurement range of the sensor is ranging from 0…50°C with a resolution of 0,1°.
For both sensors a calibration to correct the measuring value is possible.

4.4.2 Holding Register

Modbus Holding Register (R/W)	
Register Data Address	**Description**
4	(#) Offset internal sensor Display process value: 1,0°C = 10_{dez} Default: 0,0°C Adjustable range 0,0 - 15,0°C
5	(#) Offset external sensor Display process value: 1,0°C = 10_{dez} Default: 0,0°C Adjustable range 0,0 - 15,0°C
6	(#) Unit temperature Default: $0x01_{hex}$: °Celsius Value range: $0x00_{hex}$: none $0x01_{hex}$: °Celsius $0x02_{hex}$: °Fahrenheit

The registers marked with # are saved in EEPROM. They shall be written only during configuration of the device and not at runtime !

4.4.3 Input Register

Modbus Input Register (R)	
Register Data Address	**Description**
514	Internal temperature sensor Display process value: 21,5°C = 215_{dez}
515	External temperature sensor Display process value: 21,5°C = 215_{dez}

4.5 Inputs

4.5.1 Overview

Two digital inputs are available, whereas input 1 is a potential-free universal input and input 2 is a 230V input. Depending on the selected input different functions such as window contact, dew point contact, occupancy contact, change-over contact, keycard switch and external temperature sensor can be configured which are briefly explained in the following chapters. For every input, polarity can be configured in addition (make contact/break contact).
The internal input state is linked by an OR-function with the corresponding Modbus register when being configured as window or dew point contact. As for occupancy or change-over configuration the corresponding Modbus register overrides the internal state.

Table 2: Overview of possible combinations

Input 230V	Input Universal
Change-Over DI	Sensor
	Window contact
	Dew point contact
	Occupancy contact
	Keycard switch
Not used	Sensor
	Change-over DI
	Change-over sensor
	Window contact
	Dew point contact
	Occupancy contact
	Keycard switch

4.5.2 Configurabe Functions

4.5.2.1 External Temperature Sensor (NTC10k)

At universal input 1 an external temperature sensor of type NTC10k can be connected. If configures the external sensor value is automatically used as actual value for the internal controller and is shown in display.

4.5.2.2 Change-Over Digital Contact

The input is used as a digital change-over-default for the controller. At maximum one input can be configured as a change-over contact! For further information see chapter **Change-Over**.

4.5.2.3 Change-Over Sensor(NTC10k)

An external temperature sensor of type NTC10k can be connected at the universal input. With this configuration the measured temperature-value determines the change-over-default to the controller. At maximum one input can be configured as a change-over contact! Read more in chapter **Change-Over**.

4.5.2.4 Window Contact

Universal input can be configured as window contact. They are linked by an OR-function. Further information in chapter **Window Contact/Energy Lock** .

4.5.2.5 Dewpoint Contact

Universal input can be configured as dewpoint contact. They are linked by an OR-function . Read more in chapter **Dewpoint**.

4.5.2.6 Occupancy Contact

The input is used as a occupancy contact. At maximum one input can be used as an occupancy contact. Further information to be obtained in chapter **Occupancy**.

4.5.2.7 Keycard Switch

Input will be used as keycard detection. Further information to be obtained in chapter **Keycard Switch**.

4.5.3 Holding Register

Modbus Holding Register	
Register Data Address	**Description**
18	(#) Input 1: Universal input Default: $0x00_{hex}$: Not used Value range: $0x00_{hex}$: Not used $0x01_{hex}$: External temperature sensor (NTC10k) $0x02_{hex}$: Change-over sensor (NTC10k) $0x03_{hex}$: Change-over make contact $0x04_{hex}$: Window contact make contact $0x05_{hex}$: Occupancy make contact $0x06_{hex}$: Dew point make contact $0x07_{hex}$: Change-over break contact $0x08_{hex}$: Window contact break contact $0x09_{hex}$: Occupancy break contact $0x0A_{hex}$: Dew point break contact $0x0B_{hex}$: Keycard switch make contact $0x0C_{hex}$: Keycard switch break contact
19	(#) Input 2: 230V Default: $0x00_{hex}$: Not used Value range: $0x00_{hex}$: Not used $0x03_{hex}$: Change-over make contact $0x07_{hex}$: Change-over break contact

The registers marked with # are saved in EEPROM. They shall be written only during configuration and not at runtime!

4.5.4 Input Register

Modbus Input Register (R)	
Register Data Address	**Description**
519	State input 1: Universal Display process value: $0x00_{hex}$ = Open Value range: $0x00_{hex}$: Open $0x01_{hex}$: Closed
520	State input 2: 230V Display process value: $0x00_{hex}$ = Open Value range: $0x00_{hex}$: Open $0x01_{hex}$: Closed

4.6 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.

Picture 15: Header with faded-in alarm symbol

4.6.1 Holding Register

Modbus Holding Register (R/W)	
Register Data-Address	**Description**
263	Default alarm Default: $0x00_{hex}$: No alarm Value range: $0x00_{hex}$: No alarm $0x01_{hex}$: Alarm

4.7 Set point

4.7.1 Overview

The active set point is determined by configuration of the time channels. The user can modify values in defined limits.
The Modbus type enables the option to configure the set point according to your needs and/or to indicate the set point from a supervisory system at runtime.

4.7.2 Holding Register

Set point after reset
(Parameter)
After a restart of the device this value is used as a set point until a new set point or a Modbus default is activated.

Adjustment range of set point
(Parameter)
Determines the limits of the set point adjustment range. When selecting the display of the set point adjustment (register 113) as stage display – 3…+3 this parameter must be set to the value of the set point offset of stage 3!
Example: Step size 1K => Stage 3 is equivalent to 3K => enter this value!! Take care of the scaling!

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

Dead band/Dead band ECO-mode
(Parameter)
Determines the deadband in normal controller mode or in ECO-mode. For activation of the ECO-mode refer to chapter **Time Channels**.

Set point Adjustment Standby
(Parameter)
When using the occupancy function by a digital input or via Modbus, the configured value is automatically deducted from the heating set point or added to the cooling set point in the UNOCCUPIED state.

Frost Protection/Heating Protection
(Parameter)
By use of the window function (energy lock) through a digital input or via Modbus, the heating and cooling set points are set to the configured values in case “Window open/Energy lock active”

Basic Set point
This register is designed for the set point default by a supervisory system. Heating and cooling set point are calculated internally out of this value and the dead band depending on the mode (normal/ECO).

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

Modbus Holding Register (R/W)	
Register Data Address	**Description**
20	(#) Set point after reset Display process value: 21,5°C = 215_{dez} Default: 21,0°C Adjustable range: 0,0 - 50,0°C
21	(#) Adjustable range set point Display process value: 3,0°C = 30_{dez} Default: 3,0°C Adjustable range: 0,0 - 10,0°C

22	(#) Set point step range Display process value: 0,5°C = 5_{dez} Default: 0,5°C Adjustable range 0,0 - 10,0°C
23	(#) Dead band Display process value: 1,0°C = 10_{dez} Default: 2,0°C Adjustable range 0,0 - 15,0°C
24	(#) Dead band ECO mode Display process value: 10,0°C = 100_{dez} Default: 10,0°C Adjustable range: 0,0 - 15,0°C
25	(#) Set point adjustment standby Display process value: 2,0°C = 20_{dez} Default: 2,0°C Adjustable range: 0,0 - 15,0°C
26	(#) Frost Protection Display process value: 7,0°C = 70_{dez} Default: 7,0°C Adjustable range: 0,0 - 15,0°C

27	(#) Heat protection Display process value: 35,0°C = 350_{dez} Default: 35,0°C Adjustable range: 0,0 - 50,0°C
255	Basic set point Display process value: 21,0°C = 210_{dez} Default: 21,0°C Adjustable range: 0,0 - 50,0°C
256	Set point offset Display process value: 1,0°C = 10_{dez} Default: 0,0°C Adjustable range: 0,0 - 15,0°C

The registers marked with # are saved in EEPROM. They shall be written only during configuration of the device and not at runtime!

4.7.3 Input Register

Set point heating
Output of active heating set point which depends on the default of basic set point (time channel/Modbus default), set point offset (user/Modbus) and mode (normal/ECO, occupied/unoccupied).
The value changed at last determines the set point, i.e. set point of the active time channel will be overwritten by an update of Modbus register 256 or if a new time channel is activated.

Set point cooling
Output of the active cooling which depends on the default of basic set point (time channel/Modbus default), set point offset (user/Modbus) and mode (normal/ECO, occupied/unoccupied).
The value changed at last determines the set point, i.e. set point of the active time channel will be overwritten by an update of Modbus register 256 or if a new time channel is activated.

Set point offset
Output of internal offset which is defined by user setting at JOY or via Modbus register 257. The value changed at last determines the set point. This means for example that a set point adjusted by user will be overwritten with the next update by Modbus register 257.

Modbus Input Register (R)	
Register Data Address	**Description**
511	Set point heating Display process value: 21,5°C = 215_{dez}
512	Set point cooling Display process value: 21,5°C = 215_{dez}
513	Set point offset Display process value: 0,5°C = 5_{dez}

4.8 Fan coil stages

4.8.1 3 stages fan coil type (3 relays)

4.8.1.1 Overview

JOY comes with three outputs for control of up to three fan coil stages. Fan coil stage can be changed manually. The number of existing stages can be configured. The user can select between OFF, STAGE1, STAGE2, STAGE3 and AUTOMATIC operation. In automatic mode the fan coil stage is linked to the controller. The fan coil can be freely assigned to controller mode (enabled at (a) heating/cooling, (b) only heating or (c) only cooling).
To guarantee a save start-up of the fan, a period of time can be parameterized in which the fan starts with the highest possible stage available.
The function of the fan coil stage is determined during configuration of the time channels (see chapter **time channels**) per period. The user is able to override the time channel settings by manual operation. With start of the next time channel period the fan coil stage is set to the value configured in the period.
In addition to the aforementioned options for default of a fan coil stage, it is possible to override the stage via Modbus. With start of next time channel period the fan coil stage is set to the value configured in the period.
When using the option occupancy the fan stage is linked with the occupancy status.
In the manual mode, the fan is switched into the automatic mode if a change to the status
UNOCCUPIED is made. Then, the set points of the UNOCCUPIED status are valid. When returning to the status OCCUPIED the automatic mode is activated with the set points of the OCCUPIED status.

4.8.1.2 Holding Register

Treshold stage 1/2/3
The value parameterized determines the threshold between set and actual value at which the individual fan stages are switched on as a rule. 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 switching- on and off of the fan stages is activated (+/-0.3°C) to prevent a flickering of the outputs!

Start-up time fan coil
To guarantee a save start-up of the fan, a period of time can be parameterized in which the fan starts with the highest possible stage available.

Fan coil assignment
Optionally, the fan can only be allocated to the heating/cooling controller or to both at the same time.

Modbus Holding Register (R/W)	
Register Data Address	**Description**
9	(#)Number of fan coil stages Default: $0x03_{hex}$: Stage 3 Value range: $0x01_{hex}$: 1 stage $0x02_{hex}$: 2 stage $0x03_{hex}$: 3 stage
30	(#) Treshold stage 1 ON Display process value: 1,0°C = 10_{dez} Default: 0,0°C Adjustable range 0,0 - 15,0°C
31	(#) Treshold stage 2 ON Display process value: 1,5°C = 15_{dez} Default: 1,5°C Adjustable range 0,0 - 15,0°C
32	(#) Treshold stage 3 ON Display process value: 3,0°C = 30_{dez} Default: 3,0°C Adjustable range 0,0 - 15,0°C

98	(#)Fan coil assignment Default: $0x00_{hex}$: Heating/Cooling Value range: $0x00_{hex}$: Heat/Cool $0x01_{hex}$: Heat $0x02_{hex}$: Cool
113	(#) Start-up time fan coil Default: $0x0A_{hex}$ = 10 = 1s Value range: $0x00_{hex}$ – $0x12C_{hex}$ = 0 – 300 = 0 – 30s
270	Fan coil stage Default: $0x04_{hex}$: Automatic Value range: $0x00_{hex}$: Off $0x01_{hex}$: Stage 1 $0x02_{hex}$: Stage 2 $0x03_{hex}$: Stage 3 $0x03_{hex}$: Automatic

The registers marked with # are saved in EEPROM. They shall be written only during configuration of the device and not at runtime!

4.8.1.3 Input Register

Modbus Input Register (R)	
Register Data Address	**Description**
518	State fan coil stage Default: $0xFFFF_{hex}$: Off Value range: $0x00_{hex}$: Off $0x01_{hex}$: Stage 1 $0x02_{hex}$: Stage 2 $0x03_{hex}$: Stage 3

4.8.2 EC-fan coil (0-10V)

4.8.2.1 Overview

A 0-10V output is designed for control of an EC fan. The speed of the fan can be changed manually via the keys. The number of steps for changing the speed between 0 and 100% is configurable.
In automatic mode the fan coil stage is linked to the controller. The fan coil can be freely assigned to controller mode (enabled at (a) heating/cooling, (b) only heating or (c) only cooling).

When using a PI controller, the output value corresponds to the control variable of the controller, adapted to the number of stages of the fan control. With a 2-point controller the output value is also adapted to the number of stages of the fan control depending on the parameter “deviation temperature for maximal fan stage control”.
To guarantee a save start-up of the fan, a period of time can be parameterized in which the fan starts with the highest possible stage available.

The function of the fan coil stage is determined during configuration of the time channels (see chapter **time channels**) per period. The user is able to override the time channel settings by manual operation. With start of the next time channel period the fan coil stage is set to the value configured in the period.
In addition to the aforementioned options for default of a fan coil stage, it is possible to override the stage via Modbus. With start of next time channel period the fan coil stage is set to the value configured in the period.

When using the option occupancy the fan stage is linked with the occupancy status.
In the manual mode, the fan is switched into the automatic mode if a change to the status
UNOCCUPIED is made. Then, the set points of the UNOCCUPIED status are valid. When returning to the status OCCUPIED the automatic mode is activated with the set points of the OCCUPIED status.

The parameter fan-minimum and fan-mMaximum enable the option to adapt the fan speed individually to the control signal of the controller (0-100%), e.g. 20%-80% fan speed.

4.8.2.2 Holding Register

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

Fan coil assignment
Optionally, the fan can only be allocated to the heating/cooling controller or to both at the same time.

Steps fan coil control
Determines the number of steps and thus the step size of the fan stage control.

Fan coil minimum, Fan coil maximum
Minimum and maximum output value for fan control. The calculation of the stages is made between minimum and maximal value.

Special case:
When setting the most significant bit of the minimum value, the minimum value corresponds to stage 1. The step size of the control is calculated of the steps of the fan control, the minimum and maximum.
Example:

Number of steps: 3
Minimum: 50%, Maximum:70%

⇨ OFF=0%, Stage1=50%, Stage2=60%, Stage3= 70%

Startup-time fan coil

To guarantee a save start-up of the fan, a period of time can be parameterized in which the fan starts with the highest possible stage available.

Default fan coil

Default of fan speed in percentage or toggling in automatic mode. It is converted corresponding to the parameter *steps fan coil control* to the matching step.
Example: Default: 65%, Steps fan coil:3 (33%, 66%,100%)=> Output 66%

Modbus Holding Register (R/W)	
Register Data Address	**Description**
30	(#)Maximum fan coil value (100%) at temperature deviation Display process value: 1,0°C = 10_{dez} Default: 4,0°C Adjustable range: 0,0 - 15,0°C
98	(#)Fan coil assignment Default: $0x00_{hex}$: heating/cooling Value range: $0x00_{hex}$: heating/cooling $0x01_{hex}$: heating $0x02_{hex}$: cooling
110	(#)Steps fan coil control Default: $0x05_{hex}$ – 5 steps = 20% steps Value range: $0x01_{hex}$ – 1 = 100% step $0x02_{hex}$ – 2 = 50% steps $0x03_{hex}$ – 2 = 33% steps $0x04_{hex}$ – 4 = 25% steps $0x05_{hex}$ – 5 = 20% steps
111	(#)Fan coil minimum Default: $0x0_{hex}$ = 0% = 0V Value range: $0x00_{hex}$ – $0x64_{hex}$ = 0-100% (0-10V) Special case $0x8xxx_{hex,}$ see **description: Fan coil minimum, Fan coil maximum**
112	(#)Fan coil maximum Default: $0x64_{hex}$ = 100% = 10V Value range: $0x00_{hex}$ – $0x64_{hex}$ = 0-100% (0-10V)

113	(#) Startup time fan coil Default: $0x0A_{hex}$ = 10 = 1s Value range: $0x00_{hex}$ – $0x12C_{hex}$ = 0 – 300 = 0 – 30s
270	Default fan coil $0x0_{hex}$ = 0% = 0V Value range: $0x00_{hex}$ – $0x64_{hex}$ = 0-100% MANUAL 0xFF00hex = -256 = AUTOMATIC

4.8.2.3 Input Register

Modbus Input Register (R)	
Register Data Address	**Description**
518	Fan coil value Value range: $0x00_{hex}$ – $0x64_{hex}$ = 0-100% fan coil value, fan coil mode=MANUAL $0xFFxx_{hex}$: fan coil value with fan coil mode=AUTOMATIC

4.9 Keycard Switch

If the card is not inserted the device is set into the energy-saving mode. The operation of the keys is locked, the display is switched-off and the controller uses the set points of the “room unoccupied” mode (lowering set point heating by value of register 25 *Set point adjustment standby* and increase set point cooling accordingly). If a key-card switch is parameterized the function “switch device on/off” via buttons or Modbus is locked.

4.10 Occupancy

4.10.1 Overview

JOY has an occupancy function which has, if activated, a direct effect on the set point default of the controller.
The occupancy function is activated via the configuration of a digital input. Further information can be obtained in the chapter **Inputs**. In case of activated occupancy function the symbol for occupancy is faded-in automatically. In addition it is possible to override the occupancy state via Modbus by a supervisory system. The default via Modbus has a higher priority than the internal state!
In state “room unoccupied” the heating set point is reduced by value register 25 *Set point adjustment standby*, the cooling set point is increased accordingly.

4.10.2 Holding Register

Default Occupancy
The symbol Occupied/Unoccupied is faded-in automatically if value “room occupied” or “room unoccupied” is written in register 257 and a symbol is allocated to the position in the footer.

Modbus Holding Register (R/W)	
Register Data Address	**Description**
257	Default Occupancy Default: $0xFFFF_{hex}$: No function Value range: $0x00_{hex}$: Room unoccupied $0x01_{hex}$: Room occupied $0xFFFF_{hex}$: No function

4.10.3 Input Register

Modbus Input Register (R)	
Register Data Address	**Description**
521	Occupancy state Default: $0xFFFF_{hex}$: No function Value range: $0x00_{hex}$: Room unoccupied $0x01_{hex}$: Room occupied $0xFFFF_{hex}$: No function

4.11 Dewpoint

4.11.1 Overview

JOY has a dewpoint function which has a direct effect on the setpoint default of the controller if activated. An active dewpoint contact locks the cooling controller.
The dew point function is activated via one digital input or via Modbus. The default via Modbus is linked by an OR-function to internal state.
Detailed information to be found in the chapter **Inputs**. With activated dewpoint function the dew point symbol “dewpoint active“ is faded-in automatically and cooling controller is locked.

4.11.2 Holding Register

Modbus Holding Register (R/W)	
Register Data Address	**Description**
257	Default dewpoint Default: $0xFFFF_{hex}$: No function Value range: $0x00_{hex}$: Dewpoint inactive $0x01_{hex}$: Dewpoint active $0xFFFF_{hex}$: No function

4.11.3 Input Register

Modbus Input Register (R)	
Register Data Address	**Description**
522	State dewpoint Default: $0xFFFF_{hex}$: No function Value range: $0x00_{hex}$: Dewpoint inactive $0x01_{hex}$: Dewpoint active $0xFFFF_{hex}$: No function

4.12 Window Contact/Energy Lock

4.12.1 Overview

JOY comes with a window contact/ energy lock function which has direct effect on the setpoint of the controller if activated. With activated contact (window open = energy lock active) the setpoints for heating and cooling are automatically set to frost respectively heat protection. The window contact/energy lock function is activated via configuration of one digital input or via Modbus. The default via Modbus is linked by an OR-function to internal state.
More information to be obtained in chapter **Inputs**. With activated function and symbol the window symbol “Window open” is automatically faded-in and the heating and cooling controller regulate to frost or heating protection setpoint.

4.12.2 Holding Register

Modbus Holding Register (R/W)	
Register Data Address	**Description**
259	Default window contact/ energy lock Default: $0xFFFF_{hex}$: No function Value range: $0x00_{hex}$: Window closed $0x01_{hex}$: Window opened $0xFFFF_{hex}$: No function

4.12.3 Input Register

Modbus Input Register (R)	
Register Data Address	**Description**
523	State window contact/energy lock Default: $0xFFFF_{hex}$: No function Value range: $0x00_{hex}$: Window closed $0x01_{hex}$: Window opened $0xFFFF_{hex}$: no function

4.13 Change-Over

4.13.1 Overview

The room thermostat has a change-over function which has, if activated, a direct effect on the controller behaviour. Via a change-over contact the mode heating or cooling is pre-defined with a 2-pipe system.
The change-over function is activated via configuration of a digital input or via Modbus. An input activated as a change-over contact deactivates Modbus value (register 256). Detailed information can be obtained in the chapter **Inputs**. Depending on the state of the contact, only the heating or only the cooling controller is activated.
Note: Only output heating (clamp 5) is active, when using change-over.

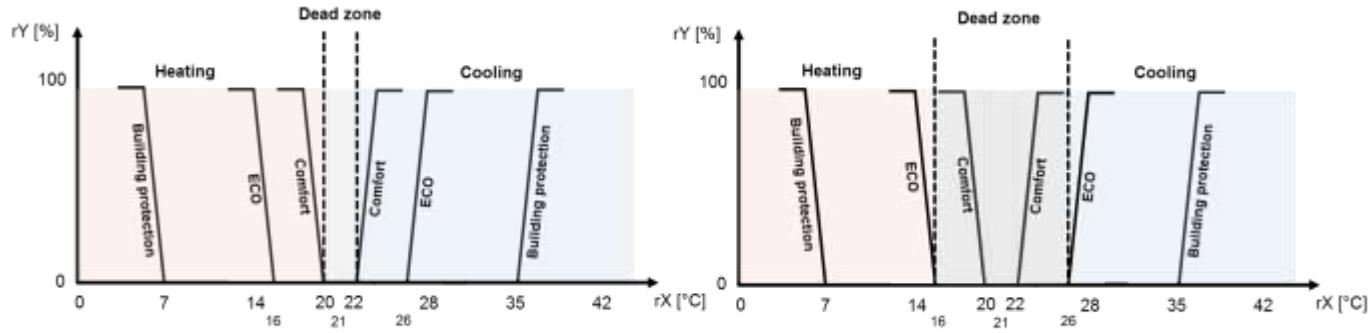
4.13.2 Holding Register

Modbus Holding Register (R/W)	
Register Data Address	**Description**
260	Default change-over Default: $0xFFFF_{hex}$: No function Value change: $0x00_{hex}$: Mode heating $0x01_{hex}$: Mode cooling $0xFFFF_{hex}$: No function

4.14 Controller

4.14.1 Overview

JOY comes with a PI- respectively two-point/three-point controller for heating and cooling. For heating and cooling a separate parameterization can be made, it can be defined which controller type shall be used and which controller shall be activated.
Besides the activation of automatic modes, heating and cooling, output can be switched manually with register 269. In this case internal controller is deactivated, but the corresponding symbol is faded-in on the screen.
In automatic operation the fan coil stages are linked with the controller. Further information to be found in chapter **fan coil stages**.



Picture 16: Two-step control with hysteresis

The setpoint defaults are made by the active time channel or a Modbus default and in addition to the dependence of ambient parameters such as occupancy, window contact, dew point, ECO mode and the user-defined setpoint offset.
Controller starts with a 4 minute delay after power-up.

4.14.2 PI-controller

The temporal behaviour of the PI-controller is determined with parameters Xp and Tn. Due to the proportional band the control variable reacts instantly on the control difference while the integral portion is only occurring with the time of action. The resulting control variable is output as a pulse width modulated signal.

4.14.3 Two-point controller

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

4.14.4 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 the corresponding valve (heating or cooling) has not been triggered for more than 96 hours. The time is fixed to Fridays at 11:00am (heating valve) or 11:15am (cooling valve). The corresponding valve is switched on for 5 minutes.
The valve protection function can be deactivated.

4.14.5 Holding Register

Controller Hysteresis
Determines the turn ON/OFF behaviour of the controller. The heating controller is switched ON if value falls below setpoint 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.

Controller Mode after device reset
Determines the mode in which the controller is placed after a restart.

Treshold Value Fan coil stage 1/2/3 One
The parameterized value determines the threshold between the setpoint and the actual value at which the single fan coil stages are turned on. For example, fan coil stage 1 starts directly with the occurrence of a controller request at parameterized threshold = 0,0°C. Please note that there is an internal hysteresis of +/- 0.3°C active to avoid flickering of the outputs!
This parameter is only relevant if a two-point controller is used.

Valve Protection Release
Release/Lock of the valve protection

Proportional band Xp
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.

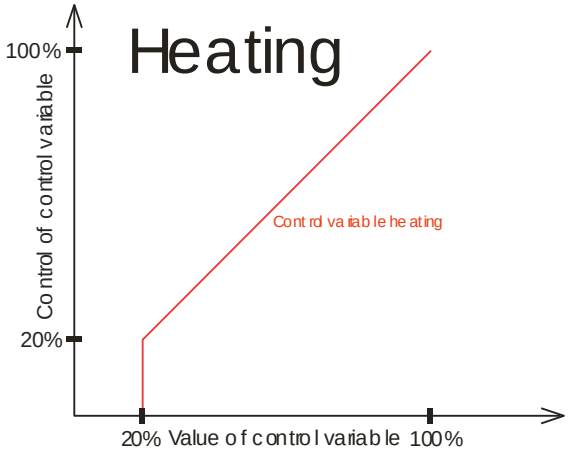
Reset time Tn
Time passing by until the Integral-part produces the same control amplitude is the same as produced directly in case of the Proportional band. To increase the integral part of the controller the reset time must be reduced.

Minimum actuating variable
Minimum value in percent.

Maximum actuating variable
Maximum value in percent.

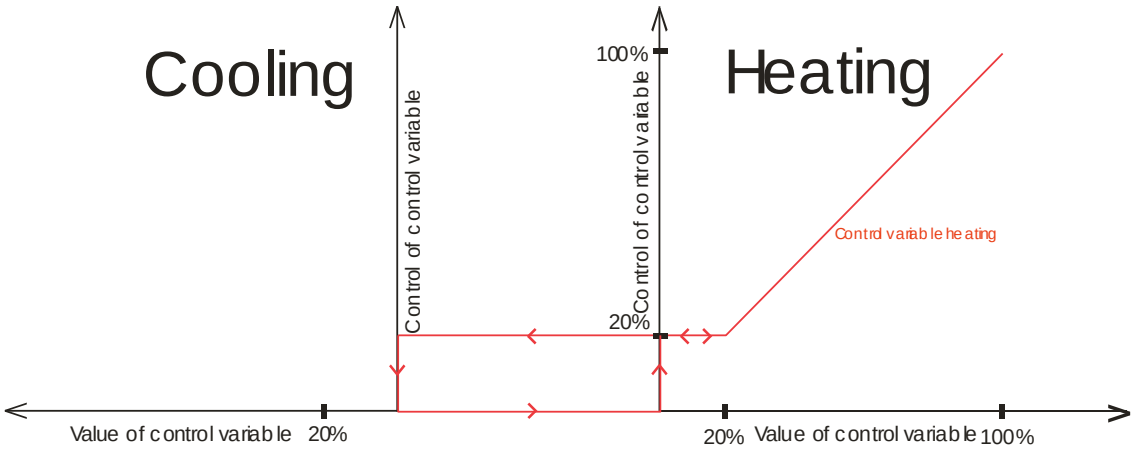
Mode Selection Control Variable

(1) Mode selection Control 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.

(2) Mode selection Control Variable = 0
Ymin = 20%



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

PWM cycle time
Cycle time of the PI-controller ouput signal.
Only relevant when using the PI-controller.

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.

Default Controller Mode
Default of controller mode. In automatic operation the controller controls to the heating and cooling setpoint. 'Heating mode enabled' means that the controller is in automatic heating mode with deactivated cooling controller and vice versa. Additionally it is possible to set heating and cooling output manually. If one of the outputs is set to manual mode the corresponding symbol in display is faded-in. Internal controller is deactivated.

Modbus Holding Register (R/W)	
Register Data Address	**Description**
28	(#) Controller hysteresis Display process value: 1,0°C = 10_{dez} Default: 1,0°C Adjustable range: 0,0 - 15,0°C
29	(#) Controller Mode after device reset Default: $0x03_{hex}$: Automatic Value range: $0x00_{hex}$: Off $0x01_{hex}$: Heating $0x02_{hex}$: Cooling $0x03_{hex}$: Auto $0x11_{hex}$: Heating mode (auto) triggering heat and cool relay/output $0x12_{hex}$: Cooling mode (auto) triggering heat and cool relay/output
33	(#)Valve protection release Default: $0x01_{hex}$: Release Value range: $0x00_{hex}$: Lock $0x01_{hex}$: Release

102	(#) Proportional band Xp Display process value: 1,5°C = 15_{dez} Default: 2°C Adjustable range: 0,0 – 10,0°C
103	(#) Reset time Tn Display process value: 10min = 10_{dez} Default: 30min Adjustable range: 0 – 1000min
104	(#) Minimum actuating variable Display process value: 10% = 10_{dez} Default: 0% Adjustable range: 0 – 100%
105	(#) Maximum actuating variable Display process value: 10% = 10_{dez} Default: 100% Adjustable range: 0 – 100%
106	(#) Mode Selection Control Variable Default: 0 - Use Minimal Control Variable with control variable = 0 Value range: 0x00 - Use Minimal Control Variable with control variable = 0 0x01 – Use Minimal Control Variable with control variable > 0

107	(#) PWM cycle time Display process value: 10min = 10_{dez} Default: 30min Adjustable range: 5 – 60min
108	(#) Heating controller type Default: 0 – PI-controller Value range: 0x00 - PI-controller 0x01 – Two-point controller
109	(#) Cooling controller type Default: 0 – PI-controller Value range: 0x00 - PI-controller 0x01 – Two-point controller
269	Default controller mode Default: $0x03_{hex}$: Auto Value range: $0x00_{hex}$: Off $0x01_{hex}$: Heating mode enabled (auto) $0x02_{hex}$: Cooling mode enabled (auto) $0x03_{hex}$: Auto mode $0x11_{hex}$: Heating mode (auto) triggering heat and cool relay/output $0x12_{hex}$: Cooling mode (auto) triggering heat and cool relay/output $0xFF01_{hex}$: Set heating output (manual mode) $0xFF02_{hex}$: Set cooling output (manual mode) $0xFF11_{hex}$: Heating mode (manual) triggering heat and cool relay/output $0xFF12_{hex}$: Cooling mode (manual) triggering heat and cool relay/output

The registers marked with # are saved in EEPROM. They shall be written only during configuration of the device and not at runtime!

4.14.5.1 Input Register

Modbus Input Register (R)	
Register Data Address	**Description**
516	Output heating Value range: $0x00_{hex}$: Off $0x01_{hex}$: On
517	Output cooling Value range: $0x00_{hex}$: Off $0x01_{hex}$: On
524	Actuating variable controller Value range: $0x00_{hex}$ -$0x64_{hex}$ = 0-100%
525	Controller mode feedback Value range: $0x00_{hex}$: Off $0x01_{hex}$: Heating $0x02_{hex}$: Cooling

5 Modbus Register Reference

5.1 3 stages fan coil type (3 relays)

5.1.1 Holding Register

Modbus Holding Register (R/W)	
Register Data Address	**Description**
0	(#)
1	(#)
2	(#) Device location recognition
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
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
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	(#) Threshold fan coil stage 1 On
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

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
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
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
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
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
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
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
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
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
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
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
96	(#) Time channel 3 ECO mode period 4
97	(#) Daylight saving
98	(#) Fan coil assignment
99	(#) Max heating load
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	(#)
111	(#)
112	(#)
113	(#) Startup-time fan coil
114	(#) Display setpoint adjustment
Register Data Address	**Description**
255	Basic set point
256	Set point offset
257	Default presence
258	Default dew point
259	Default window contact/energy lock
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

The registers marked with # are saved in EEPROM. They shall be written only during configuration of the device and not at runtime!

5.2 Input Register

Modbus Input Register (R)	
Register Data Address	**Description**
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 2
521	State presence
522	State dew point
523	State window contact/energy lock
524	Actuating variable controller
525	Controller mode feedback

5.3 EC- fan coil type (0-10V)

5.3.1 Holding Register

Modbus Holding Register (R/W)	
Register Data Address	**Description**
0	(#)
1	(#)
2	(#) Device location recognition
3	(#) Language
4	(#) Offset internal sensor
5	(#) Offset external sensor
6	(#) Unit temperature
7	(#) Format time
8	(#) Format date
9	
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
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
31	
32	
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
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
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
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
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
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
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
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
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
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
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

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
96	(#) Time channel 3 ECO mode period 4
97	(#) Daylight saving
98	(#) Fan coil assignment
99	(#) Max heating load
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	(#)
111	(#)
112	(#)
113	(#) Startup-time fan coil
114	(#) Display setpoint adjustment
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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

The registers marked with # are saved in EEPROM. They shall be written only during configuration of the device and not at runtime!

5.4 Input Register

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519	State input 1
520	State input 2
521	State presence
522	State dew point
523	State window contact/energy lock
524	Actuating variable controller
525	Controller mode feedback

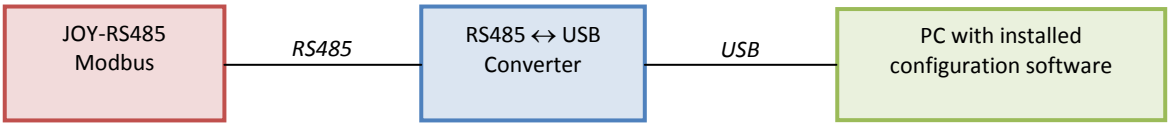
6 Configuration software

Download the latest version of the Thermokon configuration software from our website **www.thermokon.de**

Via the configuration software various device settings can be easily managed by a graphical surface. Created parameter files for the different available device types (3DI and Modbus) can be stored on a SD card and transferred to the device. Therefore the front part has to be removed, SD card has to be inserted (card slot on front part!) and front part plugged on again. Subsequently device restarts, reads the parameter file from the card and stores the file. Don´t forget to remove the SD card! ! Devices with intergrated Modbus-interface can also be parameterized by using the Modbus interface.

6.1 Connection to the PC

For connection of the JOY-RS485 Modbus and the PC an USB to RS485 Converter is needed.



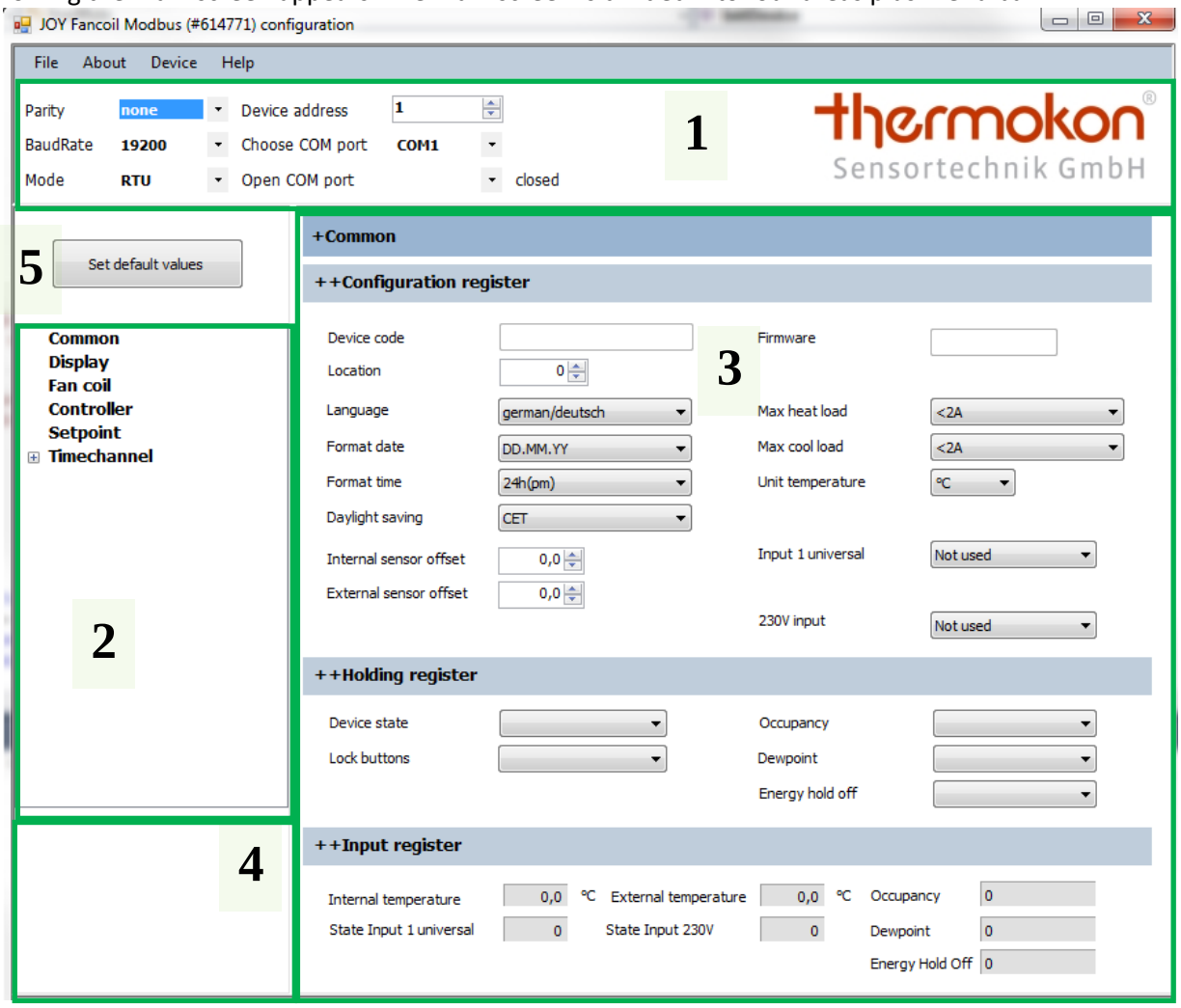
Further details can be obtained from the documentation of the corresponding converter.

6.2 Start screen

After launching configuration software start screen appears. Device model and language can be chosen.

6.3 Overview

Following the main screen appears. The main screen is divided into four areas plus menu bar.



1– Interface settings for modbus

2–Selection of device functions. In the main window (3) the corresponding process data/parameters are displayed.

3 – Main window with changeable parameters

- Configuration register: Parameters to be saved in EEPROM
- Input register: Process data (Modbus Holding Register)
- Output register: Process data (Modbus Input Register)

4 – Buttons for Modbus actions

- Read out: Single device polling
- Monitor: Continuous device polling
- Write values: The values mentioned under point "Holding Register“ are written in the device.
- Write parameter: The values mentioned under point "Configuration Register" are written in the device and are saved in EEPROM.

5 – Set default values

- All fields will be set to default values

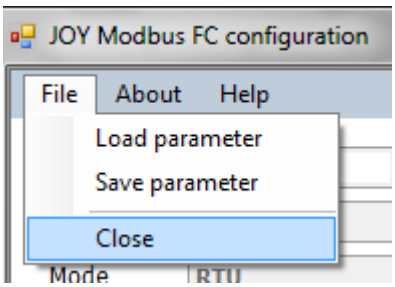
The windows 1 and 4 are faded out for types without Modbus.

6.4 Device

Choose between different device types.

6.5 Parameter load/save

In menu line there is a item "File" with subitems "Load Parameters" and "Save Parameters". A configuration file can be used for parameterization of a device by means of a SD card. For more information see chapter SD Card. During installation of the configuration software a configuration file is installed in installation directory at the same time which contains default values of the device parameter (default.csv). Thereby, initial state of parameter and process data values are restored.
The parameter files are saved under name *confJoy.csv* so that a JOY recognizes the file on SD card as a valid configuration file!



7 Appendix

7.1 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 1
Supported Modbus Commands

7.2 Data Transmission

7.2.1 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.

7.2.2 Data Frame

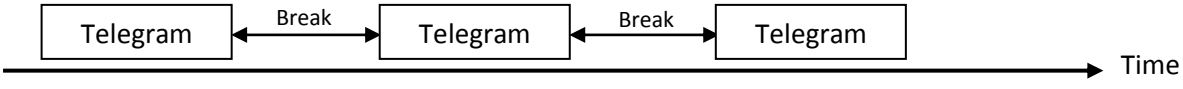
Data packets are transmitted according to strictly defined defaults:

Address	Control Command	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.

7.2.3 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.

7.2.3.1 Telegram Structure

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

7.2.3.2 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);
}
```