OPERATING MANUAL

Controller TCS.2
thermofin® control system 2nd generation

(from TCS.2 software version TCS.2_A06_v20201125)

Original version
This operating manual has been created in several languages. The German version is a manual in the original version. All other languages are translations of the original version.

Disclaimer of liability
If problems arise in connection with the installation and/or operation of the device that are not described in this manual, the operator/installer is obliged to contact thermofin® immediately. Further installation and/or operation of the device is not permitted until the facts have been fully clarified.

The company thermofin® cannot accept any liability for damage resulting from non-observance of above-mentioned provisions. Furthermore, thermofin® reserves the right to reject any further warranty claims on this device that can be traced back hereto.

If you have further questions, please contact the company thermofin GmbH.

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CONTENTS

1. GENERAL INFORMATION

The operating manual serves for optimal handling and parametrization of the TCS.2. It should enable the user to adjust the system to be controlled according to ecological and economic aspects and to guarantee trouble-free use.

Attention:
Read and follow the safety instructions in the device manual before use.

1.1 Principles

This operating manual refers to devices of the following series:

→ TCS.2: thermofin® control system, 2nd generation

and on all related device components supplied by the manufacturer. Regardless of whether wired or unwired or whether defined as a standard or a special solution with the additional designation “X”.

The binding technical data can be found in the currently valid catalogue sheets, the associated device specifications and the information on the corresponding nameplates.

For control cabinets, control and regulating devices, the information on their identification plates applies primarily.

1.2 Introduction

Dry coolers, condensers and evaporators require a correspondingly complex control system for optimal performance adjustment to the currently dissipated heat or amount of cold, taking into account the climatic environmental conditions. Modern control systems not only enable an operating mode that is precisely adapted to the conditions of the cooling systems, they are also characterized by a particularly high level of energy efficiency. Helpful additional functions increase the ease of use of the systems and enable fast communication with higher-level control systems. The use of high-quality components enables the fans to run absolutely smoothly as well as gentle and trouble-free handling of the fan drives.

Complete or split systems are available to users for such control tasks.

The complete systems for fan drives have compact units, each consisting of a control, regulation and power section.

The split systems are separate units for the control and regulation tasks as well as for the power-side control of the fan motors.

The split systems are mainly used for fan drives in which the power section is already integrated in the motor housing or the drive concept and the like provides a separate inverter or voltage regulator.

With the 2nd generation thermofin® control system **(TCS.2)**, the user receives a complete control and regulation unit for a split system. It is used to control, regulate and monitor commercially available EC fans as well as to electronically adjust the speed of fan motors in conjunction with appropriate inverters and voltage regulators. In addition, the TCS regulates and controls all water-side components in hybrid and evaporative cooling systems.

The TCS is also used in thermofin® industrial refrigeration products. In penthouse and insulation coolers, it controls, regulates and monitors not only the speed of the fans but also all flap movements and defrosting processes.

The communication between the TCS and the existing fans or power controllers can take place via a MODBUS connection. Conventional information transmission using an analogue signal is also possible with the TCS. Up to 126 CAN I/O fieldbus components can be connected via the system bus. A web or master terminal enables decentralized operation and visualization.

The TCS is a modern control unit with all necessary input and output systems. A 4.3” TFT display with touch function provides a convenient overview. All operator and system settings can be made user-friendly and intuitive.

Right from the factory, the TCS is located in a weatherproof switch box directly on the housing of the corresponding heat exchanger. If the installation is to take place spatially separated for structural reasons, the TCS can easily be installed in a separate control cabinet, e.g., be housed in the engine room of the cooling system.

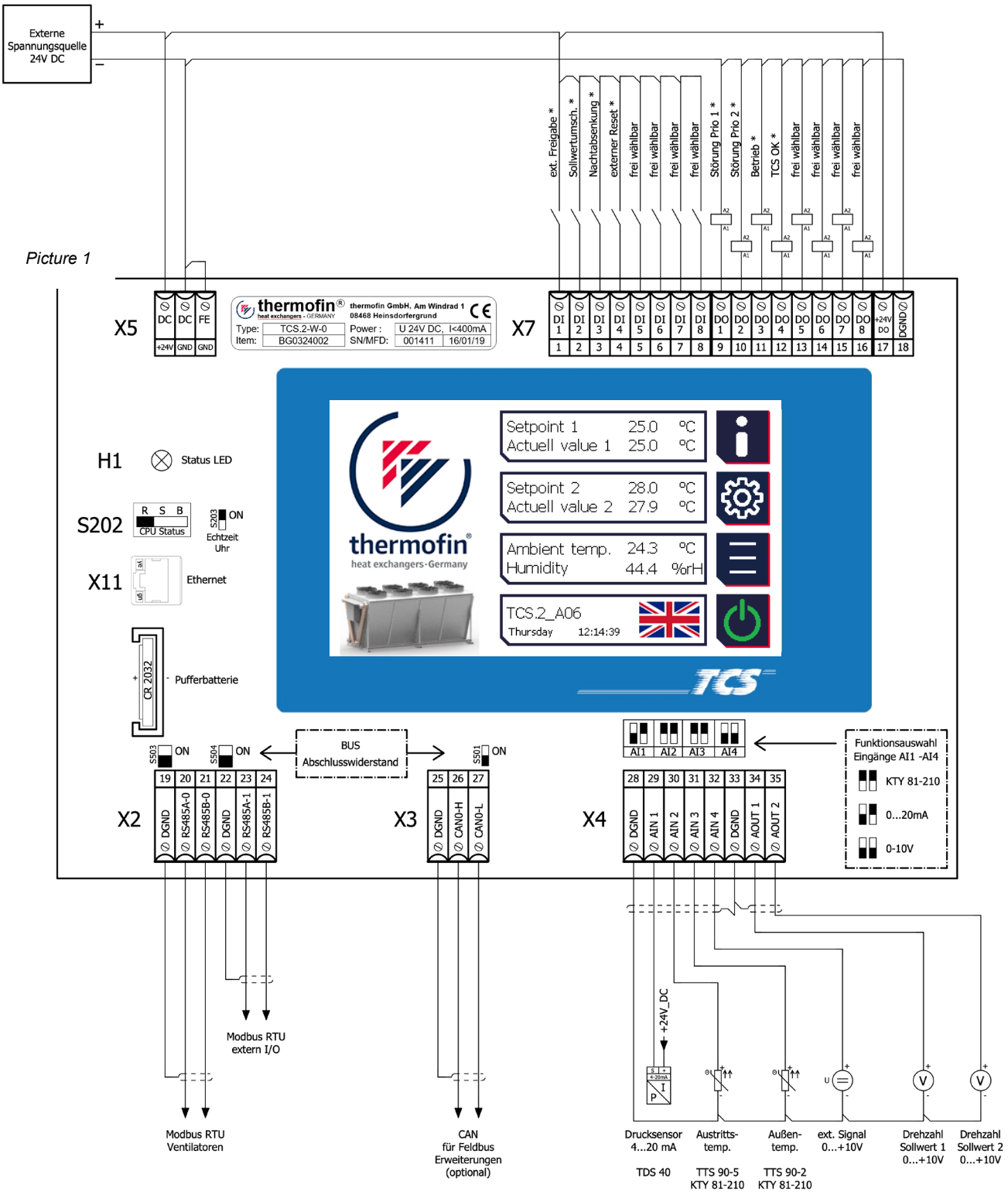
1.3 Scope of application

The TCS is used in modern and energy-efficient refrigeration and air conditioning systems to regulate, control and monitor heat exchangers and their fans, including all the necessary additional units and fittings.

Without an appropriately classified control cabinet, control units of the TCS series may only be operated in dry, weather-protected and properly air-conditioned rooms. Control cabinets from thermofin® company meet all of the important criteria for outdoor installation and therefore also enable trouble-free operation with a built-in TCS.

1.4 Circuit diagram TCS.2

Picture 1

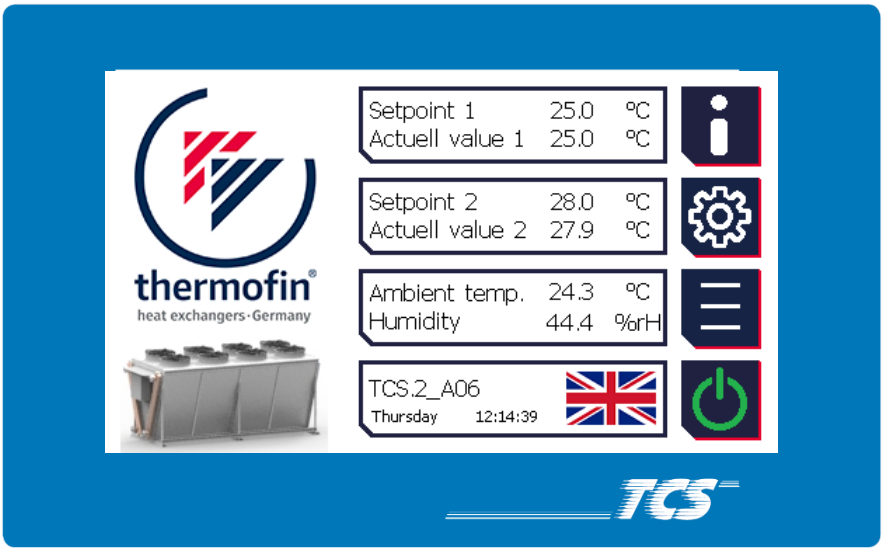


Standard assignment, it may vary. Exemplary assignment of the inputs and outputs.

2. STRUCTURE / NAVIGATION

2.1 Circuit diagram TCS.2

Picture 2



2.2 Navigation / Button functions

HOME / Start screen
This button is located on various main and submenus. Pressing the button always takes the user directly to the start screen.

Back
Jump one menu level back.

Forward
Jump one menu level forward.

Confirm
The current entry or error message is acknowledged.

Confirm all
All currently pending error messages are acknowledged.

Alarm history
With this button the user gets to a list of past error messages sorted from new to old with the information about when they occurred and when they were eliminated.

Delete
The list of stored alarms is deleted. This function requires the entry of the manufacturer password (see chapter 2.4 "*Passwords")*

Undo
The entry is reset to the previous state.

Supervision / Monitor
Direct jump to the "Monitor" submenu in which the user is shown all important set and actual values for controller optimization.

Control parameters
Direct jump to the "Control parameters" submenu. The proportional factor k_p and the reset time T_n are set by the thermofin®-PI controller here.

Modbus fan status
This icon is only displayed when the fan is controlled via Modbus and leads to a submenu where all operating, status and error messages of the fans are listed.

STOP / RUN
The Modbus fan is stopped with the STOP button. This is a prerequisite for starting the fan parametrisation process. After exiting the parametrisation menu, the Modbus is automatically restarted.

Write parameters to fan
All preselected parameters and addresses are loaded into the respective Modbus fan(s).

Manual operation
Depending on the selected device type, the user comes to a user interface in which all relevant flaps, valves and pumps can be operated or set manually.

Manual/automatic switch
The user can use this button to choose between the “Automatic” and ‘Manual” operating modes during commissioning or troubleshooting. If a digital output or an analogue output is switched to “Manual”, this is displayed on the start screen. If the control is set back to automatic mode, the output takes on the original value (before switching to manual).

Manual operation

Automatic operation

The following icons / symbols are only used for wetted / humidified device types:

effSLIDE settings
The limit values (switch-on and switch-off conditions for the mat moistening) for the “water-saving” or “power-saving” mode are set here.

Cooling mat system
Device-specific settings for all devices in which the supply air is pre-cooled using mats (adiabatic pads).

	Summer operation		Winter operation
	Main or spray valve is OPEN		Main or spray valve is CLOSED
	Main or spray valve is opening		Main or spray valve is closing
	Control valve is OPEN		Control valve is CLOSED
	Control valve partially open (with % indication)		Neutral position
	All parameters for switching the humidification on and off are set to “energy-saving”		All parameters for switching the humidification on and off are set to “water-saving”

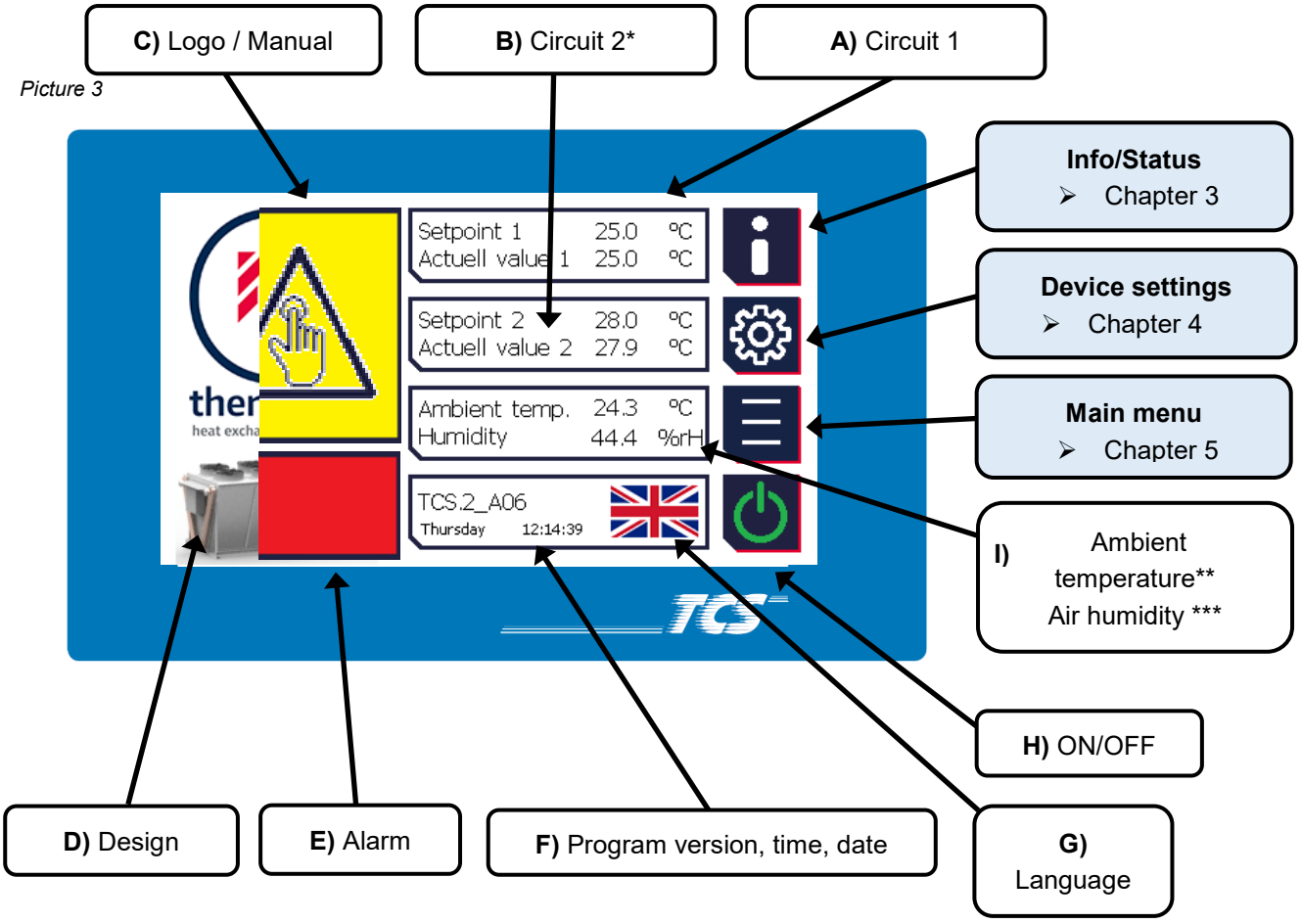
2.3 Menu structure

2.3.1 Start screen

After switching on the control voltage, the thermofin® logo appears in the display with the address of the headquarters in Heinsdorfergrund.

The installed program is then loaded with the following start screen:

Picture 3



* only visible if a two-circuit device is selected

** only visible if a wetted or humidified device has been selected or an ambient temperature sensor has been selected as the analogue input

*** only visible if a thermofin® adiabatic pad device is selected

There are four main function buttons in the right half of the display of the start screen. These are described in a separate chapter. All other symbols and displays are briefly explained below:

A) Circuit 1

Devices that only have one hydraulic line with the corresponding sensor (temperature or pressure) are referred to as “single-circuit”. The sensor is selected automatically when the factory settings are loaded (chapter 4.1.3). This marked display “Circle 1” shows the **setpoint** (editable in the main menu → **Setpoints** (chapter 5.6) and the **actual value** (measured by the sensor) for this string. Both values influence the internal controller 1.

If the operating mode “Slave operation” is selected, the “Control value” (specified in percent) is displayed instead of the setpoint. The actual value display remains.

To switch slave operation on or off, two settings must be made in the “Control” menu:

- *Device settings* → *Control* → *Slave control value* → *“select the desired control signal*” (chapter 4.2.5)
- *Device settings* → *Control* → *Inputs* / *Outputs* → *Analogue IN basic unit* → *Analogue IN 3* → “*Slave speed 1*” (chapter 4.3.3)

B) Circuit 2

If a two-circuit or multi-circuit device is selected, the **setpoint** and **actual value** for the second hydraulic line are displayed under the display of the first circuit. The sensors are selected automatically when loading the factory settings (chapter 4.1.3). This setpoint can also be edited in the main menu → Setpoints (chapter 5.6). The setpoint and actual value from circuit 2 influence internal controller 2.

If the operating mode “Slave operation” is selected, the “Control value” (specified in percent) is displayed instead of the setpoint. The actual value display remains.

To switch slave operation on or off, two settings must be made in the “Control” menu:

- *Device settings* → *Control* → *Slave control value* → *select the desired control signal* (chapter 4.2.5)
- *Device settings* → *Inputs* / *Outputs* → *Analogue IN basic unit* → Analogue IN 4 “*Slave speed 2*” (chapter 4.3.3)

C) Logo / Manual

The thermofin® logo is displayed here in normal operation. However, if manual operation of a digital or analogue output is activated, a yellow hand symbol appears with the information which output is currently set to manual operation.

By pressing the yellow highlighted information window, the user gets directly to the corresponding, still activated, output.

D) Design

Device design shown as an example. This is selected at the factory. See also chapter 4.1.2 (Selection of device design). The following device designs can be selected from the factory. These are shown as examples during the selection and on the start screen.

E) Alarm / Warning - Message window

This window is not visible if there are no warnings or alarms or if they have not yet been acknowledged. As soon as a current fault occurs, regardless of whether it is high priority (alarm) or low priority (warning), the device design and the date/time window are hidden. A red-green flashing error message window opens with a plain text display which shows the last message that occurred (see also 5.4“).

By activating the message window, the user is taken directly to the main menu under the sub-item “Alarms” (see also chapter 5.4 “Alarms”.)

F) Program version, time, date

- TCS.2 – Device generation
- _A01 - Version status in short form, detailed version number in the first main window: “Status / Info” (see chapter 3)
- Weekday, editable in the *Main menu* → “*Time*/*date*“ (see chapter 5.9 “*Time / date*”)
- Time in format: hh:mm:ss, editable in the *Main menu* → “*Time*/*date*” (see chapter 5.9 *„Time / date“*)

G) Language

By pressing the “country flag” directly, the user gets to a language selection menu. The user can currently choose between the following languages:

- German
- English
- French
- Spanish

H) ON / OFF

This button is used to switch the device on and off with priority. This means that even if there is an external release (requirement), the device remains switched off until the switch-on command is also given via the display button. The status is indicated by the background colour:

RED → OFF
- Briefly press this button to switch on the device
- The display changes to green

GREEN → ON
- To switch off the device, the user must hold the button down for 5 seconds
- This is to prevent the system from being switched off unintentionally
- The display changes to red

I) Ambient temperature / Air humidity

Ambient temperature:
If an ambient temperature sensor is selected, it is also displayed in °C or °F on the start screen. The display of °C and °F can be switched in the main menu → "SI/IMP" (see also chapter "SI/IMP" 0). The Ambient sensor can be selected in the program as follows:

- The factory settings of a humidified or wetted device are loaded.
- In the menu *Device settings → Inputs / Outputs → Analogue IN selection →* "*Analogue IN 2, 3 or 4*" (see also chapter "Analogue IN basic unit" 4.3.3)
- If the demand for the analogue temperature inputs increases to over 4 (these are available as standard on the basic unit), the Ambient sensor is automatically assigned to an analogue IN CAN extension (see chapter C) *„Assignment of possible analogue I*/O extensions*")*.

Air humidity:
In order to precisely calculate the maximum evaporation, a relative humidity sensor is built into thermofin® adiabatic pad devices. If such a device is selected, the humidity is also displayed on the start screen. There are the following options for selecting a humidity sensor in the program:

- The factory setting of a thermofin® adiabatic pad device is loaded.
- In the menu *Device settings → Inputs / Outputs → Analogue IN selection →* "*Analogue IN 3 or 4*" (see also chapter "Analogue IN basic unit" 4.3.3)
- If the demand for the analogue inputs increases to over 4 (these are available as standard on the basic unit), the humidity sensor is automatically assigned to an analogue IN CAN extension (see chapter C) *„Assignment of possible analogue I*/O extensions*")*.

2.4 Passwords

For security reasons, the device settings and the editable parameters are password-protected. The following three access levels are distinguished:

2.4.1 Manufacturer password

This password protects basic factory settings. Parameters such as device type, design, resetting operating hours counter, addressing fans, etc. are not accessible to the user.

2.4.2 Admin device password

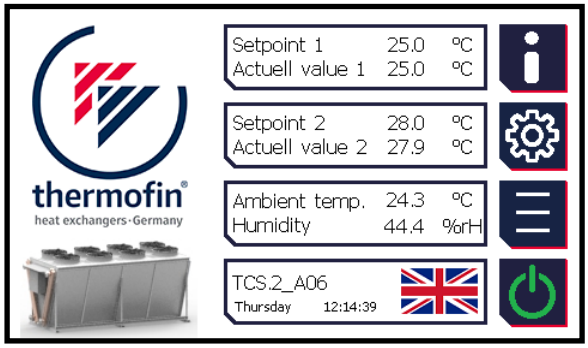
The password for the device settings can be requested from the manufacturer or supplier of the TCS if required.

2.4.3 User parameter password (editable)

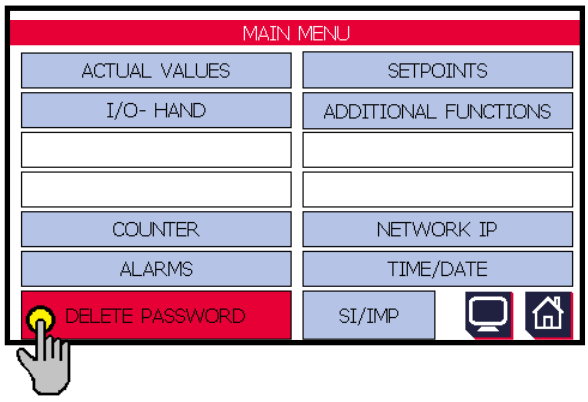
The factory-set password for parameter changes (setpoints, control parameters, time/date, etc.) is "**3333**". The operator can change this to his/her own password that is known only to him/her.

The following procedure is used to change the parameter password:

Picture 4



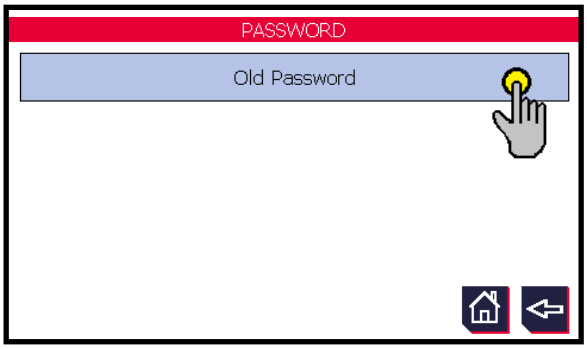
Picture 5



➔ Hold down the "DELETE PASSPORD" button for 5 seconds (Picture 5)

Then the following window opens. If the system password has already been entered, this step is skipped (22a)

Picture 6

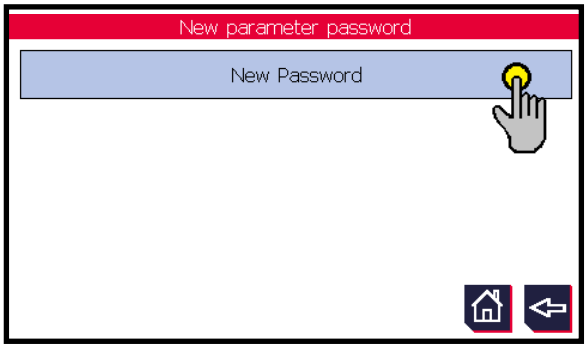


➔ Enter the current (old) User parameter password

(Picture 6)

➔ From factory this password is set to: “3333”

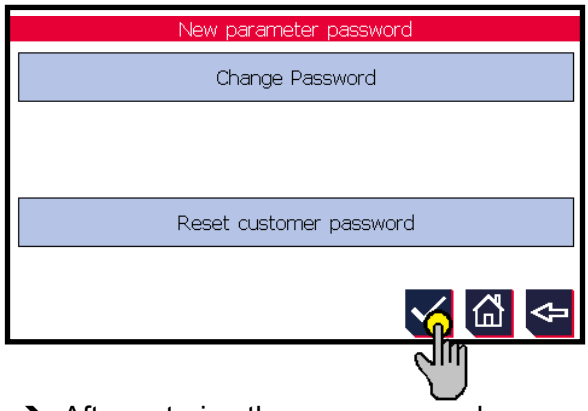
Picture 7



➔ A new 4-digit password can be entered (Picture 7)

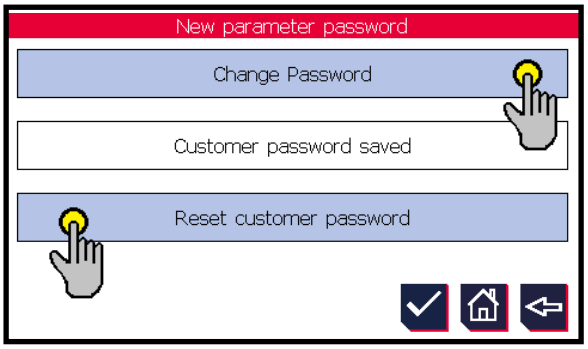
➔ **ATTENTION:** Please keep this password in a safe place. If this password is lost, the password for the device settings (Admin password) is required for further parameter adjustments. This must be requested from the manufacturer or supplier of the TCS.

Picture 8



➔ After entering the new password, confirm the entry with the tick (Picture 8)

Picture 9



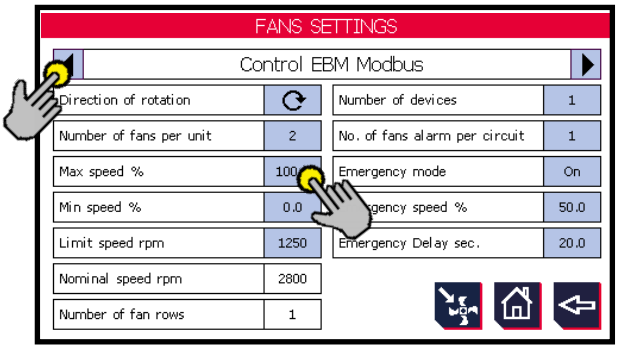
➔ The message “Customer password saved” appears (Picture 9)

➔ After this process, the process can be repeated using the currently assigned password (Picture 9)

2.5 Change (edit) values

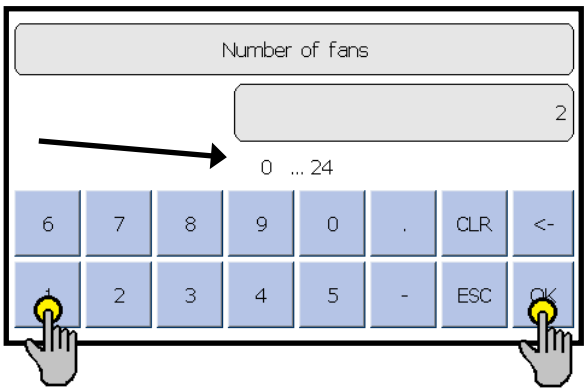
To change a value (parameter) or a status in a menu, press the field with a light blue background directly. All fields with a white background are pure displays and cannot be edited. As an example, see the following submenu (see Picture 10): “Fans settings”

Picture 10



After activating a field with a light blue background with a number, an input window with numbers or letters opens. The desired value or amount can be entered here and then confirmed with OK or cancelled with ESC. The minimum and maximum values to be entered are displayed above the keypad (see Picture 11).

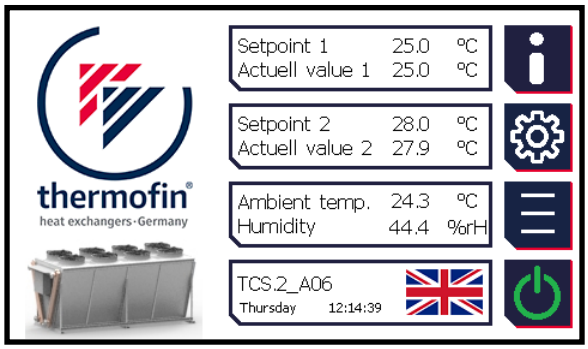
Picture 11



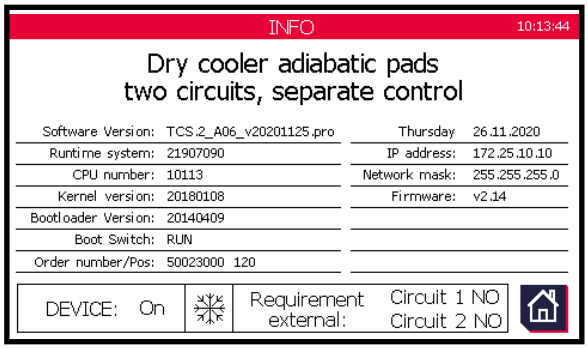
3. INFO / STATUS

On this page you will find all relevant manufacturer information as well as the software and hardware versions. This information is urgently required in order to provide the best possible help with any support requirements (see Picture 12).

Picture 12



Picture 13



Status display with the following content:

- Currently loaded software version
- Version of the runtime system (operating system)
- CPU number
- Kernel version
- Bootloader version
- Boot switch
- Order number thermofin®/position in the order
- Date and time
- Currently set IP address
- Network mask
- Firmware version
- Summer or Winter operation
- Status and type of requirement (release)

  ➔ **Off**: Device has no external release (see chapter 4.2.1: *Control -> Requirement*)
  or is switched off locally (red symbol)

  ➔ **NC:** Release active, **N**ormal **C**ooling

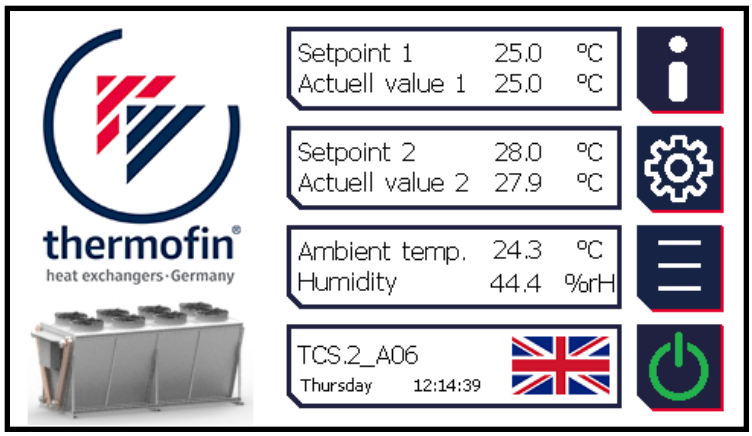
  ➔ **FC:** Release active, **F**ree **C**ooling
  (Setpoint changeover active, see chapter 4.2.2: *Control -> Setpoint changeover*)

  ➔ **HR:** Release active, **H**eat **R**ecovery - only with condensers! (Setpoint changeover active, see chapter 4.2.2: *Control -> Setpoint changeover*)

4. DEVICE SETTINGS

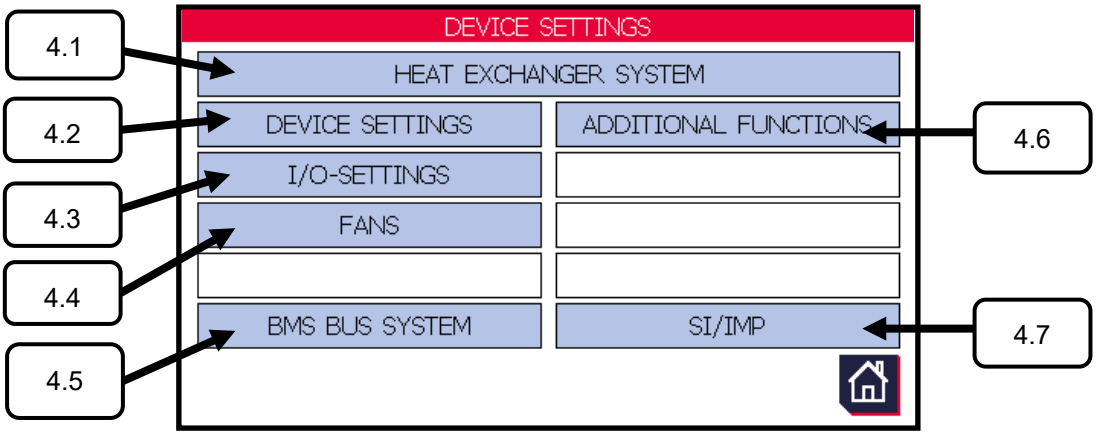
This area is protected by a device password (see chapter 2.4 "*Passwords*"). In the device settings it is possible for the manufacturer or the supplier of the heat exchanger system to adapt the TCS to their tasks for the respective customer application.

Picture 14



Device password

Picture 15

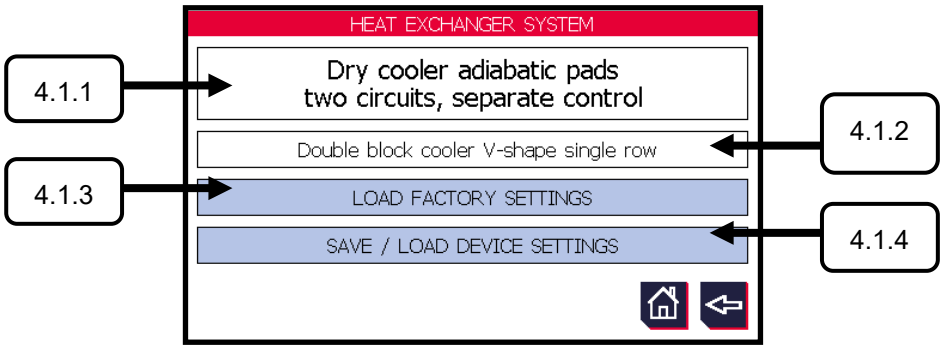


The device settings, including its submenus, are exited using the back or HOME button.

The description of the marked submenus is given below. The framed numbers indicate the chapter number.

4.1 Heat exchanger system

Picture 16



4.1.1 Selection of heating system / explanation of terms

This function is shown in white and cannot be changed by the customer (manufacturer password required). The following device types can be selected from the factory:

1. Condenser dry
2. Condenser sprayed
3. Condenser dry, multi-circuit, max. selection
4. Condenser sprayed, multi-circuit, max. selection
5. Condenser dry, two circuits, separate control
6. Condenser sprayed, two circuits, separate control

7. Dry cooler dry
8. Dry cooler sprayed
9. Dry cooler dry, two circuits, max. selection
10. Dry cooler sprayed, two circuits, max. selection
11. Dry cooler dry, two circuits, separate control
12. Dry cooler sprayed, two circuits, separate control

13. Condenser adiabatic pads
14. Condenser adiabatic pads, two circuits, separate control

15. Dry cooler adiabatic pads
16. Dry cooler adiabatic pads, two circuits, separate control

Explanation of terms:

Condenser:
An air-cooled condenser is an important component in the refrigeration system. Compressed refrigerant (refrigerant vapour) is liquefied by releasing heat into the ambient air using one or more fans.

Dry cooler:
Waste heat is generated in a wide variety of ways in industrial and cooling processes. This is transferred to a carrier medium in the form of water, a water-glycol mixture, steam or thermal oil. Our thermofin® dry coolers dissipate this waste heat efficiently and in an environmentally friendly manner to the ambient air.

Dry:
With a dry cooler or condenser, it is not possible to cool the carrier medium below the ambient air temperature. In this case, the cooling limit is the difference between the medium outlet temperature and the air inlet temperature. For dry coolers, a cooling limit of 7 – 8 °C is still considered economical.

Sprayed:
These devices are dry coolers or condensers as described above but additionally equipped with one or more nozzle sets. Depending on the design, these are arranged under or next to the lamellar heat exchanger. If necessary, the water is sprayed in or against the direction of the air, whereby the evaporation of the water then creates a pre-cooling effect for the sucked in air. Part of the sprayed water also reaches the lamellar surface and wets it. This creates a further evaporation effect which allows cooling below the ambient air temperature. Dry coolers and condensers are basically designed for dry operation. Wet mode with spraying only serves to cover peak loads.

Adiabatic pads:
Dry coolers or condensers with an adiabatic pre-cooling system have humidifying mats through which the outside air is sucked in. The air first flows through the mats, which are moistened with water, where it is cooled by evaporation (removal of the evaporation enthalpy) before it reaches the heat exchanger. This increases the temperature difference of the heat transfer and even makes it possible to drop the return or liquefaction temperatures below the ambient temperature. Because no water is applied directly to the heat exchanger, but only pre-cooled air, the possible switch-on time of the humidification is significantly longer than with the sprayed systems.

Two circuits / Multi-circuit
These devices have two to max. four hydraulically separated circuits that are installed either in one or in two separate, lamellar heat exchangers. As a result, each circuit has a separate pressure or temperature sensor.

Max. selection
This function relates to two or more circuit devices that work with only one internal controller and several sensors. The circuit with the higher value on the sensor (pressure or temperature) is determined as the control variable in the TCS and thus the regulating variable (fan speed).

Separate control:
Both lines of a two-circuit device are not only considered hydraulically but also separately in terms of control technology. As a result, there are also two internal controllers whose control variable addresses two different fan groups. Two different refrigerants or heat carriers are possible.

4.1.2 Selection of device design

Also, this function is shown in white and cannot be changed by the customer (manufacturer password required). The following device designs can be selected from the factory. These are shown as examples during the selection and on the start screen.

1. Table cooler horizontal single row
2. Table cooler horizontal double row
3. Table cooler vertical single row
4. Table cooler vertical double row
5. Double block cooler V-shape single row
6. Double block cooler V-shape double row

4.1.3 Load factory settings

After selecting the heating system, the factory settings must be loaded during commissioning. The system sets all device-specific standard settings, setpoints and configures the inputs and outputs.

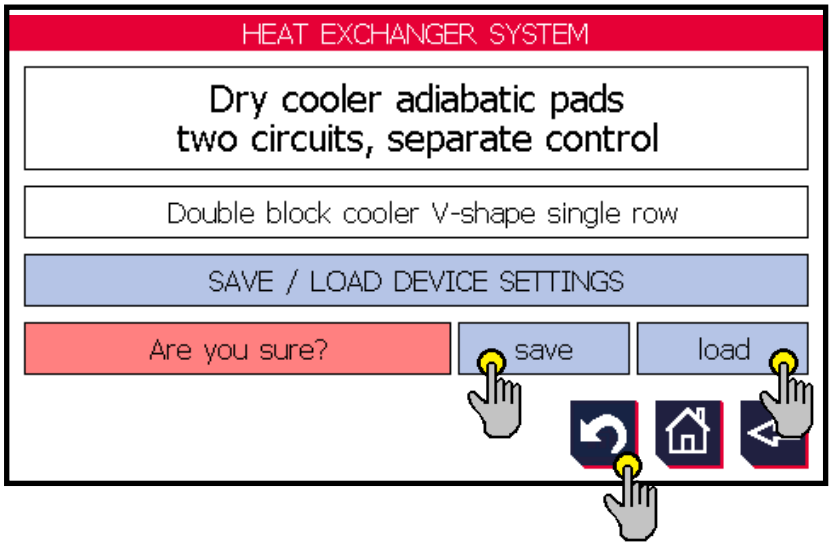
Attention! All previously made parameter adjustments and customer settings are lost. A prior comparison of the set parameters with the parameter list on the circuit diagram is essential!

4.1.4 Save / load device settings

All settings and parameters are automatically saved after entry in a voltage failure-safe manner. However, if a new program or an update is loaded, drive A: is cleaned and all data is lost.

To prevent this, the user has the option of saving own settings and parameters on an internal drive B:. To do this, please answer the security question: “Are you sure?” with “Save”.

Picture 17



After a new program version has been installed, the process can be repeated and the security question answered with “Load”.

The saved data is now loaded from drive B: back into drive A: If the process is to be cancelled, this can be done at any time with the “Undo” button.

4.2 Control

In this submenu, the user defines the signal with which the respective function is controlled or activated. With the arrow button to the right  , the user comes to the extended control menu (from chapter 4.2.7, Hygienic circuit).

Below is a list with the corresponding setting options:

4.2.1 Requirement (release)

In addition to local switch-on via the display in the start screen (see chapter 2.3.1 ON / OFF), there is a second prerequisite for putting the device into operation. The requirement (release) must be set externally or permanently via the menu. The following setting options are available for this in the menu (arrow buttons to the right and left):

Signal type:	→ Binary	0 = OFF, 1 = ON
Options:	→ Via terminal *	+ 24 V DC at terminal X7.1 (DI-1), see chapter 1.4 (circuit diagram TCS.2)
	→ Via bus	The type of communication bus is set in the *Device settings* → *BMS bus system*. See also chapter 4.5 "*BMS (Building management* system) *bus system*" The following parameters apply to direct communication via MODBUS: **Writing:** Register 1, bit 0 (Bool), (register value 1) **Reading:** Register 141, bit 6 (Bool), (register value 64)
	→ SP1 fixed ON **	The requirement is permanently activated (ON). The internal setpoint 1 (NC - normal cooling) is applied to the controller.
	→ SP2 fixed ON **	The requirement is permanently activated (ON). Internal setpoint 2 (FC - free cooling or HR - heat recovery) is applied to the controller.
	* Factory setting ** These settings are typically used for function tests and commissioning. If, for example, no external release has yet been sent from the BCS.	

4.2.2 Setpoint changeover control

The program differentiates between two editable setpoints. Can be set in the *Main menu* → *Setpoints* (see also chapter 5.6 "*Setpoints*"). These are "Setpoint 1 – NC – normal cooling" and "Setpoint 2 – FC – free cooling" or "Setpoint 2 – HR – heat recovery" for condensers.

Signal type:	→ Binary	0 = NC - normal cooling 1 = FC – free cooling / HR - heat recovery
Options:	→ Via terminal *	+ 24 V DC at terminal X7.2 (DI-2), see chapter 1.4 (circuit diagram TCS.2)
	→ Via AT (ambient temperature)	The switching of the setpoint is controlled by the ambient temperature. The switching thresholds are set in the *Main menu* → *Setpoints* → *Setpoint switch. OT*. However, this is only displayed after the selection "Via OT" (see also chapter B)
	→ Via bus	The type of communication bus is set in the *Device settings* → *BMS bus system*. See also chapter 4.5 "*BMS (Building management* system) *bus system*" The following parameters apply to direct communication via MODBUS: **Writing:** Register 1, bit 1 (Bool), (register value 2) **Reading NC1 (normal cooling 1) active:** Register 164, bit 0 (Bool), (register value 1) **Reading NC2 (normal cooling 2) active:** Register 164, bit 1 (Bool), (register value 2) **Reading FC1 (free cooling 1) active:** Register 164, bit 2 (Bool), (register value 4) **Reading FC2 (free cooling 2) active:** Register 164, bit 3 (Bool), (register value 8) **Reading HR1 (heat recovery 1) active:** Register 164, bit 4 (Bool), (register value 16) **Reading HR2 (heat recovery 2) active:** Register 164, bit 5 (Bool), (register value 32) **Reading HP1 (heat pump operation 1) active:**

		Register 164, bit 6 (Bool), (register value 64) **Reading HP2 (heat pump operation 2) active:** Register 164, bit 7 (Bool), (register value 128)
	→ Off	Function deactivated.
	* Factory setting	

4.2.3 Night time reduction control

With this function, the maximum fan speed is limited to a value in order to reduce the noise emission to a minimum at certain times (mostly at night). Can be set in the *Main menu* → *Setpoints* (see also chapter 5.6.4 "*Night time reduction*").

Signal type:	→ Binary	0 = OFF, 1 = ON
Options:	→ Via terminal *	+ 24 V DC at terminal X7.3 (DI-3), see chapter 1.4 (circuit diagram TCS.2)
	→ Via bus	The type of communication bus is set in the *Device settings* → *BMS bus system*. See also chapter 4.5 "*BMS (Building management system*) *bus system*" The following parameters apply to direct communication via MODBUS: **Writing:** Register 1, bit 2 (Bool), (register value 4)
	→ Off	Function deactivated.
	* Factory setting	

4.2.4 Setpoint shift control

This function enables the operator to adapt the condensing pressure or the outlet temperature to specific operating conditions. All relevant values are set in the *Main menu* → *Setpoints* →*Setpoint shifting.* This menu item is only displayed after a control has been selected (see also chapter 5.6.3 "*Setpoint shifting")*
The following control options are available:

Signal type:	→ Analogue	0 – 100 %
Options:	→ Off *	Function deactivated.
	→ Via terminal 0 – 10 V	0 - 10 V signal at terminal X4.31 (AI-3) or X4.32 (AI-4) for two-circuit devices, see chapter 1.4 (circuit diagram TCS.2)
	→ Via terminal 2 – 10 V	2 - 10 V signal at terminal X4.31 (AI-3) or X4.32 (AI-4) for two-circuit devices, see chapter 1.4 (circuit diagram TCS.2)
	→ Via terminal 0 – 20 mA	0 - 20 V signal at terminal X4.31 (AI-3) or X4.32 (AI-4) for two-circuit devices, see chapter 1.4 (circuit diagram TCS.2)
	→ Via terminal 4 – 20 mA	4 - 20 V signal at terminal X4.31 (AI-3) or X4.32 (AI-4) for two-circuit devices, see chapter 1.4 (circuit diagram TCS.2)
	→ Via AT (ambient temperature)	The shift starts to raise the setpoint at a certain ambient temperature. All relevant values can be set in the *Main menu* → *Setpoints* → "*Setpoint shifting*" (see also chapter 5.6.3 "*Setpoint* shifting"*)*
	→ Via bus	The type of communication bus is set in the *Device settings* → *BMS bus system* [see also chapter "4.5 *„BMS (Building management* system) *bus system*"]. The following parameters apply to direct communication via MODBUS: <u>Circuit 1:</u> Register 4 (INT), (register value: -250 to 250→ -25,0°C to +25,0°C or -450 to +450 → for -45,0°F to +45,0°F) <u>Circuit 2:</u> Register 5 (INT), (register value: -250 to 250→ -25,0°C to +25,0°C or -450 to +450 → for -45,0°F to +45,0°F)
	* Factory setting	

4.2.5 Slave control value control

The internal controller(s) can be deactivated. The fan speed is 100% influenced by the slave control value. The following signal sources can be selected:

Signal type:	→ Analogue	0 – 100 %
Options:	→ Off *	Function deactivated.
	→ Via terminal 0 – 10 V	0 - 10 V signal at terminal X4.31 (AI-3) or X4.32 (AI-4) for two-circuit devices, see chapter 1.4 (circuit diagram TCS.2)
	→ Via terminal 2 – 10 V	2 - 10 V signal at terminal X4.31 (AI-3) or X4.32 (AI-4) for two-circuit devices, see chapter 1.4 (circuit diagram TCS.2)
	→ Via terminal 0 – 20 mA	0 - 20 V signal at terminal X4.31 (AI-3) or X4.32 (AI-4) for two-circuit devices, see chapter 1.4 (circuit diagram TCS.2)
	→ Via terminal 4 – 20 mA	4 - 20 V signal at terminal X4.31 (AI-3) or X4.32 (AI-4) for two-circuit devices, see chapter 1.4 (circuit diagram TCS.2)
	→ Via bus	The type of communication bus is set in the Device settings → BMS bus system. See also chapter 4.5 "*BMS (Building management system) bus system"* The following parameters apply to direct communication via MODBUS: <u>Circuit 1:</u> Register 6 (INT), (register value: 0 to 1000 → 0.0 to 100.0 %) <u>Circuit 2:</u> Register 7 (INT), (register value: 0 to 1000 → 0.0 to 100.0 %)
	* Factory setting	

4.2.6 Winter operation control

This function is only relevant for humidified or wetted devices and can be set in the main menu.

In order to avoid frost damage to the hydraulic system, the device switches from summer mode (normal operation) to winter operation starting from a temperature which can be specified. The piping system in the frost area is emptied. The current status is shown in various submenus with a sun or an ice crystal icon (see below). All relevant settings are made in the *Main menu → Wet mode → "Winter operation"* (see also chapter 6.4.1 "*Winter operation/Summer operation").* The following options are available to activate this function:

Signal type:	→ Binary	0 = OFF → summer operation 1 = ON → winter operation
Options:	→ Internal *	The TCS records the outside temperature via the installed Ambient sensor. The function is switched on and off using the parameters set in the *Main menu → Wet mode → "Winter operation"*.
	→ Via terminal	+ 24 V DC at terminal X7.5 (DI-5) or terminal X7.8 (DI-8), selectable in *Device settings → Inputs / Outputs →* "*Digital IN basic unit*" See chapter 1.4 (Circuit diagram TCS.2)
	→ Via bus	The type of communication bus is set in the *Device settings → BMS bus system* (see also chapter "4.5 „*BMS (Building management system) bus system").* The following parameters apply to direct communication via MODBUS: Register 1, bit 13 (Bool), (register value 8192)
	→ Off	Function deactivated.
	* Factory setting	

4.2.7 Hygienic circuit control

For reasons of hygiene, stagnant water in the pipe should be avoided. The hygiene circuit is used to drain the water pipe from the main water valve to the device (see also chapter 6.4.6 "*Hygienic circuit")*.

This function must be set to "ON" in the device settings → *System* → *Humidification* → *"Hygienic circuit"*. Otherwise, the control has no effect!

There are the following options for control:

Signal type:	→ Binary	0 = OFF, 1 = ON
Options:	→ Internal *	If the adiabatic system is switched off (no water requirement), the function is activated after the set waiting time in the *Main menu* → *Wet mode* → *"Hygienic circuit"*. The function is only deactivated again after a new requirement for humidification / wetting.
	→ Via terminal	+ 24 V DC at terminal X7.7 (DI-7), selectable in the *Device settings* → *Inputs / Outputs* → "*Digital IN basic unit*" see also chapter 1.4 (Circuit diagram TCS.2)
	→ Via bus	The type of communication bus is set in the *Device settings* → *BMS bus system* [see also chapter "4.5 „*BMS (Building management system) bus system"].* The following parameters apply to direct communication via MODBUS: Register 1, bit 14 (Bool), (register value 16384)
	→ Off	Function deactivated.
	* Factory setting	

4.2.8 External master mode control

This function is used for devices that are controlled by a master in a network of several devices in slave mode (speed control, winter / summer operation). As long as the master sends an “OK” signal, the device continues to run in slave mode. If the master fails, the device switches to an independent control.

Signal type:	→ Binary	0 = OFF → external master inactive 1 = ONN → external master active
Options:	→ Off *	Function deactivated.
	→ Via terminal	+ 24 V DC at terminal X7.5 (DI-5) or X7.7 (DI-7) *“External Master OK”* *Device settings → Inputs / Outputs → “Digital IN basic unit”* Digital output X7.15 (DO-7) “Master OK” *Device settings → Inputs / Outputs → “Digital OUT basic unit”* see also chapter 1.4 (Circuit diagram TCS.2)
	→ Via bus	The type of communication bus is set in the *Device settings → BMS bus system* [see also chapter “4.5 „*BMS (Building management system) bus system”].* The following parameters apply to direct communication via MODBUS: Register 1, bit 12 (Bool), (register value 4096)
	* Factory setting	

4.2.9 Reversion of rotation control

Signal type:	→ Binary	0 = OFF, 1 = ON
Options:	→ Off *	Function deactivated.
	→ Via terminal	+ 24 V DC at terminal X7.5 (DI-5) *“Reversion of rotation”* *Device settings → Inputs / Outputs → “Digital IN basic unit”* see also chapter 1.4 (Circuit diagram TCS.2)

	→ Via bus	The type of communication bus is set in the *Device settings* → *BMS bus system* [see also chapter "4.5 „*BMS (Building management system*) *bus system*"]. The following parameters apply to direct communication via MODBUS: **Writing:** Register 1, bit 15 (Bool), (register value 32767) **Reading:** Register 143, bit 8 (Bool), (register value 256)
	* Factory setting	

4.2.10 Low load regulation control

See also chapter 4.6.5 "Low load settings" and chapter 5.7.5 "*Low* load".

Signal type:	→ Binary	0 = OFF, 1 = ON
Options: * Factory setting	→ Off *	Function deactivated.
	→ Internal	The switching thresholds for the individual levels are automatically calculated by the program based on the number of steps and the limit value. These can be set under: Device settings → Additional functions → "Low load" (chap. 0) or in the Main menu → Additional functions → "Load load" (chap. 5.7.5)
	→ Via terminal	A maximum of 2-level control is possible. The first (base load level) remains switched on, the second is activated with the following DI. + 24 V DC at terminal X7.6 (DI-6) "External low load level 1" *Device settings* → *Inputs / Outputs* → *"Digital IN basic unit"* (chap. 4.3.1) → See also chapter 1.4 (Circuit diagram TCS.2)
	→ Via bus	The type of communication bus is set in the *Device settings* → *BMS bus system* [see also chapter "4.5 „*BMS (Building management* system) bus system"]. The following parameters apply to direct communication via MODBUS: **Writing:** Register 2 SL control level 1, bit 0 (Bool), (register value 1)

		SL control level 2, bit 1 (Bool), (register value 2) SL control level 3, bit 2 (Bool), (register value 4) SL control level 4, bit 3 (Bool), (register value 8) SL control level 5, bit 4 (Bool), (register value 16) **Reading: (SL = low load)** Register circuit 1: 165 SL base load level 1 in operation, bit 0 (Bool) SL control lvl. 1 in operation, bit 1 (Bool) SL control lvl. 2 in operation, bit 2 (Bool) SL control lvl. 3 in operation, bit 3 (Bool) SL control lvl. 4 in operation, bit 4 (Bool) SL control lvl. 5 in operation, bit 5 (Bool) Register circuit 2: 165 SL base load level 1 in operation, bit 6 (Bool) SL control lvl. 7 in operation, bit 7 (Bool) SL control lvl. 8 in operation, bit 8 (Bool) SL control lvl. 9 in operation, bit 9 (Bool) SL control lvl. 10 in operation, bit 10 (Bool) SL control lvl. 11 in operation, bit 11 (Bool)

4.2.11 Spray pump control

See also in the Main menu → Additional functions → “Spray pump” (5.7.3 “Spray pump”)

Signal type:	→ Binary	0 = OFF, 1 = ON
Options:	→ Off *	Function deactivated.
	→ Internal	If the release (requirement circuit 1, DI-1) is set and the conditions in the “Spray pump” menu are met, the pump switches on. See also: Main menu → Additional functions → “Spray pump” (chap. Spray pump)
	→ Via terminal	There is currently no digital input dedicated to activating the spray pump. In case of “internal”, the pump is also switched on via the release (external requirement, DI-1).

	→ Via bus	The type of communication bus is set in the *Device settings → BMS bus system* [see also chapter "4.5 „*BMS (Building management system) bus system*"]. As soon as the below-mentioned bit is set and the conditions in the "Spray pump" menu are met, the pump switches on. The following parameters apply to direct communication via MODBUS: **Writing:** Spray pump 1 Register 2, bit 5 (Bool), (register value 32) Spray pump 2 Register 2, bit 6 (Bool), (register value 64) **Reading (feedback):** Spray pump 1 Register 144, bit 12 (Bool), (register value 4096) Spray pump 2 Register 144, bit 13 (Bool), (register value 8192)
	* Factory setting	

4.2.12 Medium pump control

See also in the Main menu → Additional functions → “Medium pump” (chapter 5.7.7)

Signal type:	→ Binary	0 = OFF, 1 = ON
Options:	→ Off *	Function deactivated.
	→ Internal	If the release (requirement circuit 1, DI-1) is set and the conditions in the “Medium pump” menu are met, the pump switches on. See also: Main menu → Additional functions → “Medium pump” (chap. 5.7.7)
	→ Via terminal	There is currently no digital input dedicated to activating the spray pump. In case of “internal”, the pump is also switched on via the release (external requirement, DI-1).
	→ Via bus	The type of communication bus is set in the *Device settings* → *BMS bus system* [see also chapter “4.5 „*BMS (Building management system) bus system*”]. As soon as the below-mentioned bit is set and the conditions in the “Spray pump” menu are met, the pump switches on. The following parameters apply to direct communication via MODBUS: **Writing:** Medium pump 1 Register 2, bit 7 (Bool), (register value 128) Medium pump 2 Register 2, bit 8 (Bool), (register value 256) **Reading (feedback):** Medium pump 1 Register 164, bit 8 (Bool), (register value 256) Medium pump 2 Register 164, bit 9 (Bool), (register value 512)
	* Factory setting	

4.3 Inputs / Outputs

The configuration of the digital and analogue inputs and outputs is described below. In addition to changing the factory settings, various additional functions can be selected and deselected. The selection is made using the arrow buttons.

4.3.1 Digital IN basic unit

Input Terminal	Possible functions
DI – 1 (X7.1)	➔ External release * (see chap. 4.2.1) ➔ Not used
DI – 2 (X7.2)	➔ Setpoint changeover * (see chap. 5.6.5 *„Setpoint changeover“)* ➔ External defrost release ➔ Not used
DI – 3 (X7.3)	➔ Night time reduction * (see chap.4.2.3 “*Night time reduction control*” and 5.6.4 “*Night time reduction”)* ➔ Dripping and pre-cooling time see chap. 9 “Insulating / penthouse cooler”) ➔ Not used
DI – 4 (X7.4)	➔ External reset * (A rising edge at this input acknowledges all warnings and alarms that have started but are not deleted. They are retained in the alarm history (see chap. 5.4 “*Alarms*”). ➔ Not used
DI – 5 (X7.5)	➔ Not used ➔ Fault fan/group 1 ➔ Rep. sw. Fan/group 1 (feedback repair switch) ➔ Lock circuit 1 ➔ Reversion of rotation (see chap. 5.6.6 “*Speed reversion of rotation*” ➔ FB (feedback) drain valve ➔ FB vent valve ➔ FB inlet valve ➔ FB Louver flap 1 ➔ FB defrosting flap closed ➔ Forced opening of valves ➔ Collection tray failure ➔ External master OK (see chap. 4.2.8) ➔ External winter operation (see chap. 4.2.6) ➔ Flow monitor (see chap. C)

DI – 6 (X7.6)	➔ Not used ➔ Fault fan/group 2 ➔ Rep. sw. Fan/group 2 (feedback repair switch) ➔ Lock circuit 2 ➔ External low load level 1 (see chap. 4.2.10) ➔ FB (feedback) main water valve ➔ FB Spray valve ➔ FB bypass valve ➔ FB Louver flap 2 ➔ FB defrosting flap open ➔ FB air cooler medium valve Fault spray pump (see chap. 5.7.3) ➔ Glycol monitoring (True = glycol OK) ➔ Fresh water meter (pulse input, 1 pulse. / litre)
DI – 7 (X7.7)	➔ Not used ➔ Fault fan/group 3 ➔ Rep. sw. Fan/group 3 (feedback repair switch) ➔ FB (feedback) external fans off ➔ FB Spray valve ➔ FB storage container (see chap.6.1.9) ➔ FB 3-way valve ➔ Fault control voltage ➔ External master OK ➔ External emergency stop 1 (circuit 1) ➔ Subcooler fan 1 ➔ External hygiene requirement (see chap. 4.2.7 and 6.4.6) ➔ Fresh water meter (pulse input, 1 pulse. / litre) ➔ Reversion of rotation (see chap. 5.6.6 “*Speed reversion of rotation*”)
DI – 8 (X7.8)	➔ Not used ➔ Fault fan/group 4 ➔ Rep. sw. Fan/group 4 (feedback repair switch) ➔ FB (feedback) pressure increase (see chap. 6.1.10) ➔ FB storage container (see chap.6.1.9) ➔ Fault dry run ➔ Frost protection monitor ➔ Door contact switch ➔ External winter operation (see chap. 4.2.6) ➔ External emergency stop ➔ External emergency stop 2 (circuit 2) ➔ Subcooler fan 2 ➔ NH_3 monitor ➔ Reversion of rotation (see chap. 5.6.6 “*Speed reversion of rotation”)*
	➔ * Factory setting

4.3.2 Digital OUT basic unit

Output Terminal	Possible functions
DO – 1 (X7.9)	➔ Warning = low priority * (see chap. 8) ➔ Fault circuit 1 ➔ Not used
DO – 2 (X7.10)	➔ Alarm = high priority * (see chap. 8) ➔ Fault circuit 2 ➔ Running ➔ Not used
DO – 3 (X7.11)	➔ Running * ➔ Operation circuit 1 ➔ Fan ring heating ➔ Defrosting flap closed ➔ Not used
DO – 4 (X7.12)	➔ TCS OK * ➔ Free cooling ➔ Rep. switch message ➔ Operation circuit 2 ➔ Frost warning ➔ Defrosting flap open ➔ humidification ➔ Not used
DO – 5 (X7.13)	➔ Not used ➔ Fan level 1 ➔ Fault fan/group 1 ➔ Rep. switch message ➔ Low load level 1 ➔ Cascade level 1 ➔ Reversion of rotation active ➔ Drain valve ➔ Vent valve ➔ Inlet valve ➔ Louver flap 1 ➔ Defrosting flap start ➔ Fresh air damper closed

DO – 6 (X7.14)	➔ Not used ➔ Fan level 2 ➔ Fault fan/group 2 ➔ Rep. switch message ➔ Low load level 2 ➔ Cascade level 2 ➔ Main water valve ➔ Spray valve ➔ Bypass valve ➔ Louver flap 2 ➔ Rotation direction of defrosting flap ➔ Air cooler medium valve Spray pump (see chap. 5.7.3) ➔ Fresh air damper open ➔ Message of hygienic circuit active (see chap. 4.2.7 and 6.4.6)
DO – 7 (X7.15)	➔ Not used ➔ Fan level 3 ➔ Fault fan/group 3 ➔ Low load level 3 ➔ Cascade level 3 ➔ Spray valve ➔ Storage container requirement (see chap.6.1.9) ➔ Flap frame heating ➔ Master OK (see chapter 4.2.8) ➔ Main contactor 1 = emergency stop (circuit 1) ➔ Subcooler fan 1 ➔ Message of flushing function active (see chap. 6.4.7)
DO – 8 (X7.16)	➔ Not used ➔ Fan level 4 ➔ Fault fan/group 4 ➔ Low load level 4 ➔ Cascade level 4 ➔ Pressure increase requirement (see chap.6.1.10) ➔ Storage container requirement (see chap.6.1.9) ➔ Dry run warning ➔ Frost warning ➔ Message door open ➔ Message winter mode ➔ Main contactor = emergency stop ➔ Main contactor 2 = emergency stop (circuit 2) ➔ Oil return solenoid valve ➔ Tray heater ➔ Subcooler fan 2

	➔ * Factory setting

4.3.3 Analogue IN basic unit

A) Possible configuration

Pressing the right arrow button enables the following functions to be selected:

Input Terminal	Possible functions
AI – 1 (X4.29)	➔ Pressure sensor 1 (4-20 mA) ➔ Outlet sensor 1 (resistance KTY 81-210) ➔ Ambient sensor (resistance KTY 81-210) ➔ Room sensor (resistance KTY 81-210) ➔ Conductivity 1 (4-20 mA) ➔ Current sensor of lift motor 1 (0-10 V) ➔ Not used
AI – 2 (X4.30)	➔ Pressure sensor 2 (4-20 mA) ➔ Outlet sensor 2 (resistance KTY 81-210) ➔ Inlet sensor 1 (resistance KTY 81-210) ➔ Ambient sensor (resistance KTY 81-210) ➔ Coil sensor (resistance KTY 81-210) ➔ Current sensor of lift motor 2 (0-10 V) ➔ Conductivity 2 (4-20 mA) ➔ Feedback of 3-way valve (0-10 V) ➔ Current sensor of lift motor 2 ➔ Not used
AI – 3 (X4.31)	➔ Pressure sensor 3 (4-20 mA) ➔ Inlet sensor 1 (resistance KTY 81-210) ➔ Ambient sensor (resistance KTY 81-210) ➔ Drip tray sensor (resistance KTY 81-210) ➔ Setpoint shifting 1 (see chap. 4.2.4) ➔ Speed slave 1 (0-10 V, see chap. 4.2.5) ➔ Current sensor of lift motor 3 (0-10 V) ➔ Humidity sensor (4-20 mA) ➔ Not used
AI – 4 (X4.32)	➔ Pressure sensor 4 (4-20 mA) ➔ Inlet sensor 2 (resistance KTY 81-210) ➔ Ambient sensor (resistance KTY 81-210) ➔ Cell sensor (resistance KTY 81-210) ➔ Setpoint shifting 2 (see chap. 4.2.4) ➔ Speed slave 2 (0-10 V, see chap. 4.2.5) ➔ Current sensor of lift motor 4 (0-10 V) ➔ Humidity sensor (4-20 mA)

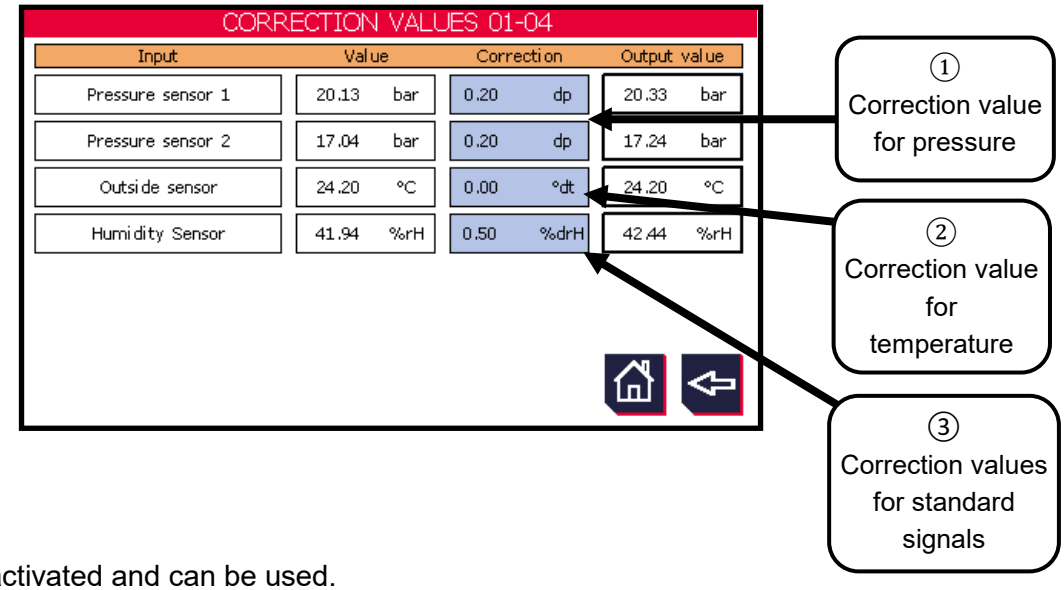
	➔ Feedback of control valve mat 1 ➔ Not used
	➔ The factory settings vary depending on the selected device type

B) Correction values

If the actual value displayed deviates too much from the current value, a correction factor can be added to or subtracted from the actual value (see examples in Picture 17).

By activating the “Correction values” field, the user gets to the following overview:

Picture 18



All blue fields are activated and can be used.

① **<u>Correction value for pressure in bar / psi</u>**

The analogue inputs for pressure sensors are adjusted absolutely in bar (dp ≙ delta p – pressure).

Editable from -1.00 bar to 1.00 bar

② **<u>Correction value for temperature in °C / °F</u>**

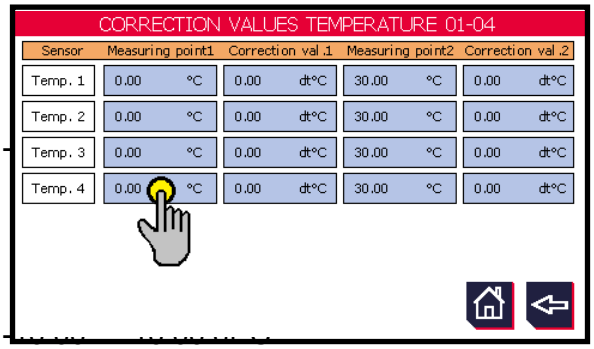
For temperature inputs, two associated correction values can be determined using two different measuring points. The characteristic curve is thus adapted to the non-100% linear course of the temperature sensors (see Picture 18).

Editable from …to:

Measuring point 1: -50.00 … 20.00 °C
-60.00 … 70.00 °F
Correction value 1:
-20.00 … 20.00 dt°F

Measuring point 2: 20.00 … 60.00 °C
70.00 … 140.00 °F
Correction value 2:
-20.00 … 20.00 dt°F

Picture 19



③ **<u>Correction values for standard signals in %</u>**

Analogue voltage or current inputs (0-10 V, 2-10 V, 0-20 mA, 4-20 mA) are corrected as a percentage.

Editable from -5.00 % to 5.00 %

4.3.4 Analogue OUT basic unit

Pressing the right arrow button enables the following functions to be selected:

Output Terminal	Possible functions
AO – 1 (X4.34)	➔ Speed circuit 1 (0-10 V) ➔ Speed circuit 1 (2-10 V) ➔ Wetting pump 1 speed (0-10 V) ➔ Adiabatic valve 1 (2-10 V) ➔ Not used
AO – 2 (X4.35)	➔ Speed circuit 1 (0-10 V) ➔ Speed circuit 2 (0-10 V) ➔ Speed circuit 1 (2-10 V) ➔ Speed circuit 2 (2-10 V) ➔ Outlet temperature circuit 1 (-50 °C → 0 V to +100 °C → 10 V) ➔ Adiabatic valve 1 (2-10 V) ➔ Adiabatic valve 2 (2-10 V) ➔ Low load level 1, 2-10 V ➔ Wetting pump 1 speed (0-10 V) ➔ Wetting pump 2 speed (0-10 V)

	➔ Free cooler bypass valve (0-10 V) ➔ Subcooler fan circuit 1 (0-10 V) ➔ 3-way valve, compressor (0-10 V) ➔ Ambient temperature (-50 °C → 0 V to +100 °C → 10 V) ➔ Not used
	➔ The factory settings vary depending on the selected device type

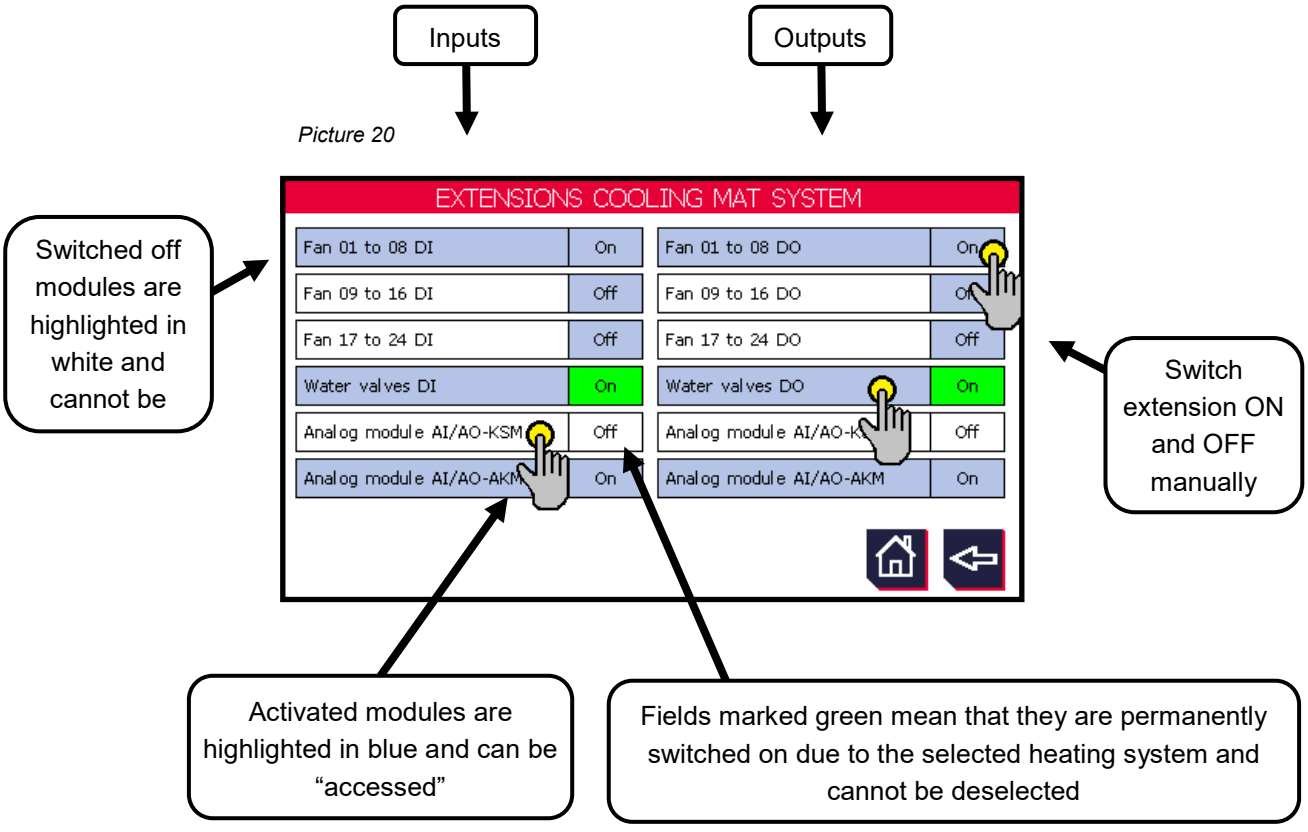
4.3.5 IN / OUT extensions

For devices with an extended range of functions (e.g. thermofin® adiabatic pad cooler or thermofin® hybrid cooler), the digital and analogue I/Os from the TCS.2 basic unit are not sufficient. They are then expanded with external I/O modules via the CAN bus. After loading the factory settings, these are automatically selected or deselected. Depending on requirements and the heat exchanger system, this presetting can still be adjusted in the following menu.

A) Display of possible I/O extensions

In the following example - a cooler with thermofin® adiabatic pads (mat cooler) see Picture 19

- ➔ 8 fans are monitored via digital inputs (e.g. a thermal contact connected) → Extension of digital inputs DI-01 to 08
- ➔ A fault message is output for each fan via the digital output → Extension of digital outputs DO-01 to 08
- ➔ Spray valves → Extension of digital inputs and outputs DI and DO
- ➔ Extension for analogue inputs and outputs (temperature, rel. humidity, control valves)



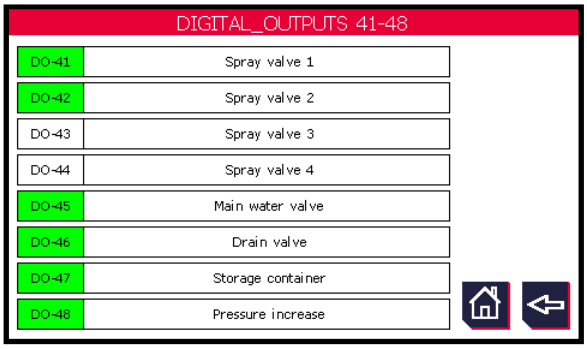
Picture 20

B) Assignment of possible digital I/O extensions

Picture 21

By pressing, e.g., the “Spray valves DO” (Picture 20) field, the user gets to the next level, the assignment and status display of the respective I/O module.

The green marking immediately shows which of the inputs or outputs are currently switched on or activated (logic high).

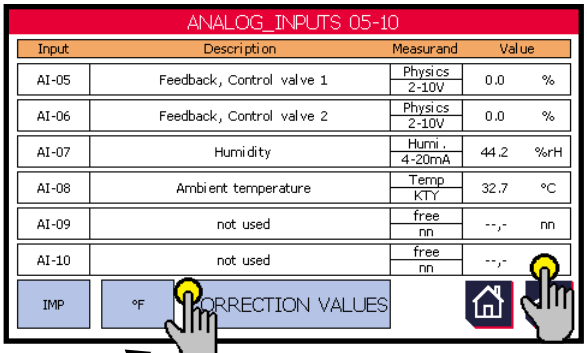


C) Assignment of possible analogue I/O extensions

Picture 22

By pressing. e.g., the “Analogue module AI/AO-KSM" field, the user gets to the next level, the status display of the respective I/O module.

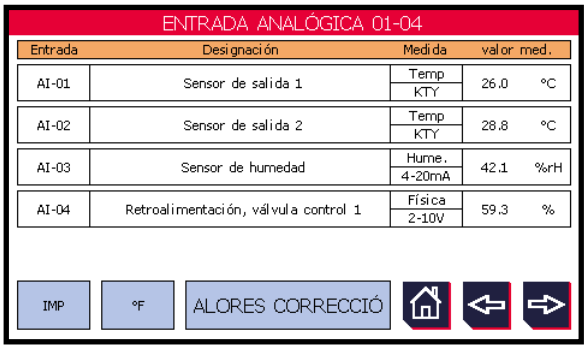
The current configuration of the analogue inputs (AI-05 to AI-10) on the extension module can be seen here. In addition to the designation and the respective unit, the measured value can be read on the right-hand side.



See 4.3.5D) *„Korrekturwerte“*

Picture 23

By pressing the right arrow button, the assignment of the analogue outputs (AO-03 to 06) and their current value are displayed.

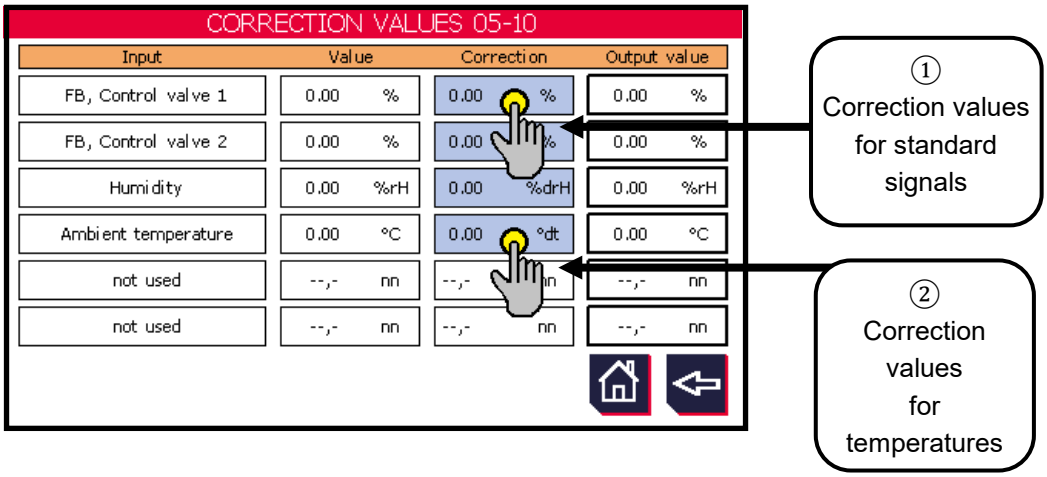


Manual operation of the outputs is not possible in this submenu. These can be operated function-related in the respective submenu (e.g. valves or pumps in the “Wet mode” menu - see chapter 5.7.1“*Wet*”).

D) Correction values extensions

Similar to the analogue inputs on the TCS.2 basic unit (see chapter 4.3.3 “*Analogue IN basic unit*”), correction values can be entered for the inputs of an analogue extension. By activating the “Correction values” field (see Picture 23), the user gets to the following overview:

Picture 24



All blue fields are activated and can be used.

① **Correction values for standard signals in %**

Analogue voltage or current inputs (0-10 V, 2-10 V, 0-20 mA, 4-20 mA) are corrected as a percentage.

Editable from -5.00 % to 5.00 %

② **Correction values for temperature in °C / °F**

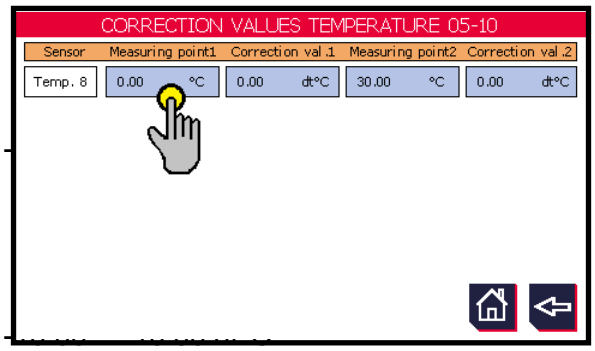
For temperature inputs, two associated correction values can be determined using two different measuring points. The characteristic curve is thus adapted to the non-100% linear course of the temperature sensors (see Picture 24).

Editable from …to:

Measuring point 1: -50.00 … 20.00 °C
-60.00 … 70.00 °F
Correction value 1:
-20.00 … 20.00 dt°F

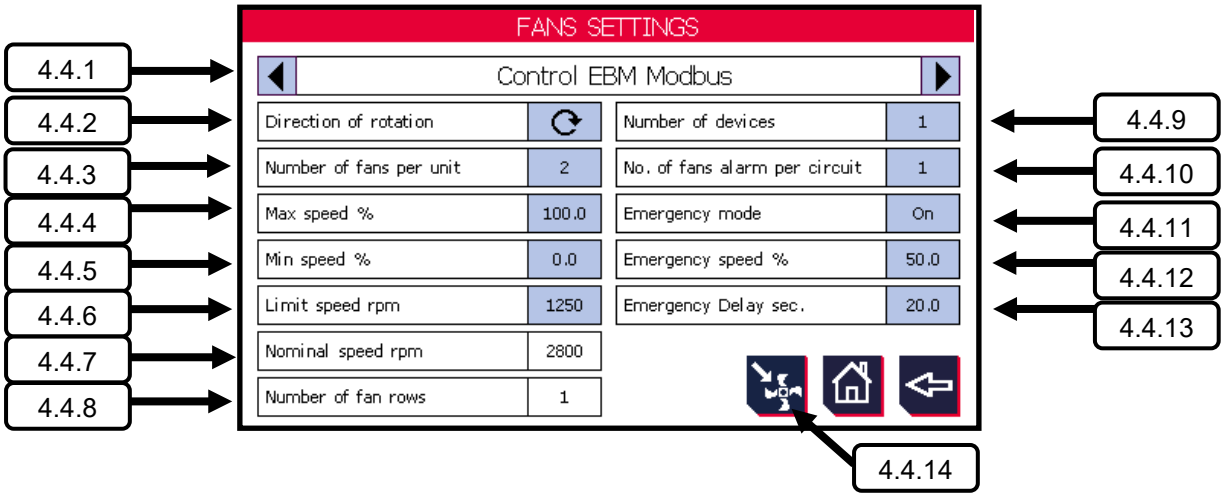
Measuring point 2: 20.00 … 60.00 °C
70.00 … 140.00 °F
Correction value 2:
-20.00 … 20.00 dt°F

Picture 25



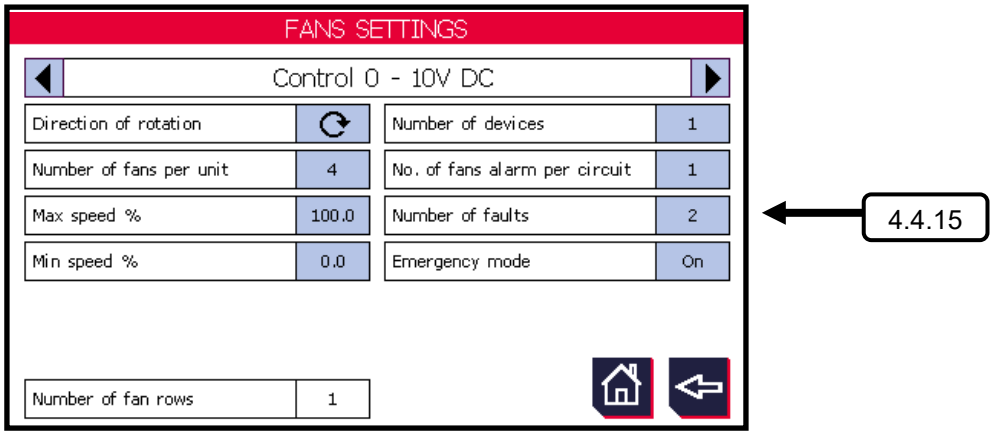
4.4 Fans settings

Picture 26



The parameters required for this change depending on the type of fan control (see Picture 25). When activating “Step switching” or “0 - 10 V DC”, various setting options are hidden and another is displayed [see chapter 4.4.15 *“Number of faults”* (Picture 26)].

Picture 27



4.4.1 Control of the fans

The setpoint source of the fans is determined here. There are the following options to choose from:

Setpoint source	Explanation
Control of EBM Modbus*	Setpoint, status and fault messages are transmitted via Modbus. All registers are written and read according to ebm-Papst specifications. For setting the communication parameters, see chapter 4.5 “*BMS (Building management system) bus system”.*
Control of ZA Modbus	Setpoint, status and fault messages are transmitted via Modbus. All registers are written and read according to Ziehl-Abegg specifications. For setting the communication parameters, see chapter 4.5 “*BMS (Building management system) bus system”.*
Control of EBM Modbus wireless	Setpoint, status and fault messages are transmitted via Modbus. All registers are written and read according to ebm-Papst specifications. The data transfer is realized by the TCS wireless system instead of a signal cable. For setting the communication parameters, see chapter 4.5 “*BMS (Building management system) bus system”.*

Control of ZA Modbus wireless	Setpoint, status and fault messages are transmitted via Modbus. All registers are written and read according to Ziehl-Abegg specifications. The data transfer is realized by the TCS wireless system instead of a signal cable. For setting the communication parameters, see chapter 4.5 "*BMS (Building management system) bus system".*
0 – 10 V DC control	The setpoint is transmitted via an analogue 0 - 10 V DC standard signal. The alarm relay outputs of the fans are connected to a digital input. With up to 4 fans this is possible on the TCS basic unit (DI-5 to DI-8), see also chapter 4.3.1 "*Digital IN basic unit".* With more than 4 fans, no digital inputs are used on the TCS basic unit; one or more digital CAN extensions are used instead (see also chapter 4.3.5 *"IN / OUT extensions*").
Step switching	Unregulated AC fans are used which are controlled in up to 12 levels with a contactor circuit via digital outputs. With up to 4 fan groups or external fault inputs, this is this is possible on the TCS basic unit (DI-5 to DI-8), see also chapter 4.3.1 "*Digital IN basic unit".* With more than 4 external fault inputs, no digital inputs are used on the TCS basic unit; one or a maximum of two digital CAN extensions are used instead (see also chapter 4.3.5 *"IN / OUT extensions").*
* Factory setting	

4.4.2 Direction of rotation

This function enables the user to blow away leaves or other contaminants from the heat exchanger by reversing the direction of rotation of the fans. It is controlled via a terminal or bus. See also chapter 4.2.9 "*Reversion of rotation control"* or 5.6.6 "*Speed reversion of rotation (ROR)".*

The following two options are available:

 *

Clockwise rotation in normal operation. As soon as "Reversion of rotation" is activated,
the fan rotates to the left.

Counter-clockwise rotation in normal operation. As soon as "Reversion of rotation" is activated,
the fan rotates to the right.

* Factory setting

4.4.3 Number of fans per unit

Number of fans installed in the device. There are the following options:

Single row: 1-12 fans **Double row**: 2-24 fans

Factory setting: 1/2 fans, depending on the chosen heating system

4.4.4 Max speed in %

Not editable with step switching (see also chapter *4.4.1 "Control of the fans")*

Percentage upper speed limit related to the limit speed. The controller only outputs this entered value as a maximum.

Factory setting: 100 %

In principle, the percentage limit of the speed output can also be sent via the bus (setting option from 10...100%). The value entered in the menu always forms the upper limit. For example, if the maximum speed was limited to 80% in the menu, a value of 10 ... 80% can be sent via the bus. If the sent value is outside the permissible range, the user receives a message "Values outside the permissible range". If the register is not written to (register value: 0), there is no error message.

Register	Register value (INT)	Max speed in %
12 "Max speed per day"	100 ... 1000*	10.0 ... 100.0 %*

* A maximum register value of 1000 (≙ 100%) is possible, if the value set in the "Setpoints" menu is also at 100%. If this value is lower, it represents the upper limit for the value sent via the bus.

4.4.5 Min speed in %

Not editable with step switching (see also chapter 4.4.1 "*Control of the fans")*

Percentage lower speed limit related to the limit speed. The controller only outputs this entered value as a minimum.

Factory setting: 0 %

4.4.6 Limit speed in rpm

Not displayed with step switching or fan control 0 - 10 V DC (see also chapter 4.4.1 "*Control of the fans").*

Maximum upper speed limit with 100% control which is written into the EC fan (see also chapter 4.4.14 "*Write parameters to fan*" Absolute value in rpm)

Factory setting: 1250 rpm

Upper limit: Rated speed of the fan

4.4.7 Rated speed in rpm

Not displayed with step switching or fan control 0 - 10 V DC (see also chapter 4.4.1 "*Control of the fans").*

Non-editable, stamped speed on the type plate of the fan which is read out directly via the bus. Absolute value in rpm.

Factory setting: 2800 rpm

4.4.8 Number of fan rows

Definition of the number of rows in which the fans are arranged. Minimum one, maximum two rows.

Factory setting: 1/2 fan rows, depending on the chosen heating system

4.4.9 Number of devices

Number of installed devices that are to be controlled and regulated by this TCS.

Factory setting: 1 device

4.4.10 Number of fans alarm per circuit

In this parameter the minimum number of impaired fans is entered in order to trigger an alarm (DO-2, Alarm → High priority). (DO-2 drops out)

Among the specified number of impaired fans, only one warning is recorded and digital output 1 (DO-1, Warning → Low priority) drops out.

Lower limit: 1 *
Upper limit: Number of fans installed in the device

* Factory setting

4.4.11 Emergency mode

Not editable with step switching (see also chapter 4.4.1 "*Control of the fans")*

In case of a failure of the signal source of installed fans, there is an emergency function in the EC fan. It is independent of the TCS or upstream controls and must be activated (parametrized) in the EC fan. The electronics integrated in the fan monitor the bus communication and the signal level of the analogue signal.

If the bus communication or the analogue signal breaks off and takes longer than the set time (4.4.13 *"Emergency delay"*), the emergency speed is activated by the internal electronics in the fan. The height is specified in the following parameter: 4.4.12 "*Emergency speed in* %"

Emergency mode when monitoring the analogue signal can then only take place with control via 2 ... 10 V. If the analogue signal falls below 1.9 V, the emergency speed is activated after the set waiting time.

Possible settings: OFF
ON *

* Factory setting

4.4.12 Emergency speed in %

Not editable with step switching (see also chapter 4.4.1 "*Control of the fans")*

Adjustable speed in percent if the signal source is lost. This value relates to the maximum speed (see chapter 4.4.4 "*Max speed in* %*").*

Possible settings: 10 to 100% of maximum speed

Factory setting: 50 %

4.4.13 Emergency mode delay in seconds

Not editable with step switching (see also chapter 4.4.1 "*Control of the fans")*

Waiting time if the signal source is lost until emergency mode is activated.

Possible settings: 5 to 60 seconds

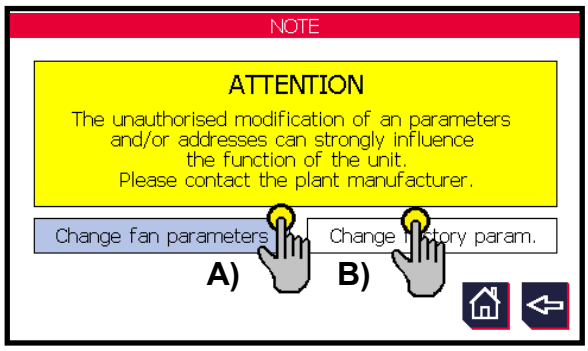
Factory setting: 20 seconds

4.4.14 Write parameters to fan *

* This button or this function is only visible when the fan is controlled via Modbus.

Once all settings and changes have been made, they must be loaded into the fan. To do this, the "Write parameters to fan" button (see left) must be pressed. The following message window then opens:

Picture 28



All further steps have an influence on the function of the device and can seriously impair it. Only trained or instructed personnel should make changes here.

B) Changing factory parameters (fan addresses etc.) is only possible with the manufacturer password (see also chapter 2.4.1 "*Manufacturer password").*

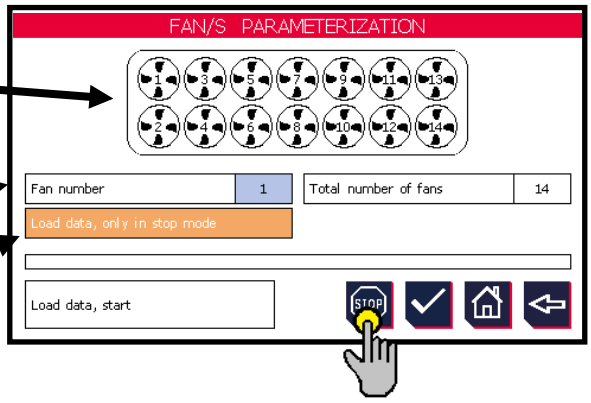
A) Change fan parameters

Picture 29

The configured device is shown schematically here, including the number and position of the fan

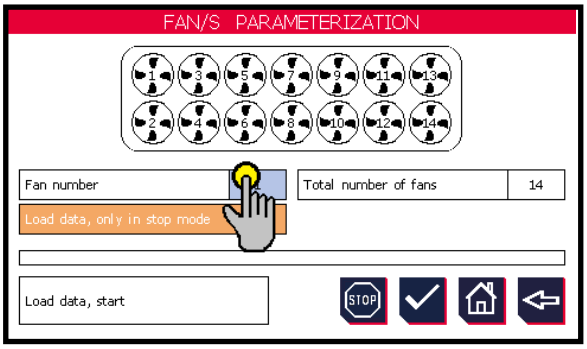
Enter the number of the fan to be described.

Text message / notes



The bus must be stopped in order to start the “Data loading”. To do this, press the “Stop” button.

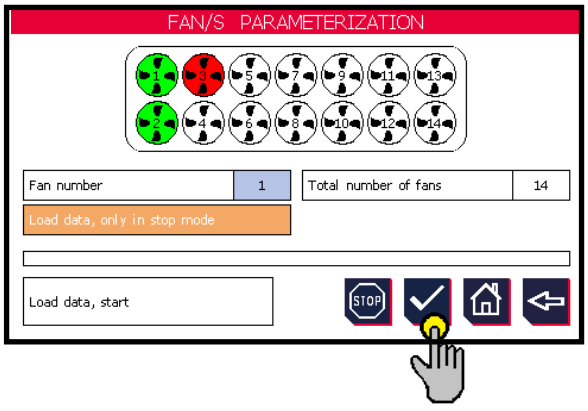
Picture 30



As soon as the bus has stopped, the symbol appears: “Write parameters to fan”. The process starts after pressing. All in chap. 4.4 “Fans settings” are written to fan.

The status bar shows the progress of the loading process.

Picture 31



Colour codes of fans:

Red: Incorrect parametrization, please pay attention to the text message and correct the failure. The loading process is stopped. The process is continued with the “tick” or “Acknowledge” button. → Repeat the process. (Possible error: Limit speed is greater than rated speed; communication interrupted; there is no voltage at the fan)

Green: Parametrization successful.

White: Fan has not yet been parametrized.

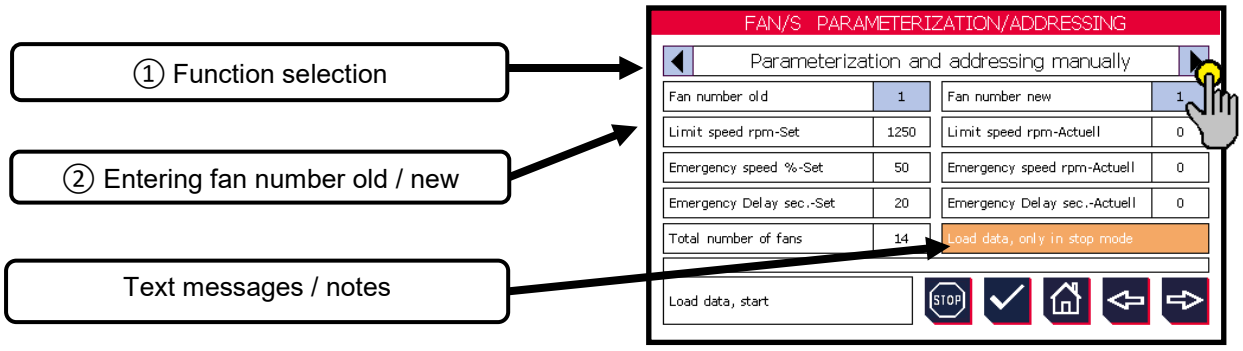
When exiting the menu, the bus is automatically set back to RUN.

B) Change factory parameters

Access to this area is reserved for the manufacturer and is protected with the manufacturer password.

At this level, the fan can not only be parametrized (as under **A**) but also re-addressed or the address can be reset to the factory setting.

Picture 32



① Function selection:

➔ **"Parametrization and addressing manually"**
- All parameters set in chap 4.4 (Fans settings) are written to fan.
- The addresses entered manually (see ②) are written to the fan.

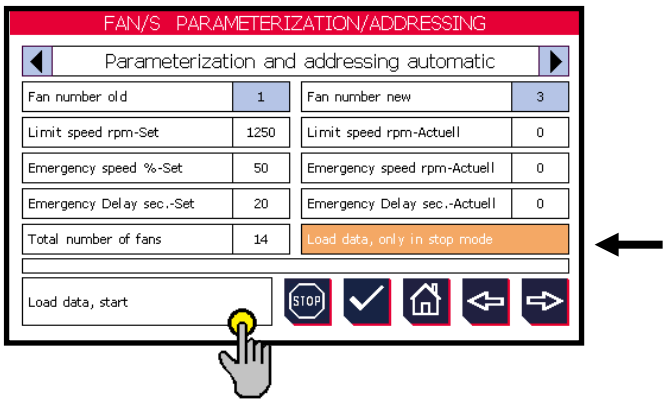
➔ **"Parametrization and addressing automatically"**
- All parameters set in chap 4.4 (Fans settings) are written to fan.
- The fans are being re-addressed. After each successful addressing process, the "Fan number new" (see ②) is automatically counted. Starting with 1 up to the edited "Number of fans per unit" (see chapter 4.4.3 "*Number of fans* per unit").

➔ **"Fan(s) - only parametrization"**
- All parameters set in chap 4.4 (Fans settings) are written to fan.
- The address set is not changed.

➔ **"Reset fan address(es)"**
- The addresses of all fans connected to the BUS and supplied with voltage are reset to "Factory settings".

The bus must be stopped in order to start the function selected in ①. To do this, press the “Stop” button (see Picture 32).

Picture 33



As soon as the bus has stopped, the symbol appears: “Write parameters to fan”.

After pressing, the  function selected in ① starts.

The status bar shows the progress of the loading process.

When exiting the menu, the bus is automatically set back to RUN.

4.4.15 Number of faults

Only effective when controlling with 0-10 V DC and step switching.

Editable number of digital inputs that report an OK message or fault. These can be assigned as desired by a single fan or your group of signalling contacts connected in rows.

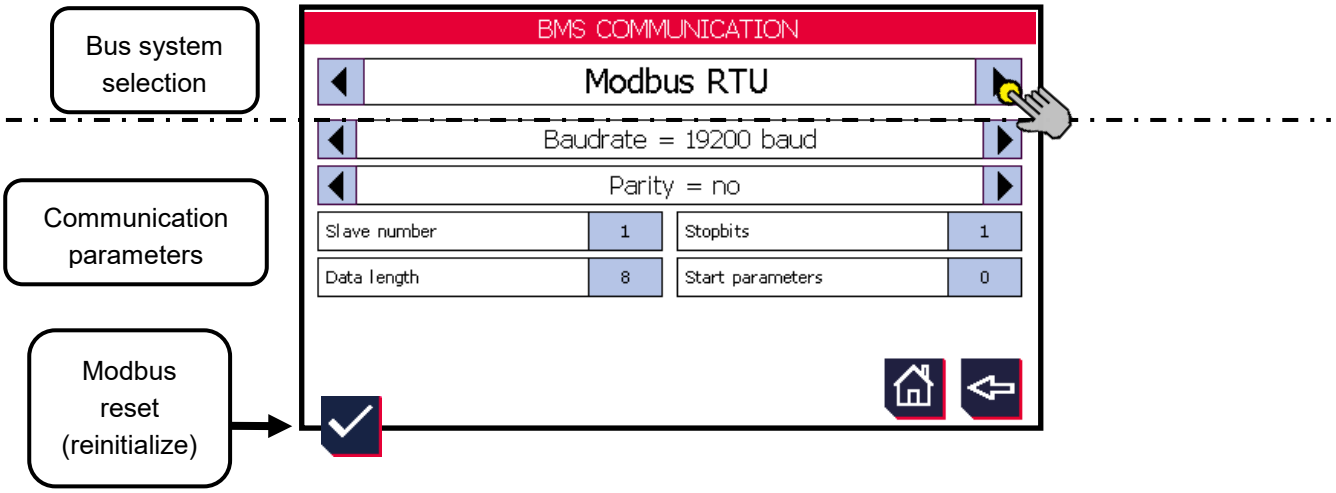
Upper limit: Number of fans in the device (max. 1 fault per fan)

Lower limit: 0 faults

4.5 BMS (Building management system) bus system

The desired bus system is selected in the upper part of the menu. All necessary parameters for the respective communication type appear in the lower part of the menu.

Picture 34



4.5.1 Modbus RTU

The baud rate, parity and stop bit settings must be made in accordance with the values of the “Master”. The following communication settings can be edited:

Baudrate: 1200, 2400, 4800, 9600, 19200 baud

Parity: no → no parity
Even → even parity
Odd → odd parity

If the parity check (Even or Odd) is activated, either by selecting even or odd parity, the amount of all the first characters transmitted in the data content is counted. The parity is then set as “0” or “1” in order to generate an even or odd result at 1.

Slave number: Enter the desired slave device address that is to be addressed by the master (1 to 247). Address 0 is reserved for broadcast mode.

Date length: Length of the data bits to be transmitted. Contains the information to be transmitted. This field is subdivided into registers, the number of registers to be transmitted and, if applicable, into information that is read out or stored.

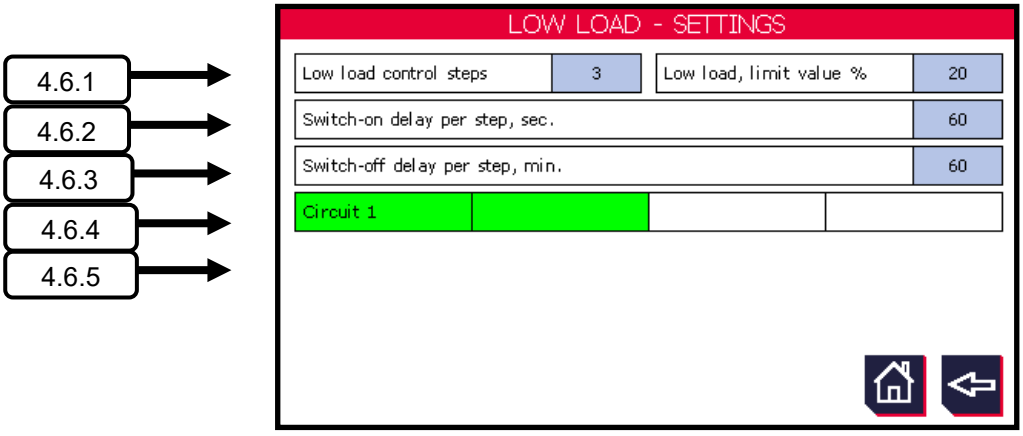
Stopbits: 1 stop bit if parity is used; 1 or 2 bits if no parity is used.

Start parameters: In contrast to the definition by the MODBUS protocol, some substations use the MODBUS register start address in the MODBUS telegram on the line starting from “1” instead of starting from “0”.

4.6 Additional functions

In contrast to the standard, there are various functions and setting levels that are listed in this submenu item. All functions that are not activated are greyed out (with a white background).

Picture 35



4.6.1 Wet settings

This menu item can only be selected for wetted or humidified devices (blue background).

For more detailed explanations and operating instructions, see:

- Chapter 6.1 “*Adjustments in: Device settings → Additional functions → Wet settings - Spray”*
- Chapter 7.1 “*Adjustments in: Device settings → Additional settings → Wet settings Mat*”
- Chapter **8.1** “Adjustments in Device settings → Additional functions → Humidification system”

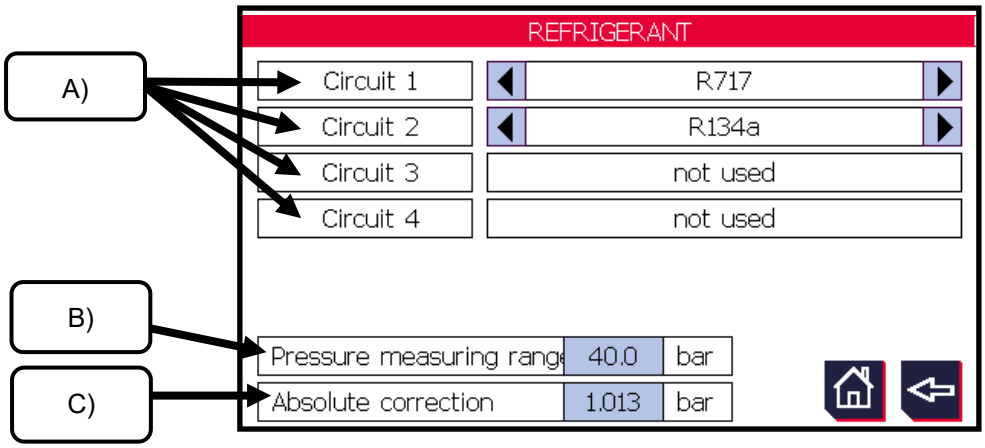
4.6.2 Water circulation

Description follows.

4.6.3 Refrigerant

This submenu item can only be selected (highlighted in blue), if a condenser has been selected as the device type.

Picture 36



A) Selection of refrigerants / possible types

Up to 4 different cooling circuits can be set in the menu (a two-circuit device is given as an example here). The refrigerant used can be selected separately for each circuit. Circuits 3 and 4 can also be selected by assigning an additional pressure sensor to input 3 or 4 in the “Analogue IN” submenu.

The following refrigerants can be selected by the user:

Refrigerant	Name
R22	HCFC (containing chlorine, partially halogenated)
R717	Ammonia NH_3 (single substance, natural refrigerant)
R134a	PFC / HFC (single substance, chlorine-free)
R404A	PFC / HFC (mixture, chlorine-free)
R410A	PFC / HFC (mixture, chlorine-free)
R507	PFC / HFC (mixture, chlorine-free)
R290	Propane (single substance, natural refrigerant)
R723	Ammonia / DME (mixture, natural refrigerant)
R407C	PFC / HFC (mixture, chlorine-free)
R407F	PFC / HFC (mixture, chlorine-free)
R744	CO_2 (single substance, natural refrigerant)
R449A	PFC / HFC (mixture, chlorine-free)
R513A	PFC / HFC (mixture, chlorine-free)
R422D	PFC / HFC (mixture, chlorine-free)
R1234ze	HFO (partially halogenated fluorine olefins)
R1270	Propene (single substance, natural refrigerant)
Pressure	Display in bar

If a refrigerant is used which is not available for the selection, the unit “bar” must be set. All displays in the TCS then take place in “bar absolute”. If the refrigerant used is stored here and selected, all displays are in °C. The actual value is then the condensing temperature.

B) Pressure measuring range

The standard pressure measuring range for thermofin® pressure sensors is 0-40 bar of relative pressure. If you use other pressure sensors, the pressure measuring range of the TCS must be adapted to the pressure sensor used. However, only pressure sensors can be used whose output signal is a standardized 4… 20 mA signal and whose zero point is at 0 bar of relative pressure.

Lower limit of pressure measuring range: 5 bar of relative pressure
Upper limit of pressure measuring range: 100 bar of relative pressure

C) Absolute correction (air pressure)

To convert pressure into refrigerant temperature, it is not the relative but the absolute pressure that is required. Therefore, the air pressure in hPa (mbar) from the installation location of the device serves as the necessary correction value.

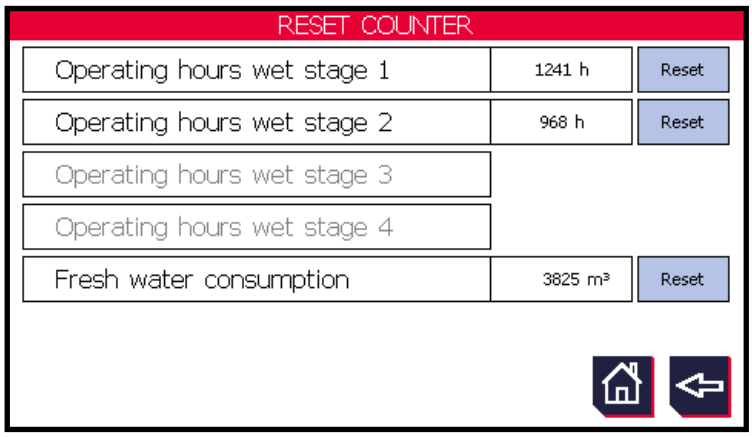
Factory setting: 1,013 bar = 1013 mbar (hPa) → Sea level air pressure

4.6.4 Reset counter

The manufacturer reserves the right to reset all installed consumption and operating hours counters. Only after entering the corresponding password, the “Reset counter” field in the “Additional functions” menu (Picture 34) is highlighted in blue and can be selected. The user gets to the following window (Picture 37).

A pure display of these counters can be found in the Main menu → “Counter”. This menu has no password protection and is therefore freely accessible. See also 5.3 “*Counter*”.

Picture 37



All greyed out displays are inactive and are not used.

4.6.5 Low load settings

This function enables a fan or a group of fans to be switched off in levels at low load. There are the following control options (see also chapter 4.2.10 “*Low load* regulation control”):

Not all types of control have the same range of functions. When controlled via terminal and via BUS, only two-level control is possible.

If reversion of rotation is activated (via terminal or BUS), the low load control is interrupted for this time. All fans are then equally active.

A) Control (activation)

➔ **Low load control "internal"** (the switching thresholds for the individual levels are automatically calculated by the program based on the number of steps and the limit value)
2 to 6 possible levels

➔ **Low load control "via terminal"** (the first base load level remains switched on, the second is activated externally with DI-6)
2 possible levels

➔ **Low load control "via BUS"** (the first base load level remains switched on, the second is activated externally via the bus)
2 possible levels

The following values apply to direct communication via MODBUS:

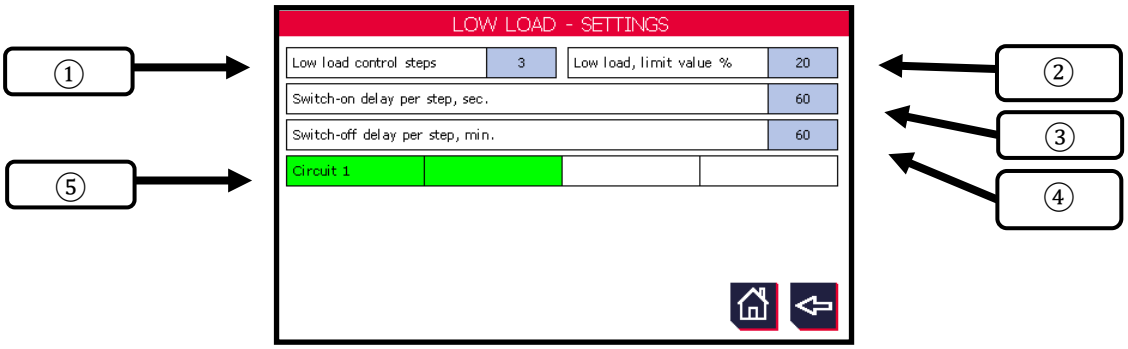
Register	Bit	Designation	Meaning	Register value
2	**0**	Low load control level 1	TRUE = Requirement for low load control level 1	Writing 1
164	**4**	Low load control level 1 active	TRUE = Low load control level 1 active	Reading 16
	5	Low load control level 2 active	TRUE = Low load control level 1 active	Reading 32
	6	Low load control level 3 active	TRUE = Low load control level 1 active	Reading 64
	7	Low load control level 4 active	TRUE = Low load control level 1 active	Reading 128
	8	Low load control level 5 active	TRUE = Low load control level 1 active	Reading 256

These functions are activated in the Device settings -> Control (see chapter 4.2.10 "*Low load* regulation control*"*).

B) Editable values

If the control has been selected, the "Low load" field in the "Additional functions" menu appears blue and can be activated (see Picture 35). The user gets to the "Low load settings".

Picture 38



① Low load control levels

Number of the desired low load levels (consisting of at least one fan or one fan group). The first level always remains the regulated base load level which is not switched off. As can be seen in the example Picture 35, there is a base load level and three further control levels with 4 low load levels. These are explained and shown under ⑤. The number of possible low load levels depends on how many fans the device has in total (see 4.4.3 "*Number of fans* per unit").

For two-circuit devices, the number of low-load levels applies equally to both circuits. For all devices from single-row to double-row and from 2 to 24 fans, there is a precisely defined assignment of the fans/groups to the individual levels. There can also be unequal groups depending on the device.

Editable in case of internal control:	2 … 6 low load levels depending on the number of the fans
Editable in case of control via terminal / BUS:	2 low load levels
Factory setting:	2 low load levels

② Low load limit in %

A low load regulation only takes place below this limit. If the speed setpoint falls below this edited value, it is switched off step by step (depending on the number of steps) after the switch-off delay (④) has elapsed. The fans or fan groups are switched on stepwise above this limit. The switch-on thresholds are based on the number of control levels and the limit set here.

See the following examples:

Example 1:
Low load – Device levels: 4 (≙ 3 control levels)
Low load – Limit: 20 %

Switch-on threshold: = 20 % + (20 % / 3 control levels) = 26,66 % (rounded down to 26 %)

When a speed setpoint of 26% is reached, the control levels are switched on again gradually after the switch-on delay (③) has elapsed.

Example 2:
Low load – Device levels: 2 (≙ 1 control level)
Low load – Limit: 40 %

Switch-on threshold: = 40 % + (40 % / 1 control level) = 80 %

When a speed setpoint of 80 % is reached, the control level is switched on again after the switch-on delay (③) has elapsed.

Editable from … to: 10 … 75 %

Factory setting: 20 %

③ Switch-on delay per level (in seconds)

After the time set here has elapsed and the switch-on threshold has been reached, the control levels are switched on gradually.

The shortest possible times are recommended to prevent overpressure or overheating of the system. The times must be optimized accordingly after commissioning.

Editable from … to: 1 … 600 s

Factory setting: 60 s

④ Switch-off delay per level (in minutes)

After the time set here has elapsed and the low load threshold has been reached, the control levels are switched off gradually.

The switch-off times should be set as long as possible so that there is no constant switching back and forth between low load and normal control. The times must be optimized accordingly after commissioning.

Editable from … to: 1 … 1440 min

Factory setting: 60 min

⑤ **Display of low load levels**

Both circuits are shown separately in bars (see Picture 35). The subdivision is based on the edited low load device levels (①). Locked levels are white and unlocked levels are green.

C) Low load - Setpoint output

➔ **Via bus**

By default, all speed setpoints are transferred to the fans via MODBUS when using the low-load control. It is also possible for individual fans or fan groups to be selected and deselected.

➔ **Via analogue output**

A second possibility (if there is no bus communication with the fans) is a speed output for two low-load device levels via the two analogue outputs of the basic unit TCS.2. The following steps are necessary to activate this function:

1. Select a type of control (Device settings -> Control (see chapter 4.2.10 "*Low load* regulation control*")*.
2. Select "Control 0-10 V DC" in the "Fan settings" menu (see chapter 4.4.1 "*Control of the* fans").
3. In the "Analogue OUT basic unit" menu, set both analogue outputs to "Speed circuit 1, 0-10 V" or "Speed circuit 1, 2-10 V" (see chapter 4.3.4 "*Analogue OUT basic unit*").

With these settings, the first analogue output (AO-1) works as a low load basic level and the second analogue output (AO-2) as a low load control level.

As a result, both analogue outputs must be wired separately with the corresponding fans or fan groups.

4.7 SI / IMP Switching units

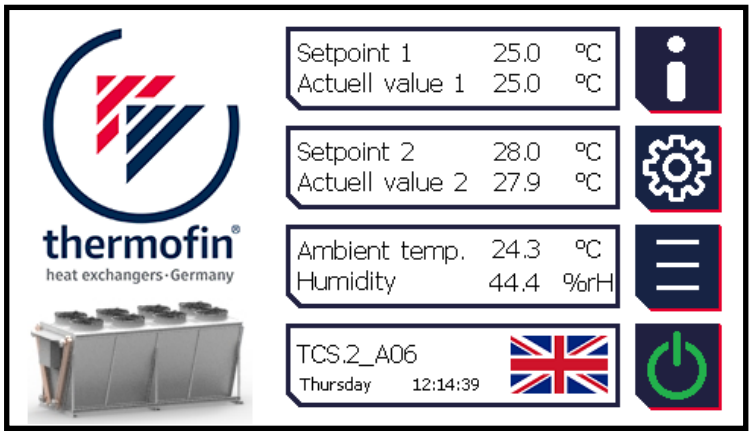
In this window, the system of units for temperature and pressure can be switched independently of one another from **SI** (international system of units) to **IMP** (Anglo-American system of units).

	SI	**IMP**
Pressure	Bar	psi
temperature	°C	°F

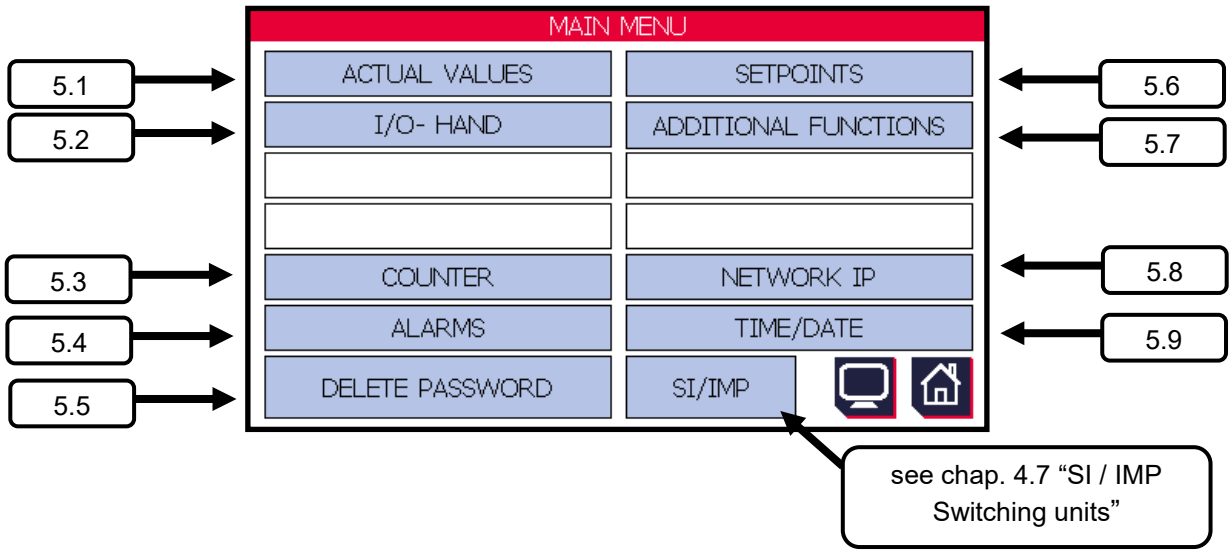
5. MAIN MENU

The following menu items can at least be called up in the main menu. Some submenus or menu items are incorporated and displayed depending on the system configuration and requirements. Menu items that are not selected or required via the device settings / heating system are not displayed.

Picture 39



Picture 40



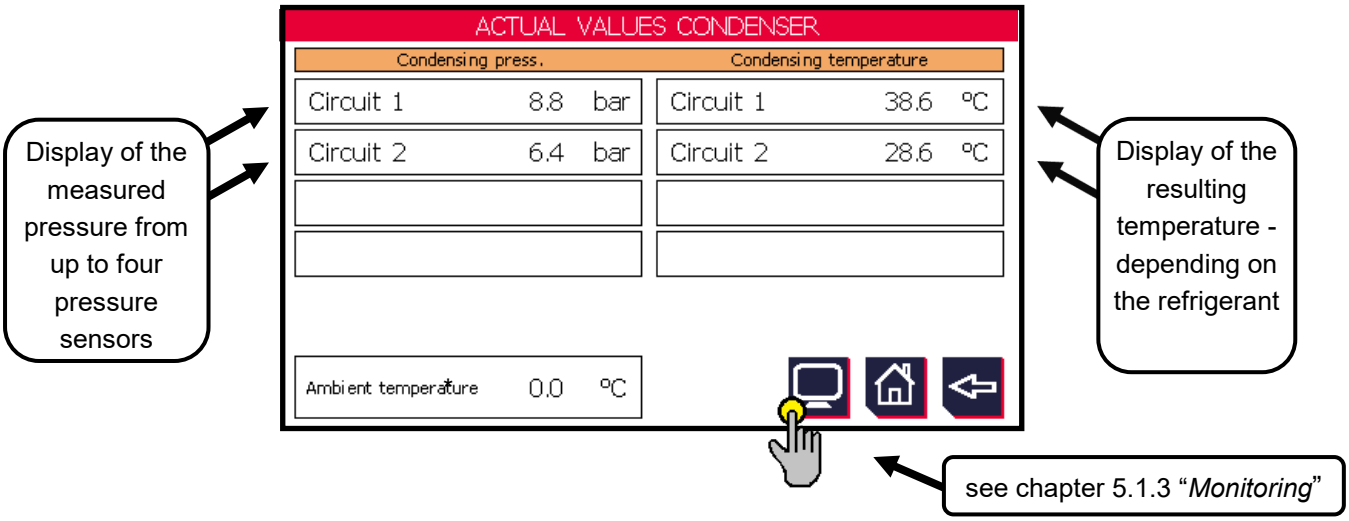
The submenus on the right in the main menu are protected with a parameter password. Instructed persons receive this password from the supplier of the TCS. See chapter: 2.4 “Passwords”.

5.1 Actual values

This overview of the current values of the system is displayed differently for condensers and dry coolers:

5.1.1 Display for condensers

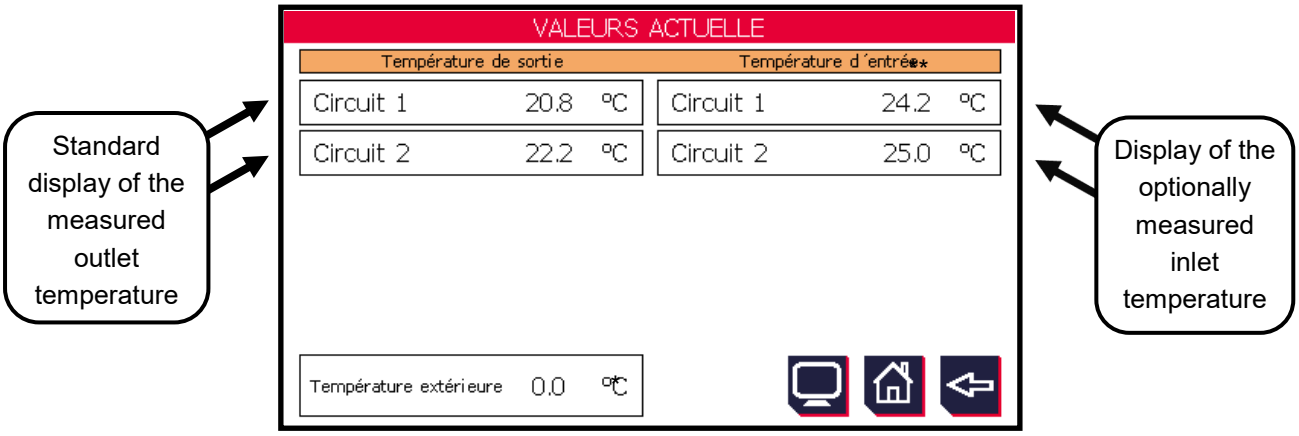
Picture 41



* The ambient temperature is only displayed if a humidified or wetted device is selected.

5.1.2 Display for dry coolers

Picture 42



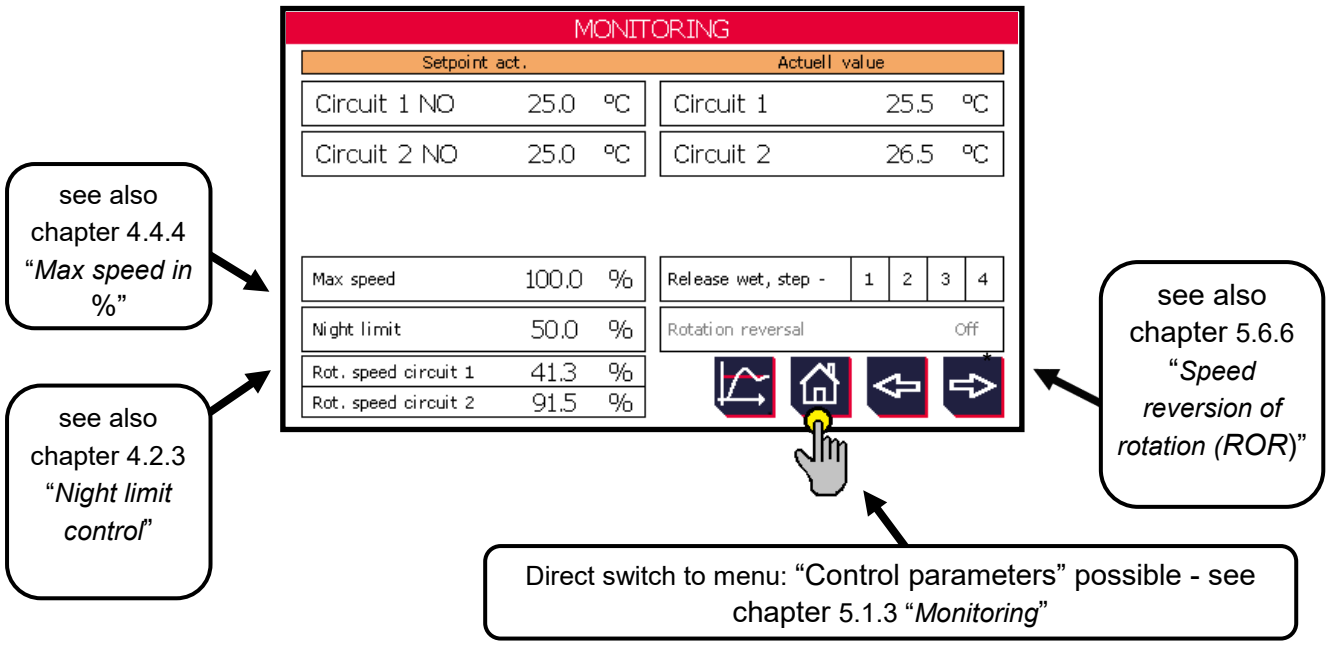
* The ambient temperature is only displayed if a humidified or wetted device is selected.

** The inlet temperature is only displayed after selecting a corresponding inlet sensor. See menu *Device settings* → *Inputs / Outputs* → *Analogue IN selection* → "*Analogue IN 3 or 4*" (see also chapter "*Analogue IN basic unit*" 4.3.3)

5.1.3 Monitoring

This "Monitoring" display window contains current setpoint and actual value temperatures, the output speed setpoint and other helpful displays for commissioning and maintenance purposes.

Picture 43

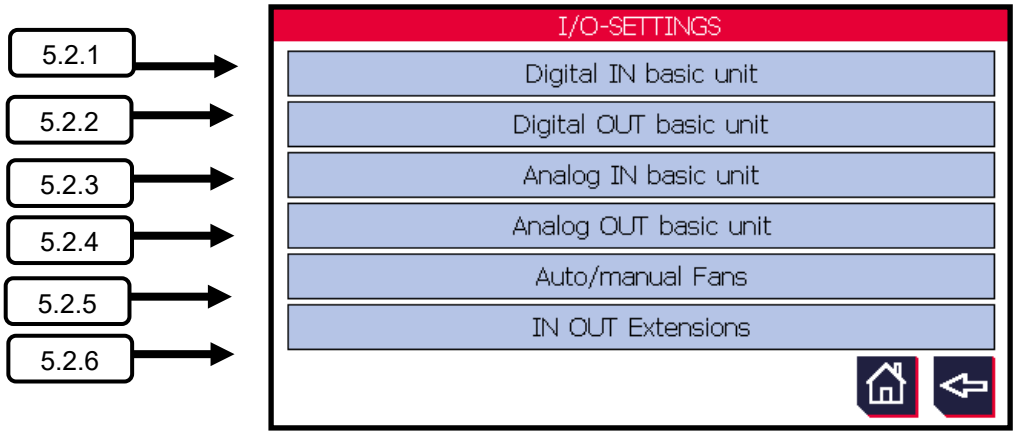


* Greyed out functions are not activated in the device settings .

5.2 I/O (Inputs / Outputs) - Display / Manual

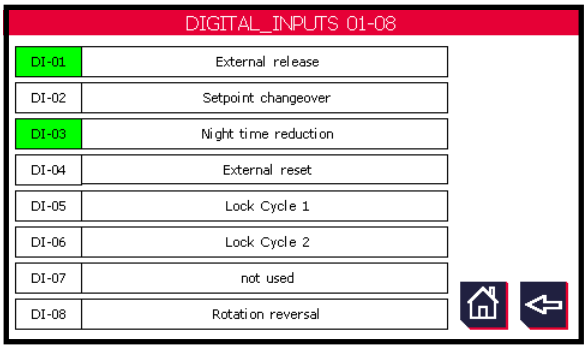
In this submenu, the user will find all digital and analogue inputs and outputs from the basic unit (TCS.2) and the CAN extensions. After selecting the category, the current status is displayed. The outputs can also be switched to “Manual operation” and operated. These functions are extremely useful during commissioning, maintenance or troubleshooting.

Picture 44



5.2.1 Digital IN basic unit

Picture 45



Overview and status display of all digital inputs on the TCS.2 basic unit.

The assignment of the respective function can be adjusted in the Device settings -> INPUTS/OUTPUTS (see also chapter 4.3.1 “*Digital IN basic unit*”).

Activated inputs (+24 V DC at the input) are shown in green (see Picture 44 DI-1 and DI-3).

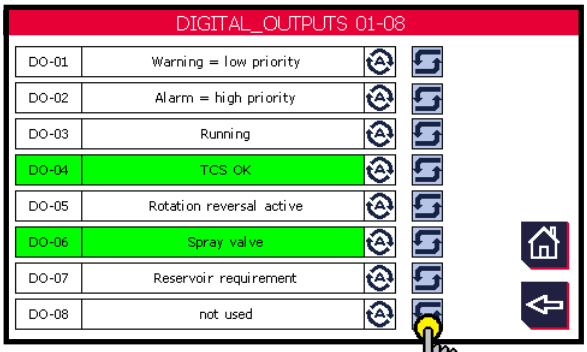
5.2.2 Digital OUT basic unit

Overview and status display of all digital outputs on the TCS.2 basic unit.

The assignment of the respective function can be adjusted in the Device settings -> INPUTS/OUTPUTS (see also chapter 4.3.2 "*Digital OUT basic unit*").

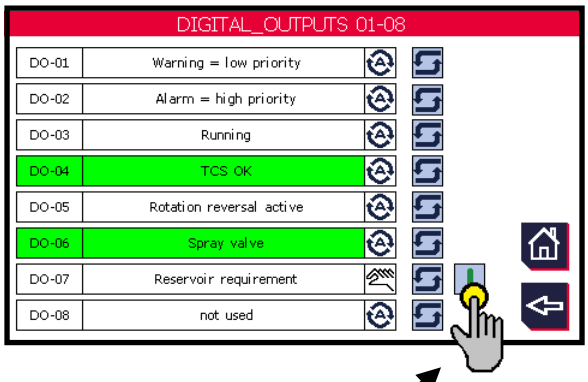
Activated outputs (+24 V DC at the output) are shown in green (see Picture 45 DO-4 and DO-6).

Picture 46



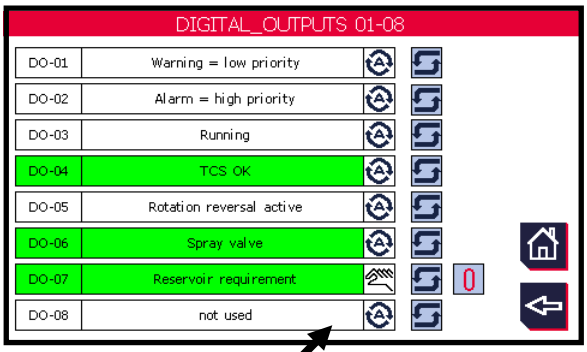
The corresponding output is switched to manual operation by pressing the "Manual-Auto switching button" .

Picture 48



The hand symbol appears.
The output can now be switched on and off manually.

Picture 47

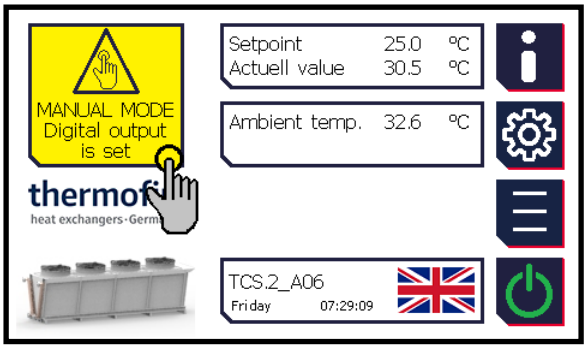


The output is now set to manual and also has a green background.

The corresponding output is switched back to automatic operation by pressing the "Manual-Auto switching button" again. It changes back to the state it would normally have in automatic operation.

If the user uses the option of leaving a certain output in manual operation, this is always displayed on the start screen. This function can strongly influence the system safety and the fail-safe operation of the device! The operator is therefore always advised that an output is in manual operation.

Picture 49



By pressing the yellow information window, the user gets directly to the corresponding submenu in which manual operation was activated (see Picture 48).

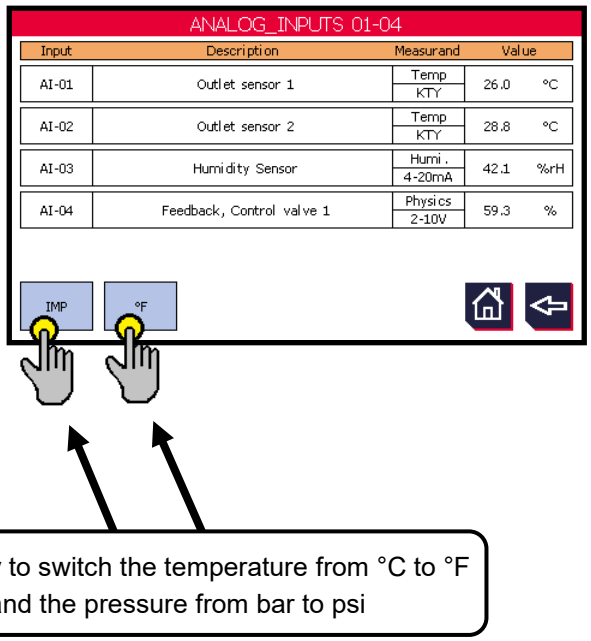
5.2.3 Analogue IN basic unit

Overview and status display of the four analogue inputs on the TCS.2 basic unit.

The assignment of the respective function can be adjusted in the Device settings -> INPUTS/OUTPUTS (see also chapter 4.3.3 "*Analogue IN basic unit*").

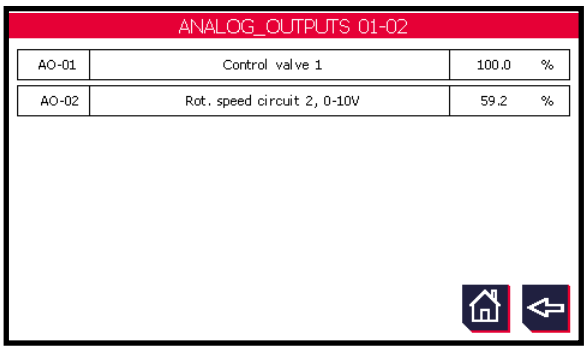
In addition to the designation of the input and the associated measured value, the type of signal is also shown (e.g., KTY, 0-10 V or 4-20 mA).

Picture 50



5.2.4 Analogue OUT basic unit

Picture 51



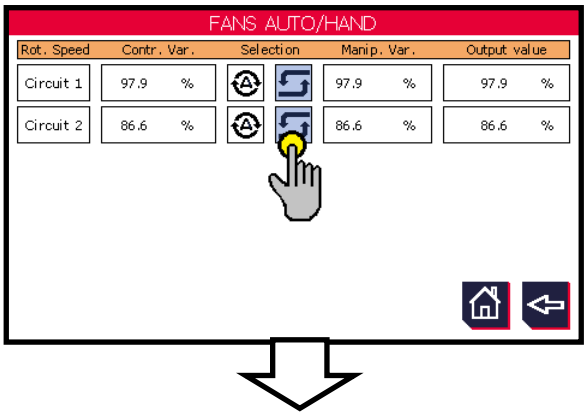
Overview and status display of the two analogue outputs on the TCS.2 basic unit.

The assignment of the respective function can be adjusted in the Device settings -> INPUTS/OUTPUTS (see also chapter 4.3.4 "*Analogue OUT basic unit*").

Manual operation of the analogue outputs in the basic unit is not possible at this point. The fans (speed outputs 1 and 2) can be controlled manually in the following submenu (see chapter 5.2.5 "*Fans – Auto/Hand*"). All other outputs are function-related and can be operated manually in the respective submenu (e.g., valves or pumps in the "Wet mode" menu - see chapter 6.4.8"*Manual operation*").

5.2.5 Fans – Auto/Hand

Picture 52

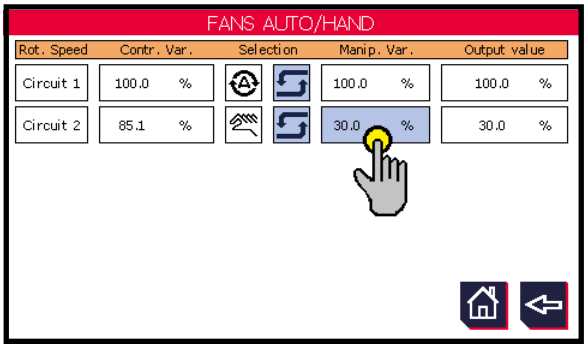


Status display and possibility of manual operation of the speed setpoint outputs of circuit 1 and possibly circuit 2.

The actual setpoint output can take place here via an analogue output or the bus. Depending on the type of fan control (see also chapter 4.4.1 "*Control of the fans*").

The corresponding output is switched to manual operation by pressing the "– Auto switching button" (see Picture 51).

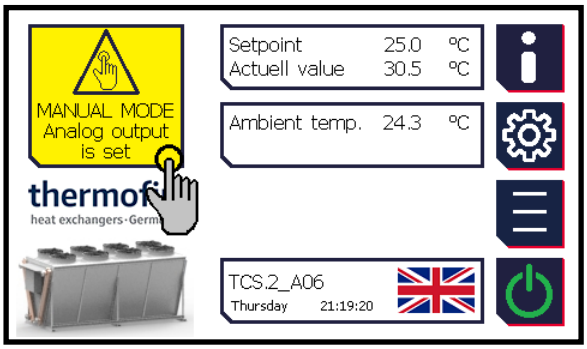
Picture 53



The hand symbol appears. The manipulated variable (highlighted in blue) can now be freely edited. The manipulated variable calculated from the controller remains unchanged. However, the selected manual manipulated variable (see Picture 52: 30 %) is now sent to the speed output.

The corresponding output is switched back to automatic operation by pressing the "– Auto switching button" again. The manipulated variable assumes the value of the controlled variable again.

Picture 54



If the user uses the option of leaving a speed output in manual operation, this is always displayed on the start screen. This function can strongly influence the system safety and the fail-safe operation of the device! The operator is therefore always advised that an output is in manual operation.

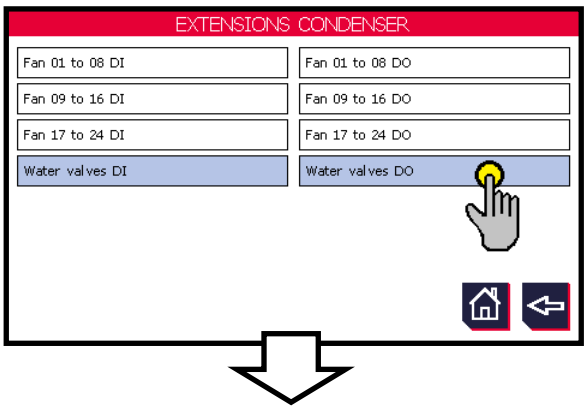
By pressing the yellow information window, the user gets directly to the corresponding submenu in which manual operation was activated (see Picture 53).

5.2.6 IN / OUT extensions

For devices with an extended range of functions (e.g., thermofin® adiabatic pad cooler or thermofin® hybrid cooler), the digital and analogue I/Os from the TCS.2 basic unit are not sufficient. They are then expanded with external I/O modules via the CAN bus. Depending on requirements and the heat exchanger system, these are activated in the device settings (see chapter 4.3.5 "*IN / OUT extensions*").

Here for example all possible IN / OUT CAN extensions of a condenser. In the device settings, however, only the extensions "Water valves DI" and "Water valves DO" are activated. These are highlighted in blue and are therefore "accessible".

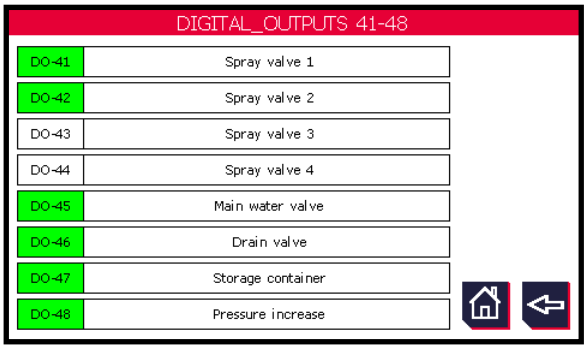
Picture 55



Picture 56

By pressing. e.g., the "Water vales DO" field, the user gets to the next level, the status display of the respective I/O module.

The green marking immediately shows which of the inputs or outputs are currently switched on or activated (logic high).



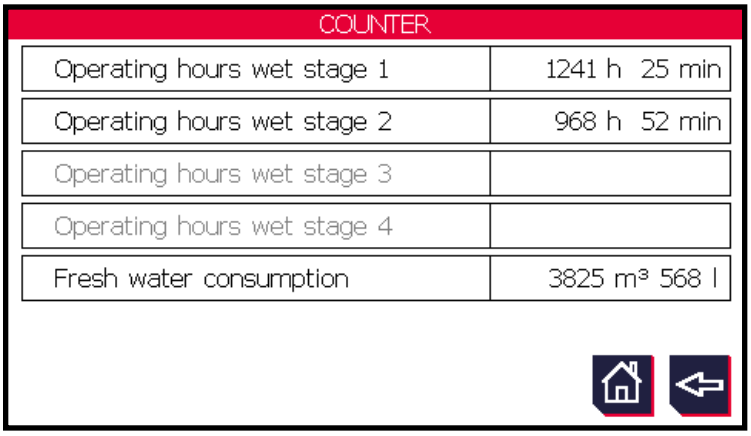
Manual operation of the outputs is not possible in this submenu. These can be operated function-related in the respective submenu (e.g., valves or pumps in the "Wet mode" menu - see chapter 5.7.1"*Wet*")

5.3 Counter

This display provides an overview of the installed consumption and operating hours counters, including the current values, for precise operating and consumption data acquisition. This menu has no password protection and is therefore freely accessible.

The manufacturer reserves the right to reset the counter and it is only possible in the Device settings → Additional functions → “Reset counter”. See also chapter 4.6.4 “*Reset counter*”.

Picture 57



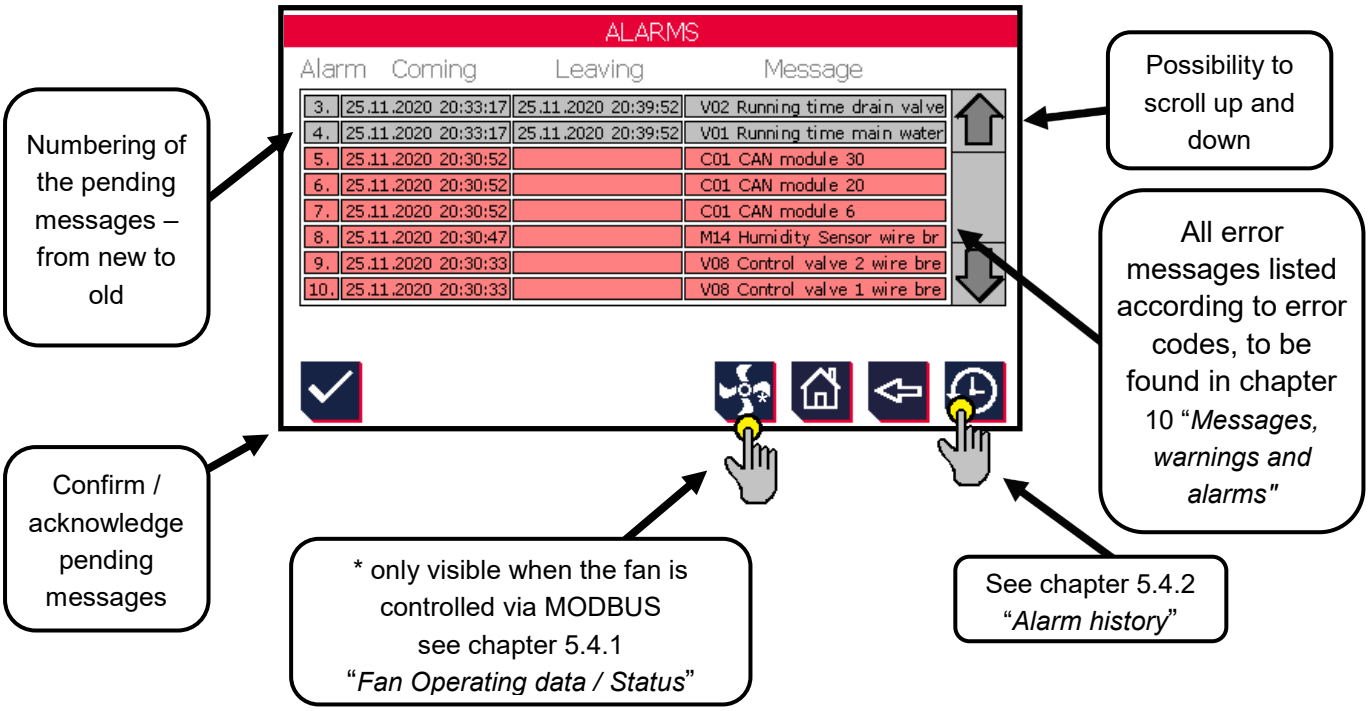
All greyed out displays are inactive and are not used.

5.4 Alarms

Messages about an incorrect operating status (warning) or any alarm are shown on the display. This is done directly in the start screen under the thermofin® lettering in a red-green-flashing window (see chapter 2.3.1 "*Start* screen*").*

All messages are secured. This means that after the error that has occurred has been eliminated or after a fault has been automatically reset, the display does not clear itself. By activating the error message window (flashing red-green) or through the Main menu -> Alarms, the user can directly access the list of currently pending messages.

Picture 58



The warnings that have already been eliminated (highlighted in grey) can be acknowledged using the button and removed from the list. The user can also confirm the warnings (still active) with a red background as registered with this button. This does not remove the fault, only the flashing display on the start screen is switched off and output 1 (DO1) is reactivated when the warning is acknowledged.

➔ New value and first value message

The warning output (digital output 1) is an output with first value and new value message. That means the following. In the good state, i.e., when there is no fault, the output is switched on. If a fault occurs on the TCS.2, the TCS.2 signals this by switching off output 1.

Service or security personnel on site can read this fault on the TCS.2 display and acknowledge it by pressing the button.

As a result, output 1 is switched on again and another fault can be sent via it again without the first cause of the fault having to be eliminated.

A first unimportant fault does not prevent the new report of a further, possibly existential, later occurring fault report through this switching.

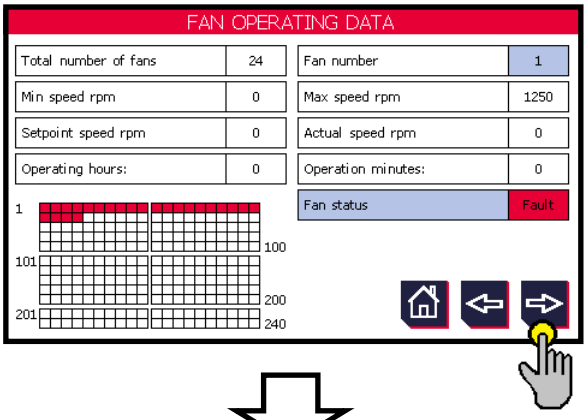
This acknowledgement process can be repeated several times without restriction. In addition, all individual faults with text, time and date are recorded in the alarm history in a voltage failure-safe manner. (see chapter 5.4.2 "*Alarm history").*

It goes without saying that the messages via outputs 1 and 2 are independent of any existing connection to a control room via a data bus to the TCS.2.

5.4.1 Fan Operating data / Status

This function in the "Alarms" menu can only be selected if the installed fans are controlled via MODBUS. Only then the electronics report all details of the following windows back to the TCS.2.

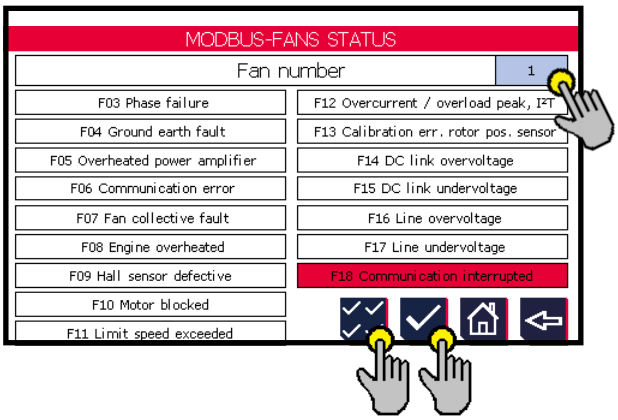
Picture 59



This window provides a general overview of the fan operating data.

All faulty fans are displayed with a red box at the bottom left of the window. (White -> fan OK, red -> fan error) In this example, all 24 fans are currently malfunctioning. A maximum of 240 fans can be displayed.

Picture 60



One level deeper the detailed cause of the fan fault and the associated error code can be read out. Here in the example F18 has a red background.

In order to display the status of the faulty fan, the corresponding number must be entered at the top right. (See picture ...)

All errors of the selected fan are acknowledged or deleted with the “Confirm” button. The errors of all fans are reset by pressing the “Confirm all” button.

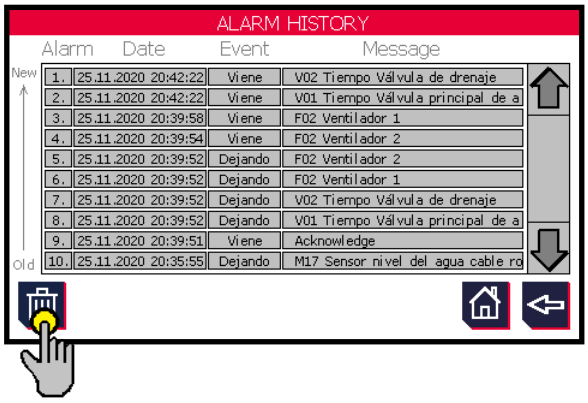
The list of all error codes, their meaning and options for remedying them are described in the 10 “Messages, warning and alarms” section.

5.4.2 Alarm history

All messages and special operating cases are recorded in the “Alarm history” submenu.

The most recent entry is at the top. All messages in the log are saved with error code, text, date and time. You can scroll through all entries by pressing the “Up and Down” arrow buttons.

Picture 61



It is a so-called ring buffer for 200 entries each. If the lists are filled with 200 entries, the oldest entry is deleted when another new entry is written. The entries in these log lists can be deleted with this button. However, this function requires a password and is therefore reserved for the manufacturer.

5.5 Delete password

The TCS.2 has several access levels in which various settings and parameters can be adjusted. These are secured with different passwords to avoid misuse.

If a user enters a corresponding password, it remains active for 30 minutes after the last touch of the display. If this time has expired, the password entry is automatically deleted and the control switches to the start screen. If the user would like to make further protected device settings, the necessary password (see chapter 2.4 “*Passwords*”) must be entered again.

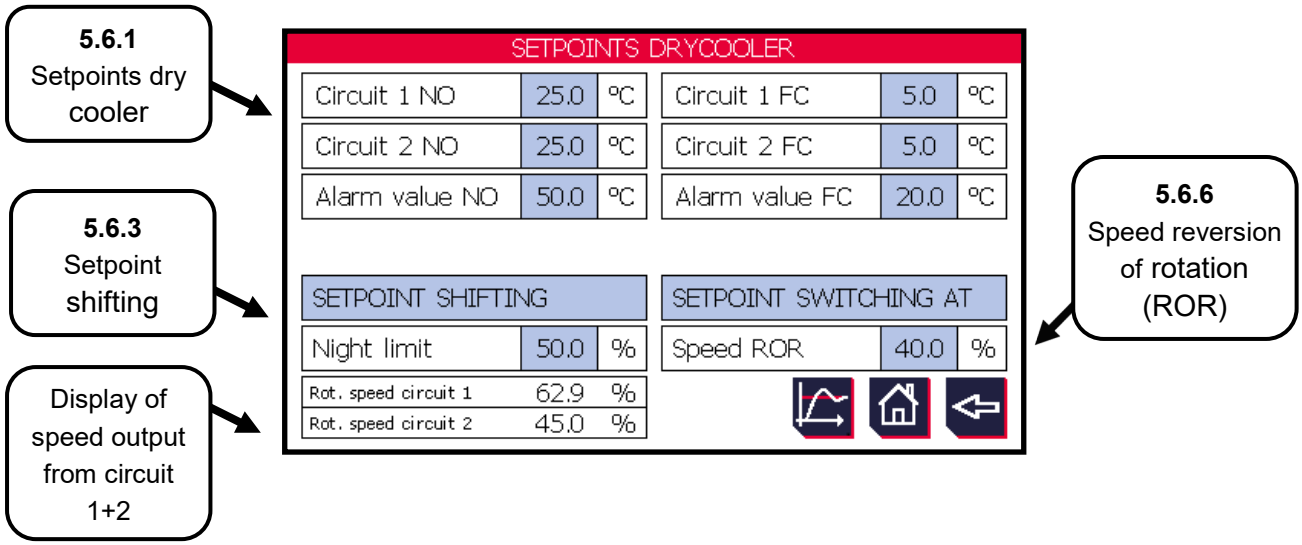
If the operator wants to delete the password immediately for security reasons, for example because he has finished commissioning, it can be done with the button in the main menu (delete password).

5.6 Setpoints

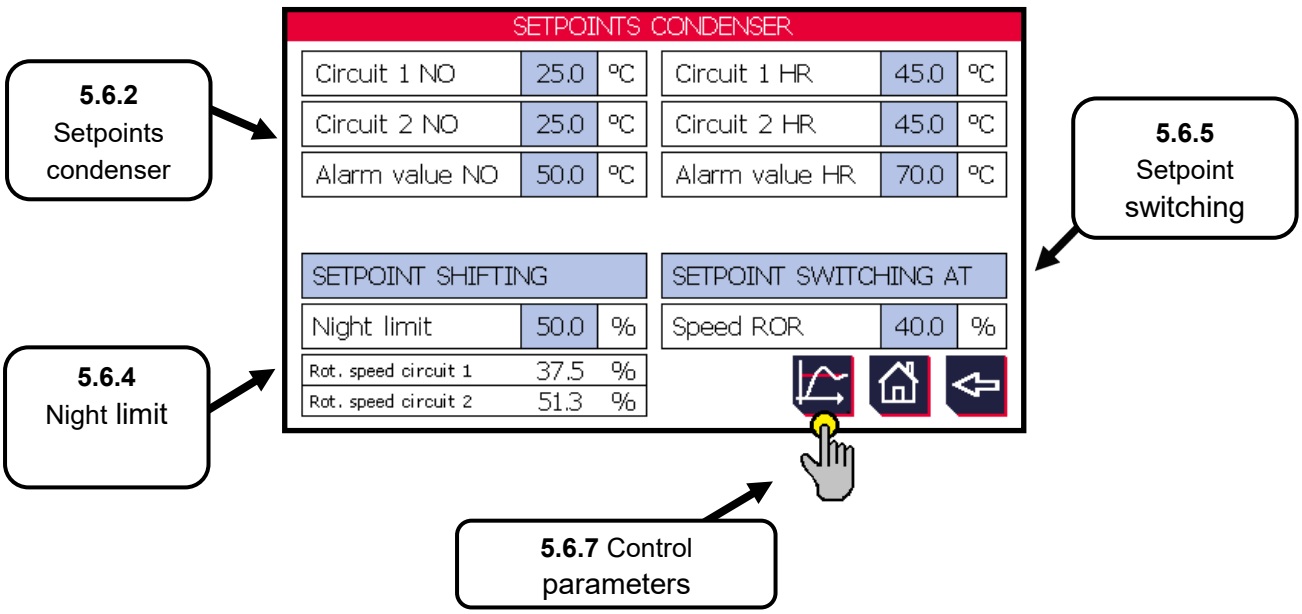
Depending on the selected heating system in the device settings (see chapter 4.1.1 "*Selection of heating system* / explanation of terms"), the user can view and edit all relevant setpoints in this window. For doing this, see the Picture 61 and Picture 62. A single-circuit dry cooler and a double-circuit condenser are shown as examples. As always, all white fields are displays and the blue fields can be operated or adjusted. All texts shown in grey are possible functions that are not activated in the Device settings -> Control (see chapter 4.2 "*Control*") or by the selected heating system.

For a more detailed description of the individual areas, see the following chapters:

Picture 62



Picture 63



5.6.1 Setpoints dry cooler

Setpoint and alarm values for "NC" – normal cooling

Setpoint temperature* °C:	Editable from 0 ... 90 °C	Factory setting: 25 °C
Setpoint temperature* °F:	Editable from 30 ... 200 °F	Factory setting: 25 °F

* for two-circuit devices can be edited separately for circuit 1 and circuit 2

Alarm overtemperature** °C:	Editable from 20 ... 90 °C	Factory setting: 50 °C
Alarm overtemperature** °F:	Editable from 70 ... 200 °F	Factory setting: 50 °F

** edited alarm value applies equally to circuit 1 and 2

When the Setpoint changeover is activated (see chapter 4.2.2 "*Setpoint changeover control")*, the following setpoint becomes active:

Setpoint and alarm values for "FC" – free cooling[1]

[1] If the ambient temperature falls below the flow temperature, cooling can take place without using the refrigeration machine.

Setpoint temperature* °C:	Editable from 0 ... 90 °C	Factory setting: 5 °C
Setpoint temperature* °F:	Editable from 30 ... 200 °F	Factory setting: 5 °F

* for two-circuit devices can be edited separately for circuit 1 and circuit 2

Alarm overtemperature** °C:	Editable from 5 ... 90 °C	Factory setting: 20 °C
Alarm overtemperature** °F:	Editable from 40 ... 200 °F	Factory setting: 20 °F

** edited alarm value applies equally to circuit 1 and 2

5.6.2 Setpoints condenser

Setpoint and alarm values for "NC" – normal cooling

Setpoint temperature* °C:	Editable from 0 ... 90 °C	Factory setting: 25 °C
Setpoint temperature* °F:	Editable from 30 ... 200 °F	Factory setting: 25 °F

* for two-circuit devices can be edited separately for circuit 1 and circuit 2

Alarm overtemperature** °C:	Editable from 20 ... 90 °C	Factory setting: 50 °C
Alarm overtemperature** °F:	Editable from 70 ... 200 °F	Factory setting: 50 °F

** edited alarm value applies equally to circuit 1 and 2

When the Setpoint changeover is activated (see chapter 4.2.2 "*Setpoint changeover control")*, the following setpoint becomes active:

Setpoint and alarm values for "HR" – heat recovery[2]

[2] The system runs, for example, to heat process water at a significantly higher condensing temperature. The refrigerant is largely de-heated in an upstream heat exchanger and must then not be cooled down too far in the condenser.

Setpoint temperature* °C:	Editable from 0 … 90 °C	Factory setting: 45 °C
Setpoint temperature* °F:	Editable from 30 … 200 °F	Factory setting: 45 °F

* for two-circuit devices can be edited separately for circuit 1 and circuit 2

Alarm overtemperature** °C:	Editable from 30 .... 90 °C	Factory setting: 20 °C
Alarm overtemperature** °F:	Editable from 90 ... 200 °F	Factory setting: 20 °F

** edited alarm value applies equally to circuit 1 and 2

5.6.3 Setpoint shifting

The operator often wishes to adapt the condensing pressure or the outlet temperature to specific operating conditions. The TCS.2 offers three options to choose from. These are described in detail below. The selection is done in the Device settings -> Control (see chapter 4.2.4 "*Setpoint shift ")*.

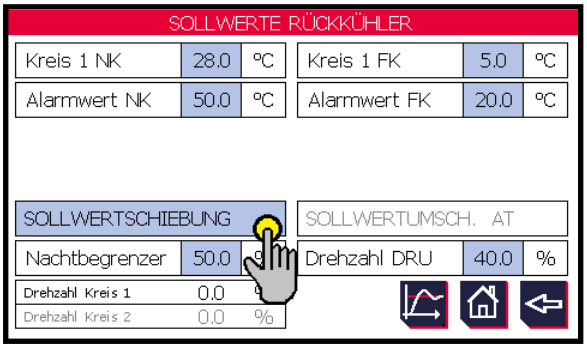
A) Setpoint shifting via external standard signal

The setpoint shifting can take place via an analogue signal on input AI-3 for circuit 1 or on AI-4 for circuit 2 (see also chapter 4.3.3 "*Analogue IN basic unit*").

The following standard signals are possible: 0-10 V, 2-10 V, 0-20 mA, 4-20 mA

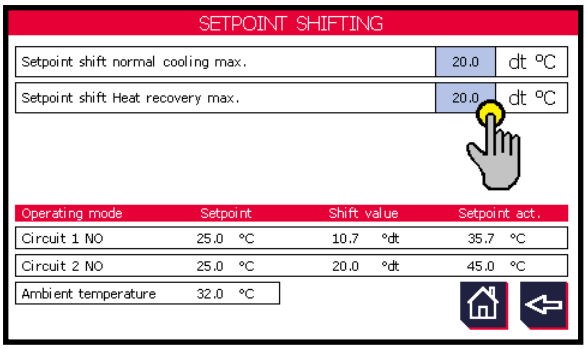
This function is activated in the Device settings -> Control (see chapter 4.2.4 "*Setpoint shift ")*. As soon as a type of control has been selected, the "Setpoint shifting" button in the "Setpoints" menu has a blue background and can be pressed. The user gets to the following settings window: Picture 63.

Picture 64



Picture 65

The value edited here is added to the setpoint if the analogue signal is 100%. Depending on whether a condenser (as shown here Picture 64) or a dry cooler has been selected as the heating system, both setpoints (NC - normal cooling + FC - free cooling or HR - heat recovery) can have their own value for the maximum setpoint shifting. However, both setpoints react to only one analogue input (AI-3 for circuit 1 and AI-4 for circuit 2).



"Setpoint": Set target temperature (25 °C)

"Shift value": Corresponds to the value of the analogue input (0-100%) of the maximum set shift value (in the example Picture 64 dt 20 °C).

"Setpoint act.": Addition of setpoint and shift value
Circuit 1: (25 + 10.7 °C = 35.7 °C) → Analogue input 3 (0-10 V) 5.3 V ≙ 10.7 °C
Circuit 2: (25 + 20 °C = 45 °C) → Analogue input 4 (0-10 V) 10 V ≙ 20,0 °C

Adjustable parameters:

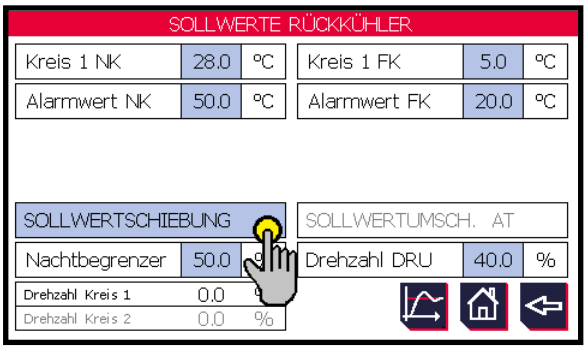
	Editable from ..to	Factory setting
Setpoint shifting NC – normal cooling max.	0 ... 50.0 °C	20.0 °C
	0 ... 70.0 °F	20.0 °F
Setpoint shifting FC – free cooling max.	0 ... 20.0 °C	10.0 °C
	0 ... 40.0 °F	10.0 °F
Setpoint shifting HR – heat recovery max.	0 ... 50.0 °C	20.0 °C
	0 ... 70.0 °F	20.0 °F

B) Setpoint shifting via ambient temperature

Another option is the setpoint shifting via the outside air temperature. An outside air temperature sensor is required for this. The TTS-90 temperature sensor is used as the sensor (see chapter 6.3.1 "*TTS temperature sensors*" in the device manual).

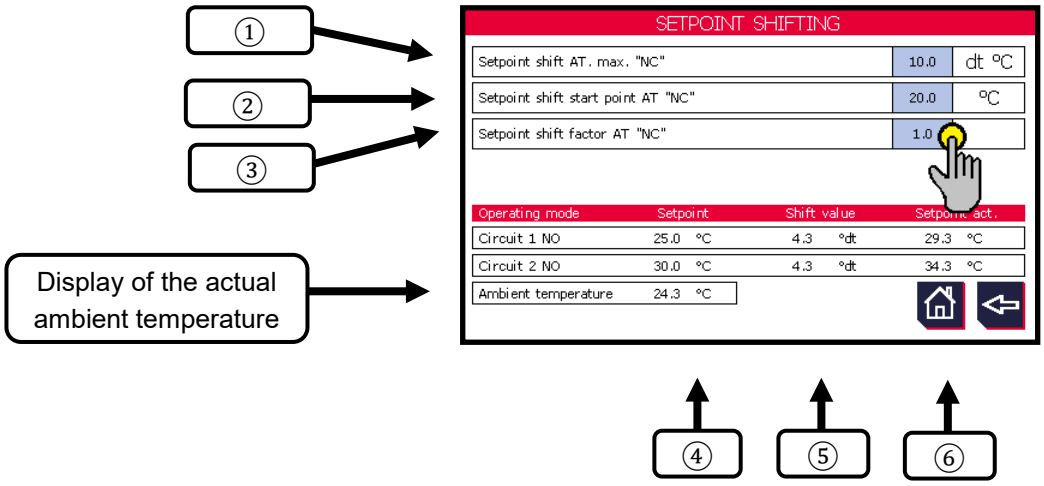
This function is limited to the setpoint for "Normal cooling" (NC). There is no setting option for the setpoints for free cooling and heat recovery. Circuit 1 and 2 are also treated the same. The shift value has the same effect on both circuits (see Picture 66).

Picture 66



This function is activated in the Device settings -> Control (see chapter 4.2.4 "*Setpoint shift ")*. If "via AT" is selected, the "Setpoint shifting" button in the Setpoints menu has a blue background and can be pressed. The user gets to the following settings window: (Picture 65)

Picture 67



① "Setpoint shift ambient temperature max":
The value edited here is added to the setpoint when the ambient temperature rises. How much the ambient temperature has to rise for this maximum value depends on the shift factor ③.

② "Setpoint start point ambient temperature":
Ambient temperature value at which the setpoint shift starts. The setpoint remains unchanged below this temperature.

③ "Setpoint shift factor ambient temperature":
The shift factor quantifies the shift effect per Kelvin change in the ambient air temperature. With a factor of 1.0, the setpoint is shifted by 1K when the ambient air temperature is increased by 1K.

④ "Setpoint":
Set target temperature of circuit 1 (25 °C) and circuit 2 (30 °C)

⑤ "Shift value":

Difference between current ambient temperature and ② “Setpoint start point ambient temperature“:

⑥ “Setpoint act.”:
Addition of ④ setpoint and ⑤ shift value

Circuit 1: (25,0 + 4,3 °C = 29,3 °C) → Shifting start point ② is at 20 °C
→ Current ambient temperature: 24.3 °C
→ Corresponds to a difference to the start point of 4.3 °C
→ With a shift factor ③ of 1.0 °C per Kelvin AT, the setpoint increases by 4.3 °C (⑤) to 29.3 °C

Circuit 2: (30,0 + 4,3 °C = 34,3 °C) → Shifting start point ② is at 20 °C
→ Current ambient temperature: 24.3 °C
→ Corresponds to a difference to the start point of 4.3 °C
→ With a shift factor ③ of 1.0 °C per Kelvin AT, the setpoint increases by 4.3°C (⑤) to 34.3 °C

When shifting the setpoint above the ambient air temperature, it must be ensured that it is only shifted upwards. The setpoint without the influence of the shift signal is set to the lowest permissible value of the system. If this value is not listed in the system documentation, this information can either be provided by the responsible cooling system manufacturer or the responsible engineering office.

Adjustable parameters:

	Editable from ..to	Factory setting
Setpoint shifting ambient temperature max.	0 ... 50.0 °C	10.0 °C
	0 ... 70.0 °F	20.0 °F
Setpoint shift start point ambient temperature.	0 ... 50.0 °C	25.0 °C
	30 ... 120.0 °F	10.0 °F
Setpoint shift factor ambient temperature max.	0.5 ... 2,0 K_{SP}/K_{AT}	1,0 K_{SP}/K_{AT}

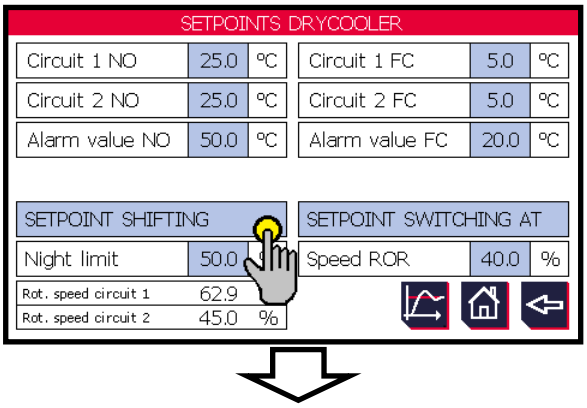
C) Setpoint shifting via BUS

Control via bus is also possible, similar to the setpoint shifting via a standard signal → (see A).

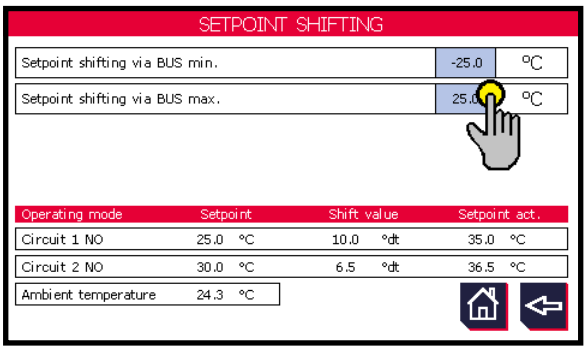
The type of communication bus is set in the *Device settings* → *BMS bus system* (see also chapter “4.5 „”). In contrast to the setpoint shifting using the ambient temperature, the setpoint can be shifted up and down via the BUS.

This function is activated in the Device settings -> Control (see chapter 4.2.4 “*Setpoint shift ”)*. If “via BUS” is selected, the “Setpoint shifting” button in the Setpoints menu has a blue background and can be pressed. The user gets to the following settings window: (Picture 67)

Picture 68



Picture 69



With these two values the user limits the possible shift up and down. Depending on the requested setpoint (NC – normal cooling + FC – free cooling or HR – heat recovery), both setpoints react to the same shift value from the bus.

The value written by the bus (divided by 10) is added to the setpoint. In this example Picture 68, register 4 (SPS circuit 1 is 100 ≙ 10.0 °C and register 5 (circuit 2) is 65 ≙ 6.5 °C.

With direct communication via MODBUS, the following setting values and limits apply (equally for circuit 1 + circuit 2:

Circuit	Register	Register value (signed integer)	Converted to °C/°F
1	**4** “Setpoint shifting circuit 1”	-250 ... 250	-25.0 ... 25.0 °C
		-450 ... 450	-45.0 ... 45.0 °F
2	**5** “Setpoint shifting circuit 2”	-250 ... 250	-25.0 ... 25.0 °C
		-450 ... 450	-45.0 ... 45.0 °F

5.6.4 Night time reduction

With this function, the manipulated variable of the fans (speed output) is limited to a maximum value. The aim is to minimize the noise during rest periods, especially at night and on Sundays and public holidays. The following 3 control options are available to the user:

In principle, the percentage limit of the speed output can also be sent via the bus (setting option from 40 ... 100 %). This applies to all three types of control. The value entered in the menu always forms the upper limit. As a result, as can be seen in the example in Picture 69, a value of 40 ... 50 % can be sent via the bus. If the sent value is outside the permissible range, the user receives a message “Values outside the permissible range”. If the register is not written to (register value: 0), there is no error message.

Register	Register value (INT)	Night time reduction in %
13 “Max speed at night”	400 ... 1000*	40.0 ... 100.0 %*

* A maximum register value of 1000 (≙ 100%) is possible, if the value set in the “Setpoints” menu is also at 100%. If this value is lower, it represents the upper limit for the value sent via the bus (see Picture 69).

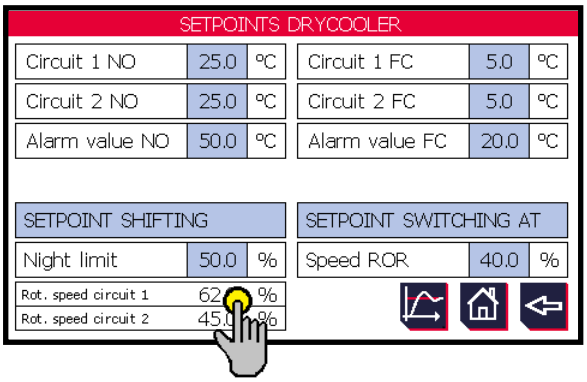
A) Night time reduction via terminal

Two steps are necessary to activate the “Night time reduction via terminal” function:

➔ The digital input DI-3 must be configured to “Night time reduction" (see also chapter 4.3.1 “*Digital IN basic unit*”).

➔ The type of control must be set to “Via terminal”, for this see Device settings -> Control (see chapter 4.2.3 “*Night time reduction* control”). As soon as this step has been processed, the percentage value of the Night time reduction is highlighted in blue in the Setpoints menu and can therefore be pressed (Picture 65).

Picture 70



The speed is now limited to the percentage value set here with a “high” signal from the corresponding digital input. (based on the max speed)

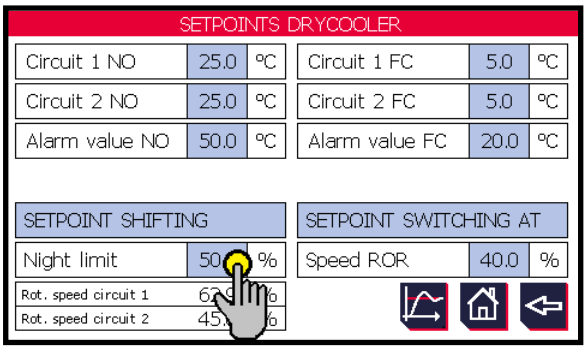
Editable: from 40 % to 100 %

Factory setting: 50 %

B) Night time reduction via BUS

This function is activated in the Device settings -> Control (see chapter 4.2.3 “*Night time reduction* control*”*). As soon as “Via bus” has been selected, the percentage value of the Night time reduction is highlighted in blue in the Setpoints menu and can be pressed (Picture 65).

Picture 71



The speed is limited to the percentage value set here when the corresponding bit is set (see table below). (based on the max speed)

Editable: from 40 % to 100 %

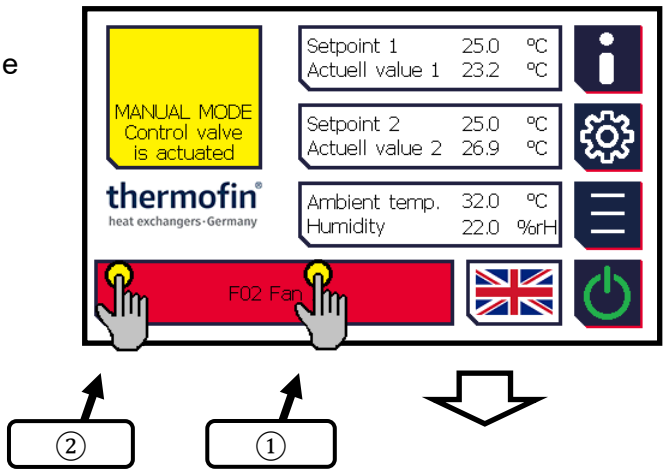
Factory setting: 50 %

Register	Bit	Meaning	Register value
1 “Night time reduction”	**2**	TRUE = Night time reduction active	4

C) Night time reduction via internal clock

This function is activated in the Device settings -> Control (see chapter 4.2.3 "*Night time reduction control*"). As soon as "Via internal clock" has been selected, the "Night time reduction" field and the percentage value in the "Setpoints" menu are highlighted in blue and can be pressed (Picture 65).

Picture 72

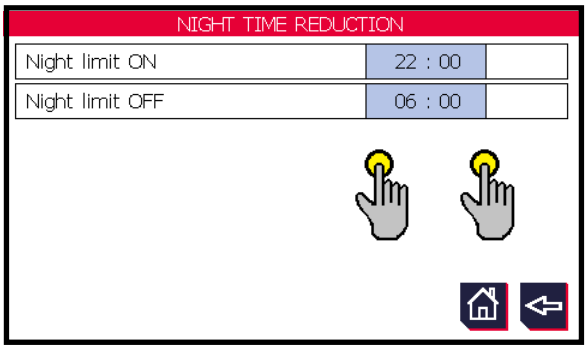


① The speed is limited to the percentage value set here during the set time in (②).
(based on the max speed)

Editable: from 40 % to 100 %

Factory setting: 50 %

Picture 73



② If the "Night time reduction" button is pressed, the following window opens. See Picture 72. The switch-on and switch-off time of the Night time reduction can be adjusted here.

Editable from … to:
Night time reduction ON: 18 - 23 o'clock
Night time reduction OFF: 01 - 10 o'clock

Factory setting:
Night time reduction ON: 22:00 o'clock
Night time reduction OFF: 06:00 o'clock

5.6.5 Setpoint changeover

This function enables you to switch between two fixed setpoints for the controller. The TCS.2 offers three control options for this. Depending on whether a condenser (as can be seen here in Picture 73) or a dry cooler has been selected as the heating system, it is possible to switch from NC – normal cooling to FC – free cooling or HR – heat recovery.

A) Setpoint changeover via terminal

Two steps are necessary to activate the "Setpoint changeover via terminal" function:

➔ The digital input DI-2 must be configured to "Setpoint changeover". See also chapter 4.3.1 "*Digital IN basic unit*".

➔ The type of control must be set to "Via terminal", for this see Device settings -> Control (see chapter 4.2.2 "*Setpoint changeover* control").

B) Setpoint changeover via AT (ambient temperature)

A corresponding ambient temperature sensor must be installed and configured.

This function is activated in the Device settings -> Control (see chapter 4.2.2 "*Setpoint changeover* control*"*). If "via AT" is selected, the "Setpoint changeover AT" field in the Setpoints menu has a blue background and can be pressed (see Picture 73).

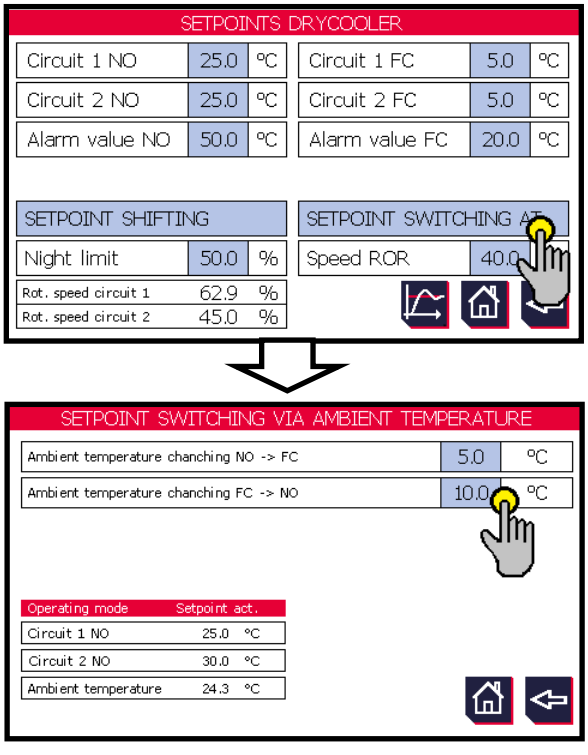
NC → FC/HR:
If the ambient temperature of the value edited here is reached or undershot, the setpoint changes from NC (normal cooling) to FC (free cooling) or HR (heat recovery for condensers).

Editable: from 0.0 … 30.0 °C

Factory setting: 5 °C

FC/HR → NC:
If the ambient temperature of the value edited here is reached or exceeded, the setpoint changes

Picture 74



Picture 75

from FC (free cooling) or HR (heat recovery for condensers) back to NC (normal cooling).

Editable: from 10.0 … 50.0 °C

Factory setting: 10 °C

C) Setpoint changeover via BUS

This function is activated in the Device settings -> Control (see chapter 4.2.2 "*Setpoint changeover* control*")*.

- ➔ Select "via BUS" control
- ➔ If the corresponding bit is set to "true" via the BUS (see table), the setpoint changes from NC (normal cooling) to FC (free cooling) or HR (heat recovery for condensers).

- ➔ The following parameters apply to direct communication via MODBUS:

Register	Bit	Designation	Meaning	Register value
1	**2**	Setpoint changeover	TRUE = Setpoint changeover requirement	Writing 2
164	**0**	Normal cooling NC active	TRUE = Normal cooling NC active	Reading 1
	1	Free cooling FC active	TRUE = Free cooling FC active	Reading 2
	2	Hear recov. HR active	TRUE = Heat recovery HR active	Reading 4
	3	Heat pump oper. HP active	TRUE = Heat pump operation HP active	Reading 8

5.6.6 Speed reversion of rotation (ROR)

After the requirement to "Reversion of rotation", the direction of rotation of the fans changes to the percentage value set here (based on the maximum speed). Depending on the preselection in the Device settings → Fans (see also chapter 4.4.2 "*Direction of rotation*"), the fans change from right to left rotation or vice versa. The following control options are available to the user: (see also chapter 4.2.9 "*Rev*ersion of rotation control")

D) Reversion of rotation via terminal

Two steps are necessary to activate the "Reversion of rotation via terminal" function:

➔ One of the following digital inputs must be configured to “Reversion of rotation”. DI-5, DI-7 and DI-8. See also chapter 4.3.1 “*Digital IN basic unit*”.

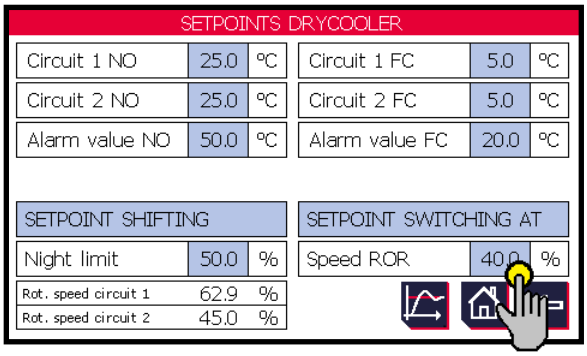
➔ The type of control must be set to “Via terminal”, for this see Device settings -> Control (see chapter 4.2.9 “*Reversion* of rotation control”).

After the above steps have been carried out, the “Speed ROR” value in the “Setpoints” menu has a blue background and can be freely edited. See Picture 75.

Editable: from 0.0 … 100.0 %

Factory setting: 100 %

Picture 76



E) Reversion of rotation via BUS

The following steps are necessary to activate the “Reversion of rotation via BUS” function:

➔ Select “via BUS” control. (Device settings -> Control, see chapter 4.2.9 *„Reversion* of rotation control*“)*

➔ If the corresponding bit is set to “true” via the BUS (see table), the setpoint changes from NC (normal cooling) to FC (free cooling) or HR (heat recovery for condensers).

Register	Bit	Designation	Meaning	Register value
1	**15**	Reversion of rotation	TRUE = Reversion of rotation requirement	Writing 32768
143	**8**	Reversion of rotation Feedback	TRUE = Reversion of rotation active	Reading 256

5.6.7 Control parameters

If necessary, the parameters of the thermofin®-PI controller can be adjusted. In addition to the existing setpoint (see chapter 5.6 “*Setpoints*”) to which the system is to be regulated, two other important parameters are required. These are the proportional factor “Kp” and the reset time “Tn”. In

addition to speed and precision, these two parameters are also responsible for the stability of the desired control process.

F) Reset time “Tn”

If the factory defaults for these parameters do not correspond to a controlled system, this can become noticeable in the system being regulated too slowly. As a result, the delayed condenser pressure control can lead to an impermissible pressure increase in the system. This fact can lead to the system being switched off automatically via the corresponding high-pressure safety devices. As a rule, this cause can be eliminated by reducing the reset time “Tn” which is too long.

The controller can also react too sensitively or too quickly, so that the system constantly fluctuates around the setpoint with the condensing pressure or the outlet temperature. Since the system does not find a constant operating point and therefore the fan speed varies constantly, the thermal contacts of the fan drives can protect them from overheating by switching off the fans but can also cause a fault. If the operating point does not remain constant, the reset time “Tn” is often set too short and it must be extended by readjusting accordingly.

G) Proportional factor “Kp”

The proportional factor “Kp” is also included in the stability conditions of a controller. The greater the gain, the more sensitive the controller becomes and the system can tend to oscillate. The smaller the gain, the slower the controller becomes. However, this is not an inertia that is generated by a time constant of the controller. The apparent inertia is related to the controller gain.

The value of the control deviation (deviation of the actual value from the setpoint) is determined and multiplied by the controller gain. The result is the manipulated variable that specifies the speed of the fans. The greater the controller gain, the greater the control signal (manipulated variable) per unit of control deviation. This effect makes the control process appear faster or slower, since the actual value changes do not take place directly but rather take place with a time delay due to the system. PI- and P-controllers both work with the “Kp value” which is why the aforementioned behaviour can also be perceived with both control modules.

If the “Kp value” is too low, the control process can take too long. If this occurs, the “Kp value” must be increased. In the case of pure P-controllers with a “Kp value” that is too small, the remaining control deviation can be too large. In this case the “Kp value” must also be increased. If the “Kp value” is set too high, the controller usually reacts too strongly and causes the system to oscillate. In such cases the “Kp value” must be reduced.

H) Adjustment aids

Control systems require exact control parameters that correspond to the conditions of the system on site. In order to determine these parameters, the user needs in-depth specialist knowledge and appropriate measuring devices to analyse the controlled system. Since the equipment required for this is usually not part of the equipment of the commissioning personnel, we refer at this point to a

simple and sufficiently precise procedure which enables the specialist to determine the parameters for a properly functioning control system during operation.

In order to determine the parameter values, the user must proceed in a concentrated and slow manner. It should be constantly observed whether the changes made improve or worsen the control process.

If improvements have been made, the values can be further adjusted in small steps in the same direction. Always slowly and with constant observation of the system. If the control process deteriorates, the last step is reversed and the values changed in the opposite direction.

Steps to adjust the Kp:

- ➔ To simplify the adjustment, the reset time “Tn” is switched off by setting it to the value “0”.
- ➔ For two-circuit devices, set both “Kp values” to be the same. Now both controllers work as pure P-controllers with the same parameters.
- ➔ Increase the or both “Kp values” until the system becomes unstable and tends to oscillate.
- ➔ Once this value has been determined, the “Kp values” are reduced a little so that the controlled system works stably. This is the optimal (adapted) proportional factor for the system.

After determining and setting the proportional factor, the reset time “Tn” is determined.

Steps to adjust the Tn:

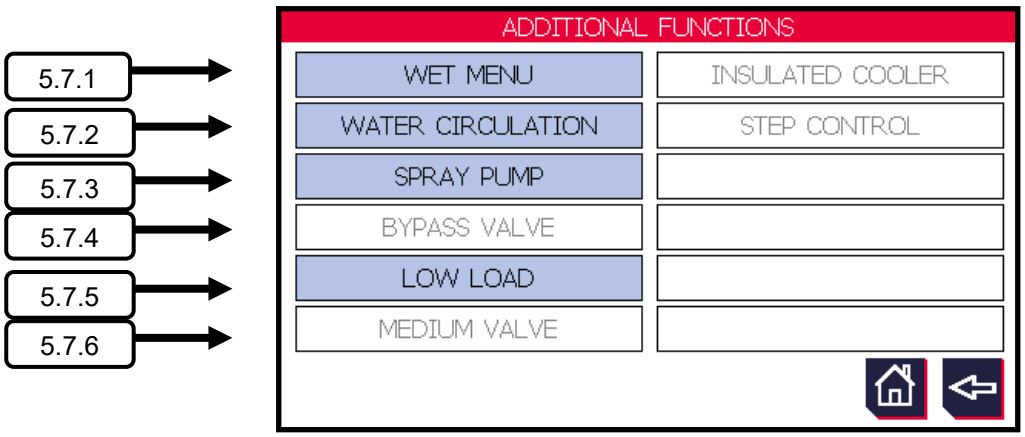
- ➔ Switch off the cooling system.
- ➔ Set the value “Tn” to approx. 60 seconds.
- ➔ Switch on the cooling system again after a few minutes and observe the behaviour of the controller or the fans.
- ➔ If the pressure or temperature rises faster than the controller starts up the fans, “Tn” is too high. Reduce this value accordingly.
- ➔ If the fans start up faster than the pressure or the temperature in the system increases, “Tn” is too small. The value must be increased.

In perfect case scenario, the speed of the control behaviour corresponds exactly to the speed at which the pressure or temperature changes. With a controller adapted in this way to its controlled system, system vibrations are excluded and the fastest possible reaction to changes in the cooling system is achieved. The controller works with the smallest system deviation now and thus ensures optimal system operation.

5.7 Additional functions

In contrast to the standard, there are various functions and setting levels that are listed in this submenu item. All functions that are not activated in the device settings are greyed out with a white background.

Picture 77



Greyed out functions are not activated or selected in the device settings.

5.7.1 Wet menu

Depending on the selected heating system in: “Device settings” → “Heat exchanger system”, the “Wet mode” submenu is divided into the following three categories. The following list shows all available variants with the corresponding cross-references:

- → **Wet menu for sprayed devices**
  (See chapter 6.4 “*Adjustments in the Main menu → Additional functions → Wet menu Spray”)*

- → **Wet menu for devices with cooling mats (thermofin® adiabatic pads)**
  (*See chapter 7.4 “Adjustments in Main menu → Additional functions → Wet menu Mat”)*

- → **Wet menu for thermofin® hybrid coolers**
  (See chapter **8.2** “Adjustments in Main menu → Additional functions → Wet mode*”)*

5.7.2 Water circulation

Description follows …

5.7.3 Spray pump

This function enables a circulation pump to be controlled which is used, for example, for evaporators. It feeds water for wetting the tube bundle.

Function only for single-circuit devices. With two-circuit devices, the pump function only applies to circuit 1.

A) Control (activation)

Basically, the following steps must be observed for activating this function:

1. Set digital input (DI-6) to “Spray pump fault” (see also chapter 5.2.1 “*Digital IN basic unit*”)
   Logical “high” (+24 V DC at the input) ≙ Pump OK
   Logical “low” (0 V DC at the input) ≙ Pump fault
   For example for motor protection

2. Set digital output (DO-6) to “Spray pump” (see also chapter 5.2.2 “*Digital OUT basic unit*”)

   Logical “high” (+24 V DC at the output) ≙ Spray pump requirement
   Logical “low” (0 V DC at the output) ≙ No requirement

3. A type of control must be selected. There are the following options (see also chapter 4.2.12 “*Spray pump* control”):

   ➔ **Spray pump control “internal”**
   If the release (requirement circuit 1, DI-1) is set and the conditions in the “Spray pump” menu are met, the pump switches on.
   - See below (under **B**) all switch-on and switch-off conditions.

   ➔ **Spray pump control “via terminal”**
   - There is currently no digital input specifically dedicated to activating the spray pump.
   - As with “internal”, the pump is also switched on and off via the release (external requirement, DI-1) and the conditions in the menu (see **B**).

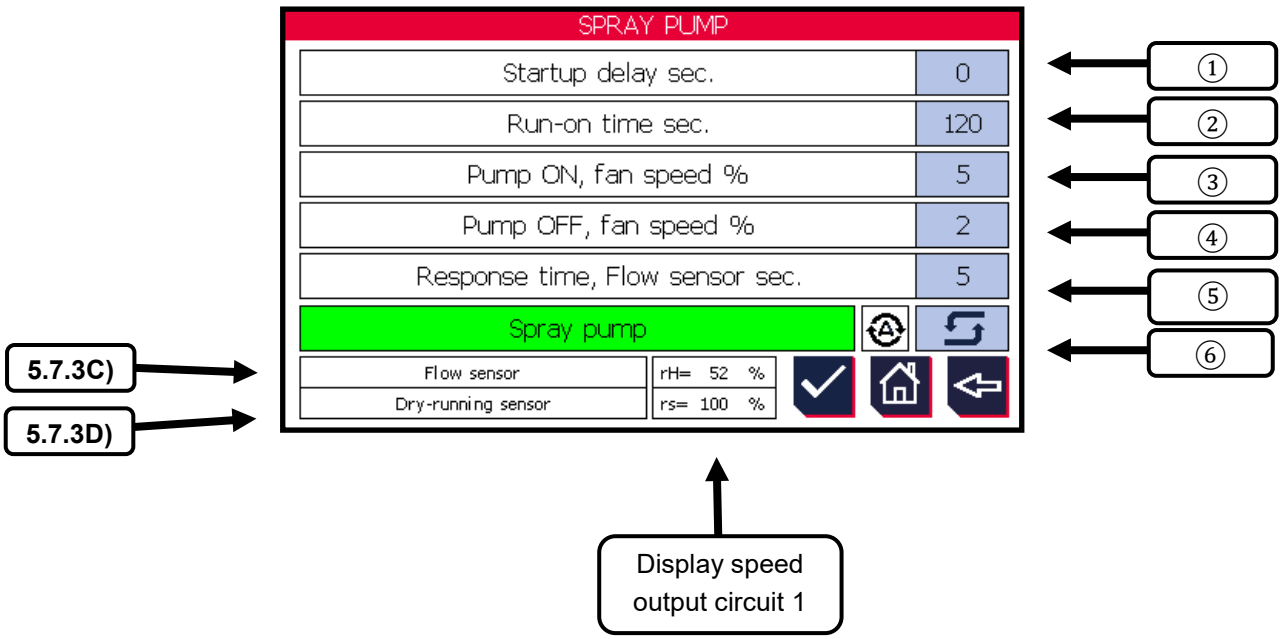
   ➔ **Spray pump control “via BUS”** - as soon as the below-mentioned bit is set and the conditions in the “Spray pump” menu are met, the pump switches on.
   - The following values apply to direct communication via MODBUS:

Register	Bit	Designation	Meaning	Register value
2	**1**	Spray pump	TRUE = Spray pump 1	Writing 2
143	**9**	“Spray pump” Feedback	TRUE = Spray pump 1 active	Reading 512

B) Editable values

If the control has been selected, the “Spray pump” field in the “Additional functions” menu appears blue and can be activated (Picture 76). The editing level of the “Spray pump” opens.

Picture 78



① **Startup delay in seconds**

If the current speed setpoint (⑦) exceeds the “Pump ON, fan speed %” value (③), the time set here starts. When it has expired, the spray pump switches ON.

Editable from … to: 0 … 600 s

Factory setting: 0 s

② **Run-on time in seconds**

If the current speed setpoint (⑦) falls below the “Pump OFF, fan speed %” value (③), the time set here starts. When it has expired, the spray pump switches OFF.

Editable from … to: 0 … 1800 s

Factory setting: 120 s

③ **Pump ON, fan speed in %**

If the current speed setpoint (⑦) exceeds the% value edited here, the startup delay (①) starts. When it has expired, the spray pump switches ON.

Editable from … to: 0 … 50 %

Factory setting: 5 %

④ Pump OFF, fan speed in %

If the current - speed setpoint (⑦) falls below the% value edited here, the run-on time (②) starts. When it has expired, the spray pump switches OFF.

Editable from … to: 0 … 3 %

Factory setting: 2 %

⑤ Response time of flow sensor in seconds

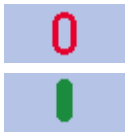
Immediately after the pump has started, the flow sensor often does not work properly and tends to “flutter”. In addition, air initially present in the system should not immediately generate a fault message. The time edited here delays the error message “S09 flow fault” after switching on the spray pump.

Editable from … to: 0 … 60 s

Factory setting: 5 s

⑥ Manual/automatic switch / Spray pump status

The user can use this button to switch between the “Automatic” and ‘Manual” operating modes during commissioning or troubleshooting. If a digital output or an analogue output is switched to “Manual”, this is displayed on the start screen. If the control is set back to automatic mode, the output takes on the original value (before switching to manual).



After changing from “Automatic” to “Manual” operating mode, the spray pump can be switched on and off with these buttons.

Manual mode active

Automatic mode active

The following operating states of the spray pump are displayed:

Spray pump switched off, no error

Spray pump switched on, no error

Spray pump switched off, motor protection triggered or no signal at DI-6 (see also chapter 4.3.1 "*Digital IN basic unit*")

C) Flow sensor Spray pump

After activation, the flow rate of the spray line, which is measured after the spray pump, is displayed here. A possible error is only queried after the "Flow sensor response time" has elapsed [see chapter 5.6.3 B) *"Spray pump - Editable values*"].

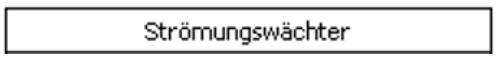
The following steps are necessary in order to monitor the function of the spray pump (or the flow through the associated line) in the TCS.2:

➔ Install a suitable flow sensor with the following output signal:
+24 V DC at the output ≙ Line flows through
0 V DC at the output ≙ No flow

➔ Configure digital input DI-5 to "Flow sensor".
See also chapter 4.3.1 "*Digital IN basic unit".*

The following states of the flow sensor are displayed:

Flow sensor deactivated.



Flow sensor active, line flows through.

Flow sensor active, flow interrupted.
See also chapter 10.5 "*Signals external messages – Error code S...*"

The following parameters apply to direct communication via MODBUS:

Register	Bit	Designation	Meaning	Register value
143	**11**	Flow sensor fault	TRUE = Flow interrupted	Reading 2048

D) Dry-running sensor Spray pump

It is displayed here after activation that there is not enough water available for the spray pump to operate.

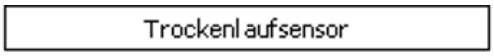
The following steps are necessary to monitor the water level in the TCS.2 and thus avoid damage to the spray pump:

➔ Install a suitable sensor or float switch with the following output signal:
+24 V DC at the output ≙ Water level Ok
0 V DC at the output ≙ Water level too low

➔ Configure digital input DI-8 to “Dry-running fault”.
See also chapter 4.3.1 “*Digital IN basic unit”.*

The following states of the dry-running sensor are displayed:

Dry-running sensor deactivated.



Dry-running sensor active, water level Ok.

Dry-running sensor active, water level too low.
See also chapter 10.5 “*Signals external messages – Error code S...*”

The following parameters apply to direct communication via MODBUS:

Register	Bit	Designation	Meaning	Register value
143	**12**	Spray pump dry-running	TRUE = Spray pump dry-running	Reading 4096

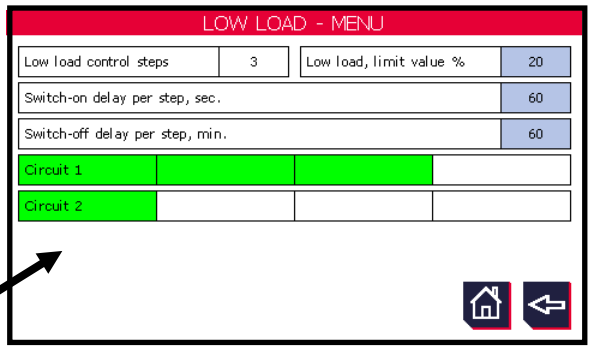
5.7.4 Bypass valve

Description follows …

5.7.5 Low load menu

This function enables a fan or a group of fans to be switched off in levels at low load.

Picture 79



All relevant parameters can be edited in the low load menu except for the low load device levels. For a precise functional description **see chapter 4.6.5 “Low load settings”**

In addition, the bars show active (green) and inactive (white) low load levels of circuit 1 and possibly of circuit 2 The left and first level is the so-called base load level. It remains regulated and is not switched off. All other levels are “control levels”.

5.7.6 Medium valve

Description follows …

5.8 Network IP

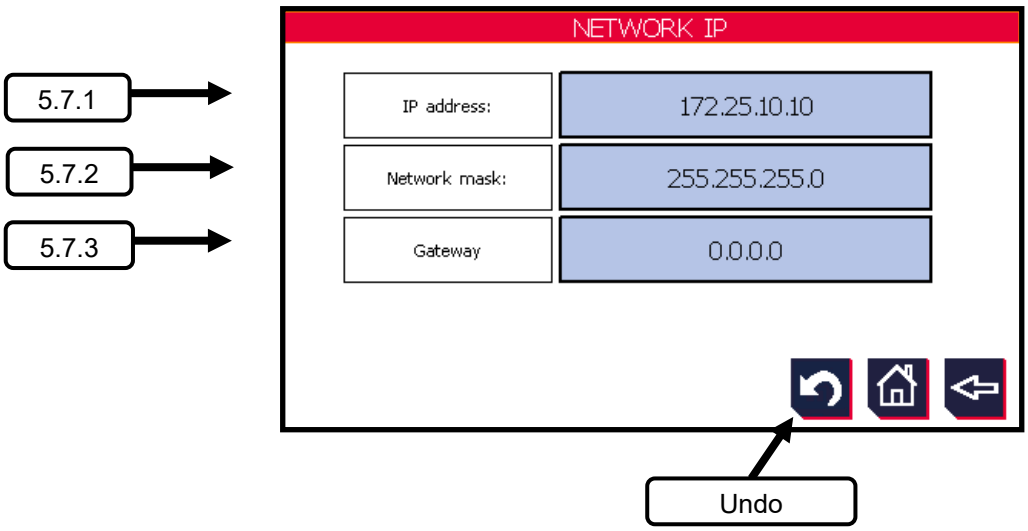
This menu contains all relevant network variables for the Ethernet interface X11 on the basic unit TCS.2 (see also chapter 1.4 "*Circuit diagram TCS.2*").

By default, the X11 interface is used to upload programs, updates or to communicate with the thermofin® WEB terminal.

Depending on the activated license in TCS.2, the RJ45 port (X11) also serves as an interface for the following IP-based bus systems:

- ➔ Ethernet IP (standard)
- ➔ Modbus-TCP
- ➔ FTP server

Picture 80



5.8.1 IP address

Adaptation of the network address. Please have the responsible administrator assign a suitable address.

Factory setting: 172.25.10.10

5.8.2 Network mask / subnet mask

The subnet mask (also called network mask) separates an IP address into a network and a device address in a network. The device addresses are also known as host addresses. The advantage of subnet masks is that the user can divide the available address space into different subnets.

There can be several reasons for this:

- ➔ There is only a certain address space available which is not fully used. The division creates two or more self-sufficient networks.
- ➔ Individual departments of a company can be logically separated from one another, e.g., for security reasons.
- ➔ Routing decisions can be made faster.

Factory setting: 255.255.255.0

5.8.3 Standard gateway

When a TCP/IP computer needs to communicate with a host on another network, it usually communicates through a device called a router. In TCP/IP terminology, a router that is specified on a host and links the host's subnet to other networks is called a **standard gateway**.

When a host tries to communicate with another device using TCP/IP, it compares the defined subnet mask and the destination IP address against the subnet mask and its own IP address. The result of this comparison tells the computer whether the target is a local host or a remote host.

If the result of this process determines that the destination is a local host, the computer simply sends the packet on the local subnet. If the result of the comparison determines that the destination is a remote host, the computer forwards the packet to the **standard gateway** defined in the TCP/IP properties. It is then up to the router to forward the packet to the correct subnet.

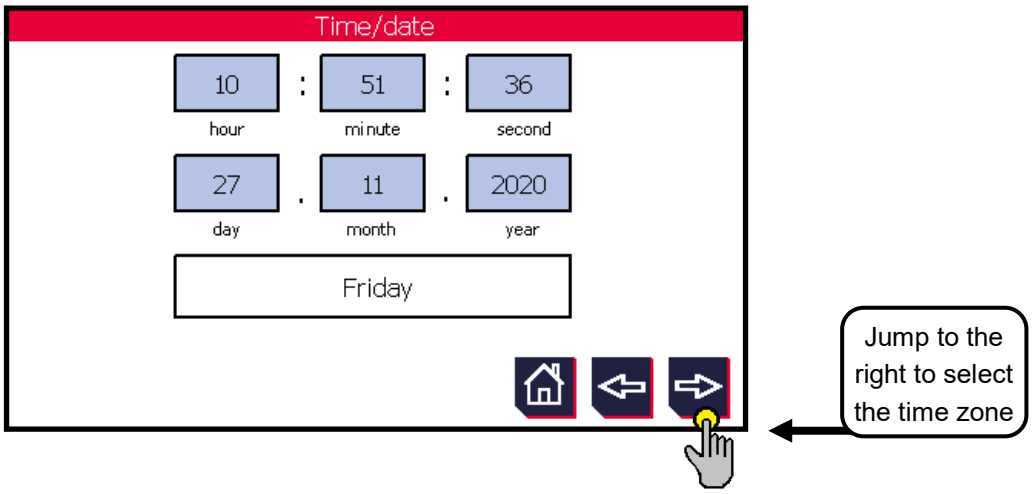
Factory setting: 0.0.0.0

5.9 Time / date

5.9.1 Set time / date

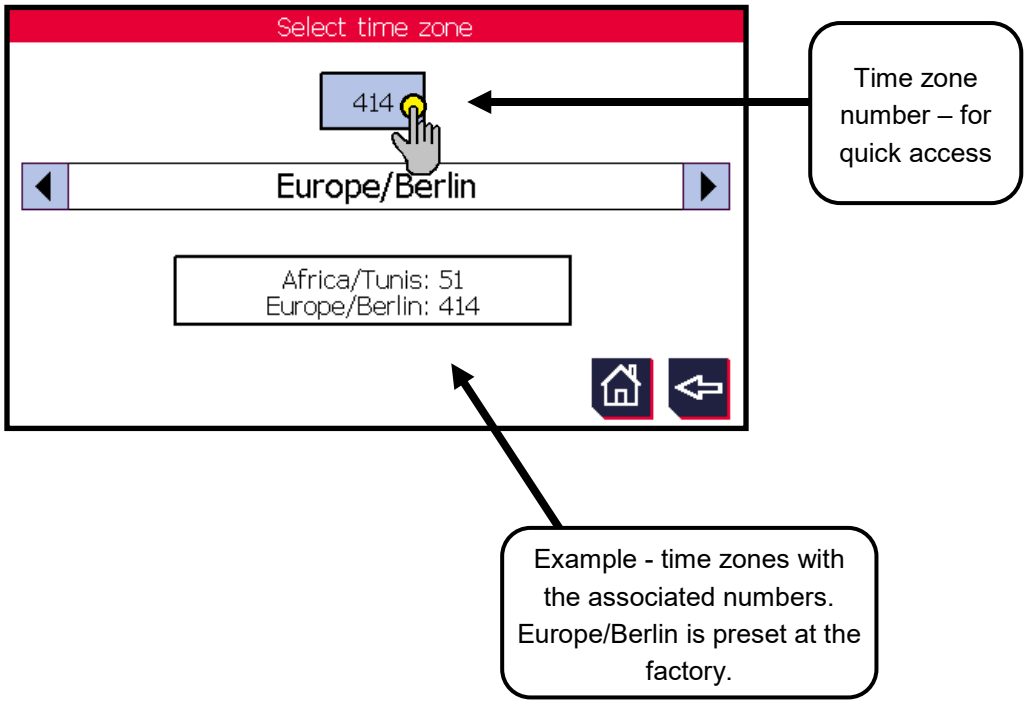
Editing of the time and date is usually not necessary. The TCS has a real-time clock that is battery-backed. The TCS is delivered with current date and time values. The summer/winter time changeover takes place automatically. However, this is only possible if the control is connected to 24 V DC at the time of the changeover. The changeover takes place in the night from the last Saturday to the last Sunday in March or October of each year. If, for whatever reason, the control is not connected to voltage at the time, the time must be edited. It can also happen that the clock no longer works due to a completely empty backup battery and an additional loss of supply voltage. After such incidents, the backup battery should of course be replaced first, see chapter 6.1.2 “Replacing the backup battery” in the device manual and then the user can set the time and date to the current value with the TCS.2 switched on.

Picture 81



5.9.2 Select time zone

Picture 82



If the time changeover is abolished in Germany, a new runtime system must normally be installed on the TCS.2. To avoid this cost, the time zone “Africa/Tunis” can be selected, for example. In Tunisia the time change was abolished in 2008 and therefore has Central European Time (CET) all year round.

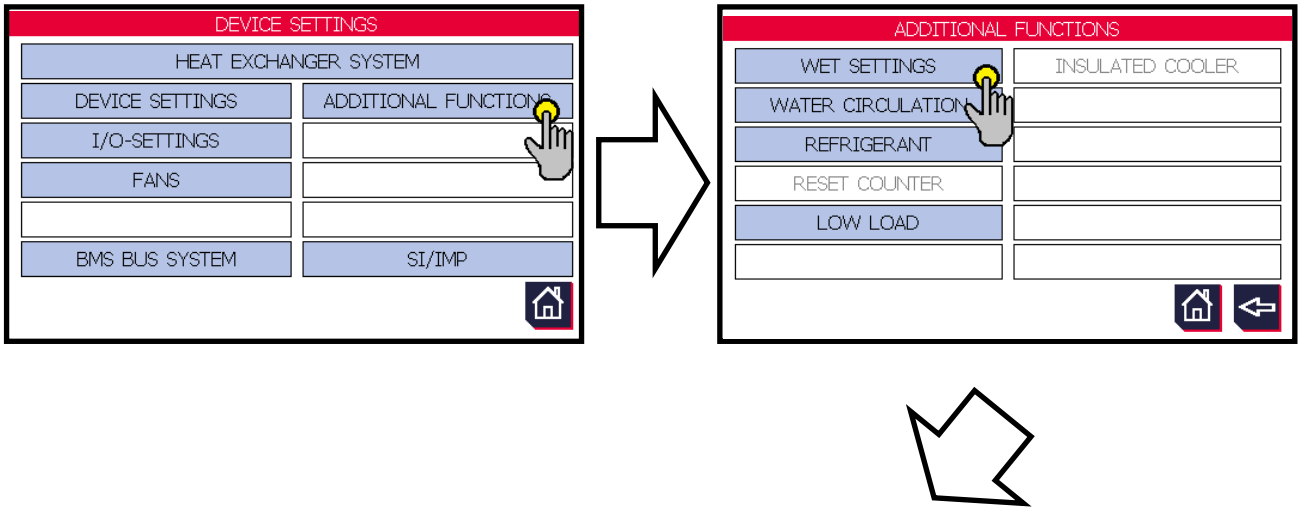
6. SPRAYED DEVICES

The thermofin® spray system on condensers or dry coolers is used to cover peak loads at high ambient temperatures. All the necessary settings on the TCS.2 are explained in the following chapter.

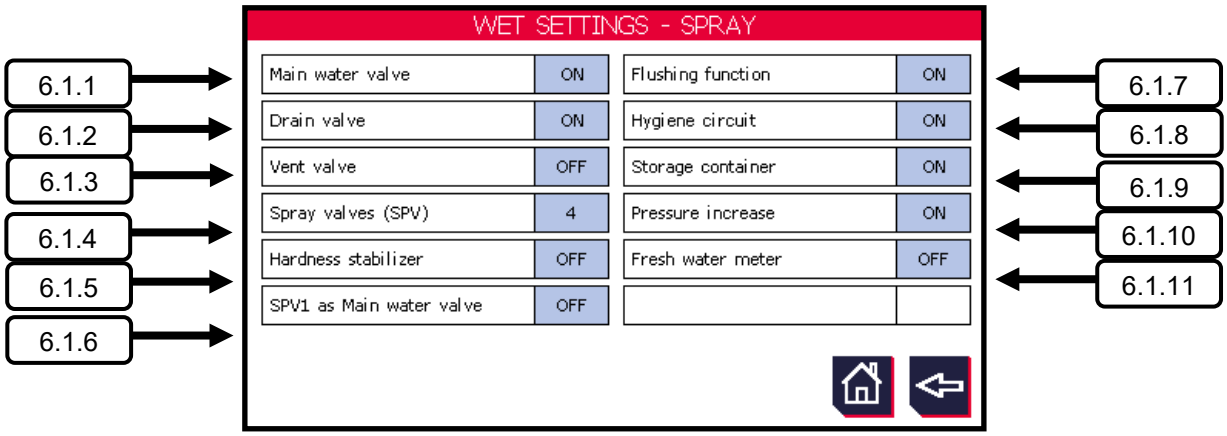
6.1 Adjustments in: Device settings → Additional functions→ Wet settings - Spray

Picture 83

Picture 84



Picture 85



6.1.1 Main water valve

Selection of a ball valve with actuator in the water supply line that is to be controlled and monitored by the TCS.2. The following requirements apply to this valve, which is usually supplied loose:

- Installation in as short a branch line as possible to avoid stagnation
- When connected to the drinking water network, the relevant standards must be observed
- Emergency position closed in the event of a power failure
- Must be installed in a frost-free area!

6.1.2 Drain valve

Selection of a ball valve with actuator that is to be controlled and monitored by the TCS.2 as a drain valve. Emptying is absolutely necessary when frost sets in and downtimes are too long (risk of legionella formation). The following requirements apply to this valve, which is usually supplied loose:

- Installation at the lowest point in the system to guarantee complete drainage of the lines
- Emergency position open in the event of a power failure

6.1.3 Vent valve

Selection of a ball valve with actuator that is to be controlled and monitored by the TCS.2 when the system is emptied (as a vent valve). Ventilation of the pipe system may be necessary because the openings on the spray valves are too small. The following requirements apply to this valve, which is usually supplied loose:

- Installation at the highest point in the system to guarantee complete drainage of the lines
- Emergency position open in the event of a power failure

6.1.4 Spray valves (SPV)

Selection of how many ball valves with actuator are to be controlled and monitored as spraying levels by the TCS.2.

Editable from … to: 1 … 4 spray valves

Factory setting: 4 spray valves

If only one spray valve is used, this can also be used as the main water valve [see chapter 6.1.6 “*Spray valve (SPV 1) as Main water valve*”].

6.1.5 Hardness stabilizer

After activating this function, the filling level of the hardness stabilizer container is monitored by the TCS.2.

6.1.6 Spray valve (SPV 1) as Main water valve

The spray valve 1 also functions as the main water valve. This option is possible when using only one spray level (valve). Any selected main water valve is automatically deselected. The following requirements apply to this valve, which is usually supplied loose:

- Installation in as short a branch line as possible to avoid stagnation
- When connected to the drinking water network, the relevant standards must be observed
- Emergency position closed in the event of a power failure
- Must be installed in a frost-free area!

6.1.7 Flushing function

The **flushing function** serves to avoid stagnation water in the branch of the water line up to the main water valve. If the spraying is out of operation, the flushing function is triggered again and again at the set time interval. The water is drained off via the drain valve. After activation, these parameters can be edited in the Main menu → Additional functions → Wet mode → Flushing function (see also chapter 6.4.7 "*Flushing function*").

6.1.8 Hygienic circuit

The **hygienic circuit** should prevent legionella formation and stagnation in the supply line of the thermofin® spray system. As soon as the adiabatic system is switched off, a counter begins to record the waiting time. When the set time is reached, the drain valve opens and the entire water line up to the main water valve is drained. The valve remains open until the device calls for water again.

After activating this function, the waiting time can be edited in the Main menu → Additional functions → Wet mode → Hygienic circuit (see also chapter 6.4.6 "*Hygienic circuit*").

6.1.9 Storage container

After activating the storage **container function**, the level of a water storage container for the spraying system is monitored via the TCS.2. The following I/Os are used for input and output:

➔ **Digital input DI-7 or DI-8** ["RM (feedback) storage container"]
After activating this function, the input must be "true", otherwise the TCS issues an error message "S06 storage container fault".
See also chapter 4.3.1 "*Digital IN basic unit*".

➔ **Digital output DO-7 or DO-8** ("Storage container requirement")
These outputs are set permanently in summer operation (winter operation deactivated). They signal a possible water requirement of the spray system.
See also chapter 4.3.2 "*Digital OUT basic unit*".

➔ **Messages via BUS**
The following status messages are output via the BUS

Register	Bit	Designation	Meaning	Register value
144	**8**	Storage container requirement	TRUE = Storage container requirement	Reading 256
145	**8**	Storage container fault	TRUE = Storage container fault	Reading 256

6.1.10 Pressure increase

After activating the **pressure increase** function, the pump(s) for the spraying system are monitored via the TCS.2. The following I/Os are used for input and output:

➔ **Digital input DI-8** ["RM (feedback) pressure increase"]
After activating this function, the input must be "true", otherwise the TCS issues an error message "S07 pressure increase fault".
See also chapter 4.3.1 "*Digital IN basic unit*".

➔ **Digital output DO-8** ("Pressure increase requirement")
This output is set as soon as a wet level (spray level) is active.
See also chapter 4.3.2 "*Digital OUT basic unit*".

➔ **Messages via BUS**
The following status messages are output via the BUS:

Register	Bit	Designation	Meaning	Register value
144	**7**	Pressure increase requirement	TRUE = Pressure increase requirement	Reading 128
145	**7**	Pressure increase fault	TRUE = Pressure increase fault	Reading 128

6.1.11 Fresh water meter

After activating the **fresh water meter** function, the pulses are counted at the corresponding digital input (1 pulse/litre) and the amount of water used is displayed by the TCS.2 in litres and m³ (see also chapter 5.3 "*Counter*"). The following inputs are used:

➔ **Digital inputs DI-6 or DI-7** ("Fresh water meter")
See also chapter 4.3.1 "*Digital IN basic unit*".
Impulse requirement: + 24 V DC ≥ 50 ms

➔ **Messages via BUS**
The following values are output via the BUS:

Register	Word	Designation	Meaning	Register value
81	**HI**	Fresh water consumption	Fresh water consumption in m³	Cubic meter
82	**LO**			

6.2 I/O valves settings

The following I/Os are used as standard for requirement or feedback from the valves:

Main valves	Variants	Basic unit		Extension	
		DI	DO	DI (CAN adr. 6)	DO (CAN adr. 20)
Main water valve	1 spray level	-	-	-	-
	2-4 spray levels	-	-	45	45
Drain valve	1 spray level	6	6	-	-
	2-4 spray levels	-	-	46	46
Vent valve	1 spray level	-	-	-	-
	2-4 spray levels	5	5	-	-

Spray valves	Variants	Basic unit		Extension	
		DI	DO	DI (CAN adr. 6)	DO (CAN adr. 20)
Spray valve 1	1 spray level	5	5	-	-
	2-4 spray levels	-	-	41	41
Spray valve 2	1 spray level	-	-	-	-
	2-4 spray levels	-	-	42	42
Spray valve 3	1 spray level	-	-	-	-
	2-4 spray levels	-	-	43	43
Spray valve 4	1 spray level	-	-	-	-
	2-4 spray levels	-	-	44	44

6.3 BUS parameter valves

Feedback via Modbus:

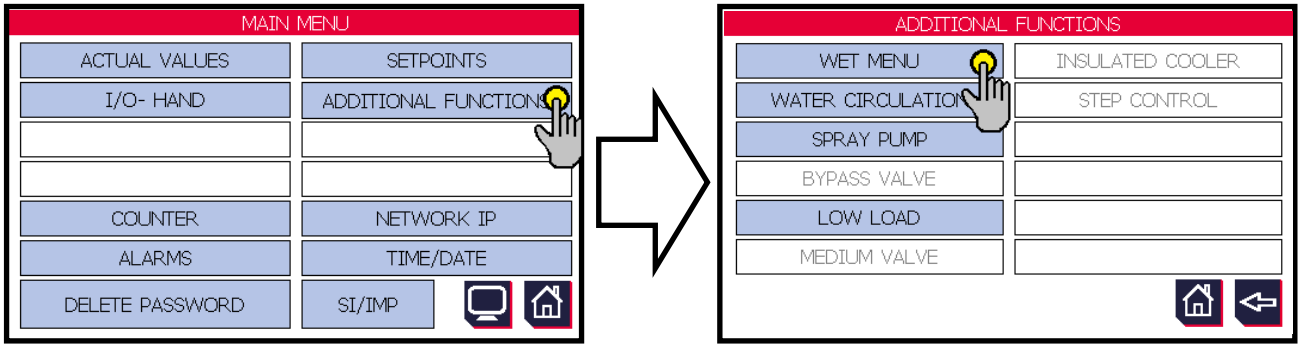
Register	Bit	Designation	Meaning	Register value
144	**0**	Main water valve open	TRUE = Main water valve open	Reading 1
145	**0**	V01 Main water valve runtime error	TRUE = Main water valve runtime error	Reading 1
144	**1**	Drain valve open	TRUE = Drain valve open	Reading 2
145	**1**	V02 Drain valve runtime error	TRUE = Drain valve runtime error	Reading 2
144	**6**	Vent valve open	TRUE = Vent valve open	Reading 64
145	**6**	V03 Vent valve runtime error	TRUE = Vent valve runtime error	Reading 64

Register	Bit	Designation	Meaning	Register value
144	**2**	Spray valve 1 open	TRUE = Spray valve 1 open	Reading 4
145	**2**	V04 Spray valve 1 runtime error	TRUE = Spray valve 1 runtime error	Reading 4
144	**3**	Spray valve 2 open	TRUE = Spray valve 2 open	Reading 8
145	**3**	V05 Spray valve 2 runtime error	TRUE = Spray valve 2 runtime error	Reading 8
144	**4**	Spray valve 3 open	TRUE = Spray valve 3 open	Reading 16
145	**4**	V06 Spray valve 3 runtime error	TRUE = Spray valve 3 runtime error	Reading 16
144	**5**	Spray valve 4 open	TRUE = Spray valve 4 open	Reading 32
145	**5**	V07 Spray valve 4 runtime error	TRUE = Spray valve 4 runtime error	Reading 32

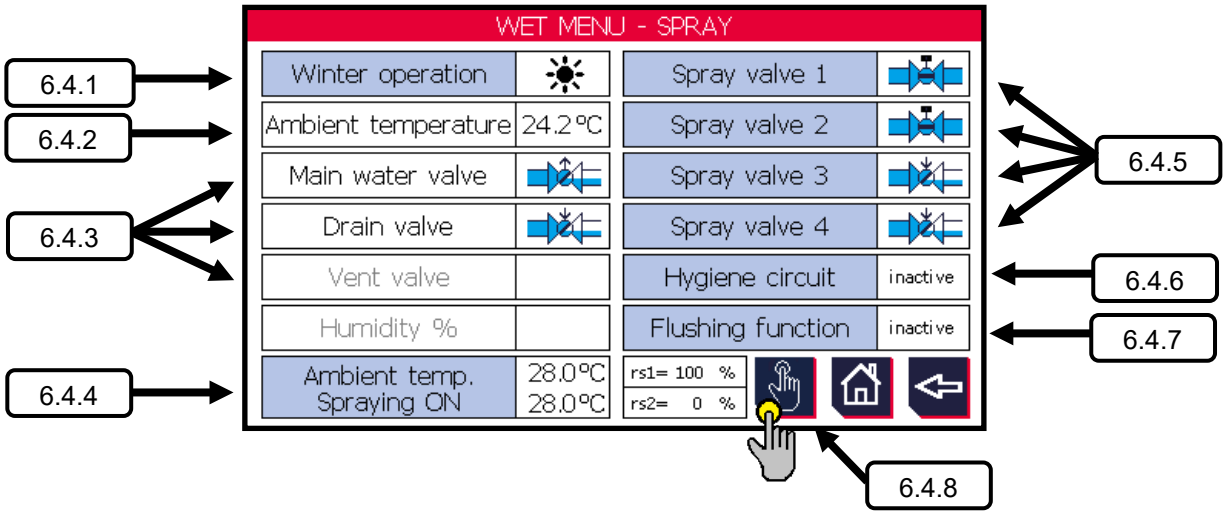
6.4 Adjustments in the Main menu → Additional functions → Wet menu Spray

Picture 86

Picture 87



Picture 88

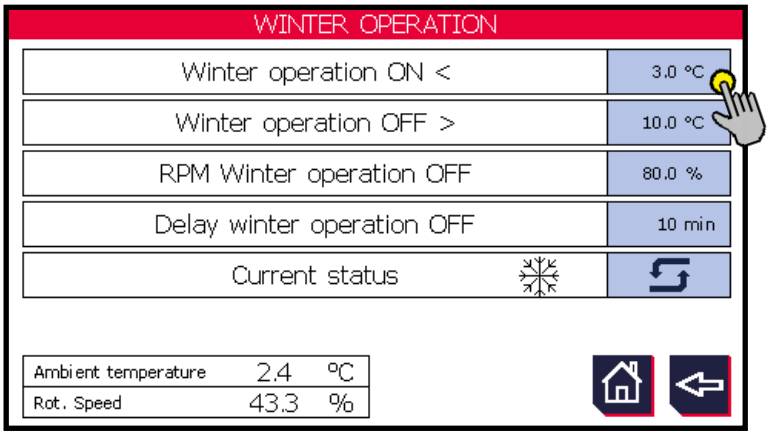


6.4.1 Winter operation/Summer operation

The **winter operation** serves to protect all water-bearing parts from frost damage. Valve positions are changed and water pipes are emptied during winter operation among other things. The use of the spray functions is not possible in winter operation. When you select the “Winter operation” menu, a submenu opens with the associated settings.

The settings can be edited by selecting the buttons with a blue background.

Picture 89



Winter operation ON <: Temperature limit from which the device switches to winter operation.

Editable from … to: 3.0 … 30.0 °C

Factory setting: 3.0 °C

Winter operation OFF >: Temperature limit from which the device switches to summer operation (winter operation deactivated). The switch-off temperature must be at least 1 °C above the switch-on temperature.

Editable from … to: 4.0 … 40.0 °C

Factory setting: 10.0 °C

RPM Winter operation OFF: Another switch-off condition that switches off winter operation from a certain speed (in %).

Editable from … to: 0 … 100 %

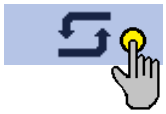
Factory setting: 80 %

Delay winter operation OFF: Defines a delay in minutes in which both the temperature (winter operation OFF >) and the “RPM Winter operation OFF” must have exceeded the set changeover limit in order to deactivate winter operation. This delay prevents winter operation from being switched on and off continuously when the changeover values are reached.

Editable from … to: 0 … 600 min

Factory setting: 10 min

Current status:   Winter or summer operation active



Allows switching between summer and winter operation using the switch symbol. This function is intended for commissioning and test purposes. If the ambient temperature falls below the lower temperature limit, it is no longer possible to switch off winter operation for safety reasons.

6.4.2 Display of ambient temperature

Currently measured ambient temperature. Useful for commissioning and adjusting the settings.

6.4.3 Display of main valves

Status display of the main valve positions. The following symbols are used as indicators in the display:

 Valve is OPEN

 Valve is CLOSED

 Valve is OPENING

 Valve is CLOSING

6.4.4 Ambient temperature Spray ON

The spraying is enabled from the ambient temperature set here. The spraying is enabled from the additional switch-on conditions for the spraying levels set here, see chapter 6.4.5 "*Spray valves*".

"Shifted" application point via BUS at which spraying is released [see following chapter 1.1.1A) "*Setpoint shift for application point spraying*"].

A) Setpoint shift for application point spraying

Possibility to adjust the application point of the spraying up and down via BUS. The previously edited value forms the start point. The "shifted" value is displayed under the edited value (see Picture 87). The following parameters apply to direct communication via Modbus:

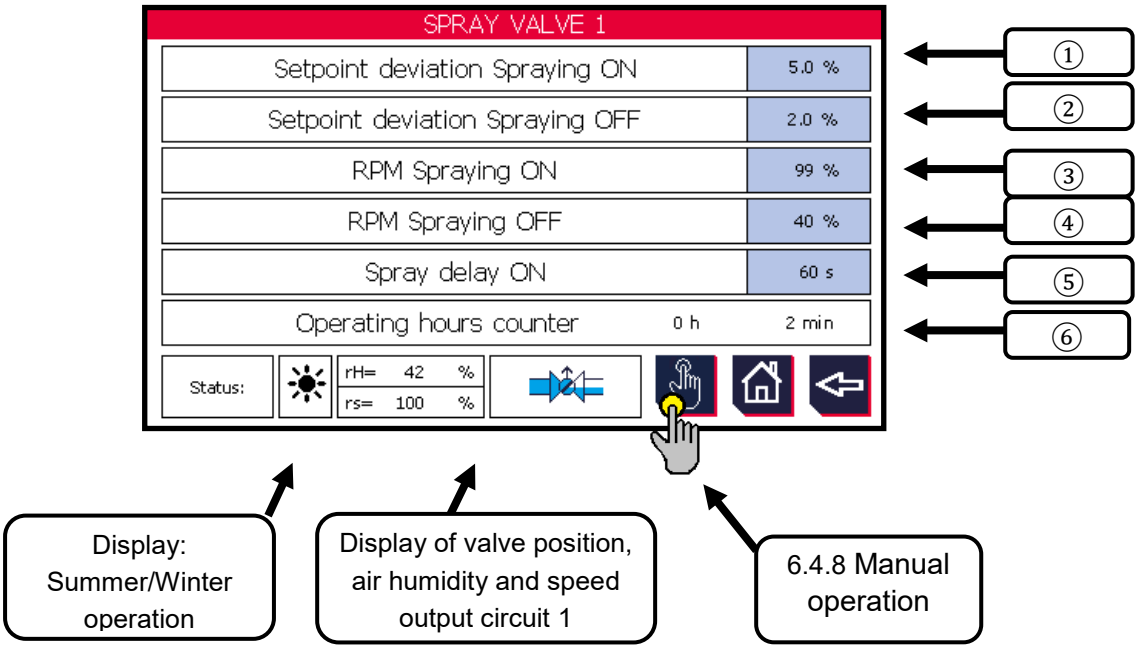
Register	Name	Register value (signed integer)	Converted to °C/°F
8	"Setpoint shift for application point wetting"	-250 ... 250	-25.0 ... 25.0 °C
		-450 ... 450	-45.0 ... 45.0 °F

6.4.5 Spray valves

The current switch-on and switch-off limits for the respective spray level are displayed in the **spray valve [No]** submenu (see Picture 89). However, the spraying is only activated if the ambient temperature limit (see 6.4.4 "*Ambient temperature Spray ON*") is exceeded. The following parameters can be edited:

The value can be edited by selecting the buttons with a blue background.

Picture 90



① **Setpoint (SP) deviation Spraying ON**

Switch-on condition for spray level [No]. This is fulfilled when the actual value is higher than the setpoint by the percentage value set here. If all switch-on conditions are met, the respective spray level switches ON.

Editable from … to: 0.0 … 20.0 %

Factory setting: 5.0 %

② **Setpoint (SP) deviation Spraying OFF**

Switch-off condition for spray level [No]. This is fulfilled when the actual value is smaller or larger than the setpoint by the percentage value set here (depending on the sign of the edited value). If all switch-off conditions are met, the respective spray level switches OFF.

Editable from … to: -20.0 … 15.0 %

Factory setting: (Level 1 … 4) 2.0 %, 2.0 %, 4.0 %, 4.0 %

③ RPM Spraying ON

Switch-on condition for spray level [No]. If the current speed setpoint exceeds the % value edited here, the startup delay (⑤) starts. If this time has expired and all other switch-on conditions are met, the spray level [no] switches ON.

Editable from … to: 80 …100 %

Factory setting: 100 %

④ RPM Spraying OFF

Switch-off condition for spray level [No]. This is fulfilled when the current speed setpoint falls below the % value edited here. If all other switch-off conditions are met, the spray level [No] switches OFF.

Editable from … to: 30 …90 %

Factory setting: 40 %

⑤ Spray delay ON

Switch-on condition for spray level [No] which defines a delay in minutes after the preconditions (① and ③) have been met. This delay prevents constant switching on and off of the respective spray level and gives the controller the necessary time to “settle in”.

Editable from … to: 1 … 600 s

Factory setting: 60 s

⑥ Operating hours counter

Display of operating hours and minutes of the respective spray level. Useful for monitoring and evaluating dry and wet operation of the system.

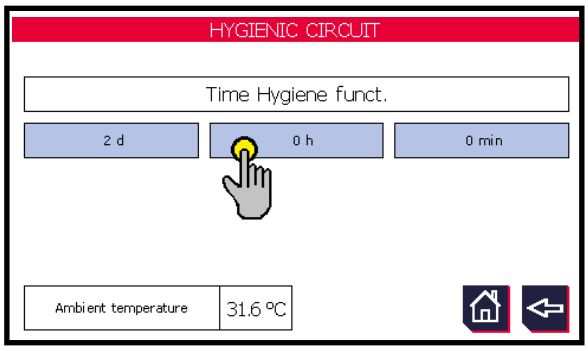
6.4.6 Hygienic circuit

The **hygienic circuit** should prevent legionella formation and stagnation in the supply line of the thermofin® spray system. As soon as the adiabatic system is switched off, a counter begins to record the waiting time. When the set time is reached, the drain valve opens and the entire water line up to the main water valve is drained. The valve remains open until the device calls for water again.

By selecting the “Hygienic circuit” button with a blue background (see Picture 90), the waiting time can be edited as follows:

	from … to	Factory setting
Day	0 … 7	2
Hour	0 … 23	0
Minute	0 …59	0

Picture 91



6.4.7 Flushing function

The **flushing function** serves to avoid stagnation water in the branch of the water line up to the main water valve. If the spraying is out of operation, the flushing function is triggered again and again at the set time interval.

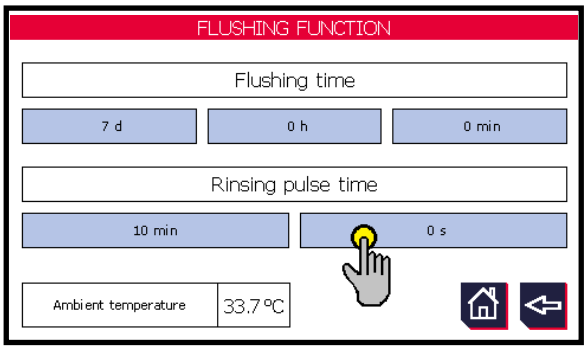
The function differentiates between the **flushing time** until the next flush is triggered and the **rinsing pulse time**. This indicates how long the main water valve remains open in order to flush the branch line.

The drain valve is first closed so that the water can also flush the lines to the device and the spray nozzles. Halfway through the rinsing pulse time, the drain valve opens. If the main water valve is closed again after the time has elapsed, the line empties itself.

Flushing time		
	from … to	**Factory setting**
Day	0 … 7	7
Hour	0 … 23	0
Minute	0 … 59	0

Rinsing pulse time		
	from … to	**Factory setting**
Minute	0 … 30	10
Second	0 … 59	0

Picture 92

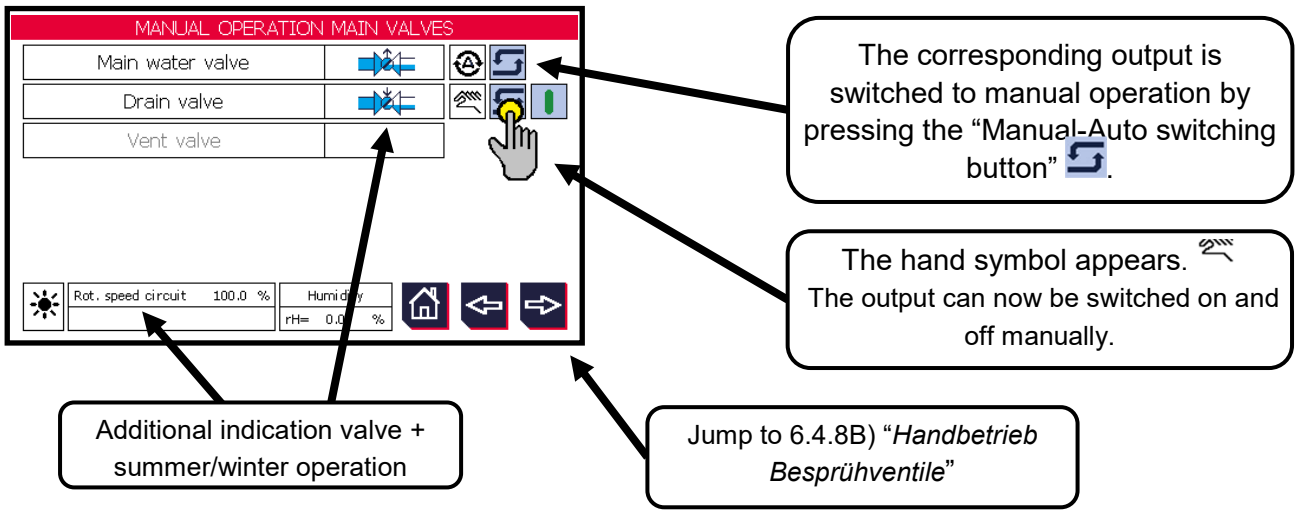


6.4.8 Manual operation

All greyed out valves in the display are not selected in the Device settings → Additional functions → Humidification.

A) Manual operation for main valves

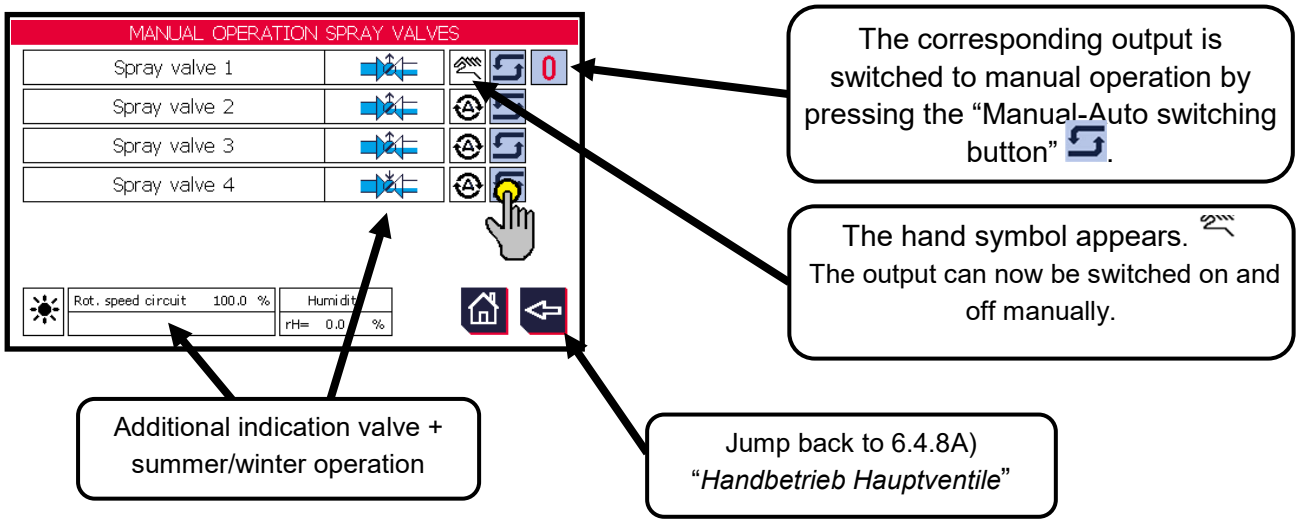
Picture 93



The corresponding output is switched back to automatic operation by pressing the "Manual-Auto switching button" again. It changes back to the state it would normally have in automatic operation.

B) Manual operation for spray valves

Picture 94



The corresponding output is switched back to automatic operation by pressing the “Manual-Auto switching button” again. It changes back to the state it would normally have in automatic operation.

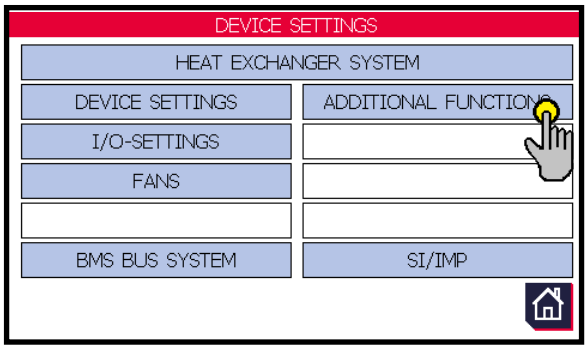
7. DEVICES WITH COOLING MATS (ADIABATIC PADS)

Devices with cooling mats (thermofin® adiabatic pads) are used to pre-cool the ambient air with the help of a wetted humidifier which is located directly in front of the lamellar tube block. The cooling mat soaks up with water. Part of the water evaporates in the air flow and cools the inlet air. The TCS.2 calculates the cooling of the air and the required amount of water. The currently required water flow is always supplied to the device via a control valve with a flow meter.

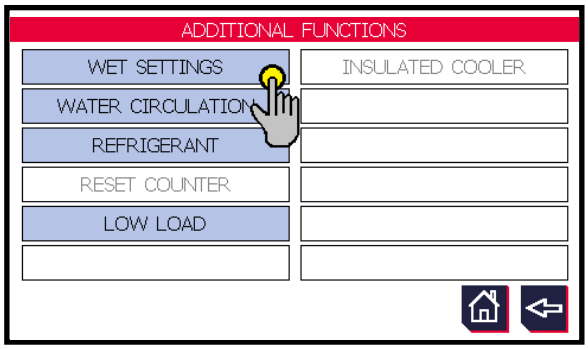
All the necessary settings on the TCS.2 are explained in the following chapter.

7.1 Adjustments in: Device settings → Additional settings→ Wet settings Mat

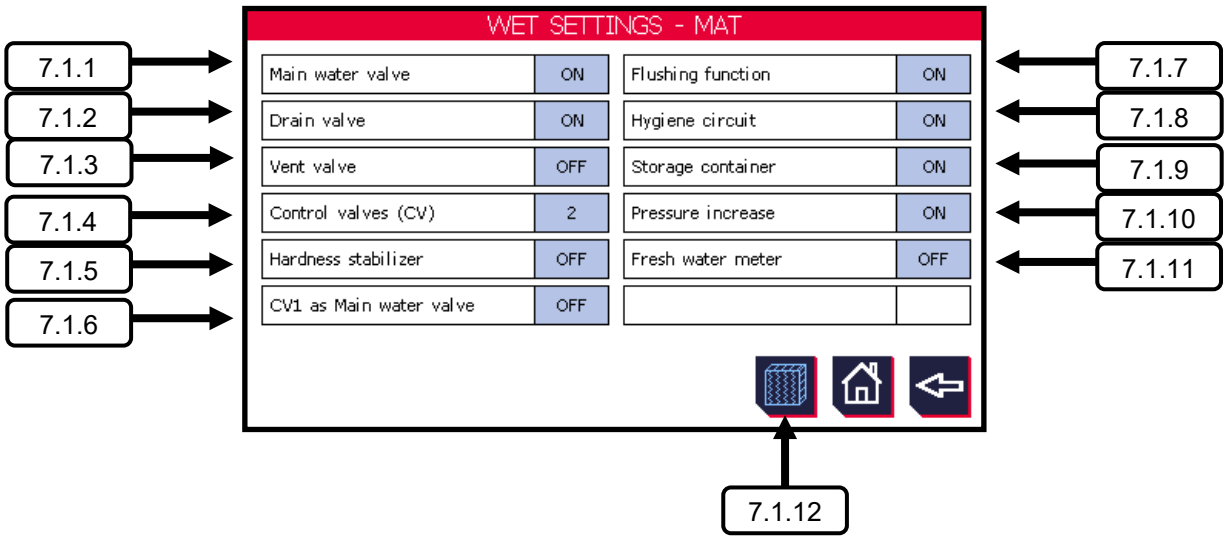
Picture 96



Picture 95



Picture 97



7.1.1 Main water valve

Selection of a ball valve with actuator in the water supply line that is to be controlled and monitored by the TCS.2. The following requirements apply to this valve, which is usually supplied loose:

- Installation in as short a branch line as possible to avoid stagnation
- When connected to the drinking water network, the relevant standards must be observed
- Emergency position closed in the event of a power failure
- Must be installed in a frost-free area!

7.1.2 Drain valve

Selection of a ball valve with actuator that is to be controlled and monitored by the TCS.2 as a drain valve. Emptying is absolutely necessary when frost sets in and downtimes are too long (risk of legionella formation). The following requirements apply to this valve, which is usually supplied loose:

- Installation at the lowest point in the system to guarantee complete drainage of the lines
- Emergency position open in the event of a power failure

7.1.3 Vent valve

Selection of a ball valve with actuator that is to be controlled and monitored by the TCS.2 as a vent valve. Ventilation of the pipe system may be necessary because the openings on the spray valves are too small. The following requirements apply to this valve, which is usually supplied loose:

- Installation at the highest point in the system to guarantee complete drainage of the lines
- Emergency position open in the event of a power failure

7.1.4 Control valves (CV)

Selection of how many control valves for mat wetting are to be controlled and monitored by the TCS.2.

Editable from … to: 1 … 2 control valves
Factory setting: 2 spray valves

If only one control valve is used, this can also be used as the main water valve [see chapter 7.1.6 "*Control valve (CV 1) as Main water valve*"].

7.1.5 Hardness stabilizer

After activating this function, the filling level of the hardness stabilizer container is monitored by the TCS.2.

7.1.6 Control valve (CV 1) as Main water valve

The control valve 1 also functions as the main water valve. This option is possible when using only one wetting level (CV). Any selected main water valve is automatically deselected. The following requirements apply to this valve, which is usually supplied loose:

- Installation in as short a branch line as possible to avoid stagnation
- When connected to the drinking water network, the relevant standards must be observed
- Emergency position closed in the event of a power failure
- Must be installed in a frost-free area!

7.1.7 Flushing function

The **flushing function** serves to avoid stagnation water in the branch of the water line up to the main water valve. If the spraying is out of operation, the flushing function is triggered again and again at the set time interval.

After activation, these parameters can be edited in the Main menu → Additional functions → Wet mode → Flushing function (see also chapter 7.4.8 "*Flushing function*").

7.1.8 Hygienic circuit

The **hygienic circuit** should prevent legionella formation and stagnation in the supply line of the thermofin® adiabatic pad system. As soon as the humidification is switched off, a counter begins to record the waiting time. When the set time is reached, the drain valve opens and the entire water line up to the main water valve is drained. The valve remains open until the device calls for water again.

After activating this function, the waiting time can be edited in the Main menu → Additional functions → Wet mode → Hygienic circuit (see also chapter 7.4.7 "*Hygienic circuit*").

7.1.9 Storage container

After activating the storage **container function**, the level of a water storage container for the wetting system is monitored via the TCS.2. The following I/Os are used for input and output:

➔ **Digital input DI-7 or DI-8** ["RM (feedback) storage container"]
After activating this function, the input must be "true", otherwise the TCS issues an error message "S06 storage container fault".
See also chapter 4.3.1 "*Digital IN basic unit*".

➔ **Digital output DO-7 or DO-8** ("Storage container requirement")
These outputs are set permanently in summer operation (winter operation deactivated). They signal a possible water requirement of the wetting system.
See also chapter 4.3.2 "*Digital OUT basic unit*".

➔ **Messages via BUS**
The following status messages are output via the BUS:

Register	Bit	Designation	Meaning	Register value
144	**8**	Storage container requirement	TRUE = Storage container requirement	Reading 256
145	**8**	Storage container fault	TRUE = Storage container fault	Reading 256

7.1.10 Pressure increase

After activating the **pressure increase** function, the pump(s) for the wetting system are monitored via the TCS.2. The following I/Os are used for input and output:

➔ **Digital input DI-8** ["RM (feedback) pressure increase"]
After activating this function, the input must be "true", otherwise the TCS issues an error message "S07 pressure increase fault".
See also chapter 4.3.1 "*Digital IN basic unit*".

➔ **Digital output DO-8** ("Pressure increase requirement")
This output is set as soon as a wet level (wetting level) is active.
See also chapter 4.3.2 "*Digital OUT basic unit*".

➔ **Messages via BUS**
The following status messages are output via the BUS:

Register	Bit	Designation	Meaning	Register value
144	**7**	Pressure increase requirement	TRUE = Pressure increase requirement	Reading 128
145	**7**	Pressure increase fault	TRUE = Pressure increase fault	Reading 128

7.1.11 Fresh water meter

After activating the **fresh water meter** function, the pulses are counted at the corresponding digital input (1 pulse/litre) and the amount of water used is displayed by the TCS.2 in litres and m³ (see also chapter 5.3 "*Counter*"). The following inputs are used:

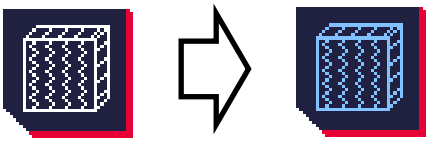
➔ **Digital input DI-6 or DI-7** ("Fresh water meter")
See also chapter 4.3.1 "*Digital IN basic unit*".
Impulse requirement: + 24 V DC ≥ 50 ms

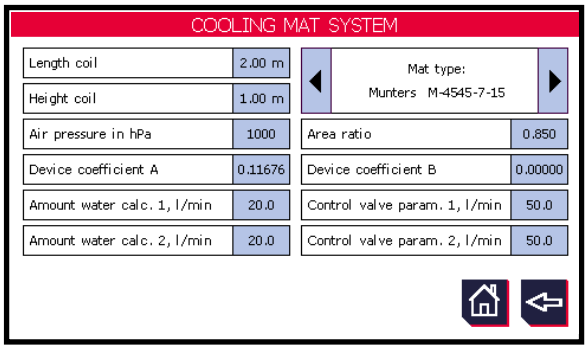
➔ **Messages via BUS**
The following values are output via the BUS:

Register	Word	Designation	Meaning	Register value
81	**HI**	Fresh water consumption	Fresh water consumption in m³	Cubic meter
82	**LO**			

7.1.12 Cooling mat system

The user can access the **cooling mat system** submenu by pressing the mat symbol (see Picture 96). If the main water valve is open, the symbol is highlighted in light blue. It thus shows whether the adiabatic mats are in operation.





Under **cooling mat system**, parameters of the device can be set that the TCS needs to correctly calculate the amount of water and the switching points. The **mat type** is selected on the right. The dimensions of the block and the air pressure at the installation site are entered in hPa on the left. The area ratio corrects the ratio of the block area to the mat area. The **device coefficients** are used to calculate the air volume. **Amount of water calc.** denotes the required water flow at the design point. **Amount of water max.** is the maximum possible flow rate to which the control valve is parametrized at the factory.

7.2 I/O valves settings

The following I/Os are used as standard for requirement or feedback from the valves:

Designation	Variants	Basic unit		Extension	
		DI	DO	DI (CAN adr. 6)	DO (CAN adr. 20)
Main water valve	1 control valve	-	-	-	-
	2 control valves	-	-	45	45
Drain valve	1 control valve	6	6	-	-
	2 control valves	-	-	46	46
Vent valve	1 control valve	-	-	-	-
	2 control valves	5	5	-	-

When using the KSM 730.29 extension module (CAN address 30):

Designation	Variants	Basic unit		Extension CAN adr. 30	
		AI	AO	AI	AO
Control valve 1	with 1 control valve	4	2	-	-
	with 2 control valves	-	-	5	3
Control valve 2	with 2 control valves	-	-	6	4
Air humidity	with 1 control valve	3	-	-	-
	with 2 control valves	-	-	7	-
Ambient temperature	with 1 control valve	2	-	-	-
	with 2 control valves	-	-	8	-

When using the AKM 730.10 extension module (optionally selectable CAN address 31):

Designation	Variants	Basic unit		Extension CAN adr. 31	
		AI	AO	AI	AO
Control valve 1	with 1 control valve	4	2	11	7
	with 2 control valves	4	2	11	7
Control valve 2	with 2 control valves	-	-	12	8
Air humidity	with 1 control valve	3	-	13	-
	with 2 control valves	3	-	13	-
Ambient temperature	with 1 control valve	2	-	-	-
	with 2 control valves	2	-	8	-

7.3 BUS parameter valves

Feedback via Modbus:

Register	Bit	Designation	Meaning	Register value
144	**0**	Main water valve open	TRUE = Main water valve open	Reading 1
145	**0**	V01 Main water valve runtime error	TRUE = Main water valve runtime error	Reading 1
144	**1**	Drain valve open	TRUE = Drain valve open	Reading 2
145	**1**	V02 Drain valve runtime error	TRUE = Drain valve runtime error	Reading 2
144	**6**	Vent valve open	TRUE = Vent valve open	Reading 64
145	**6**	V03 Vent valve runtime error	TRUE = Vent valve runtime error	Reading 64

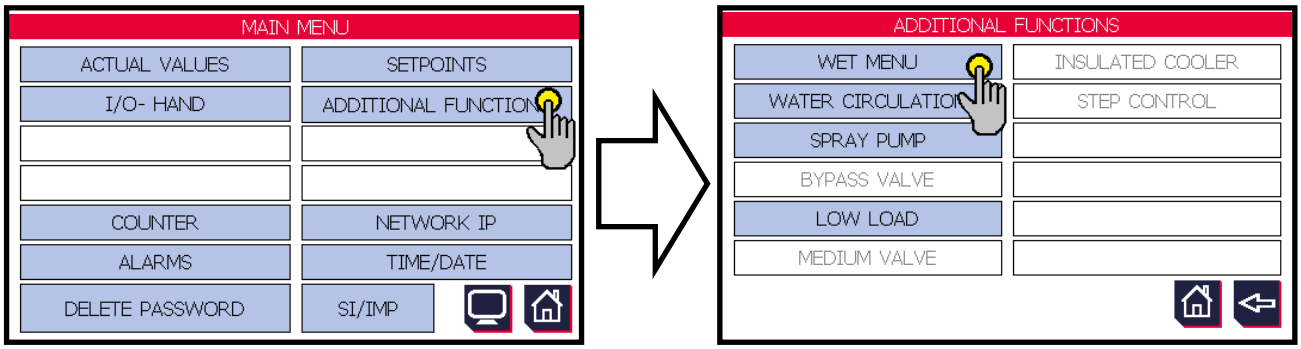
Register	Bit	Designation	Meaning	Register value/type	Output
10	**-**	Control valve 1	Control valve control value circuit 1	INT 0 … 1000	Writing 0.0 … 100.0 %
91	**-**		Setpoint	WORD	Reading 0 … 100%
92	**-**		Actual value	WORD	Reading 0 … 100 %
145	**9**	V09 Control valve 1 Position error	TRUE = Control valve adiab. pads, position error circuit 1	Reading 512	-
152	**0**	V08 Control valve 1 wire break	TRUE = Control valve adiab. pads, wire break circuit 1	Reading 1	-
11	**-**	Control valve 2	Control valve control value circuit 2	INT 0 … 1000	Writing 0.0 … 100.0 %
93	**-**		Setpoint	WORD	Reading 0 … 100 %
94	**-**		Actual value	WORD	Reading 0 … 100 %
145	**10**	V09 Control valve 2 Position error	TRUE = Control valve adiab. pads, position error circuit 2	Reading 1024	-
152	**1**	V08 Control valve 2 wire break	TRUE = Control valve adiab. pads, wire break circuit 2	Reading 2	-

7.4 Adjustments in Main menu → Additional functions → Wet menu Mat

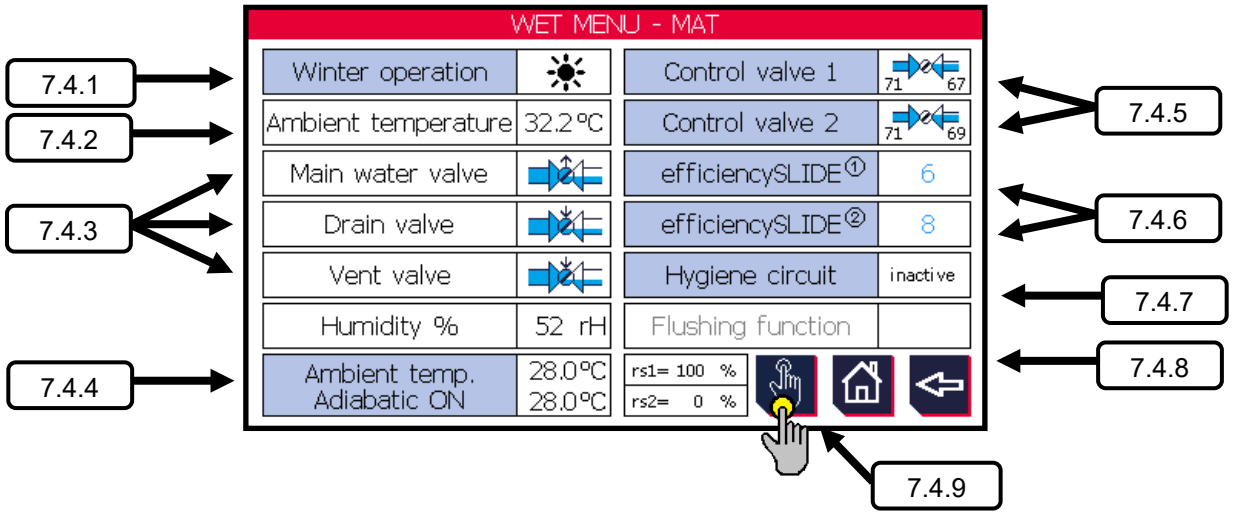
The **wet mode** submenu is available for settings. It is protected with the user parameter password [see also chapter 2.4.3 “User parameter password (editable)”].

Picture 98

Picture 99



Picture 100



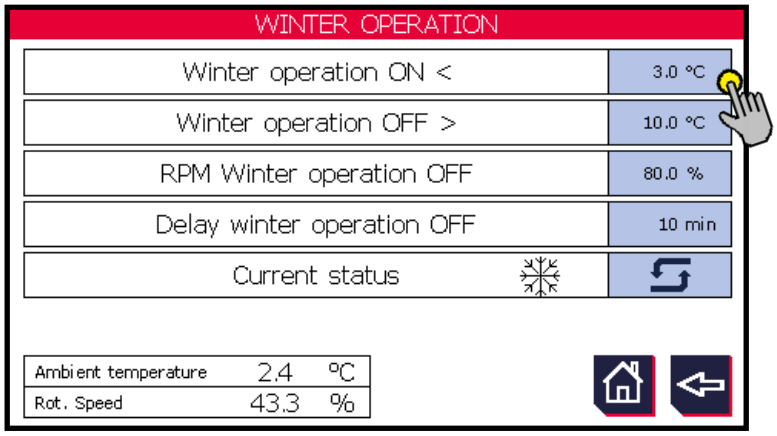
Greyed out functions are not activated or selected in the device settings.

7.4.1 Winter operation / Summer operation

The **winter operation** serves to protect all water-bearing parts from frost damage. Valve positions are changed and water pipes are emptied during winter operation among other things. The use of the humidification functions is not possible in winter operation. When you select the “Winter operation” menu, a submenu opens with the associated settings.

The settings can be edited by selecting the buttons with a blue background.

Picture 101



Winter operation ON <: Temperature limit from which the device switches to winter operation.

Editable from … to: 3.0 … 30.0 °C

Factory setting: 3.0 °C

Winter operation OFF >: Temperature limit from which the device switches to summer operation (winter operation deactivated). The switch-off temperature must be at least 1 °C above the switch-on temperature.

Editable from … to: 4.0 … 40.0 °C

Factory setting: 10.0 °C

RPM Winter operation OFF: Another switch-off condition that switches off winter operation from a certain speed (in %).

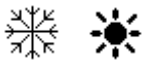
Editable from … to: 0 … 100 %

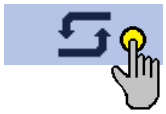
Factory setting: 80 %

Delay winter operation OFF: defines a delay in minutes in which both the temperature (winter operation OFF >) and the “RPM Winter operation OFF” must have exceeded the set changeover limit in order to deactivate winter operation. This delay prevents winter operation from being switched on and off continuously when the changeover values are reached.

Editable from … to: 0 … 600 min

Factory setting: 10 min

Current status:  Winter or summer operation active



Allows switching between summer and winter operation using the switch symbol. This function is intended for commissioning and test purposes. If the ambient temperature falls below the lower temperature limit, it is no longer possible to switch off winter operation for safety reasons.

7.4.2 Display of ambient temperature

Currently measured ambient temperature. Useful for commissioning and adjusting the settings.

7.4.3 Display of main valves

Status display of the main valve positions. The following symbols are used as indicators in the display:

 Valve is **OPEN**

 Valve is **CLOSED**

 Valve is **OPENING**

 Valve is **CLOSING**

7.4.4 Ambient temperature adiabatic ON

Picture 102

The adiabatic is enabled from the ambient temperature set here. For further switch-on conditions for humidification, see chapter 7.4.5 "*Control valve 1 / 2*".

"Shifted" application point via BUS at which adiabatic is released [see following chapter 1.1.1A) "*Setpoint shift for application point adiabatic*"].

A) Setpoint shift for application point adiabatic

Possibility to adjust the application point of the humidification up and down via BUS. The previously edited value forms the start point. The "shifted" value is displayed under the edited value (see Picture 101). The following parameters apply to direct communication via Modbus:

Register	Name	Register value (signed integer)	Converted to °C/°F
8	"Setpoint shift for application point wetting"	-250 ... 250	-25.0 ... 25.0 °C
		-450 ... 450	-45.0 ... 45.0 °F

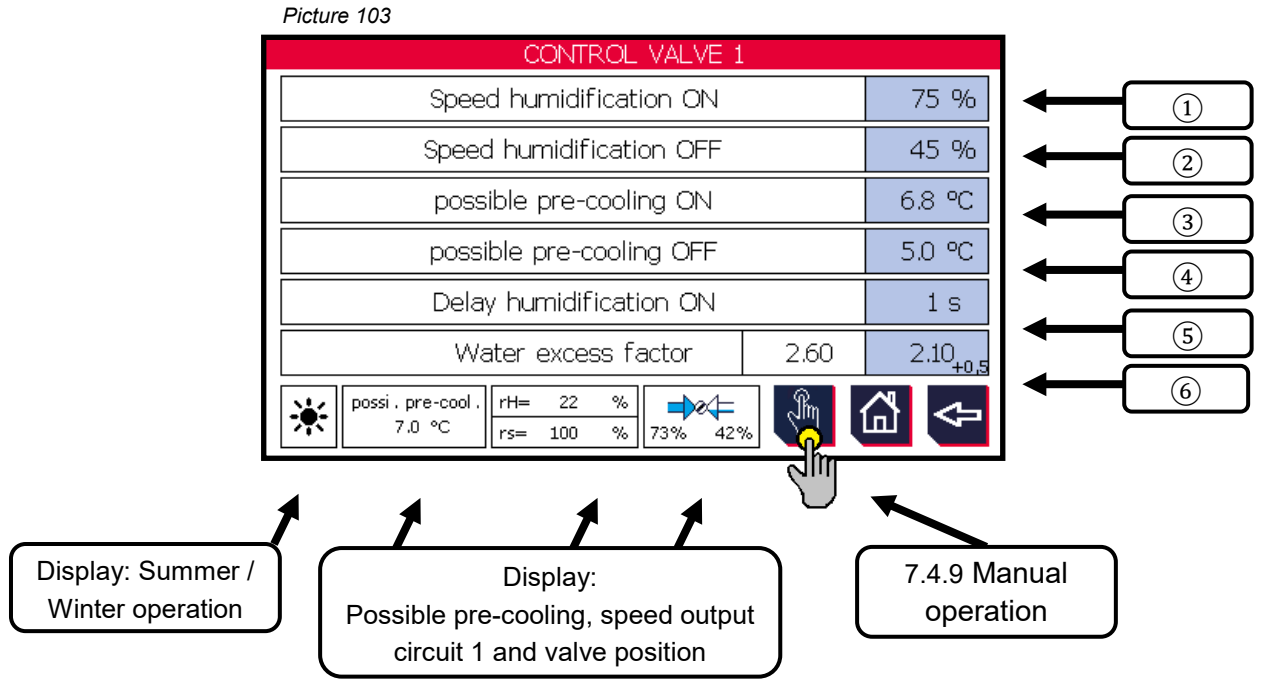
7.4.5 Control valve 1 / 2

The current switch-on and switch-off limits of the adiabatic function are displayed in the **control valve menu [No]**. However, the adiabatic is only activated if the ambient temperature limit is exceeded at the same time (see 7.4.4. "*Ambient temperature adiabatic ON*"). The menu is closely linked to the **efficiencySLIDE** menu, with the **efficiencySLIDE** is at the higher level.

The switch-on and switch-off limits are determined by the speed and the possible air pre-cooling. They are dependent on each other in a ratio that can be set in the "efficiencySLIDE" submenu. As a result, all main settings must be made there (see 7.4.6 "*efficiencySLIDE*"). The position of the **efficiencySLIDE** is displayed in the mat menu (see Picture 99).

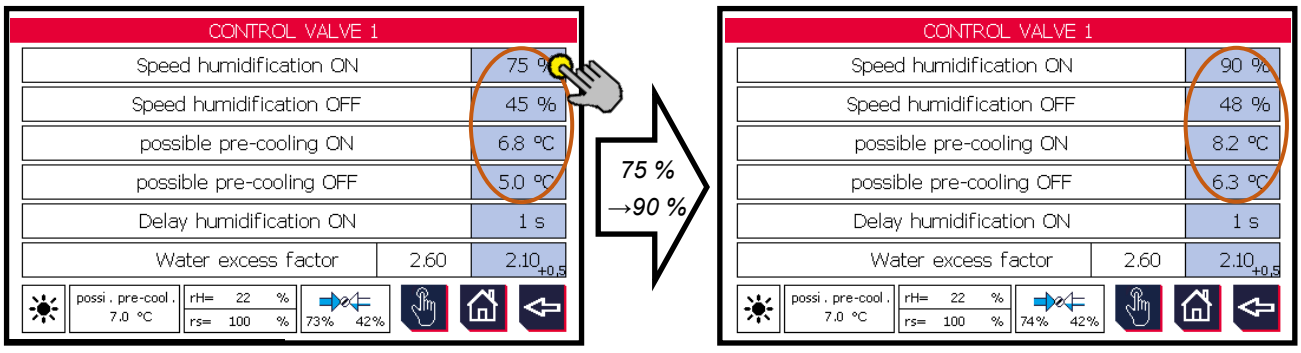
If the user changes one of the four switching limits for adiabatic mode in the **Control valve** menu, all other values change automatically. The **efficiencySLIDE** is thus shifted indirectly. A change in the switch-on speed of the adiabatic shifts, for example, all other switching limits (see Picture 103 and Picture 104).

Picture 103



Picture 104

Picture 105



① Speed humidification ON

Switch-on condition for humidification level [No]. If the current speed setpoint exceeds the % value edited here, the startup delay (⑤) starts. If this time has expired and all other switch-on conditions are met, the humidification level [no] switches ON.

Editable from … to: 65 …100 %

Factory setting: 99 %

② Speed humidification OFF

Switch-off condition for humidification level [No]. This is fulfilled when the current speed setpoint falls below the % value edited here. If all other switch-off conditions are met, the humidification level [No] switches OFF.

Editable from … to: 40 …50 %

Factory setting: 50 %

③ possible pre-cooling ON

Switch-on condition for humidification level [No]. With the help of the ambient conditions (air pressure, air humidity, temperature) and the device capacity, a **possible pre-cooling** of the sucked air is calculated internally in °C when the mat is moist. If this exceeds the value edited here, the startup delay (⑤) starts. If this time has expired and all other switch-on conditions are met the humidification level [no] switches ON.

Editable from … to: depending on the setting in “efficiencySLIDE”

Factory setting: 0 °C

④ possible pre-cooling OFF

Switch-off condition for humidification level [No]. With the help of the ambient conditions (air pressure, air humidity, temperature) and the device capacity, a **possible pre-cooling** of the sucked air is calculated internally in °C when the mat is moist. If this falls below the value edited here and all other switch-off conditions are met, the humidification level [No] switches OFF.

Editable from … to: depending on the setting in efficiencySLIDE”

Factory setting: 0 °C

⑤ Delay humidification ON

Switch-on condition for spray level [No] which defines a delay in minutes after the preconditions (① and ③) have been met. This delay prevents constant switching on and off of the respective spray level and gives the controller the necessary time to “settle in”.

Editable from … to: 1 … 600 s

Factory setting: 60 s

⑥ Water excess factor

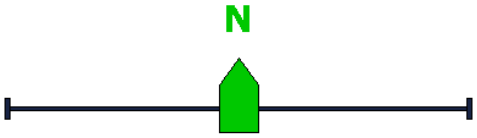
Specifies the value by which the required amount of evaporation water is multiplied. This is necessary to guarantee the long-term moistening of the mats and to limit the risk of deposits and soiling due to drying out. The factor can be edited in the range 1.0 to 3.0.

If the adiabatic system is activated, it needs more water in the startup phase as the paper mats first have to soak up. Therefore, the excess water is set to 2.5 in the first 30 minutes. If the excess is generally over 2.5, it remains unchanged.

7.4.6 efficiencySLIDE

The **efficiencySLIDE** generally regulates how often and how long the adiabatic system is used during the year. In the **water-saving** position, the adiabatic is only activated in case of peak load, when the fan speed limit is reached. With **energy-saving** operation, the adiabatic switches on earlier and is also active longer and more often. The slide can be moved anywhere between these points. Its colour indicates the mode of operation and a numerical value (0-10) indicates the position. The position of the slide is also shown in the **Mat menu** (7.4).

Precise pre-setting of the switch-on and switch-off limits and the ratio (speed - possible pre-cooling) in the efficiencySLIDE settings is of great importance in order to use the slide effectively!

Mode of operation	Display in efficiencySLIDE menu	Display in mat menu
energy-saving		
neutral		
water-saving		

efficiencySLIDE settings: definition of the switching limits for the energy- and water-saving modes of operation.

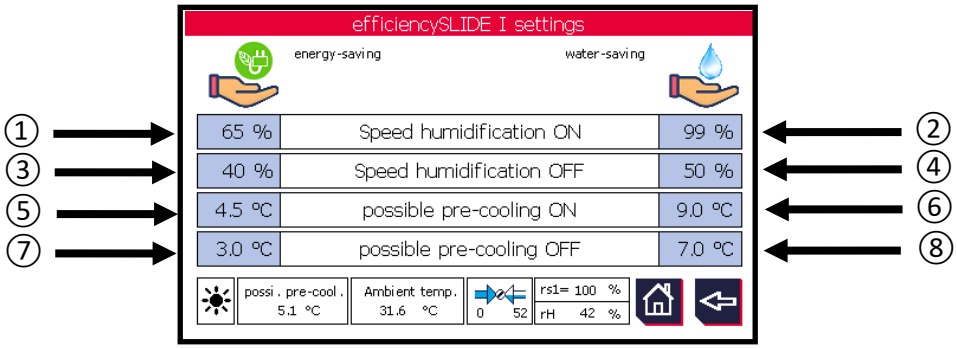
In general, there are two ways to switch the adiabatic on and off automatically.

➔ The adiabatic is switched on and off using the **speed controller** (depending on the capacity of the device). This criterion does not ask whether it makes sense to humidify the mat at this point in time and whether it causes the air to cool.

➔ Based on the **possible pre-cooling** of the air. The TCS.2 calculates this using the ambient temperature, the air pressure, the relative humidity and the current volume flow. In this way, for example, when the air humidity is very high, the adiabatic is only switched on relatively late or not at all, as this would cause little or no cooling of the air.

Both switching limits can also be combined. Careful commissioning and control of the mode of operation is imperative in order to ensure environmentally friendly operation (saving energy and water).

Picture 106



The switch-off limits cannot generally be higher than the switch-on limits and the limits in energy-saving mode cannot be set greater than those in water-saving mode.

Setting range of speed limits (%):

① energy-saving 30 to 55 % **Speed humidification ON** ② water-saving: 70 to 100 %
③ energy-saving 20 to ①-5 % **Speed humidification OFF** ④ water-saving: 50 to ②-5 %

When controlling the speed, make sure that the switch-off limit is well below the switch-on limit. By pre-cooling the air, the required air flow is reduced which reduces the speed of the fan. If the switch-off limit has already been reached during this process, the adiabatic system switches off again and the control oscillates.

Setting range limits of air pre-cooling (°C):

⑤ energy-saving: 0.0 to ⑥ **possible pre-cooling ON** ⑥ water-saving: 0.0 to 20.0
⑦ energy-saving: 0.0 to ⑤ **possible pre-cooling OFF** ⑧ water-saving: 0.0 to ⑥

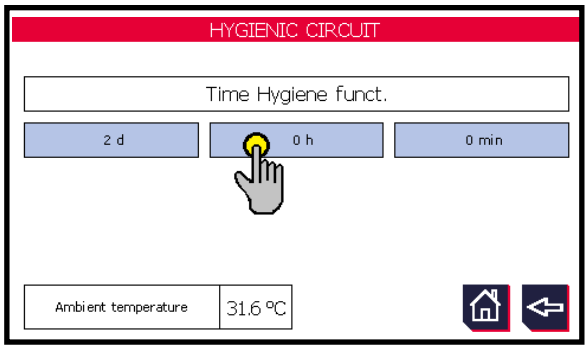
7.4.7 Hygienic circuit

The **hygienic circuit** should prevent legionella formation and stagnation in the supply line of the thermofin® humidification system. As soon as the adiabatic system is switched off, a counter begins to record the waiting time. When the set time is reached, the drain valve opens and the entire water line up to the main water valve is drained. The valve remains open until the device calls for water again.

By selecting the “Hygienic circuit” button with a blue background (see Picture 106), the waiting time can be edited as follows:

	from … to	Factory setting
Day	0 … 7	2
Hour	0 … 23	0
Minute	0 …59	0

Picture 107



7.4.8 Flushing function

The **flushing function** serves to avoid stagnation water in the branch of the water line up to the main water valve. If the humidification is out of operation, the flushing function is triggered again and again at the set time interval.

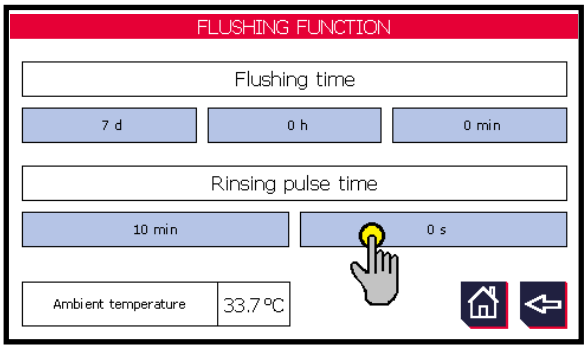
The function differentiates between the **flushing time** until the next flush is triggered and the **rinsing pulse time**. This indicates how long the main water valve remains open in order to flush the branch line.

The drain valve is first closed so that the water can also flush the lines to the device and to the water outlet. Halfway through the rinsing pulse time, the drain valve opens. If the main water valve is closed again after the time has elapsed, the line empties itself.

Flushing time		
	from … to	**Factory setting**
Day	0 … 7	7
Hour	0 … 23	0
Minute	0 …59	0

Rinsing pulse time		
	from … to	**Factory setting**
Minute	0 …30	10
Second	0 …59	0

Picture 108

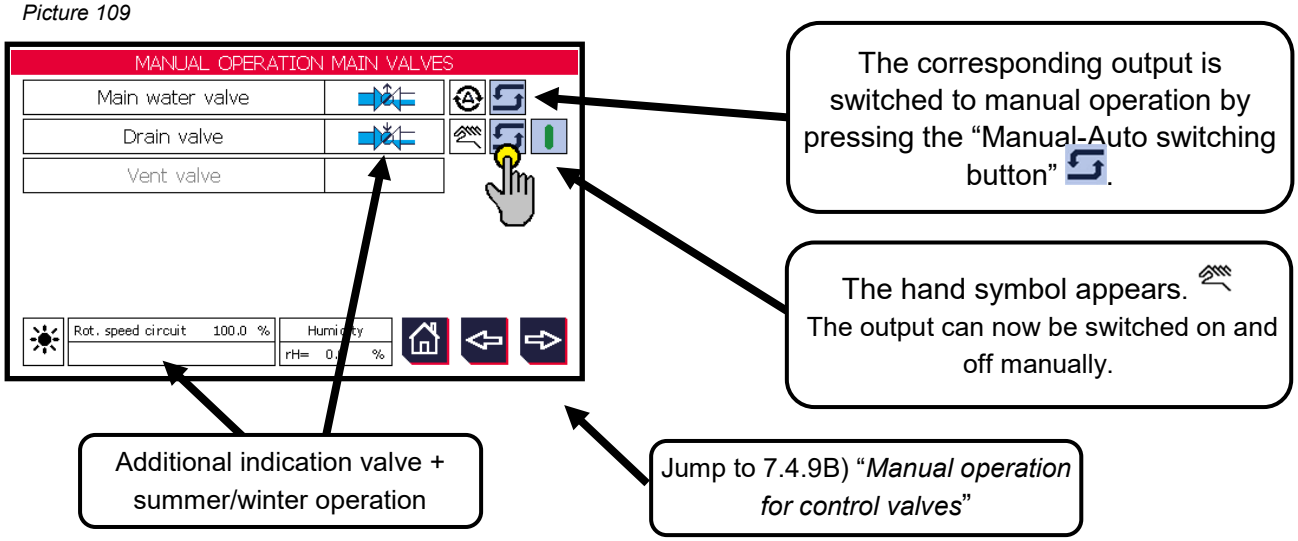


7.4.9 Manual operation

All greyed out valves in the display are not selected in the Device settings → Additional functions → Humidification.

A) Manual operation for main valves

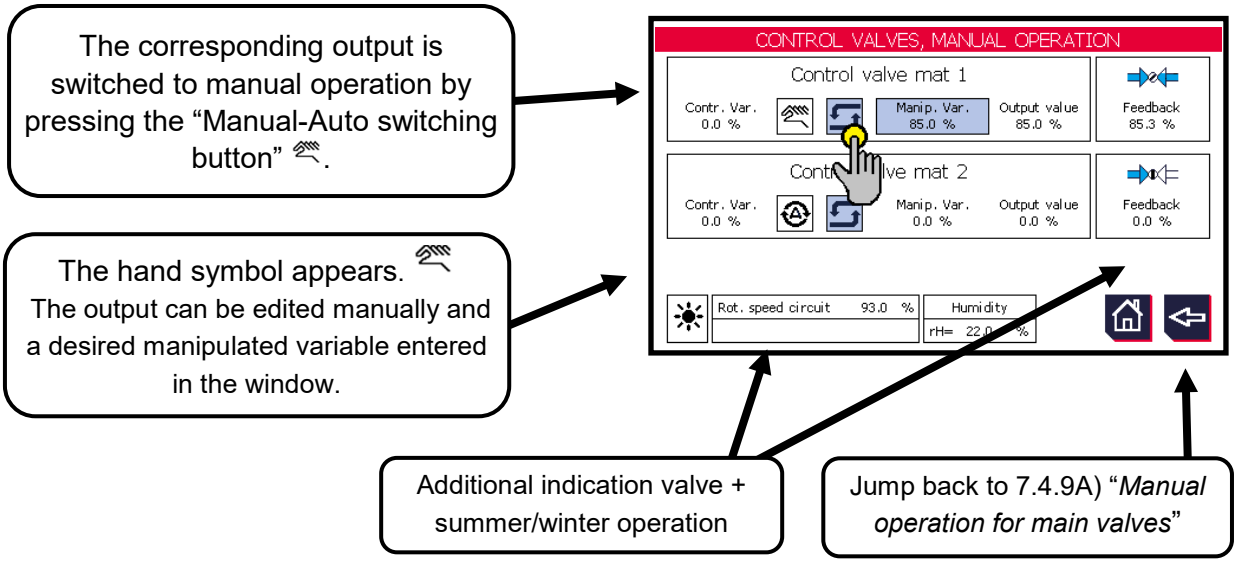
Picture 109



The corresponding output is switched back to automatic operation by pressing the "Manual-Auto switching button" again. It changes back to the state it would normally have in automatic operation.

B) Manual operation for control valves

Picture 110



The corresponding valve is switched back to automatic operation by pressing the “Manual-Auto switching button” again. The manipulated variable takes over the value of the controlled variable.

8. HYBRID COOLER

8.1 Adjustments in Device settings → Additional functions → Humidification system

Description follows

8.2 Adjustments in Main menu → Additional functions → Wet mode

Description follows …

9. INSULATING / PENTHOUSE COOLER

9.1 Adjustments in Device settings → Additional functions → Humidification system

Description follows …

9.2 Adjustments in Main menu → Additional functions → Wet mode

10. MESSAGES, WARNING AND ALARMS

All messages are divided into the following areas:

Error code	Category
C…	CAN module messages
F… (Fan)	Fan messages
K…	Flaps (K = Klappen) messages
M…	Measured values messages
S…	Signals external messages
V…	Valve messages

Type: W = Warning, A = Alarm, see chapter 5.4 “*Alarms*”

10.1 CAN module messages – Error code C...

		English	English	English		
Error code	Type	Error text	Error explanation	Error remedy	MODBUS	
					Reg.	Bit
C01	W	CAN module [no.]	Communication to the respective CAN - I/O extension is interrupted.	- Check the power supply of the extension module - Check the wiring of the CAN bus - Check terminal points - Check the set CAN address (see also device manual, chapter 5.1.3 "Setting the CAN address")	154 to 156	
C02						
C03						
C04						
C05						
C06						
C07						
C08						
C09						
C10						

10.2 Fan messages – Error code F...

		English	English	English		
Error code		Error text	Error explanation	Error remedy	MODBUS	
					Reg.	Bit
F01	W*	Fan / group [no.]	- General failure of a fan or a fan group which was reported via a digital input. - Logical high (+24 V DC) = fan OK - Logical low (0 R20T11V) = fan failure - Typically these inputs are connected to thermal contacts of the fans / groups, motor protection switch H1 or fault message outputs from frequency converters (see also chapter 5.4.1 Fan operating data / status)	- Check whether the signal is coming at the input - If yes - digital input defective (please contact the manufacturer) - If no - check the connected thermal contact, motor protection switch or other - Check sensor line / wiring - Check terminal points	142 143	
F02	W*	Fan [no.]	- General fan failure which was reported via the BUS - A detailed description of the error can be found in the submenu "MODBUS fan status" - See also chapter 5.4.1 Fan operating data / status	- Please follow the instructions in the detailed error description from the MODBUS fan status	168 169	
F03	W*	Phase failure	- At least one phase failed (with 3~ devices) - Mains undervoltage with 1~ devices	- Check whether all required phases are present on the device - Replace defective fuses - Eliminate cause of short circuit (defective fan ...)	130	0
F04	W*	Ground-to-earth fault	- Defective motor winding - Cable squeezed - Defective cable jacket on the housing - Water penetration into the fan	- Check wiring - Check terminal points - Replace the fan (please contact the manufacturer)		
F05	W*	Output level overheated	- Too high ambient temperature - Ball bearings are firm - Rotor unbalance - Electronics housing dirty	- Observe the manufacturer's operating and environmental conditions - Improve cooling - Manual reset required	130	2
F06	W*	Communication error	- Internal communication error between the microcontrollers in the fan	- Switch off the mains voltage - Wait - Switch on again	130	3
F07	W*	Fan collective failure	- General fan error sent via MODBUS	- Observe further status messages	130	4

F08	W*	Motor overheated	- Too high ambient temperature - Ball bearings are firm - Rotor unbalance - Rotor is blocked - Electronics defective	- Observe the manufacturer's operating and environmental conditions - Let the motor cool down after eliminating the cause - Lower the ambient temperature - Correct the operating point - Manual reset required	130	5
F09	W*	Hall sensor defective	- A speed or position detection required for the operation of the EC fan is faulty or defective	- Switch off the mains voltage - Wait - Switch on again - Replace the fan (please contact the manufacturer)	130	6
F10	W*	Motor is blocked	- Fan blades iced up - Other impurities prevent the fan from starting	- Switch off, make voltage-free + check - Eliminate the cause of the motor blocking - Check the fan blades for possible errors - Balance the rotor if necessary	130	7
F11	W*	Limit speed exceeded	- Exceeding a fixed, maximum speed	- Check set parameters - Parametrize again if necessary	130	8
F12	W*	Overcurrent / overload peak, I^2T	- The actual motor current or the motor current calculated over time is too high - If a defined limit value is exceeded, the system switches off	- Reduce the volume flow - Reduce the speed - Clean the rotor - Change defective bearings if necessary		
F13	W*	Calibration error of rotor position sensor	- Incorrect initialization	- An automatic restart follows	130	10
F14	W*	Intermediate circuit overvoltage	- The intermediate circuit voltage has risen above a specified value - Input voltage is too high - Braking too quickly (generating operation)	- Check the power supply - Extend the ramp times	130	12
F15	W*	Intermediate circuit undervoltage	- The intermediate circuit voltage has fallen below a specified value	- Mains phase missing - Check the power supply		
F16	W*	Mains overvoltage	- Mains voltage is too high	- Check the applied mains voltage		
F17	W*	Mains undervoltage	- Mains voltage is too low	- Check the applied mains voltage		
F18	W*	Communication interrupted	- No communication between TCS.2 and fan possible	- Check the wiring of the communication bus - Check terminal points - Check the power supply of the fan	130	15
F19						
F20						

10.3 Flaps messages – Error code K…

		English	English	English		
Error code	Type	Error text	Error explanation	Error remedy	MODBUS	
					Reg.	Bit
K01		Close AbtKL[no.], stop at I >	When closing the defrosting flap (AbtKL) [no.]			
K02		Open AbtKL[no.], stop at I >				
K03		Close AbtKL[no.], LZ error, I = OK				
K04		Close AbtKL[no.], LZ error, I = OK				
K05		Close AbtKL[no.], LZ error, limit swit.				
K06		Open AbtKL[no.], LZ error, I = OK				
K07						
K08						
K09						
K10						
K11						
K12						
K13						
K14						
K15						
K16						
K17						
K18						
K19						
K20						
K21						
K22						
K23						
K24						
K25						
K26						
K27						
K28						
K29						
K30						

10.4 Measured values messages – Error code M...

		English	English	English		
Error code	Type	Error text	Error explanation	Error remedy	MODBUS	
					Reg.	Bit
M01	A	Pressure sensor [no.] wire break	- The signal at the analogue input does not correspond to a suitable pressure sensor - Resistance is clearly too high - Incorrect configuration of the analogue input (jumper position)	- Sensor line interrupted / check wiring - Check terminal points - Check the configuration of the respective analogue input (see device manual, chapter 3.6.4) - Replace the pressure sensor - The analogue input may be defective, please contact the manufacturer	150	0 to 3
M02	A	Outlet sensor [no.] wire break	- The resistance at the analogue input does not correspond to a suitable outlet sensor - Resistance is clearly too high - Incorrect configuration of the analogue input (jumper position)	- Sensor line interrupted / check wiring - Check terminal points - Check the configuration of the respective analogue input (see device manual, chapter 3.6.4) - Replace the outlet sensor - The analogue input may be defective, please contact the manufacturer	150	4 6
M03	A	Ambient sensor wire break	- The resistance at the analogue input does not correspond to a suitable Ambient sensor - Resistance is clearly too high - Incorrect configuration of the analogue input (jumper position)	- Sensor line interrupted / check wiring - Check terminal points - Check the configuration of the respective analogue input (see device manual, chapter 3.6.4) - Replace the Ambient sensor - The analogue input may be defective, please contact the manufacturer	150	8
M04	A	Ambient sensor short circuit	- The resistance at the analogue input does not correspond to a suitable Ambient sensor - Resistance is clearly too low - Incorrect configuration of the analogue input (jumper position)	- Sensor line is short-circuited / check wiring - Check terminal points - Check the configuration of the respective analogue input (see device manual, chapter 3.6.4) - Replace the Ambient sensor - The analogue input may be defective, please contact the manufacturer	150	9

M05	W	Inlet sensor [no.] wire break	- The resistance at the analogue input does not correspond to a suitable inlet sensor - Resistance is clearly too high - Incorrect configuration of the analogue input (jumper position)	- Sensor line interrupted / check wiring - Check terminal points - Check the configuration of the respective analogue input (see device manual, chapter 3.6.4) - Replace the inlet sensor - The analogue input may be defective, please contact the manufacturer	150	10 12
M06	W	Room sensor wire break	- The resistance at the analogue input does not correspond to a suitable room sensor - Resistance is clearly too high - Incorrect configuration of the analogue input (jumper position)	- Sensor line interrupted / check wiring - Check terminal points - Check the configuration of the respective analogue input (see device manual, chapter 3.6.4) - Replace the room sensor - The analogue input may be defective, please contact the manufacturer	150	14
M07	W	Room sensor short circuit	- The resistance at the analogue input does not correspond to a suitable room sensor - Resistance is clearly too low - Incorrect configuration of the analogue input (jumper position)	- Sensor line is short-circuited / check wiring - Check terminal points - Check the configuration of the respective analogue input (see device manual, chapter 3.6.4) - Replace the room sensor - The analogue input may be defective, please contact the manufacturer	150	15
M08	W	Coil sensor wire break	- The resistance at the analogue input does not correspond to a suitable Coil sensor - Resistance is clearly too high - Incorrect configuration of the analogue input (jumper position)	- Sensor line interrupted / check wiring - Check terminal points - Check the configuration of the respective analogue input (see device manual, chapter 3.6.4) - Replace the Coil sensor - The analogue input may be defective, please contact the manufacturer	151	0
M09	W	Coil sensor short circuit	- The resistance at the analogue input does not correspond to a suitable Coil sensor - Resistance is clearly too low - Incorrect configuration of the analogue input (jumper position)	- Sensor line is short-circuited / check wiring - Check terminal points - Check the configuration of the respective analogue input (see device manual, chapter 3.6.4) - Replace the Coil sensor - The analogue input may be defective, please contact the manufacturer	151	1

M10	W	Tray sensor wire break	- The resistance at the analogue input does not correspond to a suitable tray sensor - Resistance is clearly too high - Incorrect configuration of the analogue input (jumper position)	- Sensor line interrupted / check wiring - Check terminal points - Check the configuration of the respective analogue input (see device manual, chapter 3.6.4) - Replace the tray sensor - The analogue input may be defective, please contact the manufacturer	151	2
M11	W	Tray sensor short circuit	- The resistance at the analogue input does not correspond to a suitable tray sensor - Resistance is clearly too low - Incorrect configuration of the analogue input (jumper position)	- Sensor line is short-circuited / check wiring - Check terminal points - Check the configuration of the respective analogue input (see device manual, chapter 3.6.4) - Replace the tray sensor - The analogue input may be defective, please contact the manufacturer	151	3
M12	W	Cell sensor wire break	- The resistance at the analogue input does not correspond to a suitable cell sensor - Resistance is clearly too high - Incorrect configuration of the analogue input (jumper position)	- Sensor line interrupted / check wiring - Check terminal points - Check the configuration of the respective analogue input (see device manual, chapter 3.6.4) - Replace the cell sensor - The analogue input may be defective, please contact the manufacturer	151	4
M13	W	Cell sensor short circuit	- The resistance at the analogue input does not correspond to a suitable cell sensor - Resistance is clearly too low - Incorrect configuration of the analogue input (jumper position)	- Sensor line is short-circuited / check wiring - Check terminal points - Check the configuration of the respective analogue input (see device manual, chapter 3.6.4) - Replace the cell sensor - The analogue input may be defective, please contact the manufacturer	151	5
M14	W	Humidity sensor wire break	- A current < 4mA flows at the corresponding analogue input -This does not correspond to a suitable humidity sensor (4-20mA) - Resistance is clearly too high - Incorrect configuration of the analogue input (jumper position)	- Sensor line interrupted / check wiring - Check terminal points - Check the configuration of the respective analogue input (see device manual, chapter 3.6.4) - Replace the humidity sensor - The analogue input may be defective, please contact the manufacturer	151	15

M15	W	Overtemperature [no.]	- Depending on the selected setpoint (NC normal cooling, FC free cooling or HR heat recovery), it is displayed here that the actual temperature value is above the alarm value (ATTENTION, possible risk of overpressure in the system) - The alarm values can be adjusted in the setpoint menu (see also chapter 5.5 "Setpoints" in the operating manual) - For two-circuit devices, the corresponding index number 1 or 2 is also displayed	- Control line interrupted / check wiring - Check terminal points - Incorrect functioning of the fans - Alarm values set too low - Too high ambient temperature	166	0 1
M16	A	Conductivity probe [no.] wire break	- A current < 4 mA flows at the corresponding analogue input -This does not correspond to a suitable humidity sensor (4-20 mA) - Resistance is clearly too high - Incorrect configuration of the analogue input (jumper position)	- Sensor line interrupted / check wiring - Check terminal points - Check the configuration of the respective analogue input (see device manual, chapter 3.6.4) - Replace the humidity sensor - The analogue input may be defective, please contact the manufacturer		
M17	A	Level probe wire break	- A current < 4 mA flows at the corresponding analogue input -This does not correspond to a suitable humidity sensor (4-20 mA) - Resistance is clearly too high - Incorrect configuration of the analogue input (jumper position)	- Sensor line interrupted / check wiring - Check terminal points - Check the configuration of the respective analogue input (see device manual, chapter 3.6.4) - Replace the humidity sensor - The analogue input may be defective, please contact the manufacturer		
M18	A	Level probe short circuit	- The resistance at the analogue input does not correspond to a suitable cell sensor - Resistance is clearly too low - Incorrect configuration of the analogue input (jumper position)	- Sensor line is short-circuited / check wiring - Check terminal points - Check the configuration of the respective analogue input (see device manual, chapter 3.6.4) - Replace the cell sensor - The analogue input may be defective, please contact the manufacturer		
M19						
M20						

10.5 Signals external messages – Error code S...

		English	English	English		
Error code	Type	Error text	Error explanation	Error remedy	MODBUS Reg.	MODBUS Bit
S01	W	Control voltage is missing	- No signal at digital input 7 - The control voltage supply to the digital inputs is interrupted	- Check the control voltage fuse of the digital inputs (if necessary F692) - Check wiring in the control cabinet or externally - Check terminal points - Check configuration of DI-7	141	12
S02	W	Setpoint shift [no.] wire break	- This error message is only active with signal types 4-20 mA or 2-10 V. - A current < 4 mA flows at the corresponding analogue input or a voltage < 2 V is applied - Incorrect configuration of the analogue input (jumper position)	- Control line interrupted / check wiring - Check terminal points - Check the configuration of the respective analogue input (see device manual, chapter 3.6.4) - The analogue input may be defective, please contact the manufacturer		
S03	A	Slave speed [no.] wire break	- This error message is only active with signal types 4-20 mA or 2-10 V. - A current < 4 mA flows at the corresponding analogue input or a voltage < 2 V is applied - Incorrect configuration of the analogue input (jumper position)	- Control line interrupted / check wiring - Check terminal points - Check the configuration of the respective analogue input (see device manual, chapter 3.6.4) - The analogue input may be defective, please contact the manufacturer		
S04	W	External emergency stop	- An external emergency stop has been activated - For two-circuit devices, the corresponding index number 1 or 2 is also displayed	- Control line interrupted / check wiring - Check terminal points - Eliminate the fault in the pump for the pressure increase		
S05						
S06	W	Failure Storage tank	- General message that the storage tank for the service water is faulty - If this function is not required, a wire bridge can either be installed on the respective terminals or the function is deactivated in the "Control" menu	- Control line interrupted / check wiring - Check terminal points - Eliminate the fault on the storage tank	145	8
S07	W	Failure Pressure increase	- General message that the pressure increase for the service water is faulty - If this function is not required, a wire bridge can either be installed on the respective terminals or the function is deactivated in the "Control" menu	- Control line interrupted / check wiring - Check terminal points - Eliminate the fault in the pump for the pressure increase	145	7

S08	A	Failure of spray pump	- General message that the circulation pump is faulty - Motor protection - Overheating protection	- Motor cable(s) interrupted / check wiring - Check terminal points - Check protective devices - Check the pump mechanically	143	10
S09	A	Failure of flow	- Despite the circulating pump being switched on, there is no flow through the monitored line - Pump does not work correctly - Blockage of the pipe - Defective valves - Flow monitor defective	- Control line interrupted / check wiring - Check terminal points - Check the function of the circulating pump - Replace the flow monitor	143	11
S10	W	Dry run warning	- There is not enough water to operate the pump - Water supply failed - Valves closed - Line blocked - Refill valve defective - Water supply pressure is too low	- Check water supply - Clean pipes - Check valves	143	12
S11						
S12						
S13						
S14						
S15						
S16						
S17						
S18						
S19						
S20						

10.6 Valve messages – Error code V...

		English	English	English		
Error code	Type	Error text	Error explanation	Error remedy	MODBUS	
					Reg.	Bit
V01	W	Main water valve running time	- The fixed maximum running time from opening or closing the main water valve (2:30 min) has been exceeded - Supply voltage to the valve interrupted - No feedback	- Control line interrupted / check wiring - Check terminal points - Check the voltage supply of the valve - Check the feedback (limit switch) of the valve - Check control of the valve	145	0
V02	W	Drain valve running time	- The fixed maximum running time from opening or closing the drain valve (2:30 min) has been exceeded - Supply voltage to the valve interrupted - No feedback	- Control line interrupted / check wiring - Check terminal points - Check the voltage supply of the valve - Check the feedback (limit switch) of the valve - Check control of the valve	145	1
V03	W	Vent valve running time	- The fixed maximum running time from opening or closing the vent valve (2:30 min) has been exceeded - Supply voltage to the valve interrupted - No feedback	- Control line interrupted / check wiring - Check terminal points - Check the voltage supply of the valve - Check the feedback (limit switch) of the valve - Check control of the valve	145	6
V04	W	Spray valve running time [no.]	- The fixed maximum running time from opening or closing the spray valve (2:30 min) has been exceeded - Supply voltage to the valve interrupted - No feedback	- Control line interrupted / check wiring - Check terminal points - Check the voltage supply of the valve - Check the feedback (limit switch) of the valve - Check control of the valve	145	2 to 5
V05	W	Inlet valve running time	- The fixed maximum running time from opening or closing the inlet valve has been exceeded - Supply voltage to the valve interrupted - No feedback	- Control line interrupted / check wiring - Check terminal points - Check the voltage supply of the valve - Check the feedback (limit switch) of the valve - Check control of the valve		
V06	W	Bypass valve running time	- The fixed maximum running time from opening or closing the bypass valve has been exceeded - Supply voltage to the valve interrupted - No feedback	- Control line interrupted / check wiring - Check terminal points - Check the voltage supply of the valve - Check the feedback (limit switch) of the valve - Check control of the valve		

V07	W	3-Way valve running time	- The fixed maximum running time from opening or closing the 3-way valve has been exceeded - Supply voltage to the valve interrupted - No feedback	- Control line interrupted / check wiring - Check terminal points - Check the voltage supply of the valve - Check the feedback (limit switch) of the valve - Check control of the valve		
V08	W	Adiabatic valve [no.] wire break	- There is a voltage < 2 V at the corresponding analogue input (signal type by default 2-10 V) - incorrect configuration of the analogue input (jumper position) - No respond	- Control line interrupted / check wiring - Check terminal points - Check the configuration of the respective analogue input (see device manual, chapter 3.6.4) - The analogue input may be defective, please contact the manufacturer	152	0 1
V09	W	Adiabatic valve [no.] position error	- The actual value reported by the control valve does not match the setpoint output - Supply voltage to the valve interrupted - Incorrect configuration of the analogue input (jumper position) - Control valve is defective	- Control line interrupted / check wiring - Check terminal points - Check the configuration of the respective analogue input (see device manual, chapter 3.6.4) - The analogue input or the control valve may be defective, please contact the manufacturer	145	9 10
V10						

11. CLOSING REMARKS

This operating manual does not claim to be complete. If necessary, please ask the manufacturer of the controller for the current version. The control is always kept up to date. This applies to the hardware as well as the software. The TCS.2 is continuously expanded to include new functions. The manufacturer reserves the right to adapt the software and hardware to technical requirements at any time. Basically, it is ensured that new versions are backwards compatible This means that new software versions can replace older versions without any loss of functionality. Care is also taken to ensure that older controllers can be replaced without changing the wiring, if possible.