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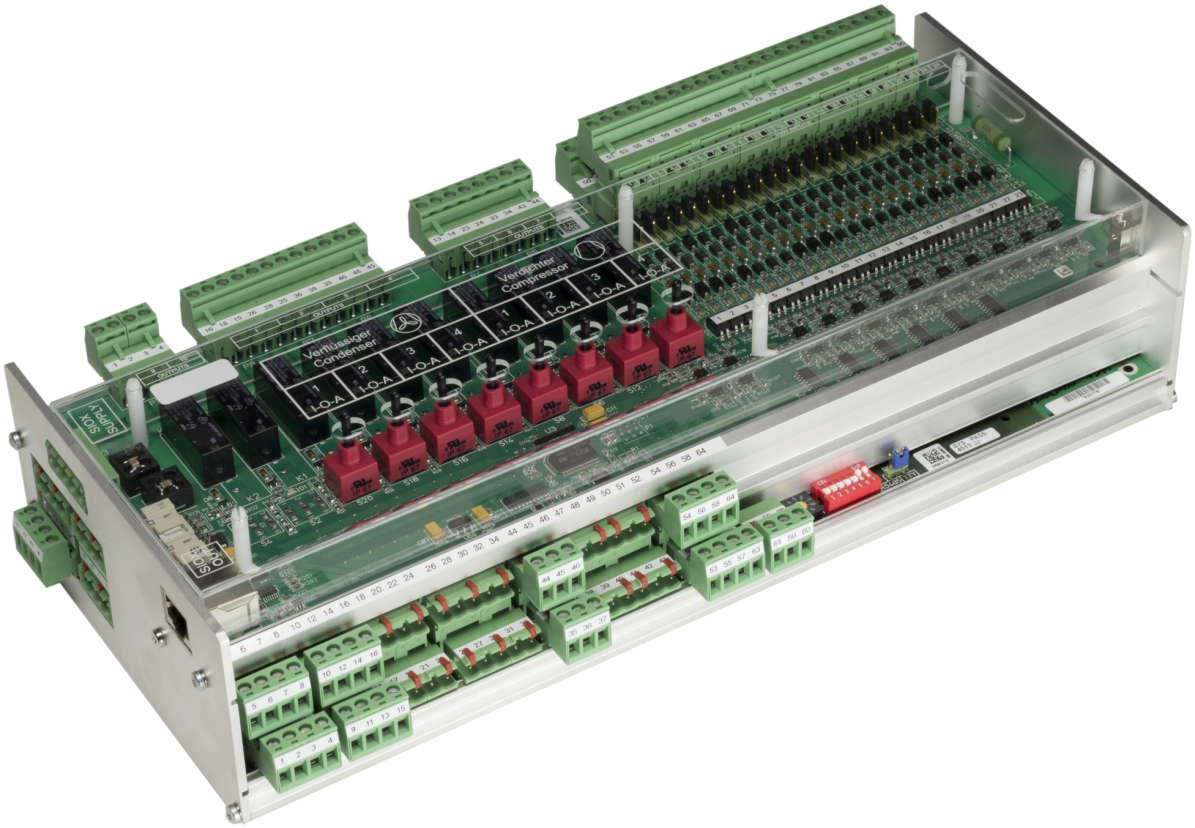
Operating instruction

VS 3010 C

Pack Controller for transcritical CO2 systems



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Before commissioning and use, please check that this is the latest version of the document. With the publication of a new version of the documentation, all previous versions lose their validity. The current operating manual and information such as data sheets, more detailed documentation and FAQs are available for you online in E°EDP (Eckelmann ° Electronic Documentation Platform) at

www.eckelmann.de/elds

You reach all relevant documents for this component directly using the QR code:

https://edp.eckelmann.de/edp/lds/_puaXGM3JhS

Information on safety and connection instructions are described in detail in chapter ”Industrial safety notes”.

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1 Conventions

1.1 Explanation of "General Instructions"

A general instruction consists of two elements:

1. A pictogram of a hand at the side of the page as well as
2. The actual text:

For example:

> Further information for the enclosure protection of the device is contained in the chapter Technical Data VS 3010 C.

1.2 Explanation of "Safety Instructions and Hazard Warnings"

Safety instructions or hazard warnings are composed of four elements:

1. The pictogram (warning sign / symbol) at the edge of the page.
2. A short, concise description of the danger.
3. A description of the possible consequences.
4. A catalogue with prevention measures.

For example:

> **Warning of dangerous electrical voltage! Danger of electric shock! BEFORE** connecting and disconnecting, it must be checked that **no voltage is present** at the 230 V AC relay outputs!

The warning signs and symbols used for the safety instructions and hazard warnings in this documentation are described in detail on the following page.

1.3 Warning Signs and Symbols Used

Explanation of the warning signs and symbols used for the safety instructions and hazard warnings in this documentation:

Attention symbol - general hazard warning

1. **Hazard warning**
   The attention symbol indicates all safety instructions in this operating and service manual which result in danger to life and limb if not observed. Carefully comply with the work safety instructions and proceed with particular caution in these cases.
2. **Attention**
   The attention symbol highlights guidelines and regulations, instructions and correct working procedures that must be particularly observed in order to prevent damage to and destruction of LDS components or malfunctioning (for example to prevent stock loss).

Failure to observe the attention symbol can result in personal injury (in extreme cases serious injuries or death) and/or material damage!

Voltage symbol - warns about hazardous electrical voltage

> This work safety symbol warns about hazards from dangerous electrical voltage with possible consequences of serious injuries and death.

ESD symbol - warning of electrostatic sensitive components and control components

 This symbol indicates electrostatic sensitive components and assemblies, for details see chapter Electrostatic sensitive components and control components (ESD)

Note symbol

> The note symbol highlights usage tips and other useful information contained in this operating and service manual.

Battery disposal symbol

	Never dispose of this product with other domestic waste. Please inform yourself about the local regulations for the separated disposal of electrical and electronic products. The correct disposal of your old equipment protects the environment and people against possible negative consequences. Further information can be found in the chapter "Decommissioning and Disposal".

2 Safety instructions

The safety regulations, instructions and information described in this chapter must be strictly observed and complied with. During repairs on the entire E*LDS system, the accident prevention regulations and general safety regulations must be strictly complied with. Important information (safety instructions and hazard warnings) are indicated by appropriate symbols (see the chapter Conventions). Follow these instructions in order to prevent accidents and danger to life and limb, as well as damage to the E*LDS system.

Warning of dangerous electrical voltage! Danger of electric shock! Beware of external voltage at the digital inputs and outputs! All device connections/male connectors must only be plugged in, unplugged and/or wired when **no voltage is present**.

- This operating manual is part of the equipment. It **must** be kept in the vicinity of the controller as well as for future use so that it can be consulted when required. The operating manual must be available for the operating and maintenance personnel **at any time** for the avoidance of operating errors, see chapter Explanation of "Safety Instructions and Hazard Warnings".
- For safety reasons, the equipment must not be used for any applications other than described in the operating manual and only for the intended use, see chapter Warning Signs and Symbols Used.
- Before using the device, check whether it is suitable for your application with regard to its limit values.
- Before connecting the device, it must be checked whether the power supply is suitable for the device.
- When using uncoded plug connectors, it is possible to connect them so that there is a danger to life and limb! If this cannot be ruled out, coded plug connectors must be used.
- Specified environmental conditions (e.g. humidity and temperature limits) must be observed and complied with. Otherwise, malfunctions are possible (see chapter Technical Data VS 3010 C).
- Before switching on the device, check correct wiring of the connections.
- The device must never be operated without its case. Before opening the case, the device must be disconnected from the power supply.
- Note the maximum load of the relay contacts (see chapter Technical Data VS 3010 C).
- Contact the supplier in the case of any malfunction.

1. According to experience, transmission of alarms is not yet functional during commissioning (no telephone line laid etc.). It is strongly recommended in such cases to monitor the controller via the CAN bus using a system centre or an operator terminal and to enable transmission of alarms using a GSM modem via a mobile telephone system. In standalone operation, or as an alternative to monitoring with system centre / operator terminal, an available alarm contact on the controller must be used to realise transmission of alarms via a telephone network.
2. After the setting up of transmission of alarms or alarm signalling, this must be tested and checked for its function.

For further information about the CAN bus, see the operating instruction "Basic and General Safety and Connection Notes".

Work on the electrical system may **only be performed by authorised specialist personnel** (according to the definition for specialists in DIN/VDE 0105 and IEC364, see chapter Explanation of "Safety Instructions and Hazard Warnings") and in accordance with the respective applicable

- VDE regulations
- Local safety regulations
- Intended use; see chapter Warning Signs and Symbols Used
- Five safety rules according to BGV A3, see chapter Safety instructions
- ESD measures, see chapter ESD - guidelines for handling

- Operating instructions

2.1 Exclusion of liability for non-observance

This operating manual contains information about the commissioning, function, operation and maintenance of the controller and the associated components.

A basic requirement for safe and trouble-free operation is **compliance with this operating manual**.

2.2 Requirements for the personnel

Special technical knowledge is required for planning, programming, installation, putting into service and maintenance work. This work may only be performed by trained or specially trained personnel. The installation, commissioning and maintenance personnel must have training which authorises interventions in the system and the automation system. The planning and programming personnel must be familiar with the safety concepts of automation technology. Specialist knowledge is required for work on electrical systems. Work on electrical systems may only be carried out by qualified electricians or persons under their guidance or supervision. In doing so, the respective applicable regulations (e.g. DIN EN 60204, EN 50178, BGV A3, DIN VDE 0100/0113) must be observed. The operating personnel must be instructed in handling the system / machine and the controller and must be familiar with the operating instructions.

2.3 Intended Use

This controller has been designed exclusively for the intended use:
The VS 3010 C controller is designed for use as pack controller in commercial and industrial refrigeration facilities in accordance with the scope of functions and in accordance with the environmental conditions described in this operating manual.

Note the safety instructions and the instructions for installation and start-up, operation and maintenance. Start the commissioning and/or operation of the machine / system AFTERWARDS.

The safety and the function of the machine / system are only fulfilled with this intended use.
Never use the machine / system, its components, control components or parts for any other purpose.
The system must not be put into operation until conformity with the applicable EU Directives has been established for the entire installation.

2.4 Five safety rules according to BGV A3

The following rules **must be strictly observed**.
1. Disconnect: The entire system to be worked on must be disconnected from the power supply at all poles.

Warning of dangerous electrical voltage! Pay attention to possible external power supply! **BEFORE** connecting and disconnecting it must be checked that **no voltage is present** at the controller! All device connections / connectors may only be plugged in, unplugged and/or wired when no voltage is present.

2. Secure against restarting: Attach information signs to the disconnected operating equipment stating:

- What has been disconnected.
- Reason for the disconnection.
- Name of the person who made the disconnection.
- Restarting must be prevented using a suitable lock (e.g. padlock).

3. Establish absence of voltage (only by authorised specialist personnel):

- Check voltmeter just before use.
- Establish absence of voltage on all poles at the disconnection point.
- Establish absence of voltage on all poles at the place of work.

4. Ground and short-circuit: All electrical parts at the place of work must be grounded and then short-circuited.

5. Cover or shield live parts: If there is neighbouring live equipment in the work area, this must be covered using appropriate materials (e.g. insulation blankets / insulating plates).

2.5 Electrostatic sensitive components and control components (ESD)

Electronic components and control components (e.g. circuit boards) are sensitive to electrostatic charges. Therefore, the guidelines for handling electrostatic sensitive components and control components must be strictly observed, see chapter ESD - guidelines for handling.

All electrostatic sensitive components and control components (referred to as "ESD" below) are labelled with the warning sign shown. Electrostatic charges arise from friction of insulating materials (e.g. floor covering, items of clothing made of synthetic fibres etc.). Even small charges can result in damage to or destruction of components. Damage cannot always be established directly, but partially does not result in failure until after a certain operating time.

2.5.1 ESD - guidelines for handling

Only transport and store ESD in the protective packaging provided for this.
Avoid materials that can produce electrostatic charge such as

- plastic containers and tabletops
- synthetic clothing
- footwear with plastic soles
- transparent covers
- polystyrene packaging
- monitors etc.

Wear

- work clothing made of cotton
- ESD footwear with electrically conductive soles or leather soles

Use

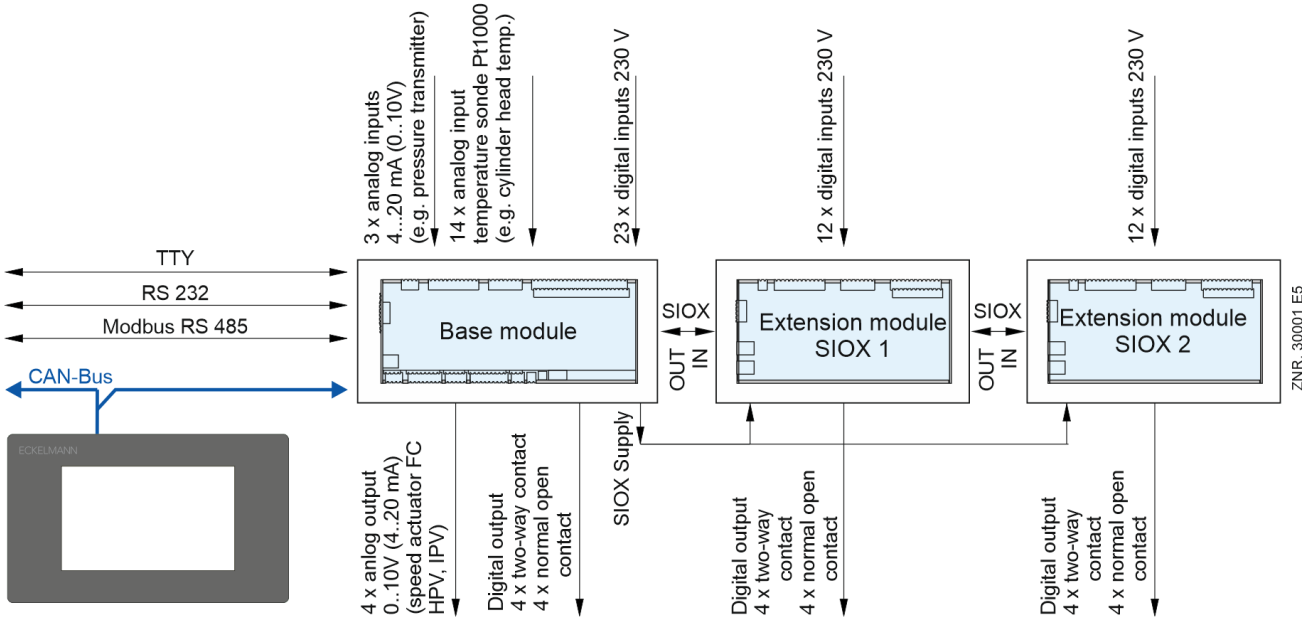
- conductive floors
- ESD work places with the tools provided for them (earthed soldering irons, earthing wrist strap and similar)
- conductive ESD bags, conductive plastic containers, IC rods or cartons with conductive foam
- containers and worktops made of wood, metal, conductive plastics or paper bags.

2.6 Abbreviations used

DIN **D**eutsches **I**nstitut für **N**ormung e. V.
EGB **E**lektrostatisch **G**efährdete **B**auelemente oder Baugruppen
ESD **E**lectro-**s**tatic **d**ischarge (**E**lectro **S**ensitive **D**evices)
VDE **V**erband **d**er **E**lektrotechnik **E**lektronik Informationstechnik e.V.
IEC **I**nternational **E**lectric **C**ommittee
BGV A3 **E**m**p**loyers Liability **A**ssociation regulations for health and safety in the workplace

3 System design VS 3010 C

The basic module of the pack controller for transcritical CO_2 - systems consists of an analogue module and a digital input/output module.
The controller is a modular design and can be extended with a maximum of 2 SIOX extension modules, see picture. The following expansion stages are possible:



VS 3010 C Basic Module	• 4 compressors • 4 fans
VS 3010 C Basic Module with one extension module SIOX 1	• 6*/8 compressors • 8 fans
VS 3010 C Basic Module with two extension modules SIOX 1 + SIOX 2	• 10*/11 compressors • 12 fans

*Spray system operation

SIOX operating instructions

Comprehensive details on the SIOX extension modules and their current operating instructions can be found here:
https://edp.eckelmann.de/edp/lds/_S88KwDvR7a

The device configuration and terminal assignment of the pack controller can be found in the chapter Connection and terminal assignment of VS 3010 C .

4 Application of VS 3010 C

The pack controller includes the following functions for the refrigeration compressor pack and condenser:

- Control functions
- Regulation functions
- Monitoring functions
- Fault signals
- Archiving of messages and operating data

These functions include the following:

Low-pressure control / compressor control

- as step controller
- as combined control

Medium pressure regulation

High pressure regulation

Compressor control (step controller) for one-circuit systems with max.

- 6 *1 compressors with 2 capacity stages each or
- 4 *1 compressors with 3 capacity stages each or
- 12 *2 individual compressors without capacity regulation
- *1 When using speed-controlled compressors with base load rotation or a spray system, the maximum number of compressors is reduced by one compressor.
- *2 When using speed-controlled compressors with base load rotation, the maximum number of compressors is reduced by one compressor and reduced by two compressors when using a spray system.

*1: When using speed-controlled compressors with base load rotation or a spray system, the maximum number of compressors is reduced by one compressor.
*2: When using speed-controlled compressors with base load rotation, the maximum number of compressors is reduced by one compressor and reduced by two compressors when using a spray system.

Fan control for one-circuit systems with max.

- 12 *3 fans
- 6 fans with separate star-delta switching of the fan motors (KKGG)
- 11 fans with common star-delta switching of the fan motors (KKGG)

*3: A maximum of 11 fans is possible for the "combined control" types of control.

Base load rotation

- Compressors
- Fans

Gas cooler regulation / fan control

- as step controller
- as speed controller
- parallel combined control
- stages combined control
- Fan protection
  spray system control
- The fans are controlled using
  - relay outputs or
  - Modbus (*ebmpapst* fan)

HRC operation

- Shutdown of the fans in gas cooler bypass operation

Monitoring functions

- Motor overload cut-out

    - compressors
    - fans
- Compressor high pressure limiter
- Cylinder head temperature
- Low-pressure regulation
- Medium-pressure regulation
- High-pressure regulation
- External alarm
- Compressor switching frequency
- Superheat
- Refrigerant level control
- Rupture disk

Load shedding

Oil balancing

Data archiving

- Messages
- Pulses
- Run times / operating hours
- Utilisation / run-time quotas

5 Function of VS 3010 C

5.1 Starting characteristics

The following are distinguished for any start-up of the controller:

- First start
- Restart

5.1.1 First start

The controller is reset to the factory settings during a first start.

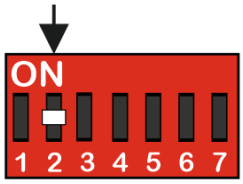
> **ATTENTION**
>
> The configuration of the controller **must be backed up before any first start** using the LDSWin software! All variables in battery backed-up RAM are specifically set to 0 during any first start.

The first start is initiated in the following ways:

- Predefined parameters are loaded by the controller when first switching on the system (i.e. after a first start).
- After a firmware update.
- If the controller has established using an internal check that no correct parametrisation is available.
- After the switching (adjustment) using the coding switches of the DIP switch S1:

Execution of a desired first start

1. The configuration of the controller **must be backed up before any first start** using the LDSWin software!
2. Put coding switch 2 of the DIP switch S1 in a different position:



   For details, see chapter Installation and start-up of VS 3010 C.
3. Switch off controller for 5 seconds and then switch on again.
4. Put coding switch 2 of the DIP switch S1 back in the original position:
5. Switch off controller and switch on again.
6. Restore the configuration of the controller using the LDSWin software.

5.1.2 Restart

The restart is always performed after restore of the power supply if the parametrisation has been preserved.

> All variables (except the parameters) of the fault memory and all archive data are are deleted.

5.2 System Configuration

The pack controller is equipped with a suction pressure control circuit (LP, compressor control), a medium pressure control circuit (MP, pressure regulation in collecting receiver), a high pressure control circuit (HP) and a control circuit for the gas cooler (t_g). The pack controller basically includes the following control and regulation functions:

Low-pressure control (LP) for one-circuit systems - as step or combined control

- Load shedding
- Emergency power mode

- Base load rotation
- Compressor monitoring
- Safety chain

High-pressure control (HP) for one-circuit systems

- Control of the high pressure control valve

Medium pressure regulation (MP)

- Regulation of the pressure in the collection receiver
- Activation of the MP control valve
- Activation of the MP compressor (parallel compressor) at the collection receiver

Regulation of the gas cooler outlet temperature (t_g) for one-circuit systems

The following possibilities are available for the control of the gas cooler fans.

	Control		Monitoring	
	Basic module / SIOX	**ebmpapst-Lüfter***	**Basic module / SIOX**	**ebmpapst-Lüfter***
Digital inputs			x	
Analogue outputs	x			
Relay outputs	x			
Modbus		x		x

* For details, see chapter Gas cooler package with ebmpapst fans

ⓘ One of the two possibilities must be selected according to the system configuration.

5.3 Configuration of the pressure transmitters

The pack controller operates with continuous pressure transmitters with linear characteristic curves. The pressure inputs can be adjusted for various transmitters with linear characteristic curves. Transmitters with both current output (4..20 mA) as well as with voltage output (0…10 V) can be used here.

ⓘ For transmitters with voltage output, appropriate jumpers must be implemented on the controller, see chapter Configuration of the analogue inputs and outputs at the factory! These are preconfigured as 4..20 mA current inputs at the factory.

The pressure transmitters can be adjusted in menu 3-1-b using the following parameters:

TRANSM. POS: XXXXX	Description	Input	Default	Dim.
LP-Transducer →	Selection of signal interface pressure transmitter LP (4..20 mA or 0..10 V)	→	Screen 3-1-b-a	
LP-Min XXX b	Pressure at 4 mA or 0 V at the output of the LP pressure sensor	0..2.0	1.0	bar
LP-Max XXX b	Pressure at 20 mA or 10 V at the output of the LP pressure sensor	25.0..80.0	60.0	bar
HP-Transducer →	Selection of signal interface pressure transmitter HP (4..20 mA or 0..10 V)	→	Screen 3-1-b-b	
HP-Min XXX b	Pressure at 4 mA or 0 V at output of HP pressure sensor	0..2.0	1.0	bar
HP-Max XXX b	Pressure at 20 mA or 10 V at output of HP pressure sensor	100.0..200.0	140.0	bar
MP-Transducer →	Selection of signal interface pressure transmitter MP (4..20 mA or 0..10 V)	→	Screen 3-1-b-c	

TRANSM. POS: XXXXX	Description	Input	Default	Dim.
MP-Min XXX b	Pressure at 4 mA or 0 V at the output of the MP pressure sensor	0..2.0	1.0	bar
MP-Max XXX b	Pressure at 20 mA or 10 V at the output of the MP pressure sensor	23.0..100.0	60.0	bar

Damage to the system and stock loss: Incorrect parametrisation of the pressure transmitters can result in high impairments of the functions! If any of these parameters is changed, the message *Sens type change* is sent!

Practical tip using the example of the "connection of a pressure transmitter - 1 .. 7 bar": The indication on the pressure transmitter here (> -1 bar) is obviously relative to the ambient pressure. The adjustment of the pressure transmitter in the controller is carried out using absolute pressure values (the absolute pressure cannot be negative). In order to parametrise the above pressure transmitter with the relative pressure indication - 1 bar (at 4 mA or 0 V) and 7 bar (at 20 mA or 10 V), the ambient pressure (1 bar) must be added. The input in this example is thus: 0..8 bar.

5.3.1 Low pressure transmitter Z2 (LP-Z2)

For installations in which the normal temperature (NT) zone is regulated using a VS 3010 C and a low temperature (LT) satellite compressor is activated directly using a case controller with electronic injection valves, the pack controller can determine the suction gas temperature of the LT circuit (Z2 circuit) and transmit this to the case controller via CAN bus for determining the superheat. This enables superheat regulation for the case controller of the LT circuit (Z2 circuit) using the evaporator outlet temperature and suction gas temperature.

In order to measure the suction gas temperature of the LT circuit (Z2 circuit), a low pressure transmitter with a measuring range from 1 to 26 bar must be connected to the third analogue input (terminals 41/42). The function is activated using the *Transducer Z2* (menu 3-1).

The CAN bus address and the temperature zone Z2 of the pack controller supplying this pressure must be entered in the case controller !

5.4 Low-pressure Regulation

The low-pressure regulation has the task of maintaining the suction side pressure at a specified setpoint. The controller provides two different methods for this regulation task:

- **Step controller**
  Regulation by loading and unloading compressor stages or compressor capacity stages
- **Combined control**
  Regulation using a speed-controlled compressor in combination with one or more fixed-speed compressors

The setpoint is specified depending on the room temperature or the refrigeration requirement.

5.4.1 Control algorithm for LP control

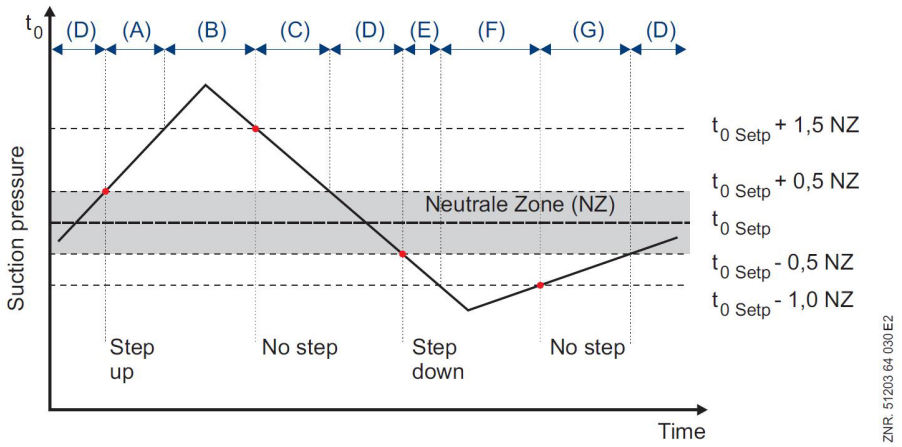
The control algorithm depends on the type of control.

In the wet vapour range, the temperature is a clear function of the pressure: t = f (p, R744). The VS 3010 C calculates temperatures for the LP range from the recorded pressures. Temperature values are used exclusively for the regulation. Temperatures (t_0/t_c) thus substitute for pressures (p_0/p_c) in this manual.

5.4.2 Control algorithm with LP step controller

The low pressure measured via an A/D converter is compared with the setpoint:

Control algorithm LP step controller



(A) At a pressure greater than the setpoint plus 0.5 times the neutral zone (NZ) and less than the setpoint plus 1.5 times the NZ, the step switching mechanism loads stages in the event of a **positive** pressure change.
(B) At a pressure greater than the setpoint plus 1.5 times the NZ, the step switching mechanism loads stages **independently** of the pressure change.
(C) In the case of falling pressure that is less than the setpoint plus 1.5 times the NZ and is greater than the setpoint plus 0.5 times the NZ, no compressor switching is performed.
(D) **No** compressor switching is performed in the NZ.
(E) At a pressure less than the setpoint value minus 0.5 times the neutral zone (NZ) and greater than the setpoint value minus 1.0 times the NZ, and in the event of a **negative** pressure change, the step switching mechanism switches down stages.
(F) At a pressure less than the setpoint minus 1.0 times the NZ, the step switching mechanism unloads stages **independently** of the pressure change.
(G) In the case of increasing pressure that is between the setpoint minus 1.0 times the NZ and is greater than the setpoint minus 0.5 times the NZ, no compressor switching is performed.

5.4.2.1 Neutral zone with compressor step control

If the low pressure regulation is performed using step controllers, no compressor switching is performed while the control error is within a configurable *Dead band*.

If the low pressure regulation is performed using combined control, no switching of the fixed-speed compressors is performed within the neutral zone.

5.4.2.2 Compressor switching times for compressor step regulation

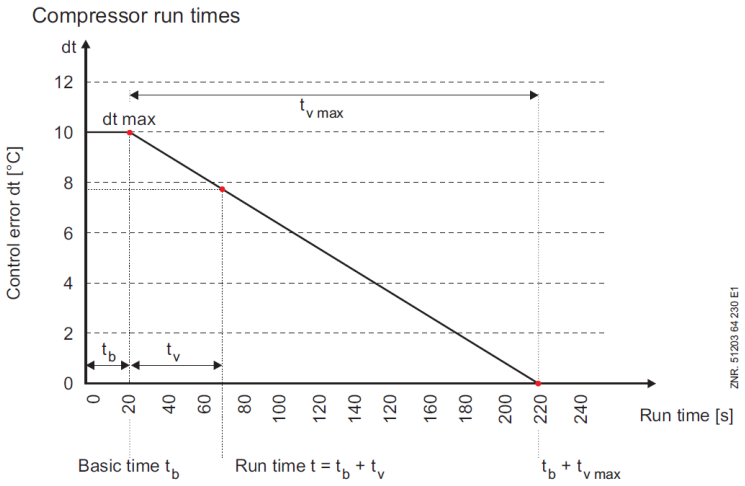
Compressor switching only occurs if the control error has exceeded a specified value (Dead band) and a specific time for loading or unloading has elapsed. With compressor combined control, the lead time has no influence on the enable of the FC compressor.

The switching time is calculated from the sum of a basic time t_b and a variable time t_v.

The variable time is inversely proportional to the control error. The higher the control error the shorter the delay. In the case of maximum control error, the variable time $t_v = 0$. In the case of declining control error, the time t_v is automatically increased up to the specified maximum time. The basic time and the maximum variable time for the shifting up (switching on) and shifting down (switching off) can be configured as parameters for each capacity stage.

In the case of combined control, the speed control is not enabled until after expiry of the basic time of the first compressor capacity stage. The speed-controlled compressor is operated with the lowest speed until expiry of the basic time.

The switch-on and switch-off delay only starts outside the neutral zone. A compressor stage is activated with the delay time for number of running compressors + 1. For step control, switching down always begins with the delay of the first stage; for combined control, the deactivation times are directly assigned to the compressor stages.



5.4.3 Control algorithm with LP combined control

Depending on the low-pressure control error, a correcting variable is calculated which controls the speed of the compressor as a 0-10 V signal.

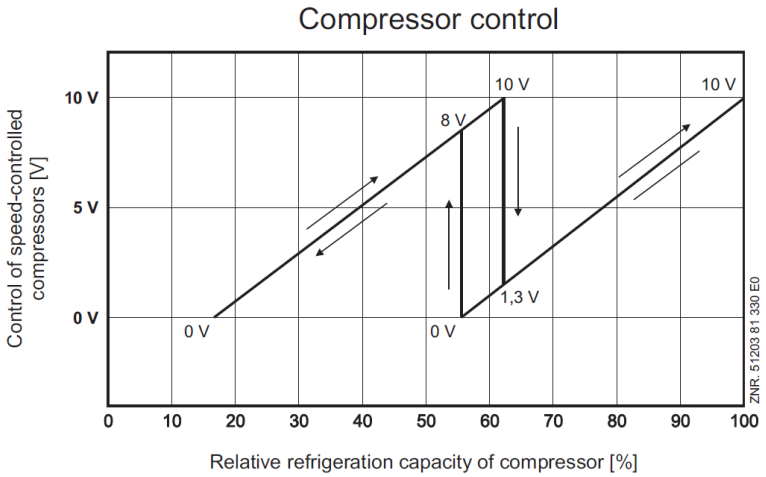
If all compressor stages are switched off and the actual value is greater than the setpoint (positive control error), the first compressor stage (C1: Release of frequency converter) is switched on immediately. The speed control is not activated until after expiry of a delay time (time = Basic time ON V1 - see also menu 3-2-4-a). The compressor is operated with a configurable minimum speed during the time delay.

The compressor speed can also be specified manually (parameter *Man. op.* menu 3-2-1-1). If "---" is entered, the signal is determined via the controller. The manual mode is only used for test and service purposes. The number of running compressor stages remains constant in manual mode. No FC base load rotation is performed.

5.4.3.1 Switching on / switching off of fixed-speed compressors

If the required capacity can no longer be provided by modifying the already set compressor speed, fixed-speed compressors can be loaded or unloaded. If the speed controlled compressor has reached its maximum speed and if the suction pressure is greater than the to setpoint plus half the neutral zone, a fixed-speed compressor is switched on.

If the speed controlled compressor has reached its minimum speed and if the suction pressure is less than the to setpoint minus half the neutral zone, a fixed-speed compressor is switched off. The following graph shows the controller profile of a compressor pack with 2 compressors without capacity regulation.

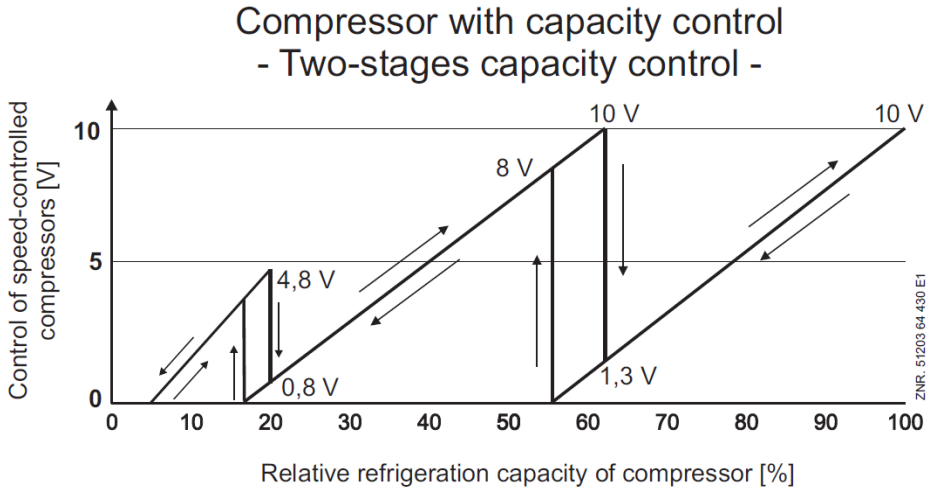


In order to do this, the frequency changer must be configured so that an output signal of 0 V at the controller's analogue output corresponds to the minimum frequency and an output signal of 10 V to the maximum frequency. The input signal of the frequency converter must be configured as 0 V - 10 V interface. Using the parameters *MaxFreq.FC* and *MinFreq.FC*, the pack controller can be adjusted to the settings of the FC.

MaxFreq.FC[Hz] = 87 The frequency to be output by the FC for 10 V correcting variable is set here (setting value must correspond to the value set on the FC; the example here uses 87 Hz).
MinFreq.FUCHz] = 30 The frequency to be output by the FC for 0 V correcting variable is set here (setting value must correspond to the value set on the FC; the example here uses 30 Hz).
L.WorkFreq[Hz] = 35 Lower operating frequency: The minimum FC speed output by the pack controller is set here. This must be selected to be greater than or equal to the minimum frequency to be output by the FC..

5.4.3.2 Loading / unloading of fixed-speed compressors during operation with capacity-controlled compressors.

Combined control operating mode with non capacity-controlled fixed-speed compressors (parameter M.com.out.reg. = No)
With capacity-controlled compressors, the additional capacity stage is only used for the speed controlled compressor. The fixed-speed compressor is always operated at 100%.
The graph shows the controller profile of a compressor pack with 2 compressors with two-stage capacity control.



In order to do this, the frequency changer must be configured so that an output signal of 0 V at the controller's analogue output corresponds to the minimum frequency and an output signal of 10 V to the maximum frequency. The input signal of the frequency converter must be configured as 0 V - 10 V interface.

Operating mode combined control with capacity-controlled fixed-speed compressors (parameter M.com.out.reg. = Yes)

With compressor combined control of capacity-controlled fixed-speed compressors, a single-stage speed controlled compressor is combined with one or more capacity-controlled fixed-speed compressors.

In the case of the combination of a single-stage speed-controlled compressor with capacity-controlled, i.e. multi-stage fixed-speed compressors, the sudden power variation when loading / unloading a fixed-speed compressor capacity stage is lower than when a complete compressor would be loaded / unloaded.

The simplified diagram below shows an example of the connection of a system with one single-stage FC compressor in combination with three two-stage fixed-speed compressors:

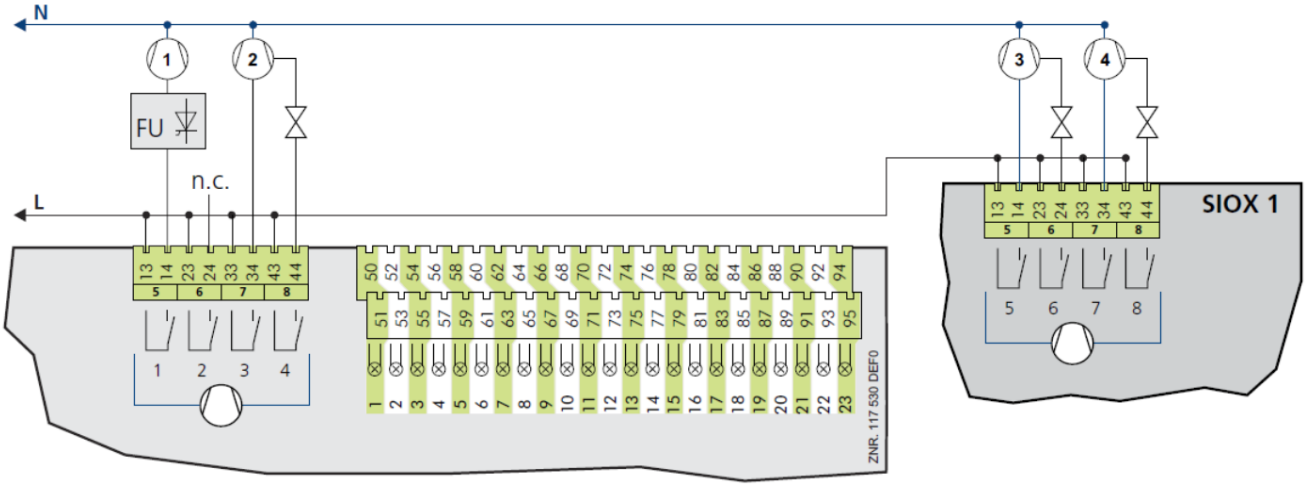


Diagram of the example system

Control action of the example system
In the following description, the control action of the system is shown using the example of the above named system. The configured frequency range is thus 35 Hz - 67 Hz; the configured capacity overlap is 10%. It can be specified using the output overlap parameter by how many percent (100% corresponds to the capacity of a completely loaded compressor at 50 Hz) the capacity after loading a compressor stage is lower than before the loading.

Parametrisation and connection of the system
Connection: the single-stage FC compressor is enabled using the compressor relay stage 1 (terminals 13/14) of the pack controller. Depending on the number of selected capacity stages (parameter *Nr comp multist* menu 3-1), one or two additional capacity stages are reserved for the FC compressor:

- If the number of selected capacity stages in the circuit is equal to two, the second relay stage (terminals 23/24) is assigned to the FC compressor.
- If the number of selected capacity stages in the circuit is equal to three, the second and third relay stages (terminals 23/24 and terminals 33/34) are assigned to the FC compressor.

These capacity stages that are assigned to the FC compressor are disabled for the operation with a single-stage FC compressor using the manual control switch(es) and the corresponding parameters (menu 3-1). Nothing is connected to the corresponding relay stages.
The capacity-controlled fixed-speed compressors are connected to the compressor relay stages (see above diagram of the example system).

Parameters: The following settings must be made in the System Configuration menu (menu 3-1) for the example configuration described above:
No. comps. = 4 Number of compressors in the pack
No.cap.stages = 2 Number of capacity stages per compressor in the pack

In the submenu *Enable comp.stages*, the capacity stages assigned to the FC compressor must be disabled using the parameters *Comp. 2* (two-stage compressor) or *Comp. 2* and *Comp. 3* (three-stage compressor).
The following settings must be made for the example configuration described above in the Compressor Control menu (menu 3) *Setpoints* / 2 *Control* / 1 *LP Control* / 1 *Compressor Control*):

- *Regelungsart = combined control*
  to-control combined with FC compressor and fixed-speed compressors
- *Diff.Power* = 10%
  Capacity overlap when loading or unloading a compressor capacity stage. The capacity overlap determines which speed setpoint for the FC compressor is output following the loading / unloading of a compressor capacity stage.
- *M.com.out.reg.* = YES
  This is used to specify that the stages of the fixed-speed compressors are switched on individually when using compressor combined control (capacity control of the fixed-speed compressors is active).
  NO in this case means that the fixed-speed compressors together with their capacity stages are always loaded and unloaded completely (capacity control of the fixed-speed compressors is inactive).
- *MaxFreq.FC[Hz]* = 87
  The frequency to be output by the FC for 10 V correcting variable is set here (setting value must correspond to the value set on the FC; the example here uses 87 Hz).
- *MinFreq.FC[Hz]* = 30
  The frequency to be output by the FC for 0 V correcting variable is set here (setting value must correspond to the value set on the FC; the example here uses 30 Hz).
- *U.WorkFreq[Hz]* = 67
  Upper operating frequency: The maximum FC speed output by the VS 3010 C is set here. This must be selected to be less than or equal to the maximum frequency to be output by the FC.
- *L.WorkFreq[Hz]* = 35
  Lower operating frequency: The minimum FC speed output by the VS 3010 C is set here. This must be selected to be greater than or equal to the minimum frequency to be output by the FC..

The following settings must be made under 3 *Setpoints* / 6 *Base Load* for the above example configuration: *BaseLoadRot.FC* = N In the case of a configuration with an FC compressor with integrated FC, the frequency converter cannot be switched. The base load rotation according to the above time interval is only performed for the fixed-speed compressors.

5.4.3.3 Speed increase for purpose of oil lubrication

In order to guarantee the oil lubrication of a speed-controlled compressor, the compressor speed can be cyclically increased if the compressor is continuously operated at minimum speed due to low refrigeration capacity.

The maximum permitted run time at low speed is specified with the parameter *RunTimeSlwSpeed*. The speed is increased if this time is exceeded. The parameter *Freq.-shift[Hz]* determines the frequency to which the compressor speed is increased. The duration of the speed increase is specified with the parameter *t Freq.-shift* (menu 3-2-2-1).

The "Speed Increase" function is only active if values not equal to "--" have been specified for *MaxFreq.FC[Hz], MinFreq.FC[Hz]* (menu 3-2-2-1) and *Freq.-shift[Hz]* and only the FC compressor is activated.

5.4.4 Setpoint shift

An optimally calculated setpoint for the operation can result in reduction of the energy costs. The determination of the t_0 setpoint (setpoint shift) for the low-pressure control can be performed using the following operations in menu 3-2-1-2:

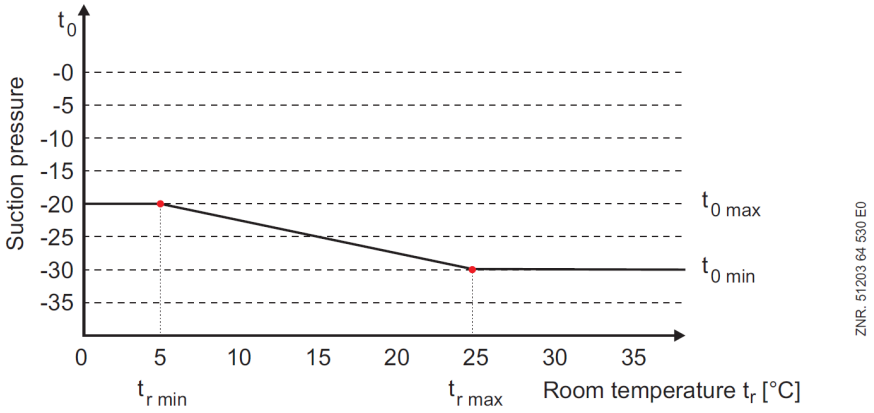
- room temperature sensor
- demand-dependent using case controller (consumer)
- external signal via CAN bus
- external signal via analogue input
- a humidity sensor

> If the room temperature sensor or the humidity sensor for the setpoint shift is not connected to the controller, these can be made available as required from another controller, see chapter Ambient data for the setpoint switching.

5.4.4.1 Setpoint shift via room temperature

The determination of the t_0 setpoint is performed depending on the room temperature (t_0 setpoint shift via room temperature, see menu 3-2-1-2). The room temperature is provided here either by a Pt1000 temperature sensor that is connected directly to the analogue input (terminals 5/6/7/8) of the pack controller or provided via the CAN bus from another pack controller in the E*LDS system, see chapter Ambient data for the setpoint switching.

Low-pressure control



t_{0_max} = maximum t_0 setpoint
t_{0_min} = minimum t_0 setpoint
t_{r_max} = maximum room temperature for setpoint shift
t_{r_min} = minimum room temperature for setpoint shift

t_{0_max}, t_{0_min}, t_{r_min} and t_{r_max} can be configured.

5.4.4.2 Setpoint shift - demand-dependent via consumer

The t_0 setpoint is calculated in accordance with the refrigeration needs of the refrigeration points.

Here, in the case of controllers with electronic expansion valves, the opening degree of the refrigeration point expansion valves for standard controllers with thermostatic expansion valves is determined according to information equivalent to the opening degree in the UA 300/UA 400 controller.

If a configurable maximum load level (parameter *Max.LoadLevel* menu 3-2-1-2) is exceeded on at least one of the refrigeration points associated with the pack, the suction pressure is reduced.

Conversely, if all the associated refrigeration points for the pack have a lower load level than the configurable minimum load level (parameter *Min.LoadLevel* menu 3-2-1-2), the suction pressure is increased. The adjustment of the suction pressure setpoint is performed within configurable limits (parameter *to-Min., to-Max.* menus 3-2-1-3 / 3-2-1-4) using a configurable step size (parameter *Increment* menu 3-2-1-2) for the to setpoint increase; a configurable step size (parameter *Decrement* menu 3-2-1-2) for the to reduction and a configurable updating interval (parameter *Interval* menu 3-2-1-2). If "--" is entered for the parameter *Decrement* the to reduction is also performed with value set for *Increment*.

If the refrigeration of a case is subject to a forcibly actuated shutdown (defrost, external OFF etc.), the associated case controller does not influence the to-adjustment. The same applies when the corresponding control sensor (supply air/return air/room air temperature) on the case controller fails.

5.4.4.3 Setpoint shift via CAN bus

If the function to-shift via CAN bus is selected, the to-setpoint shift is performed via the CAN bus. This can be implemented using a higher level E*LDS controller (e.g. GLT 3010).

5.4.4.4 Setpoint shift via external analogue signal

If the to-adjustment via external signal has been selected (menu 3-2-1-2), the to setpoint shift is performed via an external 0..10 volts signal. The 0..10 volts analogue input at the terminals 51/52 is used for the to-adjustment.

> As this input is also used for the HP setpoint shift in HRC mode, a to-shift via the external signal is only possible when the HP setpoint shift is inactive. Conversely, an HP setpoint shift can only be activated when the to-shift is not performed via an external signal.

If the external to-shift is active, then - in order to detect a measuring circuit fault - a minimal input voltage can be specified using an offset. If the input signal falls below the specified offset value minus 2% for longer than 30 seconds, the error message "*M.err.ext.to-shift*" is output. If the offset is set to zero, no message is output. The default value for the signal is Prio. 2. If the to-shift via an external 0..10 Volt signal is active, the to-setpoint is calculated using the following function:

(1) $$t_{0Setpoint} = t_{0\_max} - \frac{(t_{0\_max} - t_{0\_min})}{(10V - U_{min})} \cdot (U_{ext} - U_{min})$$

toset: to-setpoint shifted by an external signal
to_{max}: Maximum permissible to (from already available to-characteristic curve)
to_{min}: Minimum permissible to (from already available to-characteristic curve)
U_{ext}: External 0..10 V voltage signal
U_{min}: Offset for the monitoring of a cable break

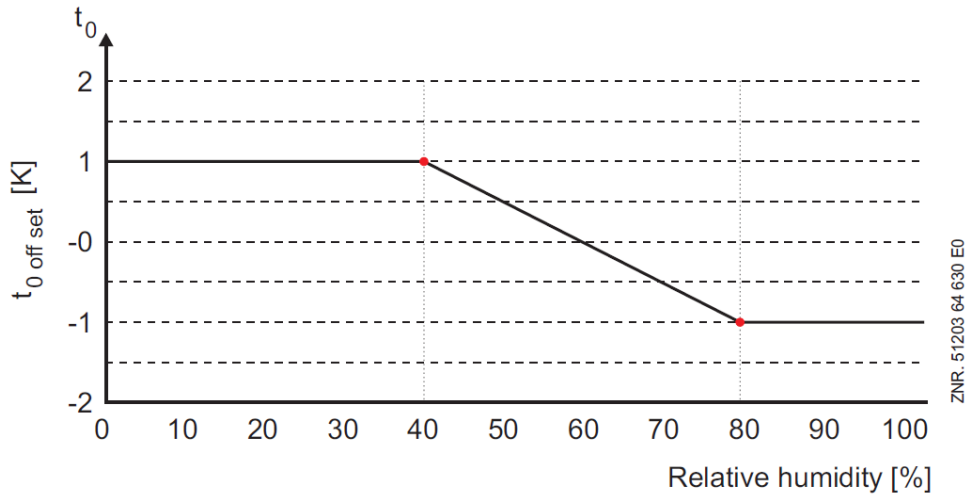
> In order to prevent large fluctuations in the to-setpoint, the change in the setpoint is delayed relative to the external signal.

Display of the associated setpoints:
If the HRC setpoint shift is active, the t0 setpoint shift cannot be activated and therefore the entry *Ext. Signal* is not displayed in the selection list.
If the to-adjustment via *Ext. Signal* is active, the HRC setpoint shift cannot be activated and therefore the parameter "*Setp.shift*." is not displayed in the HRC setpoints menu.
The parameters *Max.LoadLevel, Min.LoadLevel, Increment* and *Interval* in the to-adjustment menu are hidden if the to-adjustment is performed via the room temperature, CAN bus or an external signal.
The parameter *Off.Ext.Sig.* is only displayed if the to-adjustment is performed via the external signal.

5.4.4.5 Setpoint shift via humidity sensor

> If a demand-dependent setpoint shift (menu 3-2-1-2) has been selected, this parameter is **not** active / visible.

It can be set using the *humid. adapt.* parameter (menus 3-2-3 and 3-2-4) whether the t_0 setpoint should also be adjusted depending on the air humidity. The signal for air humidity can be accepted either from the humidity sensor or via the CAN bus from another pack controller (see chapter Ambient data for the setpoint switching). Depending on the air humidity, a temperature offset, $t_{0\ offset}$ is then formed that is added to t_{0_set}:



The setpoint for taking account of the air humidity can be set separately for the day and night operation.

5.4.5 Base load rotation

The operating time of each compressor is monitored internally. In order to achieve even operating time of the compressors, the compressor with the longest operating time is disabled and the compressor with the shortest operating time is enabled after expiry of a configurable cycle time.

For capacity-controlled compressors, base load rotation only occurs when the base load stage of an additional compressor is available. During base load rotation, the compressor with the longest operating time is disabled and the compressor with the shortest operating time is loaded. For base load rotation with capacity-controlled compressors, the switching state of the capacity stage(s) is also adopted for the new compressor. The base load rotation is only active under the following conditions:

- If all configurable compressors are enabled, base load rotation is only performed in the case of increasing pressure within the neutral zone.
- If compressors have been disabled due to load shedding, base load rotation is only performed in the case of increasing pressure.

The base load rotation can be adjusted using the *Cycle time F. / Cycle time C.* parameter (menu 3-6). If base load rotation is not required, the value "--" can be assigned to the parameter, and thus the base load rotation has been deactivated.

5.4.5.1 Base load rotation for speed controlled compressors

For systems with speed-controlled compressors, a speed controller can be assigned to the first two compressors (C1 and C2). Further fixed-speed compressors (C3..Cn) can also be controlled.
The base load rotation of the fixed-speed compressors (C3..Cn) is performed according to the procedure described in chapter Base load rotation Base load rotation, page 27.. Compressors (C1 and C2) that can be assigned to the speed controller are alternately activated on the speed controller following expiry of the cycle time or when all compressors are idle via a relay output of the VS 3010 C according to the following sequence.

Base load rotation with 2 running compressors (C1 + C2)	Base load rotation with 1 running compressor (C1 or C2)
Reduce speed to minimum value	
Disconnect compressor from the mains power supply	
Reduce speed to 0	Reduce speed to 0

Base load rotation with 2 running compressors (C1 + C2)	Base load rotation with 1 running compressor (C1 or C2)
3 seconds delay	3 seconds delay
Switch off speed controlled compressor	Switch off speed controlled compressor
6 seconds delay	6 seconds delay
Base load rotation	Base load rotation
3 seconds delay	3 seconds delay
With oil balancing: disable compressor at mains for idle time	
Without oil balancing: switch on compressor at the mains power supply	
Switch on speed controlled compressor	Switch on speed controlled compressor
Increase input signal (0..10 V) by 2 V/sec.	Increase input signal (0..10 V) by 2 V/sec.

If the cycle time for the base load rotation is specified as "-", no rotation is performed. The functioning of the oil balancing is described in chapter Oil balancing.
If there is any fault (motor overload cut-out or oil pressure switch) for the speed-controlled compressor (C1 or C2), any base load rotation is only performed once on the still available fixed-speed compressors. No base load rotation is performed if the compressor with the fault is on the mains power supply.
In order to switch over the FC compressor, the **last** compressor output of the corresponding expansion stage is used in each case:

- VS 3010 C in the basic configuration, output 4, terminals 43/44
- Configuration with one SIOX extension module, output 8, terminals 72/73
- Configuration with two SIOX extension modules, output 12, terminals 72/73

> The second stage of the spray system **cannot** be used when the system is operated with compressor combined control. If all outputs are occupied for compressors, no base load rotation occurs.

5.4.6 Load shedding

In order to prevent any defined energy consumption being exceeded, it may be necessary to initiate a forced shutdown of consumers. 3 digital inputs are provided in the pack controller for the load shedding. The compressors are switched off immediately.

> If the positive t_0 control error exceeds the limit value "*to max. diff.*" (menu 3-3) for 10 minutes, the signals at the digital inputs for load shedding are ignored at 10 minute intervals. This guarantees the intrinsic reliability of the refrigeration pack system (sufficient refrigeration capacity is provided).

One compressor per load shedding input is unloaded for single-stage compressors. One capacity stage of a compressor per load shedding input is unloaded for capacity-controlled compressors. If a capacity-controlled compressor should be completely unloaded via a load shedding input, the parameter *CompOFF.w.LdSh* (menu 3-1) must be set to "Y". This parameter is only displayed for capacity-controlled compressors.

Refer to the following table for the effect of the digital load shedding inputs:

	Number of disabled stages		
Number of activated load shedding inputs	**Parameter Verd.mLabw.AUS set to N**	**Parameter Verd.mLabw.AUS set to Y**	
		2 stages per compressor	**3 stages per compressor**
None	0	0	0
1	1	2	3

2	2	4	6
3	3	6	9

In the case of single-stage compressors, the compressor with the highest operating time is always unloaded. In the case of capacity-controlled compressors, the compressor which is not loaded to 100% is unloaded. If all compressors are loaded to 100%, the compressor with the highest operating time is unloaded.

Independently from the 3 load shedding signals, a minimum refrigeration capacity must be guaranteed which requires a minimum number of enabled compressors. The minimum number of enabled compressors is dependent on the number of compressors of a system. The following applies:

		Minimum number of the enabled stages		
Number of compressors	**Number of effective load shedding stages**	**Parameter Verd.mLabw.AUS set to N**	**Parameter Verd.mLabw.AUS set to Y**	
			2 stages per compressor	**3 stages per compressor**
1	**0**	1	2	3
2	**1**	1	2	3
3	**2**	1	2	3
4	**3**	1	2	3
5	**3**	2	4	-
6	**3**	3	6	-
7	**3**	4	-	-
8	**3**	5	-	-
9	**3**	6	-	-
10	**3**	7	-	-
11	**3**	8	-	-
12	**3**	9	-	-

If the suction pressure regulation is speed-controlled, the compressor connected to the FC can **not** be unloaded using load shedding. If single-stage and multi-stage compressors are in the pack, the single-stage compressors will be unloaded first.

5.4.7 Emergency power mode

The emergency power mode operating mode can be activated using the *Emerg.working* parameter (menu 3-1).

If the emergency power mode is activated using the above parameter, another entry *No.emerg.stages* is displayed on the operating screen (menu 3-1). The maximum number of compressor stages permitted to run in the emergency power mode can be set here. This parameter can be set between the following limits:

- minimum 1 compressor stage (guarantee of minimum refrigeration capacity)
- maximum 1 compressor stage less than maximum configuration

If the emergency power mode is selected, it can be activated via the digital input 19 (Load Shedding 3 / Emergency Power Mode, terminals 86/87), see chapter Connection and terminal assignment of VS 3010 C).

If emergency power mode is activated, all compressors are initially switched off. Afterwards, using the controller, up to "*No. emerg. stages*" (see menu 3-1) compressors can be activated again.

The emergency power operation is signalled from the VS 3010 C to the corresponding case controller via CAN bus. The addressed case controllers - depending on their parametrisation - then interrupt their energy intensive processes such as defrosting, cooling, fan etc. Further information about their settings can be found in the respective operating instructions of the relevant case controller in the chapter emergency power mode.

5.5 High-pressure regulation

The high-pressure is regulated in the controller using a high-pressure valve. The valve is actuated using an 0...10 V signal via the analogue output 3 (terminals 57/58).
The control variable, High pressure pc, is measured using a continuous pressure transmitter with linear characteristic at the analogue input 4 (terminals 44/45). The setpoint for the regulation is calculated depending on the gas cooler outlet temperature.

5.5.1 Control of high pressure control valve

The high pressure is regulated by a continuous HP control valve using a PI controller which calculates an opening degree for the valve via a control signal (0..10 V) from the controller. However, a configurable minimum value is not undercut. The amplification factors for the P-component (parameter *P-Wert*, see menu 3-2-2-2), the I-component (parameter *i-factor*, see menu 3-2-2-2) can be configured. If all available compressors have failed or if the input *System.OFF* is active, the HP control valve is closed).

The HP control valve can also be operated in manual mode. Using the parameter *Man. op. xxx %* in menu 3-2-2 -2), the valve opening degree can be set from 0... 100%. If "---" is entered, the opening degree is controlled via the controller.

In the event of a failure of the HP transmitter, a voltage of 5 volts is applied at the output for the HP control valve (middle opening degree)

5.5.1.1 Neutral zone HP control

A neutral zone is provided for the HP valve to prevent many load changes. If the high pressure is within a neutral zone, the correcting variable of the HP valve (0 to 10 volts output) is not changed. If 0.0 bar is specified as the HP neutral zone (parameter *Neutr.zone HP*, see menu 3-2-2-2), this function is deactivated.

5.5.1.2 HP valve control for stopped compressors

The parameter *HPV off w/comp* (see menu 3-2-2) defines whether the HP valve is closed for stopped compressors. If the parameter is set to *YES*, zero volts is output as control signal if the high pressure has undercut the *HP On Comp* (see menu 3-3) HP limit value and all compressor stages are unloaded. With the switching on of the first compressor stage, at least the minimum control signal is output again immediately (parameter *Min contr val.,* see menu 3-2-2) . The HP valve is not closed if the parameter is set to *NO*. The signal calculated by the controller or the minimum control signal is maintained.

5.5.1.3 Limitation of the HP valve opening degree by the medium pressure

The maximum opening degree of the HP valve in normal operation is 100% (10 volts at the output of the controller). If the pressure difference between the maximum permissible medium pressure and the actual value reduces, the maximum opening degree of the HP valve reduces to prevent any further increase of the medium pressure to critical values.
The limitation is used if the average value of medium pressure, setpoint and maximum pemissible medium pressure is exceeded (parameter *Setp. MP* menu 3-2-3 and parameter *MP Off Comp*, menu 3-3).
When the maximum permissible medium pressure is reached, the opening degree of the HP valve is 15% plus the minimum required opening degree (parameter *Min contr val.,* see menu 3-2-2).

5.5.2 High pressure setpoint calculation

The setpoint for the HP regulation depends on the operating mode of the regulation. Setpoint calculation is performed in normal and in HRC operation. The heat recovery mode can be activated and deactivated using the parameter *Ht. rec. mode Y/N* (menu 3-2-2-2). The activation and deactivation of the heat recovery mode are performed using the digital input 21 (terminals 90/91) or via CAN bus from an external controller.

5.5.2.1 HP regulation setpoint calculation in normal operation

The HP setpoint is calculated depending on the gas cooler outlet temperature.

> ⓘ If the sensor for the gas cooler outlet temperature is defective an HP setpoint of 80 bar is implemented.

The calculated high pressure setpoint ensures optimal use of energy under supercritical and subcritical conditions. The HP setpoint is limited by the parameters *HP-Min* and *HP-Max* (menu 3-2-2). Any desired supercooling is also taken into account. The supercooling can be configured using the parameter *Subcooling* (menu 3-2-2).

5.5.2.2 HD regulation setpoint calculation in HRC mode

In HRC mode, the HP setpoint can be determined using three different methods:

- Calculation using the HRC outlet temperature
- Specification using an external signal (0..10 V)
- HP setpoint specification from an external controller via CAN bus

Setpoint calculation using HRC outlet temperature
A setpoint is calculated that prevents any condensation of the refrigerant in the heat exchanger.Any specified superheat is not undercut for this. The superheat can be configured using the parameter *subcool.HRC* in menu 3-2-2. The HP setpoint may not exceed the limit value *HP-Max.HRC* (menu 3-2-2). If the sensor for the heat recovery outlet temperature is defective, the system is switched to controlled operation.

Setpoint specification by an external 0..10 V signal
The HRC setpoint is shifted using an external 0..10 V signal into the limits *HP-Min.HRC* and *HP-MAX.HRC* (menu 3-2-2-3). A lower limit value can be specified using the offset *Off.ext.Sig.* to, for example, connect a 1..10 V signal. If any signal offset is specified, an error message *M.err.ext.HP-shift* is output if the signal undercuts the value *Off.ext.Sig.* (cable break detection).

HD setpoint specification from an external controller via CAN bus
This function is only possible in combination with a GLT 3010. The operating mode can only then be activated if the parameter *HRC- mode* = *YES* and the parameter HRC-Pump = *YES* (menu 3-2-2-3) and an HRC request telegram is sent from the GLT 3010.
The setpoint calculation in this operating mode is performed by the external controller.

5.6 Gas cooler outlet temperature regulation

The gas cooler outlet temperature is regulated using the gas cooler fans .

Regulation

Various types of control (menu 3-2-2-1-a) are provided for the fan control:

- **Step controller**
  Regulation using enable and disable of fan capacity stages.
- **Speed controller**
  Regulation using speed controller (continuous control). The high pressure control is performed here using an analogue signal which specifies the required speed to the speed controller. The fans are all permanently connected in parallel to the speed controller.

- **Parallel combined control**
  Regulation using speed controller (continuous control). The high pressure control is performed here using an analogue signal which specifies the required speed to the speed controller. The fans are all connected in parallel to the speed controller, however they can be loaded or unloaded individually.
- **Stages combined control**
  Combination of step controller and continuous control. The high pressure control is performed here by enabling or disabling condenser capacity stages and using a speed-regulated fan.

5.6.1 Neutral zone fan control

Step control
If the gas cooler outlet temperature is within a configurable neutral zone, no switching of the fan stages is performed.

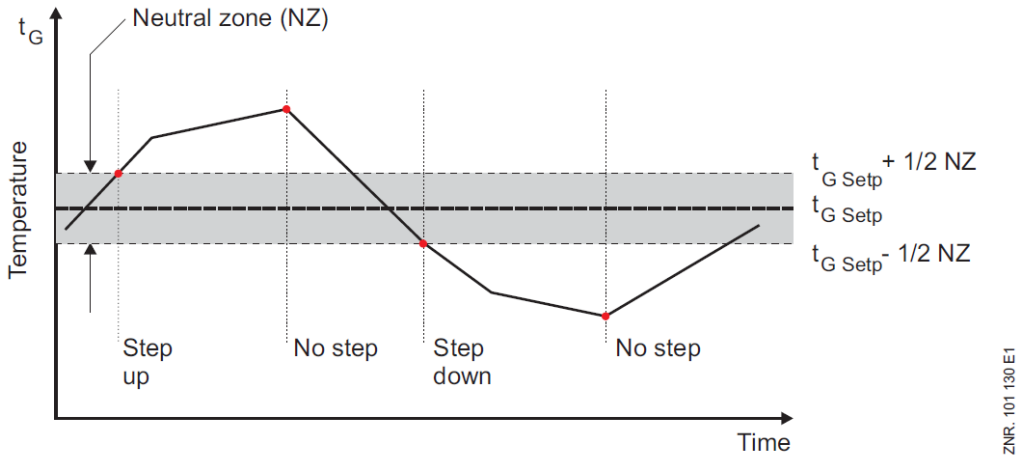
Continuous control
When the combined control type of control is active (stages combined control or parallel combined control), the neutral zone speed control (parameter *NZ speed con.*, see menu 3-2-2) affects the switching on and switching off of the fixed-speed fans.
If the actual value of the fan controller is within the neutral zone speed control, no fixed-speed fan is switched on or off.
The speed controller is enabled if the gas cooler outlet temperature exceeds the setpoint minus half the neutral zone speed controller. The enable for the speed controller is withdrawn when the setpoint has been undercut and the speed = Min. speed.

5.6.2 Control algorithm for fan control

The control algorithm depends on the type of control.

5.6.3 Control algorithm with step controller

If the gas cooler outlet temperature is increasing and outside the neutral zone, the step switch switches forwards one stage. In the case of negative control error and dropping gas cooler outlet temperature, the step switch, outside the neutral zone, switches back one stage. Fan stages are also disabled (provided this is selected via the parameter *Fan off w/comp* (menu 3-3-1)) when all compressors are switched off.

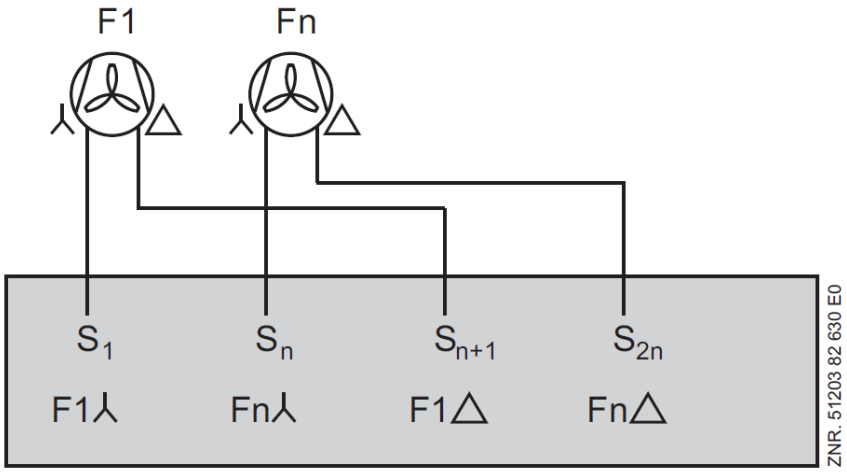


5.6.4 Switching modes for step control

There is a choice of three switching modes (menu 3-2-2-1-b) for the step control:

- **Direct**
  No star-delta switching
- **KKGG**
  The first half of the relay outputs actuates the star operation of the fan motors (K = low speed) while the second half of the outputs actuates the delta operation (G = high speed). A maximum of 6 fans can be controlled.
- **KKKG**
  The fan motors are loaded or unloaded with all except the last relay stage. With the last relay stage, all fans are switched simultaneously from star operation (K = low speed) to delta operation (G = high speed). A maximum of 11 fans can be controlled.

The following table shows the control of the fan outputs using the example of a system with two fans and four fan stages using the KKGG operating mode:



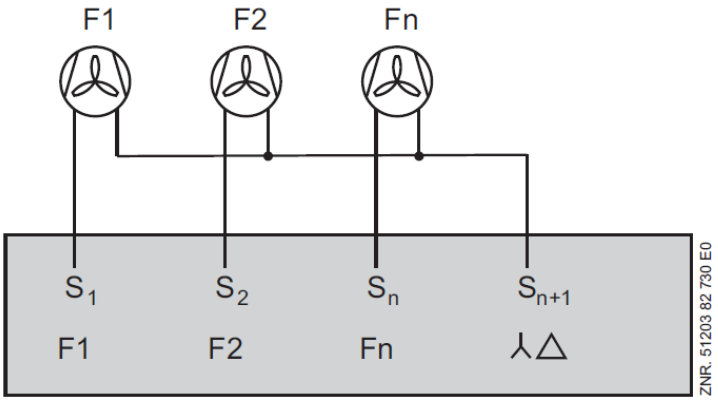
Config: 2 Fans
Actuation type: SSFF
n=2

n_{max}=
- VS 3010 basic module:
- 1st SIOX extension module:
- 2nd SIOX extension module:

S = Relay stage of the pack controller
F = Fan

Switching sequence KKGG	**Fan stage:**				
	$L1_{Stern}$ S1	**$L2_{Stern}$ S2**	**$L1_{\Delta}$ S3**	**$L2_{\Delta}$ S4**	
Shifting up					Fan 1: OFF / Fan 2: OFF
	F				Fan 1; low speed / Fan 2: OFF
	F	F			Fan 1; low speed / Fan 2: low speed
	F	F	F		Fan 1; high speed / Fan 2: low speed
	F	F	F	F	Fan 1; high speed / Fan 2: high speed
Shifting down	F		F		Fan 1; high speed / Fan 2: OFF
	F	F	F		Fan 1; high speed / Fan 2: low speed
		F			Fan 1: OFF / Fan 2: low speed
	F	F			Fan 1; low speed / Fan 2: low speed
	F				Fan 1; low speed / Fan 2: OFF
					Fan 1: OFF / Fan 2: OFF

The following table shows the control of the fan outputs using the example of a system with three fans and four fan stages using the KKGG operating mode:



Config: 3 Fan
Actuation type: SSSF
n=3

n_{max}=
- VS 3010 basic module: 3
- 1st SIOX extension module: 7
- 2nd SIOX extension module: 11

S = Relay stage of the pack controller
F = Fan

Switching sequence KKKG	Fan stage:				
	L1S1	L2 S2	L3S3	Star/Δ S4	
Shifting up					Fans 1, 2 and 3 OFF
	F				Fan 1 low speed / Fans 2 and 3 OFF
	F	F			Fans 1 and 2 low speed / Fan 3 OFF
	F	F	F		Fans 1, 2 and 3 low speed
	F	F	F	F	Fans 1, 2 and 3 high speed
Shifting down					All fans OFF
	F	F	F		Fans 1, 2 and 3 low speed
	F	F			Fans 1, 2 low speed / Fan 3 OFF
	F				Fan 1 low speed / Fans 2 and 3 OFF
					All fans OFF

The time delay for the switching from delta to star operation can be set using the parameter *Del. slow speed* (menu 3-2-2-1). In the *KKGG* and *KKKG* operating modes, the switching to high speed during night operation can be disabled to prevent noise using the parameter *Fast speed N* (menu 3-2-2-1).
If the gas cooler outlet temperature exceeds the setpoint specified in t_G*-Max* (menu 3-2-2-1), the high speed is loaded independently from the parameter described above. The fans do not switch back to the low speed again until the capacity stages are shifted down due to the falling pressure.

5.6.5 Regulation of the fan speed with continuous control

For the regulation of the gas cooler outlet temperature t_G , the controller calculates a fan speed that is specified via an analogue output or via Modbus. The following parameters are available in menu 3-2-2-1

Min. Drehzahl = Minimum speed
Max.Drehzahl T = Maximum speed day operation
Max.Drehzahl N = Maximum speed night operation
P-Wert = Configurable proportional factor
I-Wert = Configurable integral factor
Intervall I = Time interval for calculation of the I-component
Offset = Offset for fan speed control signal
tG-Max = tg- Max threshold value

The parameter *Min. speed* specifies the minimum speed that must not be undercut when a fan is switched on. The maximum fan speed for the day and night operation can be limited using the parameters *Max.speed D* and *Max.speed N*. The changeover of the limit values is performed using the setpoint shift (see Setpoint switching). If the tg- Max- threshold values is exceeded during night operation, the fan speed is limited again to the *Max.speed D* limit value. If the *TG-Max* threshold value is set to "---", no shifting down to *Max.speed D* during night operation is performed. The input is made in percent and refers to the speed range of the fans.

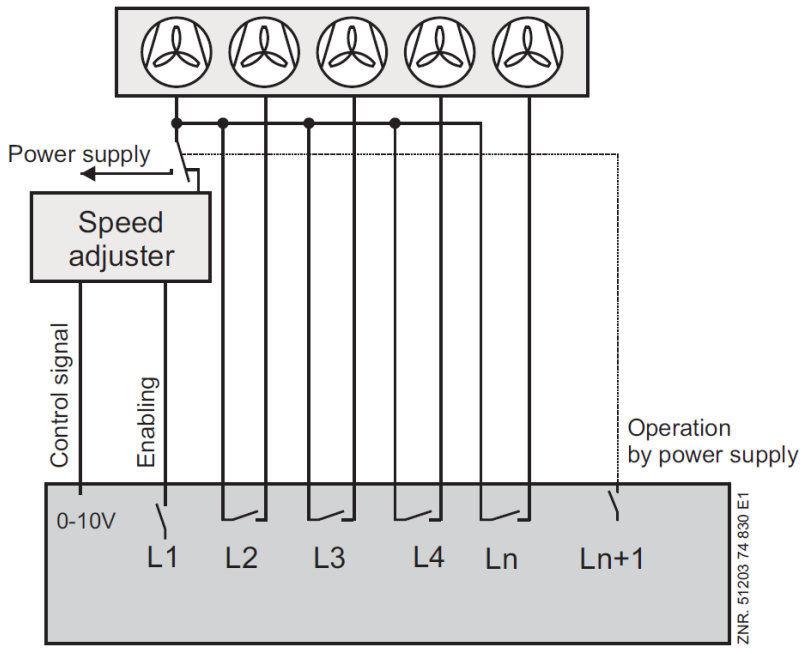
Power supply bridging (not for fan control via Modbus)
In the case of exceeding tg-Max limit value or any fault of the fan speed controller, power supply bridging is activated.
The activation of the power supply bridging can be deactivated by setting the parameter *tG-Max* to "-".
The power supply bridging is performed by switching the speed controlled fans to the mains power supply via an output of the controller and the 1st capacity stage (enable speed actuator) is disabled. Switching to controlled operation is performed when the gas cooler outlet temperature has undercut the setpoint again. The switching to mains operation for speed control is performed with the second fan stage and for the combined control with the fan stage (*No. cond.stages + 1*). The mains operation for stages combined control is deactivated if the motor overload cut-out of L1 trips.

> ⓘ In the case of condenser combined control, it must strictly be ensured that the output for the power supply bridging is used.

5.6.6 Control algorithm for parallel combined control type of control

The speed controller regulates the speed of all fans connected in parallel that can be switched on or off individually. Depending on the expansion stage of the VS 3010 C, the following maximum numbers of fan stages can be controlled:

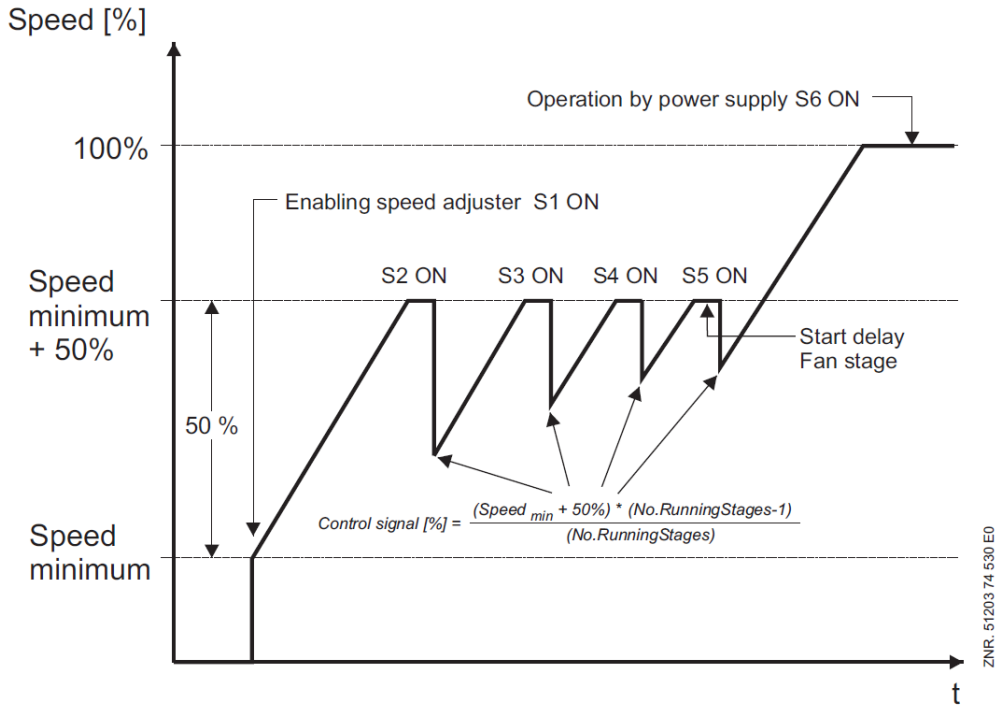
- VS 3010 C in the basic configuration: 3 fan stages
- Configuration with one SIOX extension module: 7 fan stages
- Configuration with two SIOX extension modules: 11 fan stages



The input signal for the first to the last but one fan stage is limited to the specified minimum speed plus 50% of the maximum input signal. If a stage reaches this limit value, a further capacity stage is activated after a time delay. The input signal for all now activated fans is calculated according to the following formula:

$$\text{input signal}\,[\%] = \frac{(\text{speed}_{min} + 50\%) \;\cdot\; (\text{number of running stages - 1})}{\text{number of running stages}}$$

If the last fan stage is activated, the input signal can achieve its maximum value. Fans which have been shut down via the motor overload cut-out will be ignored by the controller. The following diagram shows the speed sequence for starting using the example of a system with five fans:

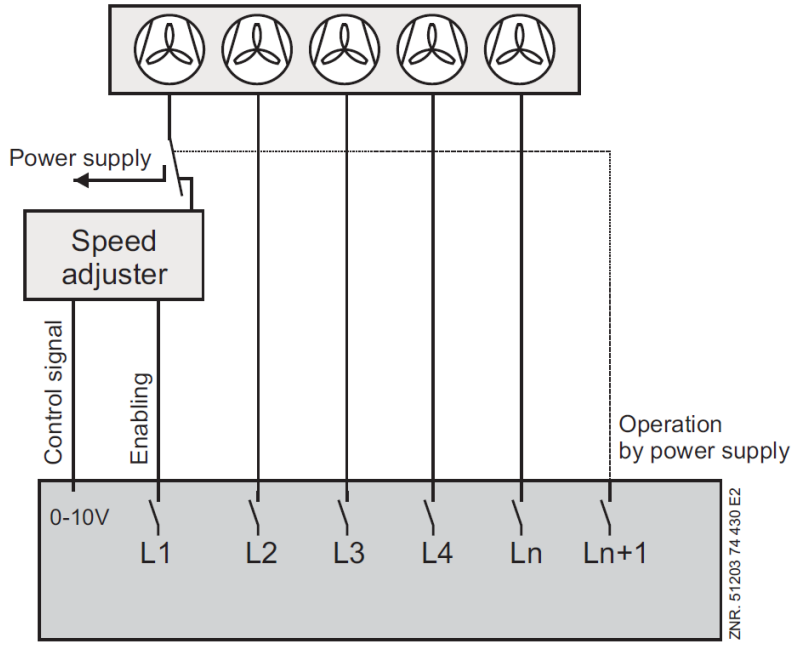


If the gas cooler outlet temperature is lower than the setpoint, the speed of all loaded fans is reduced to the minimum speed + 20%. Subsequently, fan stages are switched off at intervals. If only one fan stage is still active, the speed can be reduced to the minimum speed. Finally, the speed controller is disabled. The speed controller can be disabled by disabling the fan stage 1 (parameter *ENABL.COND* screen 3-1-e). The fan regulation then operates as a step controller with the steps 2 to n-1.

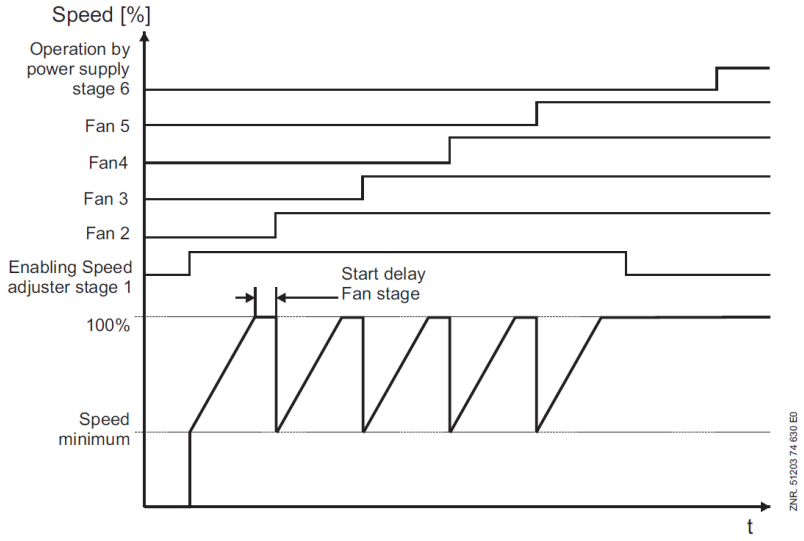
5.6.7 Control algorithm for stages combined control type of control

The fan regulation is performed using a fan that is controlled by a speed controller. Other stages connected to the mains power supply can be switched on or off individually.
Depending on the expansion stage of the controller, the following numbers of fan stages can be controlled:

- VS 3010 C in the basic configuration: 3 fan stages
- Configuration with one SIOX extension module: 7 fan stages
- Configuration with two SIOX extension modules: 11 fan stages



If the speed reaches its maximum value, a further capacity stage is activated after a time delay.
The input signal for the first fan stage is reduced to the minimum speed. Fans which have been shut down via the motor overload cut-out will be ignored by the controller.
The following diagram shows the speed sequence for starting using the example of a system with five fans:



The speed is reduced if the gas cooler outlet temperature is lower than the setpoint. If the minimum speed is reached, a fan capacity stage is unloaded after a time delay and the speed is increased to the maximum value at the same time. Finally, the speed controller is disabled via the first fan output S1 of the controller when the speed has reduced to 0. The speed controller can be disabled with the connected fans by disabling the fan stage 1 (parameter *ENABL.COND* screen 3-1-e) The fan regulation then operates as a step controller with the steps 2 to n-1.

5.6.8 Gas cooler package with integrated outdoor evaporator in bypass operation

The gas cooler package can be designed as follow in the refrigeration pack system:

- Gas cooler package can be bypassed using a gas cooler bypass (3-way valve)

- An outdoor evaporator (heat pump) can be integrated

The control of the gas cooler bypass and the outdoor evaporator is performed, for example by a GLT 3010.

The pack controller can specifically control the gas cooler fans in these two cases.

Gas cooler bypass operation

If the gas cooler is bypassed using a gas cooler bypass (3-way valve), the fans can be switched off during this operation. The parameter "*Fan OFF w.Byp.*" must be set to YES for this. The information whether the bypass is activated is signalled by a GLT 3010.

Outdoor evaporator

If the outdoor evaporator is activated, a GLT 3010 can request the activation of the gas cooler fans. The activation of the fans is performed in a cycle of seconds (the duty times are not taken into account here).

> ⓘ The activation of the gas cooler fans when the outdoor evaporator is activated has higher priority than the switching off during gas cooler bypass operation.

5.6.9 Gas cooler package with ebmpapst fans

ebmpapst is a manufacturer of fan motors that are controlled by the pack controller via the Modbus.

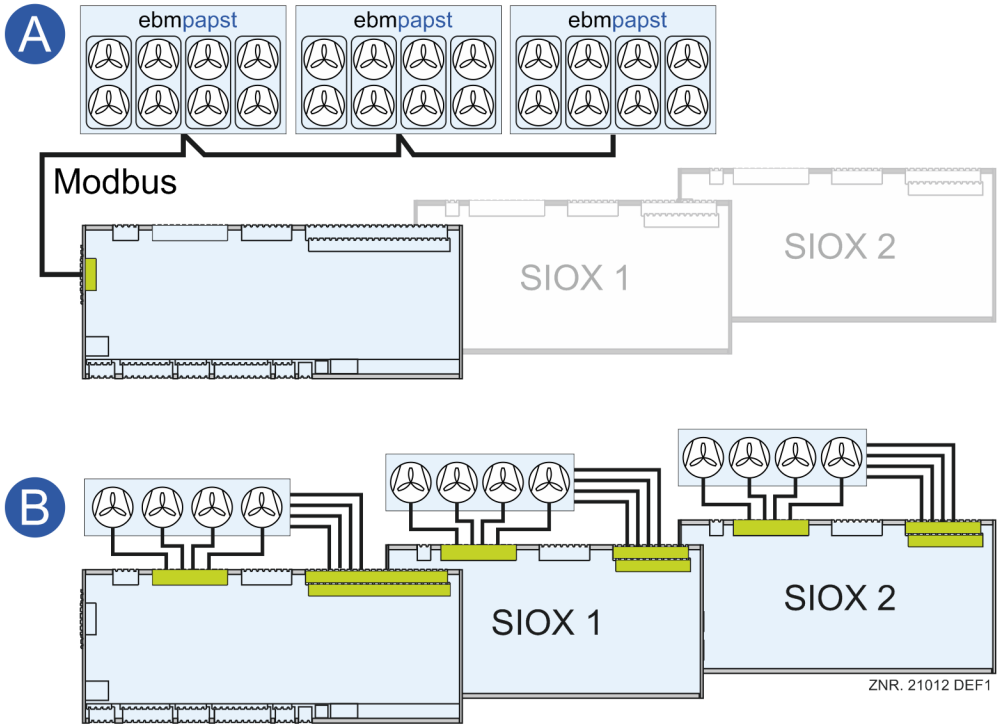
Requirements

- Pack controller must have a serial number (SN) >= 14xxxxx
- DIP switch 5 = ON, see Basic settings with S1, page 77 Basic settings with S1
- Jumper 1 must be set to "RS485 active", see chapter Setting of the interface RS485/TTY using jumper J1
- Modbus interface must be correctly wired, see chapter CAN bus, SIOX and Modbus (ebmpapst fans) terminal assignment

Function

The control and the diagnostics of the *ebmpapst* fans in the gas cooler package are performed exclusively via the Modbus. The regulation and the types of control for control of the *ebmpapst* fans via Modbus are identical to the control via the relays. The fan relays and their manual control switches on the basic module and the SIOX are then available for other functions.

Example: control of *24 ebmpapst* fans in two-row gas cooler packages (A) as compared with 12 fans that are controlled via relays (B) - here the basic module with 2 SIOX extension modules in full expansion:



For details about the pin assignment of the Modbus, see chapter CAN bus, SIOX and Modbus (ebmpapst fans) terminal assignment.

Commissioning of ebmpapst fans

1. The following possibilities are available for finding the fans:

- **Partial Search** e.g. after replacement of a defective fan
  Condition: the new fan must have the Modbus address 1 (factory setting). If this is not the case, the Manual Search (recommended) or the Complete Search must be performed.
- **Complete Search** for all fans (recommended for initial commissioning)
  Note: the configuration of the switching sequence is lost for the complete search and must be checked / defined.
- **Manual Search** for a fan by entry of its serial number

2. Defining configuration of the switching sequence
In the first step, the complete search sorts the switching sequence of the individual fans in the gas cooler package in ascending order according to their serial numbers. As the fans in the gas cooler package have a fixed (physical) position, their switching sequence (assignment to a stage) must be defined.

Example with 4 fan stages and a single-row gas cooler package:

- Modbus address allocation is performed automatically (not configurable), the fan with the lowest serial number always obtains the address 10 etc.
- Switching sequence is performed automatically, the fan with the lowest address obtains the switching sequence 1 etc.
- The switching sequence in this case is appropriate and does not have to be adjusted.

Single-row gas cooler package			
Stage 1	**Stage 2**	**Stage 3**	**Stage 4**
 **1** SN: JJWW00**0101** Modbus address: **10** Switching sequence: **1**	 **2** SN: JJWW00**0102** Modbus address: **11** Switching sequence: **2**	 **3** SN: JJWW00**0103** Modbus address: **12** Switching sequence: **3**	 **4** SN: JJWW00**0104** Modbus address: **13** Switching sequence: **4**

Example with 4 fan stages and a two-row gas cooler package:

- Modbus address allocation is performed automatically (not configurable), the fan with the lowest serial number always obtains the address 10 etc.
- Switching sequence is performed automatically, the fan with the lowest address obtains the switching sequence 1 etc.
- **Note: In the case of a two-row gas cooler package, the fans arranged in pairs are controlled jointly (as "one stage").**
  Therefore, their switching sequence for the fan pairs must be identical and manually adjusted:

Two-row gas cooler package			
Stage 1 **Fan pair 1**	**Stage 2** **Fan pair 2**	**Stage 3** **Fan pair 3**	**Stage 4** **Fan pair 4**
 **1** SN: JJWW00**0101** Modbus address: **10** Switching sequence: **1**  **2** SN: JJWW00**0102** Modbus address: **11** Switching sequence: ~~**2**~~ **becomes 1 ***	 **3** SN: JJWW00**0103** Modbus address: **12** Switching sequence: ~~**3**~~ **becomes 2 ***  **4** SN: JJWW00**0104** Modbus address: **13** Switching sequence: **4 becomes 2 ***	 **5** SN: JJWW00**0105** Modbus address: **14** Switching sequence: ~~**5**~~ **becomes 3 ***  **6** SN: JJWW00**0106** Modbus address: **15** Switching sequence: **6** **becomes 3 ***	 **7** SN: JJWW00**0107** Modbus address: **16** Switching sequence: ~~**7**~~ **becomes 4 ***  **8** SN: JJWW00**0108** Modbus address: **17** Switching sequence: **8** **becomes 4 ***

* Important: The automatic switching sequence (crossed out here) must be corrected manually!

> **Practical tip:** It is recommended to document the serial numbers, Modbus addresses and switching sequences of the ebmpapst fans in the gas cooler package. For other tips, see also chapter Inbetriebnahme Lüftersteuerung per Modbus.

3. Matching the number of ebmpapst fans to the number of fans in the system configuration (menu 3-1)

In the case of a two-row gas cooler package, the number of ebmpapst fans does not match those in the system configuration and must be adjusted. The number of fans in the system configuration must be half the number of ebmpapst fans.
Up to 24 ebmpapst fans are supported.

4. Removal of an ebmpapst fan

- For example, this function is required for the replacement of a defective fan

5. Emergency operation function of an ebmpapst fan

Every ebmpapst fan has its own emergency operation function (refer to the manual of the ebmpapst fans for details). The emergency operation function is **always activated for every** fan automatically by the pack controller via the Modbus and is configured as follows:

- In the event of failure of the Modbus communication, the emergency operation starts after a delay time of 30 seconds
- The fan runs at 80% of its speed during emergency operation

> In the case of interrupted Modbus communication (e.g. during service work or switching off the pack controller), the fans **always go automatically** into emergency operation. If this does not happen for a fan (e.g. reserve fan), these fans must be disconnected from the power supply.

6. Alarm signalling

The pack controller outputs the following messages in the event of faults:

- A status is requested from each ebmpapst fan via the Modbus. If the status of a fan has a value greater than zero, the message "Motorschutz Lx" (x can have the values 1..12) is output. The priority of the alarm is set in menu 3-7.
  At the same time, a second message is output in which an error status is transmitted. This message is structured as follows:
  Example message: L yy A:zz xxxxxxxx
  L: fan
  yy: switching sequence of the fan from 1..12
  A:zz: address 10..33
  xxxxxxxx: hexadecimal error code (refer to the manual of the ebmpapst fans for details).
- "*Comm.Error Fx*":
  This message is output if no ebmpapst fans are registered in the system or where the fan number "--" is registered for at least one fan.
- "*Comm.Error Fx*" (x can be the values 1..12):
  This message is output if communication with fan Lx is not possible.
  Note: this response is evaluated for each request and an internal error counter is incremented for each error. An alarm is signalled if this value reaches 5.

7. Manual Mode

In manual mode, the fans can be controlled between 0..100% during the normal operation (menu 3-2-2-1). The message "*EBM Manual Run"* is output if manual mode is activated. Manual mode is automatically deactivated after 60 minutes for the system safety.

Configuration

Menu	Parameter	Description	Value range	Default	Unit
3-1	No. cond.stages xx	Number of condenser stages. Note: the number of fans according to the gas cooler package must be checked / configured! Please note: • for single-row ebmpapst fans: number of condenser stages = number of ebmpapst fans • for two-row ebmpapst fans: number of condenser stages = number of ebmpapst fans / 2	0..12	4/8/12	-
The following parameters are only visible if DIP switch 5 = ON					
3-2-2-1	Switching sequence →	To the submenu for defining the switching sequence. The switching sequence (of the stages in the gas cooler package) for the controllers of the pack controller are set in the submenu. The switching sequence must be assigned for the physical position in the gas cooler package (see above point "*2. Defining configuration of the switching sequence"*): -- : Switching sequence has not been assigned and a message is output. This state is not permissible; the fan must be disconnected from the power supply otherwise it will run with 80% of its output in emergency operation. 0*: fan is removed from the switching sequence list. * Can only be set if authorisation = Master	--, 0, 1..12	--	-

Menu	Parameter	Description	Value range	Default	Unit
3-2-2-1	EBM Manual Run →	To the submenu for manual mode. Each fan can be manually controlled between 0..100% in the submenu. -- : Manual mode deactivated - the fans are controlled via the controller (automatic)	--, 0..100	--	%
3-2-2-1	Fan Scan Repl.	"Partial Search": only new fans added to the Modbus are searched for here, e.g. in the case of replacement of a defective fan. Condition: the new fan must have the Modbus address 1 (factory setting). If this is not the case, the "Manual Search" (recommended) or the "Complete Search" must be performed	Y/N	N	-
3-2-2-1	Fan Scan New	"Complete Search": all fans on the Modbus are searched for and reconfigured (recommended for initial commissioning) Note: the configuration of the switching sequence is lost for the complete search and must be checked / defined. Only visible if authorisation = Master	Y/N	N	-
3-2-2-1	New SNr:.:	"Manual Search": an ebmpapst fan can be added by entering its serial number (e.g. *1703000103*).	10-digit number	-	-
3-2-2-1	DEBUG EBM	This screen is for the Modbus diagnostics of ebmpapst fans and is not described in detail. Can only be set if authorisation = Master	-	-	-

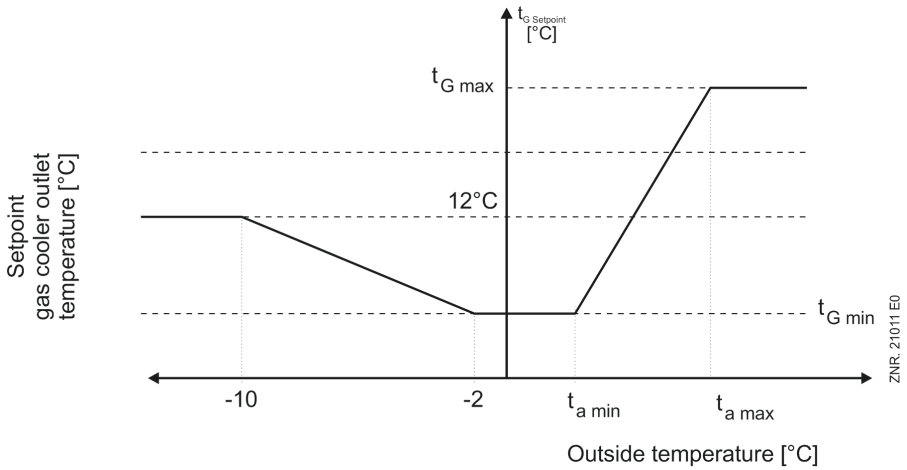
5.6.10 Setpoint calculation tG

The calculation of the t_G setpoint depends on the operating mode (normal operation or HRC operation).

5.6.10.1 Setpoint calculation in normal operation

The setpoint for the gas cooler temperature t_G is calculated depending on the outdoor temperature .
t_{G_max} = maximum t_G setpoint
t_{G_min} = minimum t_G setpoint
t_{a_max} = max. outdoor temperature for setpoint shift
t_{a_min} = min. outdoor temperature for setpoint shift
t_{G_min}, t_{a_min}, t_{G_max}, t_{a_max} can be configured.

In order to prevent system failures in the case of extremely low outdoor temperatures due to extreme part load, the "gas cooler outlet temperature" setpoint is increased in winter according to the characteristic curve below.



If the outdoor temperature is lower than -2 °C, the t_G setpoint is increased to maximum 12 °C.

5.6.10.2 Setpoint calculation in HRC mode

If HRC mode is active, the t_G setpoint is calculated depending on the high pressure. A tG setpoint is set that results from the HP setpoint minus the desired supercooling (parameter *subcool.HRC*, menu 3-2-2-3).

The setpoint cannot undercut the minimum specified gas cooler outlet temperature or the outdoor temperature. For high pressures, the setpoint is limited to 31 °C minus the configured supercooling (parameter *subcool.HRC*).

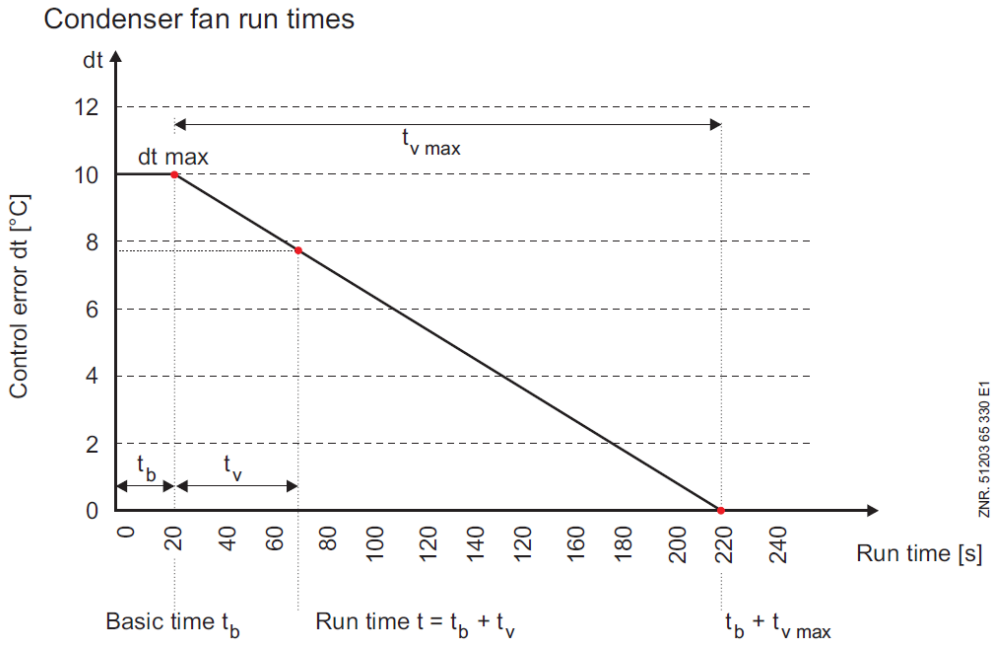
5.6.11 Switching times of the fans

Fan switching only occurs if the control error has exceeded a specified value (Neutrale Zone) and a specific time for loading or unloading has elapsed.
In the case of continuous control with a speed controller, the lead time has no influence on the enable of the speed controller. The switching time is calculated from the sum of a basic time t_b and a variable time t_v.

The variable time is inversely proportional to the control error. The higher the control error the shorter the delay. In the case of maximum control error, the variable time tv approaches zero. In the case of declining control error, the time tv is increased up to the specified maximum time.

If the gas cooler outlet temperature is greater than the setpoint plus 1.5 times the neutral zone, the switch-on delay is maximum 30 seconds. The basic time and the maximum variable time for the switching forward (switching on) and back (switching off) are parameters that can be configured for every switching forward/back

of a gas cooler capacity stage. The following diagram shows the switching time calculation:



5.6.12 Setpoint increase tG

It is possible for the VS 3010 C to enter a temperature offset t_G-Offset N (menu 3-2-2-2) which is added to the setpoint temperature t_{G_Soll} when setpoint switching is active.

5.6.13 Protection and base load rotation of the fan motors

In order to prevent long standstill times, base load rotation can be activated using the parameter *BaseLoadRot.F* (menu 3-6). If base load rotation is activated, the following additional parameters are displayed:

1. On time cond.
You can select between 2 operating modes:

- **Fan protection**
  If the parameter *On time cond.* is set to *N*, fans that were switched off for longer than the time *Cycle time F.* (menu 3-6) will be switched on for the duration of 20 seconds.
- **Runtime equalisation**
  If the value is set to *Y*, the switching sequence for the fans is changed. If a fan should be switched on, the fan with the shortest operating time is switched on. If a fan should be switched off, the fan with the longest operating time is switched off.
  If the gas cooler outlet temperature is in the neutral zone after the time *Cycle time F.* (menu 3-6), after expiry of this time, if available, the fan with the shortest operating time is switched on and the fan with the longest operating time is switched off.

2. *Cycle time F.*
A time can be entered, after which the previously described operating modes will be performed.

5.7 Medium pressure regulation

The VS 3010 C regulates the medium pressure (MP) of a CO_2 system using a PI controller. The analogue output 2 (terminals 55/56, 0..10 Volt) is available for the output of the correcting variable.

5.7.1 Regulation

The control signal for the MP control valve is calculated using a PI controller. The amplification factors *P-factor*, *I-factor* and the time interval for the formation of the I-component *Interval I* can be configured using the menu 3-2-3. The valve is closed if the "*Device OFF*" input is active. The MP control valve can also be operated in manual mode. Using the parameter *Man. op. xxx %* in menu 3-2-3 MP Regulation, the valve opening degree can be set from 0...100%. If "--" is entered, the opening degree is controlled via the PI controller. The manual mode is only used for test and service purposes.

In the event of failure of the MP transmitter, a voltage of 0 Volt is applied at the output for the MP control valve.

5.7.2 Medium pressure shift / monitoring of minimum superheat

Introduction
A minimum superheat guarantees safe operation of the compressor on the suction side. If this minimum superheat no longer takes place, an alarm is signalled that does not have an effect on the control action. The minimum suction gas superheat is monitored using two suction gas temperature sensors via the terminals 33/34 ($ÜH_k$) and 27/28 ($ÜH_v$) and covers a temperature range of -50 .. 200 °C. Two superheat values ($ÜH_k$ and $ÜH_v$) result from this that are monitored separately.

Restrictions

- When all compressors are idle, these error messages are blocked.
- The function can only be used for a system configuration of up to maximum 9 compressors.

Monitoring of the medium pressure shift / minimum superheat
The following setpoints exist for the monitoring of the minimum superheat:

Configuration

Parameter	Menu	Value range	Default	Unit	Description
Min.OH-C	3-3	2..15	4	K	Minimum permissible superheat on the case side
Del.Min.OH-C	3-3	1..30	10	Min.	Message transmission delay for the message ÜH-K too small
Min.OH-P	3-3	2..15	4	K	Minimum permissible superheat on the compressor side
Del.Min.OH-P	3-3	1...30	10	Min.	Message transmission delay for the message ÜH-V too small

"OH" stands for superheat, the "C" stands for cases and the "P" for pack:
- OHc: Suction pressure superheat between flash gas line and cases
- OHp: Suction pressure superheat between flash gas line and compressor

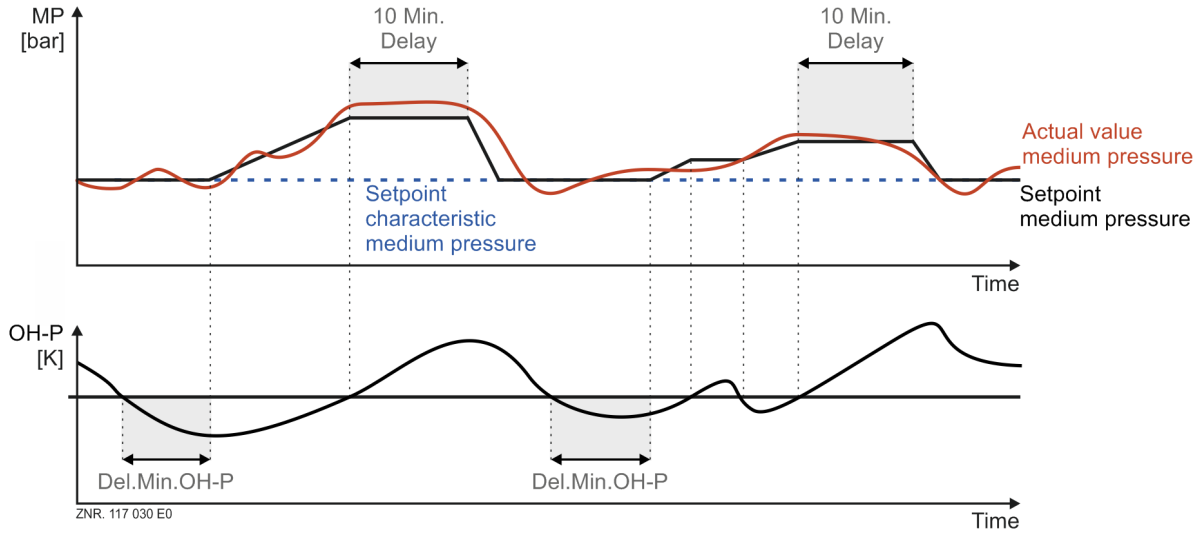
When all compressors are idle, these error messages are blocked. The following setpoints exist for the medium pressure setpoint shift:
OH-P-Incr./m: Ramp speed in bar/minute, using which the medium pressure setpoint should be increased in the event of a OHp fault (*Low Superheat-P*).
OH-P-Decr./m: Ramp speed in bar/minute, using which the medium pressure setpoint should be reduced in the event of a OHp fault (*Low Superheat-P*).
OH-C-Ramp/m: Ramp speed in bar/minute, using which the medium pressure setpoint should be reduced or increased in the event of a OHc fault (*Low Superheat-P*).

Function Description

A. Alarm signalling

- **Superheat on the case side**: if the superheat on the case side (OHc) falls to a value lower than the minimum superheat (Parameter *min.OH-C*), the error message "*Low Superheat-C*" is output after expiry of a time delay (parameter *Del.Min.OH-C*).
  The alarm is reset when the superheat OHc exceeds the setpoint "*min.OHc*" again and the MP setpoint is reset to its configured value (see C). If no compressor is switched on, no message is generated.
- **Superheat on the pack side**: if the superheat on the pack side (OHp) falls to a value lower than the minimum superheat (parameter *min.OH-P*), the error message "*Low Superheat-P*" is output after expiry of a time delay (parameter *Del.Min.OH-P*).
  In the event of a measuring circuit error "*M.err.SuctTemp-P*", no message is generated. The alarm is reset when the superheat OHp exceeds the setpoint "*min.OH-P*" again and the MP setpoint is reset to its configured value (see **B**).
  If no compressor is switched on, no message is generated.

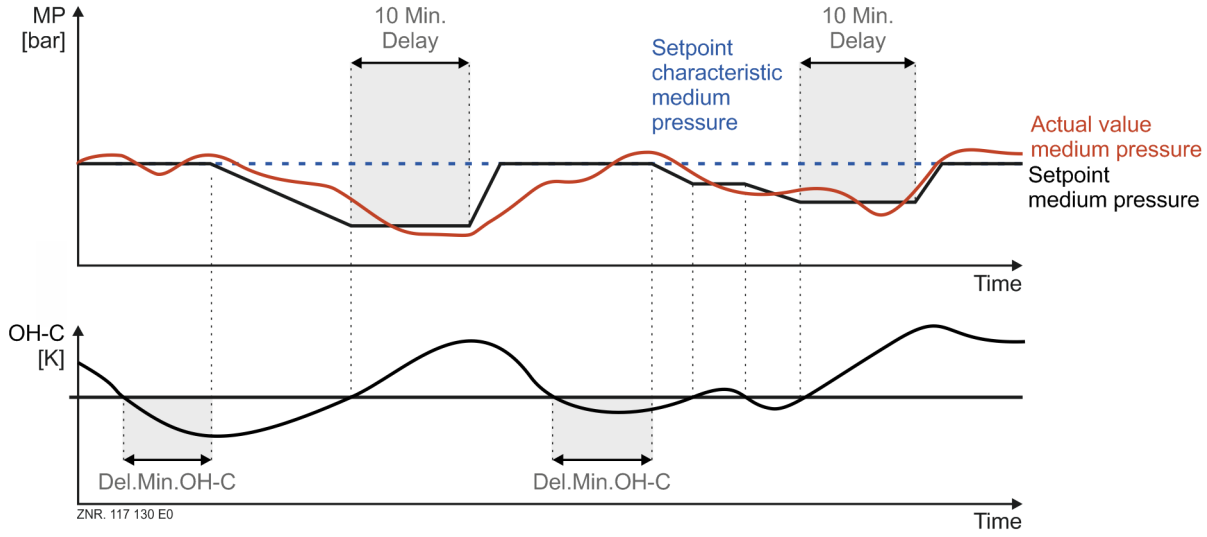
B. Medium pressure setpoint increase in the case of alarm "*Low Superheat-P*"
This function only becomes active if no setpoint reduction is active (see **C**). If the message "*Low Superheat-P*" is output after a configurable time delay, the medium pressure setpoint is increased using a ramp function. The setpoint is increased using the parameter "*OH-P-Incr./m*" until the superheat OHp has increased again to a value greater than "*min.OH-P*". Once this has occurred, the MP setpoint remains at the changed setpoint for a delay time of 10 minutes. If the superheat OHp is still greater than the minimum superheat "*min.OH-P*" after the delay time has elapsed, the setpoint is reduced again to the configured MP setpoint using the ramp "*OH-P-Decr./m*".
If the superheat OHp falls below the limit value "*min.OH-P*" within the 10 minutes delay time, the increasing of the setpoint is continued without taking account of the delay time "*Del.Min.OH-P*". The following diagram shows the process graphically:



The function is only active when the suction gas sensor OH-P is available.

C. Medium pressure setpoint reduction in the case of alarm "*Low Superheat-C*"
This function has priority over the setpoint increase. If the setpoint increase is active, this is interrupted by the setpoint reduction. If the message "*Low Superheat-C*" is output after a configurable time delay, the medium pressure setpoint is reduced using a ramp function. The setpoint is reduced using the parameter "*OH-C-Ramp/m*" until the superheat OHc has increased again to a value greater than "*min.OH-C*". Once this has occurred, the MP setpoint remains at the changed setpoint for a delay time of 10 minutes.
If the superheat OHc is still greater than the minimum superheat "*min.OH-C*" after expiry of the delay time, the setpoint is increased again to the MP setpoint using the ramp "*OH-C-Ramp/m*". The MP setpoint is reduced to the currently calculated to-setpoint plus 3 bar. If the superheat OHc falls below the limit value "*min.OH-C*" within the 10 minutes delay time, the reduction of the setpoint is continued without taking account of the delay time

"*Del.Min.OH-C*".
The following diagram shows the process graphically:



The function is only active when the suction gas sensor *OH-C* is available. As long as MP setpoint reduction is active due to "*Low Superheat-C*", no setpoint increase due to "*Low Superheat-P*" can take place.

5.7.3 Setpoint reduction above medium pressure

The function is only active when *MP const.valve* is set to "*No*" (menu 3-1). This function is deactivated when ECO operation is running.

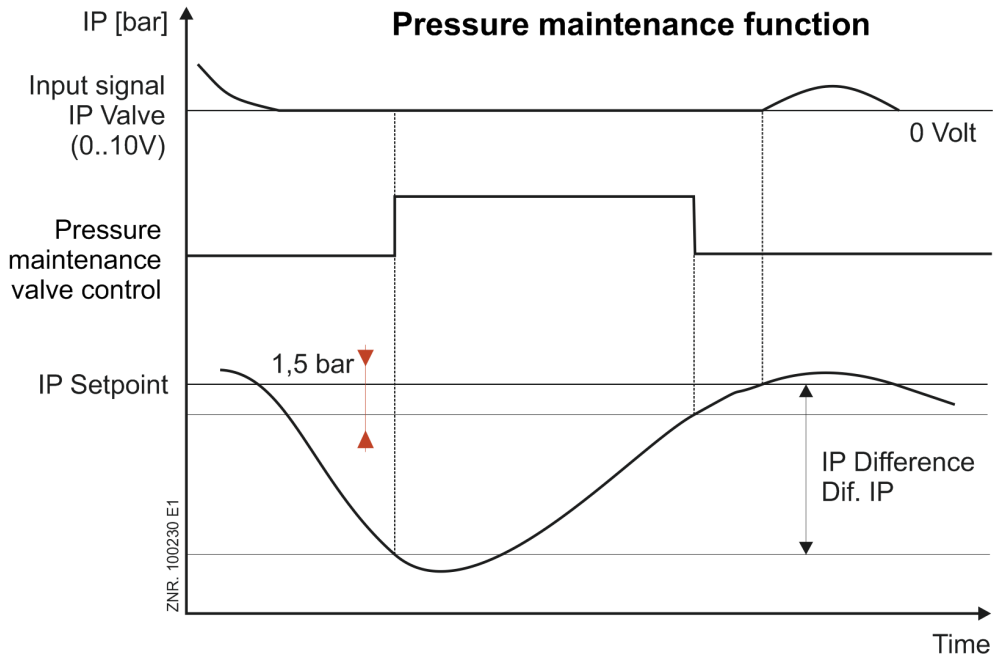
A minimum difference between the medium pressure actual value and the suction pressure setpoint is maintained with this function. The desired pressure difference can be configured with the parameter *Min MP/LP Diff* (menu 3-3). The suction pressure setpoint is reduced with falling medium pressure that results in loading of compressors and thus in increase of the medium pressure to the desired pressure level.

5.7.4 Medium pressure maintenance

The medium pressure can be maintained using a pressure maintenance valve or by opening the HP valve . The operating mode can be set with the parameter *MP const.valve* (menu 3-1).

5.7.4.1 Medium pressure maintenance via pressure maintenance valve

If the medium pressure valve is closed (0 Volt control signal) and the medium pressure falls below the medium pressure setpoint minus a maximum pressure difference, a pressure maintenance valve is activated.
The pressure maintenance valve is switched off again when the medium pressure has reached the MP setpoint minus 0.5 bar. The maximum pressure difference can be configured.
The following is a graphic representation of the pressure maintenance valve control:



The pressure maintenance valve is switched off for a fast unload. The setpoints for the MP regulation or control of the pressure maintenance valve *Setp. MP* and *MP dif.* are configured using the menu 3-2-3.

5.7.4.2 Medium pressure maintenance by opening the HP valve

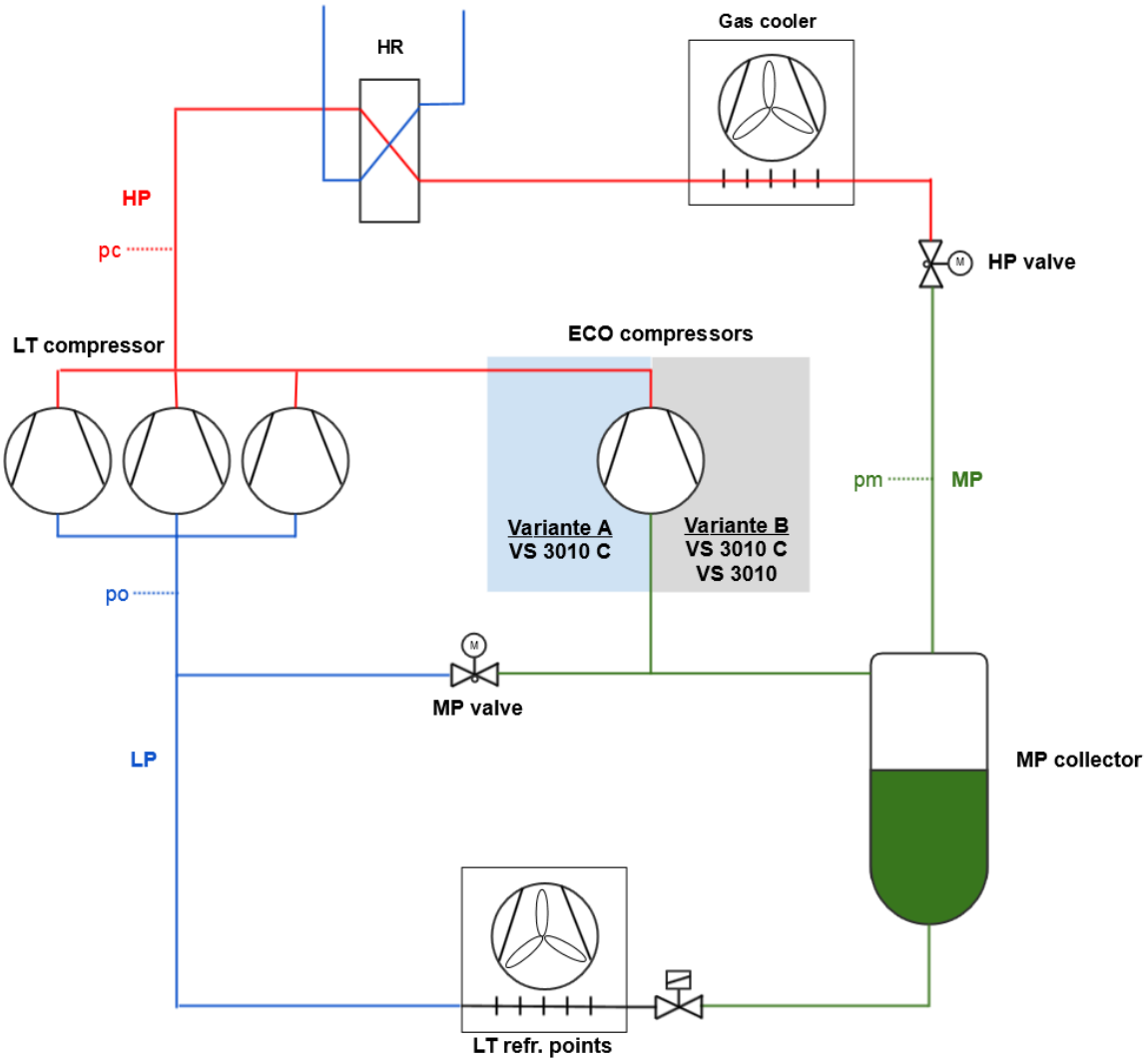
If no pressure maintenance valve is available, the HP valve can be opened when medium pressure is dropping. The HP valve can be opened with the minimum opening degree *Min contr val.* (menu 3-2-2-2) when the high pressure is greater than 40 bar and the medium pressure has fallen to 1.0 bar below the MP setpoint. If the medium pressure falls lower than 1.5 bar below the MP setpoint, the HP valve can be opened continuously for further dropping medium pressure. Using this function, the HP valve can be opened up to 30% of the maximum opening degree. However, the opening degree can be higher due to the HP regulation. This function is deactivated when ECO operation is running.

5.8 ECO operation

Introduction

A configuration of a refrigeration pack system that controls the "ECO compressors" for regulation of the medium pressure is designated as ECO operation. The ECO compressors can be controlled in two ways:

- Variant A: Control by the VS 3010 C pack controller
- Variant B: Control by the VS 3010 C pack controller **and** a separate pack controller (e.g. VS 3010)



These variants are described below.

5.8.1 Control by a VS 3010 C

Introduction

The ECO compressors are controlled via the VS 3010 C pack controller.

Requirements

- DIP switch S1 - coding switch 5 set to ON, see Basic settings with S1
- The parameter "*ECO operation*" (menu 3-2-4) must be set to YES.
- The parameter "*ECO compressor*" (menu 3-2-4) must be set to YES.

Conditions for the enable of ECO operation

The following values are included for the enable of the ECO operation**:**

- In normal operation, the outdoor temperature must be above the "*Temp.ECO ON*" limit value.
- In HRC mode, the gas cooler outlet temperature must be above the "*Temp.ECO ON HR*" limit value.
- In HRC mode, the HRC outlet temperature must be above the "*Temp.ECO ON HR*" limit value if the gas cooler package is bypassed using the gas cooler bypass valve.
- Opening degree of the medium pressure valve that must be above the "*Min.op.deg.MPV*" limit value for 3 minutes.
- The minimum standstill time of the ECO operation must be complied with, see parameter "*ECO Idletime*".

> If any of these conditions is not met, the enable is withdrawn immediately!

Conditions for the block of ECO operation

The following values are included for the blocking of the ECO operation**:**

- No low pressure compressor is running (at least one LP compressor must run).
- There is a high pressure fault.
- The outdoor temperature sensor or the medium pressure transmitter has a measuring circuit error.

Configuration

The following parameters are required for the control of the ECO compressor. The ECO compressor draws in the refrigerant before the medium pressure valve and pumps the refrigerant to the high pressure side before the gas cooler.

ECO operation

Menu	ECO POS: XXXXX	Description	Input	Default	Dim.
3-2-4	ECO-Mode X	Activation of the ECO operation (YES)	Y/N	N	-
3-2-4	Temp.ECO ON XX °C	Switch-on temperature for the ECO operation solenoid valve --: The switch-on temperature for the HRC ECO operation solenoid valve is ignored.	--, 20..40	29	°C
3-2-4	Temp.ECO ON HR	Switch-on temperature for the HRC ECO operation solenoid valve when gas cooler bypass is active --: The switch-on temperature for the HRC ECO operation solenoid valve is ignored.	--, 15..40	29	°C
3-2-4	Hysteresis XX K	Difference for the ECO operation switch-on temperature, using which the temperature for the shutdown of the ECO operation is defined.	2..10	4	K
3-2-4	Min.op.deg.MPV	Minimum opening degree of the medium pressure valve for the enable of the ECO compressors	10..80	60	%
3-2-4	ECO Idletime	Minimum standstill time of the ECO compressor	10..360	300	sec.

3-2-4	ECO compressor *	Activation of the ECO compressors YES: ECO compressors are controlled via the VS 3010 C NO: ECO compressors are controlled via a separate VS 3010	Y/N	N	-
The following parameters are only visible if "ECO-compressor" = Yes					
3-2-4	No.ECO comp.	Number of ECO compressors	1	1	-
3-2-4	Basic load time →	Display basic times t_b ON	→	Screen 3-2-4-a Screen 3-2-4-b Screen 3-2-4-c Screen 3-2-4-d	
3-2-4	Vari. load time →	Display of the variable times t_v ON	→		
3-2-4	Basic unload time →	Display basic times t_b OFF	→		
3-2-4	Vari. unload time →	Display of the variable times t_v OFF	→		
3-2-4	Control const. XX K	Max. control error for variable switching times	1..15	3	K
3-2-4	Enab.Mot.Prot.	Enable for the motor protection monitoring of the ECO compressors	Y/N	Y	-
3-2-4	Enab.Oil/HP-C.	Enable for the oil/HP monitoring of the ECO compressors	Y/N	Y	-
3-2-4	P-factor X.X	P-factor of the combined control for the ECO compressors Example: for control error of 1 K with a P-Wert of 1, the P-component is 1 V	0.0..3.0	0.7	V/K
3-2-4	I-factor X.XX	I-factor of the combined control for the ECO compressors Example: for control error of 1 K with an I-Wert of 0.5, the I-component changes with 0.05 V per cycle time (1 second) of the controller **Attention:** The set value is reduced by a factor of 10!	0.00..1.00	0.10	V/K.s
3-2-4	MP-Valve offs. X.Xb	Offset to the setpoint of the medium pressure valve regulation	0.5..2.5	1.0	bar

* The parameter is only displayed if the DIP switch S1 coding switch is set to ON.

5.8.2 Control by a VS 3010 C and a separate pack controller

Introduction

The ECO compressors are controlled via the VS 3010 C pack controller **and** a separate pack controller (e.g. VS 3010) that receive an enable signal from the VS 3010 C pack controller. The VS 3010 C outputs the enable signal at the relay output 10 (terminals 3/4).

Requirements

- Second VS 3010 pack controller
- The parameter "*ECO-Mode*" (menu 3-2-4) must be set to YES.
- The parameter "*ECO-Compressor*" (menu 3-2-4) must be set to NO.

Conditions for the enable of ECO operation

The following values are included for the enable of the ECO operation:

- In normal operation, the outdoor temperature must be above the "*Temp.ECO ON*" limit value.
- In HRC mode, the gas cooler outlet temperature must be above the "*Temp.ECO ON HR*" limit value.
- In HRC mode, the HRC outlet temperature must be above the "*Temp.ECO ON HR*" limit value if the gas cooler package is bypassed using the gas cooler bypass valve.
- Opening degree of the medium pressure valve that must be above the "*Min.op.deg.MPV*" limit value for 3 minutes.
- The minimum standstill time of the ECO operation must be complied with, see parameter "*ECO idletime*".

ⓘ If any of these conditions is not met, the enable is withdrawn immediately!

Conditions for the block of ECO operation

The following values are included for the blocking of the ECO operation:

- No low pressure compressor is running (at least one LP compressor must run).
- There is a high pressure fault.
- The outdoor temperature sensor or the medium pressure transmitter has a measuring circuit error.

Configuration

The following parameters are required for the control of the ECO compressor. The ECO compressor draws in the refrigerant before the medium pressure valve and pumps the refrigerant to the high pressure side before the gas cooler.

Menu	ECO POS: XXXXX	Description	Input	Default	Dim.
3-2-4	ECO-Mode X	Activation of the ECO operation (YES)	Y/N	N	-
3-2-4	Temp.ECO ON XX °C	Switch-on temperature for the ECO operation solenoid valve --: The switch-on temperature for the HRC ECO operation solenoid valve is ignored.	--, 20..40	29	°C
3-2-4	Temp.ECO ON HR XX °C	Switch-on temperature for the HRC ECO operation solenoid valve when gas cooler bypass is active --: The switch-on temperature for the HRC ECO operation solenoid valve is ignored.	--, 15..40	29	°C
3-2-4	Hysteresis XX K	Difference for the ECO operation switch-on temperature, using which the temperature for the shutdown of the ECO operation is defined.	2..10	4	K
3-2-4	Min.op.deg.MPV	Minimum opening degree of the medium pressure valve for the enable of the ECO compressors	10..80	60	%
3-2-4	ECO idletime	Minimum standstill time of the ECO compressor	10..360	300	sec.
3-2-4	ECO compressor *	Activation of the ECO compressors YES: ECO compressors are controlled via the VS 3010 C NO: ECO compressors are controlled via a separate VS 3010	Y/N	N	-

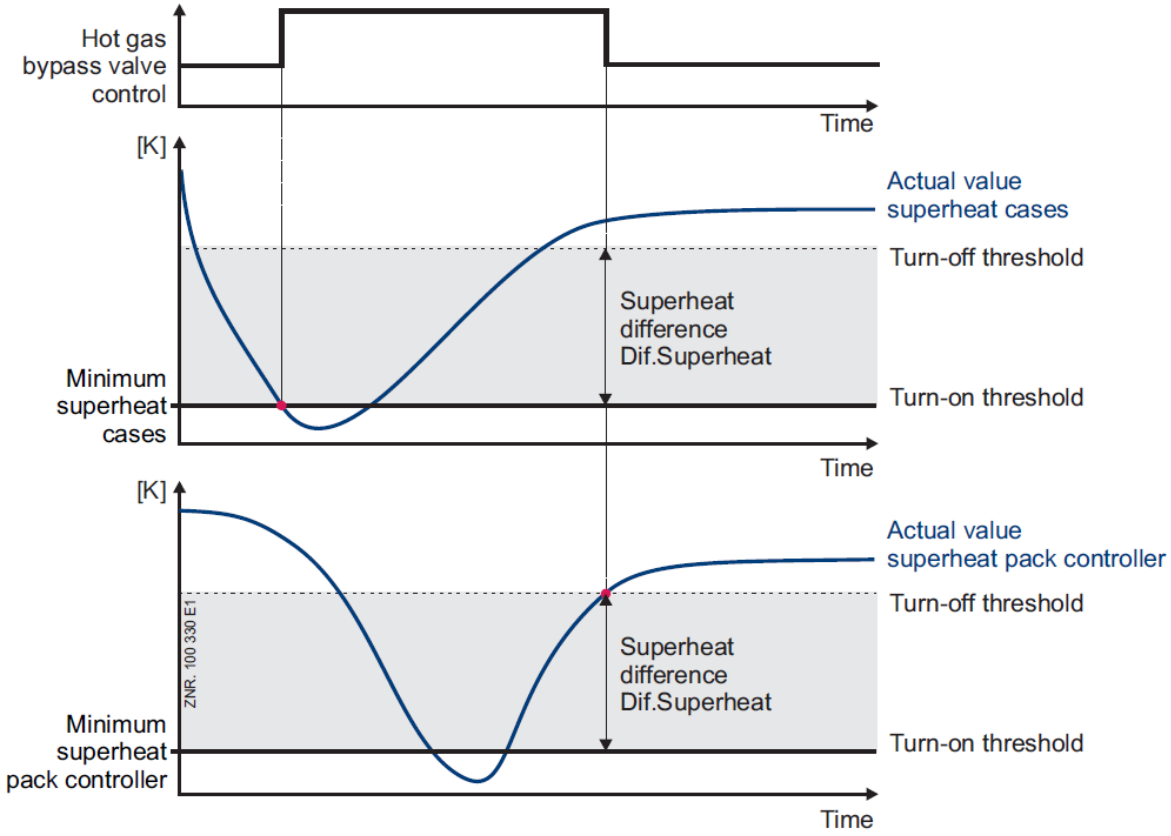
* The parameter is only displayed if the DIP switch S1 coding switch 5 is set to ON.

5.9 Regulation of the minimum superheat using a hot gas bypass valve

The VS 3010 C can control a hot gas bypass valve. The control is only possible if the ECO operation has **not** been activated and the parameter "*HotGasByp.*" (menu 3-3) is set to **YES**.

The hot gas bypass valve is opened/switched on when either the specified minimum superheat of the refrigerated cases (parameter *Min.OH-C*) or the minimum superheat of the pack (parameter *Min.OH-P*) has been undercut. The valve is closed again when the refrigerated cases superheat has exceeded the superheat setpoint "*Min.OH-C*" plus the difference "*Dif.Superheat*" again and the pack superheat has exceeded the superheat setpoint "*Min.OH-P*" plus the difference "*Dif.Superheat"* again.
If only one of the two suction gas temperature sensors (suction gas temperature of pack or refrigerated cases) is recognised so that it is only possible to calculate one of the two superheat values, the function only refers to the available sensor.

The following is a graphic representation of the hot gas bypass valve:



In the case of a fast unload, the hot gas bypass valve is switched off.
The parameters superheat difference *Dif.Superheat* minimum refrigerated cases superheat *Del.Min.OH-C* and minimum pack superheat *Del.Min.OH-P* used for controlling the hot gas bypass valve can be reached via the menu 3-3.

5.10 Regulation of the maximum superheat using the suction gas injection valve

Introduction
The suction gas injection valve regulates or influences the following two factors:

1. Cylinder head temperature of the compressors
2. Suction gas temperature or suction gas superheat

The suction gas injection valve is controlled using on-off control. The cylinder head temperature and/or suction gas superheat are used for the regulation.

Requirements
This function is only available when

- Menu 3-1: "*HotGasByp.*" set to N
- Menu 3-2-4: "*ECO-Mode*" must be set to N or
  ECO operation is activated (Yes) and parallel compressors are activated (Yes)

Configuration

Menu	Parameter	Description	Value range	Default	Unit
3-3	Inj.Temp	Limit value of the cylinder head temperature at which injection is performed or the valve is operated in normal operation.	---, 80..140	140	°C
3-3	Inj.Temp.HR	Limit value of the cylinder head temperature at which injection is performed or the valve is operated in HRC operation.	---, 90..150	140	°C
3-3	Dif.Inj.Temp	Hysteresis for switching off the suction gas injection valve. The limit value for switching off the suction gas injection is calculated with this: Limit value = "Inj.Temp" - "Dif.Inj.Temp" or Limit value = "Inj.Temp.HR" - "Dif.Inj.Temp"	5..20	20	K
3-3	Min.Superht.-C XX	Minimum permissible superheat on the case side. The valve for suction gas injection is switched off if the minimum superheat undercuts this limit value	5..15	4	K
3-3	Min.Superht.-P XX	Minimum permissible superheat on the pack side. The valve for suction gas injection is switched off if the minimum superheat undercuts this limit value.	2..15	4	K
3-3	Dif.Superheat XK	Hysteresis for switching on the suction gas injection valve. Limit value = "Min.Superht.-C" + "Dif.Superheat" or Limit value = "Min.Superht.-P" + "Dif.Superheat" Note: This parameter is used for the two functions "hot gas bypass" and "suction gas injection".	1..10	2	K

5.11 Monitoring

In addition to control and regulation functions, the following monitoring functions are integrated in the controller:

- Safety chain
  - Compressor high pressure limiter
  - Compressor low pressure limiter
  - Compressor oil/HP / oil/HP pressure switch
  - Compressor motor overload cut-out
- Compressor cylinder head temperature
- Low pressure
- High pressure
- Medium pressure
- Fan motor overload cut-out
- Fan speed controller
- Compressor speed controller
- External alarm
- Switching frequency
- Refrigerant

- Fast unload / external OFF
- Rupture disk

5.11.1 Safety chain

For reasons of redundancy of the monitoring system, precautionary measures, in addition to the monitoring functions of the VS 3010 C, have been taken to disable all or individual compressors of a pack under critical operating conditions. The switching contacts used for this due to the type of wiring of the system are prioritised below in ascending order:

Disable all compressors
1. Safety high pressure cut-out
2. HP limiter
3. NP monitor

Disable relevant compressors
4. Compressor high pressure limiter
5. Compressor motor overload cut-out

Due to their arrangement in the safety chain, when a high priority safety contact (e.g. high pressure limiter) is tripped, all lower priority alarm contacts are also deenergised and thus active. The sending of low priority alarm signals at the same time when a higher priority alarm event occurs is locked so that all secondary alarms are not sent by the pack controller in this case.

5.11.1.1 Monitoring of differential oil pressure switch / compressor high pressure limiter

The oil differential pressure, the high pressure at the pressure ports of every compressor, or both, can be monitored via digital inputs with floating contacts.
Using the parameter *Text Oil/HP-F.* (menu 3-1), it is possible to select which type of pressure switches should be monitored via these inputs. This parameter can be used to select the message text output when the signal inputs for the oil differential switch / HP monitor for compressors 1-12 are activated:
1 *Oil diff. pr. Cx* or
2 *HP-Cutout Cx* or
3 *Oil/HP-Fault Cx*
The pressure switches are open in the alarm state. If the pressure switch trips, the compressor is switched off immediately and disabled for the following control processes. If it is reset, the compressor is enabled.

> ⓘ If no oil differential pressure switch or HP limiter is used, the monitoring of the oil differential switch / HP limiter for the compressor can be activated / deactivated using parameters.

Oil / HP switch alarm delay (only for refrigerant CO_2)
The alarm signalling for the oil/HP switch can be delayed:
the requirements for this are:

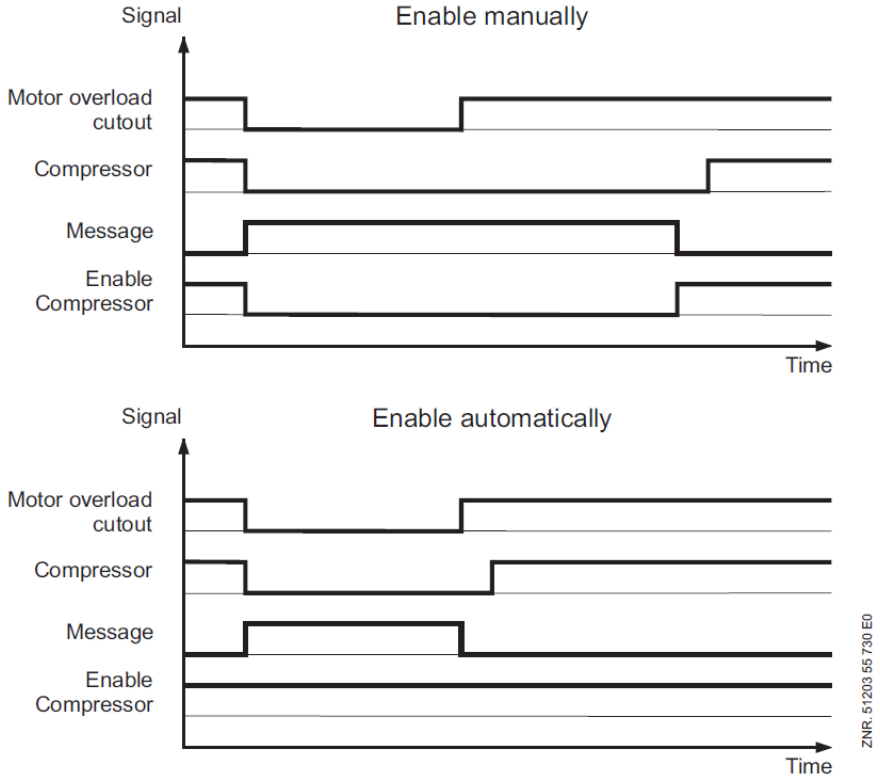
- The alarm input is enabled using the parameter *Oil pr. cutout* = *YES*
- An alarm delay *Del.Oil/HP-F.* greater than zero minutes is specified
- The alarm priority is not "---"

Then in the event of an oil / HP fault of a compressor, an appropriate alarm with the preselected message priority is not sent and registered in the message memory until after expiry of the delay time.
However, in order to ensure that any short-time compressor oil / HP fault is registered in the message list, a temporary message (timestamps "come" and "go" simultaneously) with the priority "0" is initially registered when any compressor HP fault is detected.

5.11.1.2 Monitoring of the compressor motor overload cut-out

The compressor motor is monitored by the motor overload cut-out. The auxiliary contact is open in the alarm state (no signal at the input of the controller). If the motor overload cut-out trips, the compressor is switched off immediately and disabled for the following control processes. The compressor can be enabled again automatically or manually if the motor overload cut-out is reset. The type of compressor enable after tripping of a motor overload cut-out is defined using the parameter *Motor protect.* (menu 3-1). With the entry of *Motor protect. Y*, the compressor is switched off and permanently disabled with the tripping of the motor overload cut-out. A manual enable must be performed (menu 3-1-c *Enable comp.stages*).

The error signal generated from the tripping of the motor overload cut-out is not cancelled until after the reset of the motor overload cut-out **and** after the manual enable of the compressor. With the entry of *Motor protect. N*, the compressor is switched off with the tripping of the motor overload cut-out. After the reset of the motor overload cut-out, the compressor is automatically loaded again depending on demand. The control processes when the motor overload cut-out is tripped for the manual enable (*Motor protect. Y*) and automatic enable (*Motor protect. N*) are listed below.



The monitoring of the motor overload cut-out can be activated / deactivated with the parameter *"Mot.cutout C"* (if motor overload cut-out available) using menu 3-1. If the motor overload cut-out is deactivated, the parameter "*Motor protect. Y/N*" is not displayed and not evaluated.

5.11.2 Cylinder head temperature monitoring

The compressor cylinder head temperature is monitored with respect to an upper maximum value. The maximum cylinder head temperature that results in disabling a compressor and the enabling value must be specified using the parameters *Comp. OFF temp* and *Comp. ON temp* (menu 3-4). If the upper maximum value is exceeded, the associated compressor is switched off and disabled for the following control processes after expiry of a configurable time delay (menu 3-4 *"Comp temp del."*). In addition, a message "CylTemp.too high Vx" is displayed.

The compressor remains disabled until the temperature has dropped to the enable level. If the procedure is repeated multiple times within one day (5 switchings) and there is still more than one compressor available in the refrigeration compressor pack, the compressor is permanently disabled and must be enabled again manually (menu 3-1-c Enable comp.stages). The message *Auto disable Cx* is sent here.

If the time delay (menu 3-3 Delayed evapor. temp.) is active and an alarm "Measuring circuit cyl. temp. Vx" occurs during the time delay, there should be no message "Cyl. temp. too high Vx" and no compressor shutdown. The time delay (menu 3-3 Delay Vx) should be restarted when the alarm "Measuring circuit cyl temp Vx" has gone and the cylinder head temperature is greater than the parameter (menu 3-3 Temp OFF Vx).

Compressor fault in the case of combined control
A compressor fault occurs under the following conditions:

- Tripping of motor overload cut-out
- Tripping of a high pressure switch
- Exceeding the maximum permissible cylinder head temperature

In the event of any fault on any of the compressors that can be assigned to the frequency converter (compressors 1 and 2), a compressor switch-off is performed and the generation of a signal depending on the state of the base load rotation output (relay output "*FC compressor switching*", see Connection and terminal assignment of VS 3010 C).

Compressor fault for single-stage compressors
For speed-controlled compressors, the frequency converter is always enabled with the first compressor capacity stage. Using the base load rotation, compressor 1 or compressor 2 can be assigned to the FC. If no base load rotation was performed (output base load rotation OFF), a fault of compressor 1 causes the switch-off of the capacity stage 1 with the appropriate fault signal for compressor 1. A fault of compressor 2 results in the switch-off of capacity stage 2 with the appropriate fault signal for compressor 2.

After any base load rotation (output base load rotation ON) a fault of compressor 1 causes the switch-off of the capacity stage 2 with the appropriate fault signal for compressor 1.
A fault of compressor 2 results in the switch-off of capacity stage 1 with the appropriate fault signal for compressor 2.

Fault on	Base load rotation output	Capacity stage OFF output	Message
Compressor 1	ON	Stage 2	Message C1
	OFF	Stage 1	
Compressor 2	ON	Stage 1	Message C2
	OFF	Stage 2	

Compressor fault for capacity-controlled compressors
For multi-stage compressors that are operated in combined control, the frequency converter is always enabled with the first compressor relay stage and the motor of the first compressor is controlled. The following relay stage(s) is/are used for actuation of the bypass valves of the first compressor.

In the case of combined control, compressor 1 or compressor 2 can be optionally assigned to the frequency converter by the base load rotation. However, this means for base load rotation that, in addition to the compressor base load stage, the associated compressor capacity stage(s) must also be changed over.
If no base load rotation is performed (base load rotation output OFF),a fault of compressor 1 causes the switch-off of the capacity stage 1 (enable FC and control compressor motor C1) as well as the capacity stage 2 (compressor with two capacity stages) and - depending on configuration - the capacity stage 3 (compressor with two capacity stages).

An appropriate fault signal for compressor 1 is also sent. The relay contacts for the base load and capacity stage(s) of the second compressor, in the case of a configuration with capacity-controlled compressors, move to stage *No.cap.stages* + 1 and following.
A fault of compressor 2 results in the switch-off of the capacity stage (*No.cap.stages* + 1 and following) with the appropriate fault signal for compressor 2. After any base load rotation (output base load rotation ON) a fault of

compressor 1 causes the switch-off of the capacity stage (*No.cap.stages* + 1 and following) with the appropriate fault signal for compressor 1.
A fault of compressor 2 results in the switch-off of capacity stage 1 and following with the appropriate fault signal for compressor 2.

Example: Compressor with three-stage capacity control (*No.cap.stages* = 3)

Fault on	Base load rotation output	Relay stages OFF output	Message
Compressor 1	ON	Stage 4, stage 5, stage 6	Message C1
	OFF	Stage 1, stage 2, stage 3	
Compressor 2	ON	Stage 1, stage 2, stage 3	Message C2
	OFF	Stage 4, stage 5, stage 6	

5.11.3 Low pressure monitoring

Low pressure too low

If the low pressure falls to a configurable limit value (menu 3-3 *to MP Off Comp*), all compressors are switched off. If the low pressure rises to the proportional t_0 setpoint + NZ/2 pressure value, the compressors are activated stage by stage. An alarm is signalled after expiry of a configurable delay time (menu 3-3 *Del. to OFF*). The LP monitor is also evaluated. If the pressure drops below the limit value of the LP monitor, a forced shutdown of all compressors occurs.

Low pressure too high

The alarm "*high low pressure*" is signalled if the low pressure exceeds the configurable limit value NP Max. (menu 3-3). This alarm signalling has no effect on the control action of the pack controller. The alarm is reset when the limit value "NP Max" minus 1 bar is undercut.

5.11.4 High pressure monitoring

The high pressure is monitored by the pressure transmitter in the pressure hose and using HP limiters. If multiple HP limiters are used, these must be connected to the controller in series. All compressors are unloaded if their tripping pressure is exceeded.

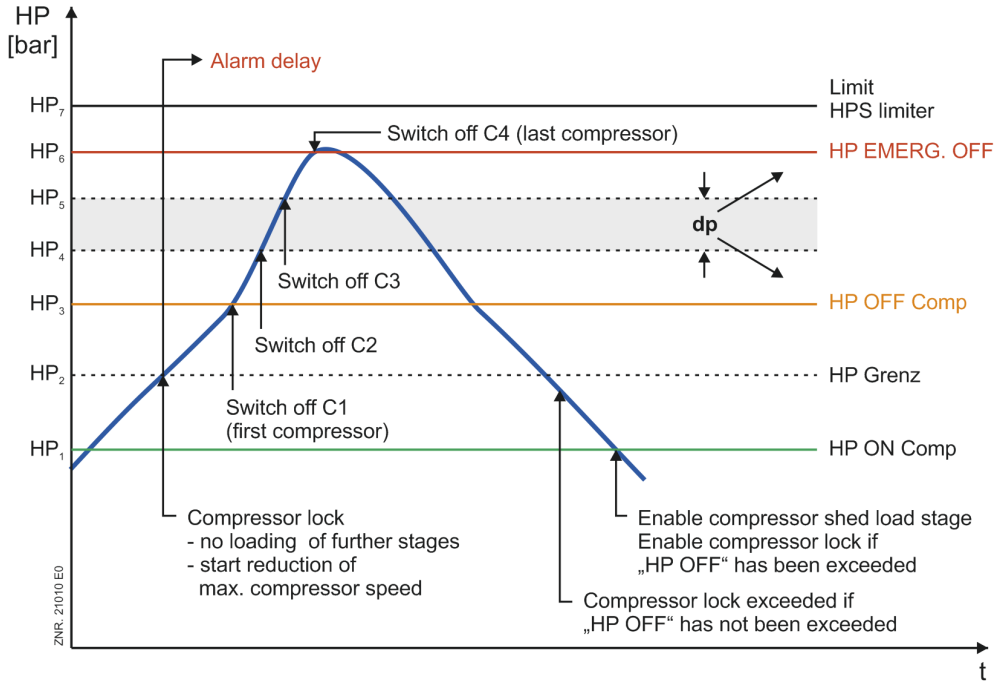
Compressor shutdown for HP EMERGENCY OFF

All compressor stages are shut down immediately if the measured high pressure exceeds the limit value *HP EMERGENCY OFF (menu 3-3)*. A compressor enable is performed when the HP value has fallen below the limit value *HP On Comp* (menu 3-3) again. They are then loaded again stage by stage. The error message "*HP EMERGENCY OFF*" is generated if the high pressure exceeds the *HP EMERGENCY OFF* limit value.

Compressor shutdown in the case of high pressure fault
One compressor is unloaded if the high pressure exceeds the limit value *HP Off Comp* (menu 3-3). Other compressors are unloaded with increasing high pressure. The unloading points for the other unloads are dependent on the number of compressors and on the parameter *HP EMERGENCY OFF* (menu 3-3). The switching intervals are calculated so that the shutdown of the last compressor is performed when reaching a pressure of *HP EMERGENCY OFF*. While the limit value *HP Off Comp* is exceeded, any shifting down of the compressor stages by the suction pressure regulation is still only performed using the basic switch-off time in order to reduce the high pressure more quickly. If the limit value *HP Off Comp* has been exceeded, compressor stages are not loaded again until the limit value *HP On Comp* has been undercut again. An exception is the heat recovery mode. In the HRC and HRC Bypass modes. no compressor shutdown and no compressor disable are performed but instead speed reduction (see Speed reduction in the event of high pressure fault below). In heat pump operation (parameter *HRC-Pump*, menu 3-2-2-3), one capacity stage can be unloaded. The HRC Bypass operation and heat pump operation are only possible in combination with a Coolheat or *ECOCool* controller.

Speed reduction in the case of high pressure fault (only for combined control)
If the compressor is controlled using combined control, the maximum compressor speed can be reduced with rising pressure. The speed reduction depends on the parameters *HP Off Comp*, *HP On Comp* and *Weighting C.OFF* (menu 3-3). As default, the pressure reduction starts when the average value of *HP Off Comp* and *HP On Comp* is exceeded. The start value can be shifted using the *Weighting C.OFF* parameter. A higher value shifts the start point in the *HP On Comp* direction, a lower setpoint in the *HP Off Comp* direction and thus to a higher pressure level. The compressor speed is limited to Min. speed (parameter in menu 3-3) if the high pressure reaches the *HP Off Comp* limit value.

High pressure fault alarm signalling
If the high pressure exceeds a limit value that is calculated using the parameters *HP Off Comp*, *HP On Comp* and *Weighting C.OFF* (menu 3-3), the error message *High HP* is generated after a configurable time delay (parameter *Del. tc/HP OFF*, menu 3-3). As default, the limit value is calculated from the average value of *HP Off Comp* and *HP On Comp*. The limit value can be shifted using the *Weighting C.OFF* parameter. A higher value shifts the value in the *HP On Comp* direction, a lower setpoint in the *HP Off Comp* direction and thus to a higher pressure level. No signal is generated In the heat recovery mode. In the event of any pending HP fault, no additional compressor output stages are switched on. The following diagram is a graphical representation of the entire HP monitoring using the example of a system with four compressors:



5.11.5 Monitoring of the medium pressure

The parameters required for the monitoring of the medium pressure can be configured using the menu 3-3. The parameter *MP OFF xxx* sets the maximum permissible medium pressure. If the pressure exceeds the specified limit value, the system is immediately shifted down to a specified number of compressors (parameter *Nr.Comp.MP-Al*). The *High MP* message is sent. The parameter *MP ON xxx* b specifies the pressure for which the compressors disabled by *MP OFF* are enabled again.

5.11.6 Monitoring of the medium pressure valve

If the medium pressure (MP) deviates from the setpoint by more than 2 bar for a period longer than 10 minutes, the controller sends the message *Alarm MP-Valve*.
In the event of a fast unload and with all compressors idle, the message is reset.

5.11.7 Monitoring of the fan motor overload cut-out

The fan motor is monitored by the motor overload cut-out. The auxiliary contact is open in the alarm state (no signal at the input of the controller). The alarm message "*Mot. cutout Fxx*" is sent if the motor overload cut-out trips.

The motor protection monitoring can be influenced with the following parameters:

Configuration

Parameter	Menu	Value range	Default	Unit	Description
No. cond.stages	3-1	0..12	4/8/12	-	The number of fans in the system configuration

Parameter	Menu	Value range	Default	Unit	Description
Fan off by al. X	3-2-2-1	Y/N	Y	-	**Setting = YES** If any fault is detected while the fan is running, the fan output is switched off, the relevant fan stage in the system configuration is deactivated and an alarm is signalled. The fan fault cannot then be acknowledged until the fan is enabled again in the system configuration. In the case of speed control, no deactivation of the outputs is performed. In the case of parallel combined control, no shutdown of fan stage 1 and no disable in the system configuration are performed. • Switch off fans when motor overload cut-out is tripped • Cancellation of the fan enable (menu 3-1) Note: The motor protection alarm cannot be acknowledged until the enable of the fan has been granted again (menu 3-1) **Setting = NO** An alarm is signalled if any fault is detected while the fan is running. The alarm can be acknowledged: • if the motor protection input of the relevant fan is carrying voltage again • after a power failure • after a fan standstill of two hours
Mon.OFF w.Fan	3-2-2-1	Y/N	Y	-	This parameter defines whether the fan should be monitored during operation **and** during standstill or only during operation. For example, the function is required to shut down EC fans for a capacity reduction without signalling an alarm. **Setting = YES** There is always an error message if the motor protection of any fan trips. For some types of system (e.g. fans in parallel on one output), the fan output must also stay activated after tripping of the motor overload cut-out. Therefore the reset of the fan output in the event of a fault can be deactivated using the parameter Mon.OFF w.Fan = *NO* (menu 3-2-2-1). If the parameter is set to YES, the relevant fan output is reset when the corresponding motor protection trips. In the parallel combined control operating mode, the fan output 1 is not reset in the case of tripping of the motor overload cut-out of the fan stage 1. Note: Fans in standstill are not monitored for their motor protection if the parameter is set to YES. **Setting = NO** The control action is also dependent on the *Mon.OFF w.Fan* parameter.

5.11.8 Monitoring of the fan speed controller

If the fan control is performed using a speed controller / frequency converter, this can be monitored during combined control via the input stage *No. cond.stages + 1*. In the case of a fault, the fan output 1 for enable of the speed controller is reset and instead the relay output of the fan stage *No. cond.stages + 1* is set so that emergency operation is possible.

5.11.9 Monitoring of the compressor speed controller

The frequency converter (speed controller) is monitored via the digital input 15 (terminals 78/79) of the controller. If there is no voltage at the input,

- the FC compressor is switched off and is no longer available for capacity regulation
- the message is transmitted after a configurable time delay according to the preselected priority

The message text can be freely configured in menu 3-5. The factory setting is "*Speed Controller*".

> The monitoring is only performed if the LP type of control is configured as "combined control" (menu 3-2-1-1).

Configuration

Parameter	Menu	Value range	Default	Unit	Description
Time delay	3-5	3..250	5	s	*Delay time for the digital input "Speed Controller" until an alarm is signalled.*
Alarm text	3-5	Text	Speed Controller	-	Message text for the monitoring of the frequency converter (speed controller) Note: This text should not be changed!
External alarm	3-7	0..99, --	2	-	Message priority with which the alarm is signalled.

5.11.10 External alarm monitoring

An external alarm can be transmitted to the controller via the digital input 15 (terminals 78/79). If there is no voltage at the input, the signal is transmitted after a configurable time delay according to the preselected priority. The input has no influence on the regulation functions of the controller. The message text can be freely configured in menu 3-5. The factory setting is "*External Alarm*".

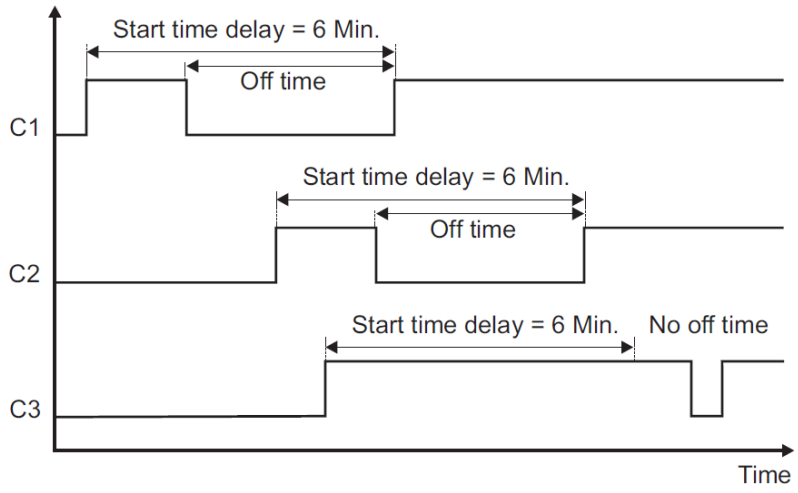
> The monitoring of the external alarm is only available if the Regelungsart (menu 3-2-1-1) for the low pressure is configured as "Step Controller".

Configuration

Parameter	Menu	Value range	Default	Unit	Description
Time delay	3-5	3..250	5	s	Delay time for the digital input "External Alarm" until an alarm is signalled.
Alarm text	3-5	Text	External alarm	-	Freely configurable message text for the external alarm
External alarm	3-7	0..99, --	2	-	Message priority with which the alarm is signalled.

5.11.11 Monitoring of the switching frequency

The number of compressor switching operations per hour is limited to prevent too high switching frequency of the compressors.



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Limiting the switching rate
It is determined using the parameter *Starts/h* (menu 3-4) in which minimum time intervals a compressor can be switched on. For example, if the switching frequency is 10 switching operations per hour, a compressor can be switched on at the earliest every 6 minutes.

Monitoring of the switching frequency
The switching frequency limitation is deactivated for compressor combined control (however, it continues to be monitored). In the case of excessive switching frequency, the message *too many starts* is output if the switching frequency specified using the parameter *Starts/h* is exceeded.

> ⓘ The deactivated switching frequency limitation for speed-controlled compressors is activated again in the event of any FC error.

5.11.12 Refrigerant monitoring

The liquid level of the system is checked using a refrigerant level sensor. The status of the refrigerant level sensor is scanned and recorded in a cycle of seconds using a configurable time interval (parameter *Interval*, menu 3-4). This parameter defines the duration of a measuring cycle. If the percentage of "Good states" falls below the parameter *threshold* (menu 3-4), an alarm is signalled if any *Alarm MP-Valve* fault is pending and the medium pressure actual value is lower than the medium pressure setpoint (pressure can no longer be maintained due to the lack of refrigerant).

> ⓘ The tripping of the refrigerant level sensor has no influence on the control and regulation functions.

After any power failure, the refrigerant level is set to 100%. A measurement result is not available until the interval time has elapsed. The calculated *Niveau* can be checked in menu 2-4 (Installation actual values).

5.11.13 Monitoring of the fast unload / External Off

The pack controller can be switched off via digital input 16 "Fast unload/External Off" (terminals 80/81). The following occurs when the input is activated:

- Fans and compressors are turned off in quick succession (2 seconds unload time).
- The consumer enable of the associated UA 300 / UA 400 case controllers is revoked, unless the low pressure is too low.
- The fault signal *Comp/cond OFF* is output.
- The pack controller is shown in grey in the store view of the PC software LDSWin.
- The medium pressure valve (MPV) is closed if all compressors are switched off (analogue output 4, terminals 63/64 at 0 volts).

5.11.14 Rupture disk monitoring

A rupture disk can be monitored via the digital input 22 (terminals 92/93). An alarm is signalled if there is no voltage at the input. The message is transmitted according to preselected priority. This digital input has no influence on the control and regulation functions.

5.12 Setpoint switching

It is possible to set a second (alternative) setpoint set of parameters, for example for day / night operation, for the low pressure regulation. The setpoint switching can be activated using the internal week timer (parameter "*Setpoint toggle*", menu 4) or using a digital input (terminals 88/89) of the controller. The polarity of the input signal can be set using the parameter "*signal setvalue*", see menu 3-1 (set to "High-active" at the factory ").

When setpoint toggle is activated, the following parameters in the controller are changed over:

- Temperature setpoints
- Neutral zone
- Control constant
- Switching times
- Humidity shift
- Gas cooler control maximum speed

5.13 Ambient data for the setpoint switching

The factors used for the setpoint switching (menu 3-1),

- room temperature (shift of $t_{0,}$, parameter *Room temp.*)
- outdoor temperature (shift of the gas cooler outlet temperature t_G, parameter *Outdoor temp.*)
- humidity (shift of t_0, parameter *Humidity*)

can either be provided using the sensors connected to the pack controller or received via the CAN bus from another pack controller.

It can be set using the parameters *Room temp.*, *Outdoor temp.* and *Humidity* whether sensors directly connected to the controller are present. If any of these parameters is set to NO, the additional parameter *"Node-Nr Env.dat*" is shown on the operating screen. Here, as required, the CAN bus address (node number) of the pack controller can be entered, from which the desired ambient data will be drawn, e.g. "1" for the CAN bus address "101".

> If no ambient data should be received via the CAN bus, the parameter *Node-Nr Env.dat* must be set to "-".

5.14 Consumer lockout

In the event of any fault of the compressor pack. the pack controller can send a consumer lockout via the CAN bus to all associated consumers. Associated consumers are case controllers where the node address of the pack controller has been programmed in the configuration of the controller. The consumer lockout is sent to all associated consumers if no compressor is available. Possible causes of failure are

- Tripping of the HP limiter
- Tripping of all motor overload cut-outs
- High pressure limiter for all compressors
- Manual shutdown of all compressors

If any of the compressor manual control switches is switched to "HAND EIN", no consumer lockout is performed.
In the case of a suction pressure fault due to too low suction pressure or tripping of the LP monitor, no consumer lockout is performed. If all compressor manual control switches are set to "*Manual OFF*", no consumer lockout is performed even in the case of pending suction pressure fault.

Consumer lockout after restart
In order to prevent liquid refrigerant being sucked in following a long idle time, pump-down of the suction line can be performed after a power failure.

- If the power failure lasts longer than 10 minutes, the consumers are locked out via the CAN bus after a restart.
- After the start of a compressor, the consumer lockout is terminated when the to-setpoint has been reached or undershot.
- After expiry of a safety time of 5 minutes after switching on the first compressor, the consumer lockout is terminated in all cases.

5.15 Spray system control

The VS 3010 C can control a two-stage spray system. The spray system can be configured in menu 3-2-5. The control of the spray system can be activated and deactivated using the parameter *Spray-System*. The spray system can only be activated when the VS 3010 C is connected to at least one SIOX extension module. The spray system always occupies the two relay outputs 7 and 8 (terminals 33/34 and 43/44) of the **last**SIOX extension module.

> As these relay outputs are also reserved for compressors 7 and 8, the spray system can only be used with a maximum of 6 compressors.

With more than 6 compressors, an additional SIOX extension module is required. The maximum number of compressors then increases to 10. Here the spray system occupies the relay outputs for compressors 11 and 12. The second stage of the spray system cannot be used when the system is operated with compressor combined control as in this case the output 8 (when operated with one external SIOX module) or 12 (2 external SIOX extension modules) is used for the base load rotation of the FC compressor. The parameter *Night-Op. Y/N* determines whether the spray system should also be activated during night operation. If not, the system is only activated during night operation if the limit value *HP Off Comp* (see Compressor monitoring, menu 3-3) has been exceeded. Once the value has fallen below the limit value *HP On Comp*, the system is deactivated again.

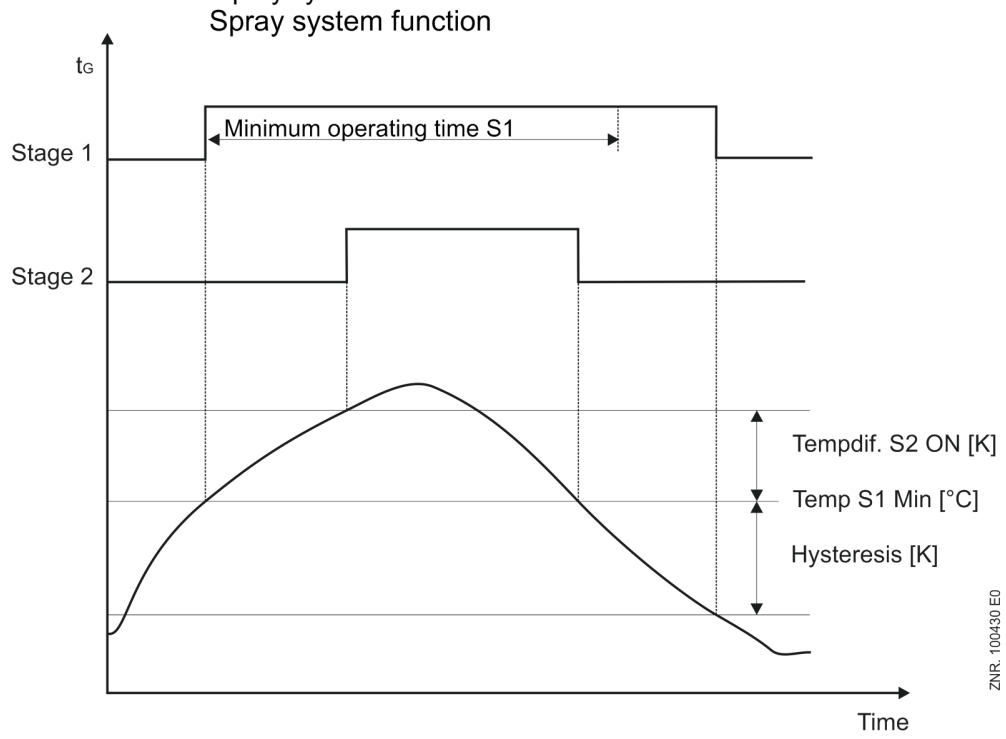
The parameter *Temp. S1 Min. xx°C* defines the gas cooler outlet temperature that must be reached in order for the first stage of the spray system to be enabled. The loading of the first stage is dependent on the gas cooler outlet temperature control mode:

Loading for systems with step controller
S1 On if: (t_G > "Temp. S1 Min") **and** all fans ON

Loading for systems with speed controller controller
S1 On if: (t_G > "Temp. S1 Min") and all fans ON and speed = 100%
t_{GSet} Measured gas cooler outlet temperature depending on the outdoor temperature.

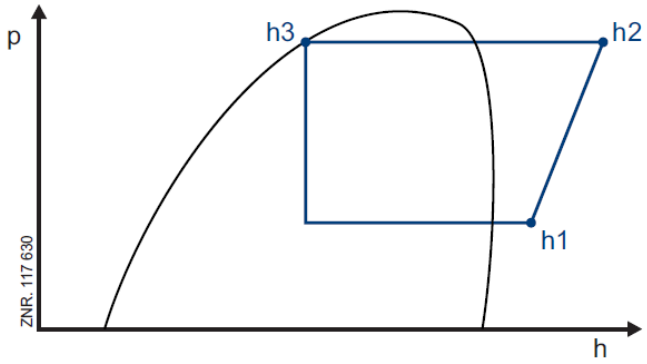
The parameter *Min. ON S1 xxm* determines the minimum switch-on time for the first stage. If the first stage is loaded, it remains switched on for the programmed minimum operating time independent of the gas cooler temperature.
The parameter *Tempdif. S2 ON xx K* defines the temperature difference at which the second stage of the spray system is switched on. If the gas cooler outlet temperature is the same or higher than the calculated switch-on temperature S1 plus the temperature difference S2, the second stage is switched on. If the gas cooler outlet temperature falls below the switch-on value S1 for the first stage, the second stage is switched off again.
The parameter *Hysterese* defines a temperature range that must be undershot in order for the first stage of the spray system to be switched off again. If the gas cooler outlet temperature falls below the switch-on value S1, minus the specified hysteresis, the first stage is switched off again. The following is a graphic representation of

the function of the spray system:



5.16 COP monitoring

COP - *Coefficient of Performance* - is a factor without units and is used to assess the energy efficiency of a refrigeration pack system. The greater the COP value, the more efficient the refrigeration system. In the E*LDS system, the COP value is calculated by the pack controller and can be monitored in the LDSWin program. In order to calculate the COP value, three enthalpies from the log-ph diagram are evaluated in the pack controller. The enthalpy tables are stored in the pack controller.



Using the three enthalpies h1, h2 and h3, the COP value of the pack controller is calculated. The calculation of the Carnot COP value is calculated on the basis of the COP values from the last 2 minutes.

> The actual values of the COP calculation are shown in menu 2-6.

Requirements

The following sensors must be present on the refrigeration pack system for the calculation of the COP:

- The LP and HP pressure transmitters
- The suction gas temperature sensors of the refrigeration points for the measurement of the enthalpy h1
- All cylinder head temperature sensors for the measurement of the enthalpy h2
- The gas cooler outlet temperature sensor for the measurement of the enthalpy h3

Connection of the temperature sensors

- Hot gas temperature sensor: terminals 25/26
  Attention: double assignment! Do not use if the refrigeration pack system has more than 8 compressors.
- Gas cooler outlet temperature: terminals 31/32
- Suction gas temperature sensor: terminals 33/34
- Cylinder head temperature sensor connection to the corresponding Pt1000 inputs

5.17 COP optimisation

In order to prevent the system from running continuously with unfavourable efficiency (FC compressor operates at excessive speed), the controller activates a compressor and reduces the speed of the FC compressor in order to switch to a more energy-efficient operating point after a delay time of 10 minutes.

5.18 Operating data and archiving

5.18.1 Operating hours of compressors and fans

The operating hours of all compressors and fans are recorded every 30 seconds and stored in non-volatile memory. The display (menu 6-1) is shown in hours. In the case of replacement of compressors or fans or the controller, the operating hours can be adjusted (menu 6-1-1 and menu 6-1-2).

5.18.2 Daily run times, switching pulses and switch-on rates

As well as the operating hours, the run times, switching pulses of the compressors per day and the switch-on rate (utilisation) of the pack are recorded daily and stored with date (menu 6-2). The data are archived in the pack controller for a period of 32 days and the display is shown in hours and minutes.

The switch-on rate is calculated in accordance with the following formula and is displayed in percent

$$\text{E-Quote} = \frac{\text{L}}{[\text{n} \cdot (\text{T}_1 - \text{T}_0)]}$$

Switch-on rate: pack switch-on rate
L: sum of all compressor run time
s: number of available compressors
T_1: current time
T_0: day change

5.19 Capacity-controlled compressors

The VS 3010 C can be used to control capacity-controlled compressors with up to 3 capacity stages (base load plus 2 capacity stages. The number of capacity stages can be configured. Capacity-controlled compressors do not have any influence on the control algorithm of the VS 3010 C; only the switching sequence changes.

The base load of an available compressor is activated first for the control of the compressors. Then the capacity stages of the compressor are switched on for the refrigeration requirement before the base load of any other compressor can be switched on. The shifting down of capacity stages is performed in reverse order.

The number of a compressor's activated output stages is taken into account during the base load rotation. The base load stage of a compressor can be switched using the integrated manual control switches. If the base load stage has been switched off, the associated capacity stages are also switched off by the controller.

If the base load stage of a compressor has been switched on, the capacity stages of this compressor are switched on first for the refrigeration requirement. If both compressors without capacity regulation as well as capacity-controlled compressors are configured, the capacity-controlled compressors are switched on first. This proceeds in the order described above (first the base load stage, followed by the associated capacity stages).

When all the capacity-controlled compressors are running at 100%, and additional refrigeration is required, the compressors without capacity regulation are switched on. When a non capacity-controlled compressor is switched on, the capacity stages of a capacity-controlled compressor are switched off so that only its base load is operating. If additional refrigeration is required then these capacity stages are switched on again.

In an example for the switching compressors on and off, the system configuration is as follows:

- Number of base load stages: 2
- Number of capacity stages per capacity-controlled compressor: 3
- Number of capacity-controlled compressors: 1

Switching on of compressors
The switching on of compressors is illustrated using the example in the following table:

	VS 3010 C			
Relay number	**S1**	**S2**	**S3**	**S4**
Meaning	Base load stage 1	Capacity stage 2	Capacity stage 3	Base load stage 4
1	X			
2	X	X		
3	X	X	X	
4	X			X
5	X	X		X
6	X	X	X	X

When unloading, the capacity stages of a capacity-controlled compressor are switched off first. This is followed by the switching of a non capacity-controlled compressor. The capacity stages of the capacity-controlled compressor are switched on again at the same time.

Shifting down of compressors
The shifting down of compressors is illustrated using the example in the following table:

	VS 3010 C			
Relay number	**S1**	**S2**	**S3**	**S4**
Meaning	GS1	LS2	LS3	GS4
1	X	X	X	X
2	X	X		X
3	X			X
4	X	X	X	
5	X	X		
6	X			

The number of a compressor's activated output stages is taken into account during the base load rotation. If a system is only equipped with one multi-stage compressor or speed controlled compressor, the switching frequency limitation for this compressor is cancelled. From the second capacity stage onwards switching frequency limitation remains active.

If there is more than one capacity-controlled or only a single-stage compressor available for a step controller, the switching frequency limitation remains active for all stages.

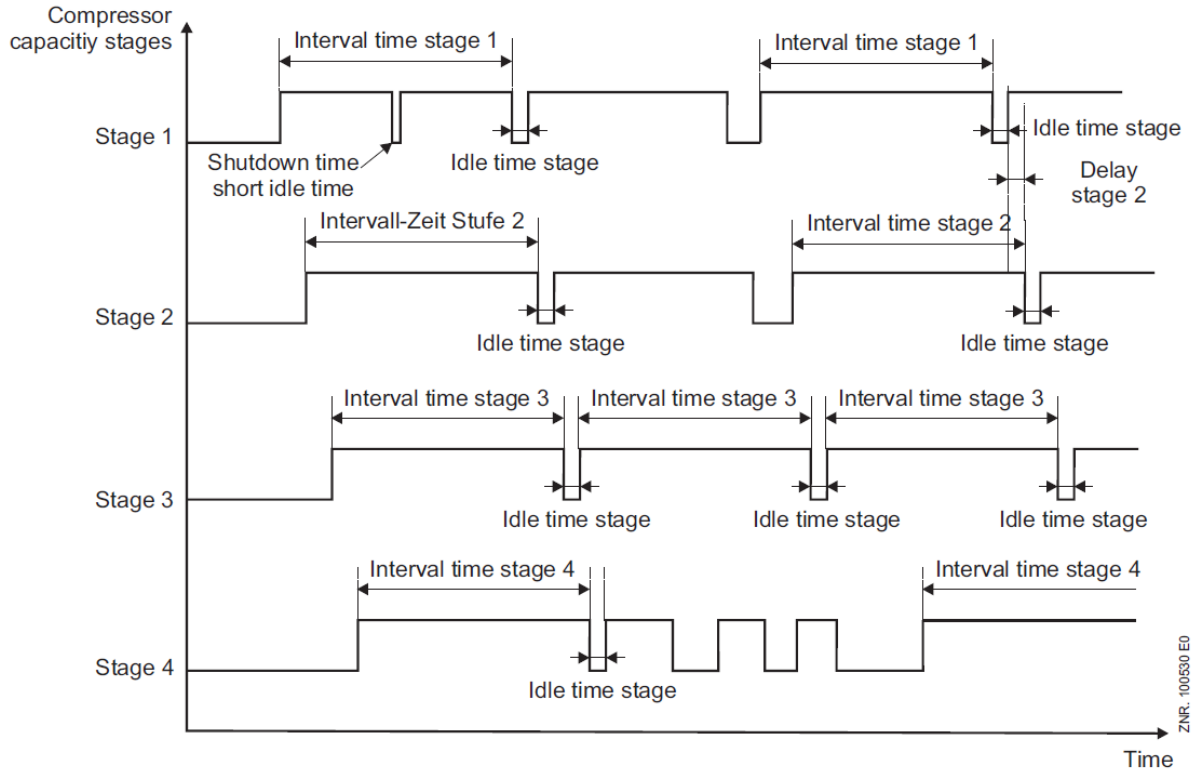
If the switching frequency limitation of the first stage is cancelled, a minimum standstill time for the first stage can be set using the parameter *Off Time S1 xxxs* (menu 3-3). The minimum standstill time is only displayed if the system only has one capacity-controlled or speed controlled compressor available.

The standstill time is always observed after switching off the first compressor by the suction pressure controller or as a result of faults. In the case of a capacity-controlled compressor, the first stage is only switched on again when the switch-on delay **and** the minimum standstill time have elapsed. A speed controlled compressor starts after expiry of the minimum standstill time and runs for the duration of the switch-on delay at the minimum speed.

5.20 Oil balancing

Step control
In order to establish an oil balance between the individual compressors, the operating time of all compressors is monitored. If the compressor operating time exceeds a configurable maximum operating time, the compressor is switched of for a configurable standstill time. If a compressor is switched off via the suction pressure control within the monitoring time, the monitoring time is restarted with the switching on of the compressor. If the regulated standstill time is shorter than the configurable standstill time for the oil balancing, the standstill time is ignored. If several oil balancing switching operations occur together, then these are staggered.

The oil balancing switching of the next stage only starts after the previous stage is at standstill and the configured standstill time has elapsed. The oil balancing is only performed if all available compressors are in operation.
During part-load operation, oil balancing is performed via the base load rotation.



Combined control
During compressor combined control, the oil balancing of the compressor which can be speed controlled (stage 1 and 2) is conducted independently from that of the fixed-speed compressors (stage 3 to stage n). After completion of the cycle time for the base load rotation, the base load rotation for the speed controlled compressor and the oil balancing of one of the two compressors that can be speed controlled is always performed at the same time.

If both compressors which can be speed controlled are not **simultaneously** in operation, the oil balancing is performed via the base load rotation of the compressors that can be speed controlled. The oil balancing / base load rotation of the fixed-speed compressors is performed as for the compressor step control.

6 Installation and start-up of VS 3010 C

IMPORTANT SAFETY INSTRUCTIONS!

Before the installation and start-up of the controller, the chapter Safety instructions must be carefully read in its entirety and all safety and hazard instructions observed. Any maintenance by the user is not intended, as possible hazards from incorrect re-assembly cannot be ruled out. Opening the device is not authorised! Furthermore, it must be noted that the safety of the system or the installation in which the device is integrated is the responsibility of the creator of the system or installation. If the device is used in any way not specified by Eckelmann AG, the protection supported by the device can be compromised!

The system centre is used, among other things, for alarming and archiving operating data and is the link between the LDSWin PC software and the controller.

Parameterisation of the controller during commissioning or subsequent changes to its configuration can **only be carried out via the LDSWin PC software**. The controller should only be used with compatible versions of LDSWin; otherwise the range of functions may be limited.
Tip: The latest LDSWin version should always be used. Among other things, setpoints, actual values and archived long-term data can also be visualised and evaluated in LDSWin.
Before commissioning the system, the necessary basic hardware and software settings, which are described in the following chapters, must be made on the controller.

6.1 DIN rail mounting

The pack controller is available as version for DIN rail mounting. It is snapped on / fastened to the DIN rail using two claws (on the underside of the device). The power loss of the device is 24 VA. This must be taken into account for the installation. The pack controller can be put into operation after completion of the mechanical and electrical installation.

ATTENTION

The pack controller may only be mounted on a DIN rail and operated as an integrated regulation and control device (EN60730). All supply lines from and to the device (with the exception of the 230 V power supply and signal lines) must be shielded! This particularly applies for the analogue inputs (sensor supply lines) as well as for the CAN bus cabling (cable type: LiYCY (TP)). These must also be installed with sufficiently large distance from live cables. This prevents faulty measurements and protects the device against electrical interference via the analogue inputs.

Protection type and dimensions can be found in the chapter Technical Data VS 3010 C.

6.2 Requirements for the activation of NT CO2 operation (transcritical)

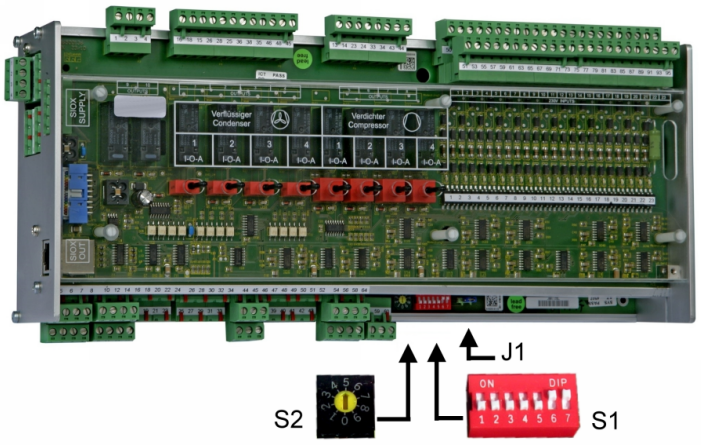
- Type identification **must**be VS 3010 C, i.e. the correct firmware must be loaded (see chapter Firmware Update)
- The 4th digit of the serial number **must** be "1", e.g. *1111**1**0000031002* (see menu 2-3 on the system centre or menu 7-2 -*Status display* - of the store computer or operator terminal)
- R744 (CO_2) is always preset as refrigerant

All the above mentioned conditions **must** be met, otherwise the controller behaves like a VS 3010!

6.3 Basic hardware settings

Warning of dangerous electrical voltage! Danger of electric shock! BEFORE connecting and disconnecting, it must be ensured that **no voltage** is present at all connections of the controller.
Wiring of the digital inputs: All digital inputs of the pack controller must be set to 230 V AC for the operation.
If 230 V AC is applied to an input that has been configured for 24 V AC, this results in destruction of the module.

The parameter basic settings of the pack controller are configured using the DIP switch S1, the decade switch S2 and the jumper J1. The setting elements S1, S2 and J1 are located next to the cover on the PCB of the pack controller (see picture).



The following basic settings must be configured using the setting elements S1 and S2:

1. DIP switch S1

Coding switch	Function
1	Not used
2 and 3	Number of SIOX extension modules with manual control switch
4	Not used
5	Activation of the Modbus interface
6 and 7	Firmware update mode

For details, see chapter Basic settings with S1.

2. CAN bus address selector switch S2

- Setting of the CAN bus address or node number (Kn.nnn) position 1..9 address 101..109
- Deactivation as CAN bus node position 0 no addressing

For details, see chapter Setting the CAN bus address with S2

3. Jumper J1 for the activation of the interfaces

- **Configured to RS485 at the factory**
  RS485 (terminals 13..16) factory setting, for control of EBM fans, in the future for connection to the BCS (building control system)
  

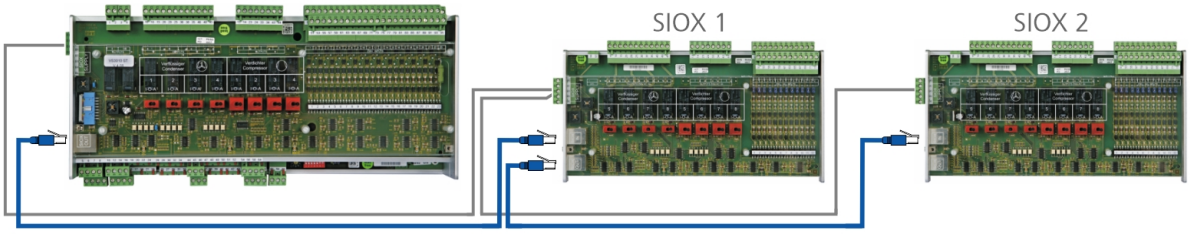
- TTY (terminals 9..12) for the communication in the LDS1 system.

> Any change of the jumper J1 is usually not necessary. For more detailed information, see chapter Setting of the interface RS485/TTY using jumper J1

6.3.1 SIOX extension module - for DIN rail mounting

> **Warning of dangerous electrical voltage! Danger of electric shock! BEFORE** connecting and disconnecting, it must be ensured that **no voltage** is present at all connections of the controller.

A maximum of 3 SIOX (**S**erial **IO**E**x**tension) extension modules can be connected to the pack controller. Each SIOX extension module extends the pack controller by an additional 8 relay outputs and 12 digital inputs. The number of connected SIOX modules must be configured, see chapter Basic hardware settings. The modules are connected to the pack controller via SIOX power supply cables and SIOX data cables:



See chapter CAN bus, SIOX and Modbus (ebmpapst fans) terminal assignment The pack controller as well as the SIOX extension modules have manual control switches so that the regulation can be manually overridden in emergency operation.

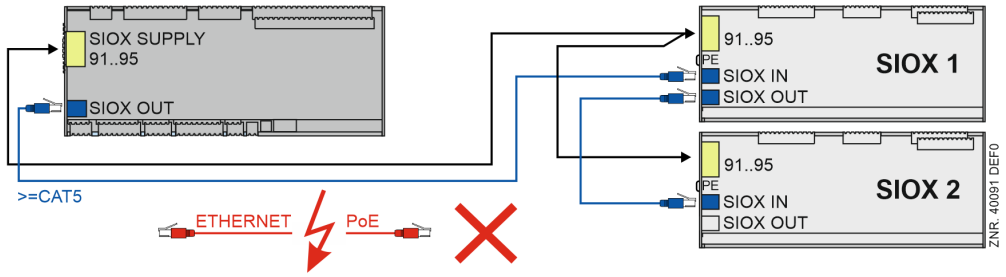
> **ATTENTION**
>
> **Only SIOX extension modules with manual control switch** may be connected. SIOX extension modules **without manual control switch are not authorised**!

> **SIOX operating instructions**
>
> Comprehensive details on the SIOX extension modules and their current operating instructions can be found here:
> https://edp.eckelmann.de/edp/lds/_S88KwDvR7a

6.3.1.1 Connection of the SIOX modules to the pack controller

The individual SIOX extension modules are supplied with power from the controller via SIOX-SUPPLY (terminals 91/92/93/94/95) and connected to each other in series via SIOX data cables (SIOX OUT and SIOX IN using RJ45).

Example configuration: base module with two SIOX extension modules:



For details, see chapter CAN bus, SIOX and Modbus (ebmpapst fans) terminal assignment.

ATTENTION

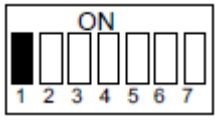
Danger of destruction of components! SIOX extension modules may **only** be connected to each other or the base module when no voltage is present! In the event of an Ethernet network cable with PoE (Power over Ethernet) being used instead of the SIOX data cable (RJ45) damage can occur to participating network devices!

SIOX operating instructions

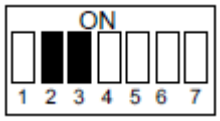
Comprehensive details on the SIOX extension modules and their current operating instructions can be found here:
https://edp.eckelmann.de/edp/lds/_S88KwDvR7a

6.3.2 Basic settings with S1

Coding switch 1 setting
DIP switch S1 coding switch 1 is not used:

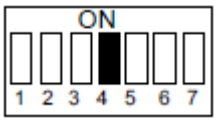
DIP switch S1 Coding switch 1	Switch position	
	**ON**	Not used
	OFF	Not used

Coding switches 2 and 3 setting - number of extension modules with manual control switch (number of capacity stages)
DIP switch S1 coding switches 2 and 3 specify the maximum number of compressor and fan capacity stages.
The VS 3010 C basic module can control 4 compressors and 4 fans.
An additional SIOX extension module is required for up to 8 compressor and 8 fan capacity stages; another second SIOX extension module is required for up to 11 compressor and 12 fan capacity stages.

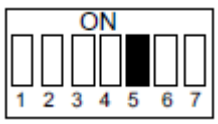
DIP switch S1 Coding switches 2 and 3	Switch position Coding switch 2	Switch position Coding switch 3	
	**ON**	**ON**	**2 external SIOX extension modules** • max. 11 compressor stages • max. 12 fans
	ON	**OFF**	**1 external SIOX extension module** • max. 8 compressor stages • max. 8 fans
	OFF	**OFF**	**no SIOX extension module** • max. 4 compressor stages • max. 4 fans

ⓘ A maximum of 11 compressors and 12 fans can be used, see chapter System design VS 3010 C.

Coding switch 4 setting

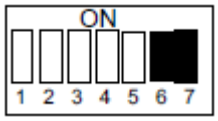
DIP switch S1 Coding switch 4	Switch position	
	**ON**	Not used
	OFF	Not used

Coding switch 5 setting

DIP switch S1 Coding switch 5	Switch position	Activation Modbus interface (ebmpapst fan)
	**ON**	Modbus interface is activated. If the gas cooler package should be controlled by the pack controller, ebmpapst fans are required. Note: No other Modbus nodes should be connected to the Modbus when controlling ebmpapst fans!
	OFF	The gas cooler package is controlled via the relay outputs on the basic module / SIOX.

The jumper J1 **must** be set to "RS485 active" for activation of the Modbus interface, see Setting of the interface RS485/TTY using jumper J1.

Coding switches 6 and 7 setting - firmware update mode
DIP switch S1 coding switches 6 and 7 specify the operating mode of the firmware update module:

DIP switch S1 Coding switches 6 and 7	Switch position	Firmware update mode
	**ON**	Normal operation
	OFF	Firmware update mode, for more details, see chapter Firmware Update

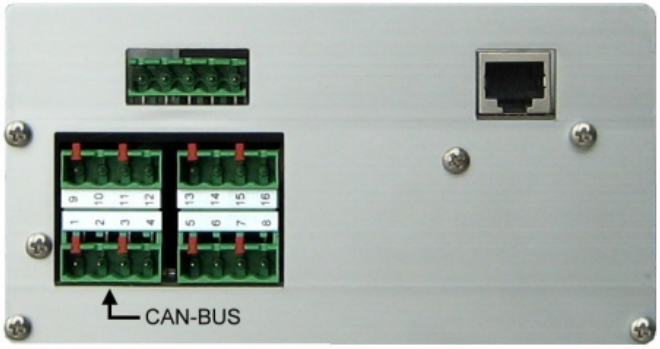
DIP switch S1 coding switches 6 and 7 may **only** be set to OFF for firmware update purposes. Firmware updates: set to OFF. In this state, the controller waits for a firmware update via a connected service PC. It is strictly required for the operation of the system that the **firmware update mode** is deactivated (DIP switch S1 coding switches 6 and 7 **must** be in the ON position)! If a switch position is changed (DIP switch S1, coding switch 2 or 3) after the start-up, the basic parameters of the set system configuration are loaded during the next start (power failure) of the controller and a first start is performed.
After changing the switch positions of both S1 and S2, the VS 3010 C **must** be disconnected from the power supply for a short time so that the new settings will be adopted!

6.3.3 Setting the CAN bus address with S2

Setting of the CAN bus address (node number) / deactivating CAN bus communication
The decade switch S2 specifies the CAN bus address and the node number (Kn.nnn). The setting is generally made at the manufacturer of the switchgear.

S2 decade switch	Switch position	CAN bus address / node number (Kn.nnn)	Function
	**0**	NONE	CAN bus communication of the pack controller disabled
	1..9	101..109	Node number nnn is assigned to the pack controller

Connection to the CAN bus
The connection to the CAN bus is made using the terminals 1-4 installed on the left side, see chapter CAN bus, SIOX and Modbus (ebmpapst fans) terminal assignment.



1	SHIELD
2	GROUND - green
3	CAN-LOW - brown
4	CAN-HIGH - white

After changing the switch positions of both S1 and S2, the controller **must** be disconnected from the power supply for a short time so that the new settings will be adopted!

6.3.4 Setting of the interface RS485/TTY using jumper J1

Setting of the interface
The jumper J1 specifies the function of the interface.

Jumper J1	Jumper position	Interface	Function
	Left	RS485 active (terminals 13/14/15/16)	Factory setting, currently has no function
	Right	TTY active (terminals 9/10/11/12)	currently has no function

For details, see chapter CAN bus, SIOX and Modbus (ebmpapst fans) terminal assignment.

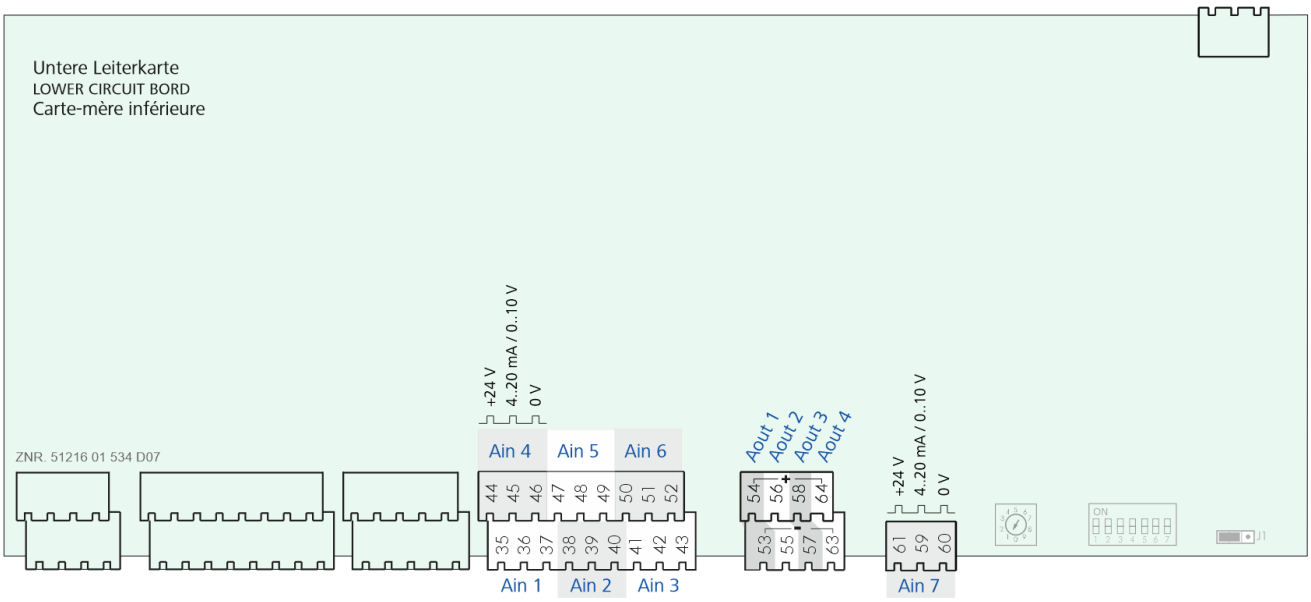
6.3.5 Configuration of the analogue inputs and outputs at the factory

ATTENTION

Important safety information! Any maintenance by the user is **not** intended as possible hazards from incorrect re-assembly cannot be ruled out. Opening the device is **not** authorised! Reconfiguration of the analogue inputs and outputs is **not** necessary. Incorrect handling can result in damage and impairment of the controller functions!

The analogue inputs and outputs are configured as follows at the factory:

Analogue inputs 1..5 and 7	4..20 mA
Analogue input 6	0..10 V
Analogue outputs 1..4	0..10 V



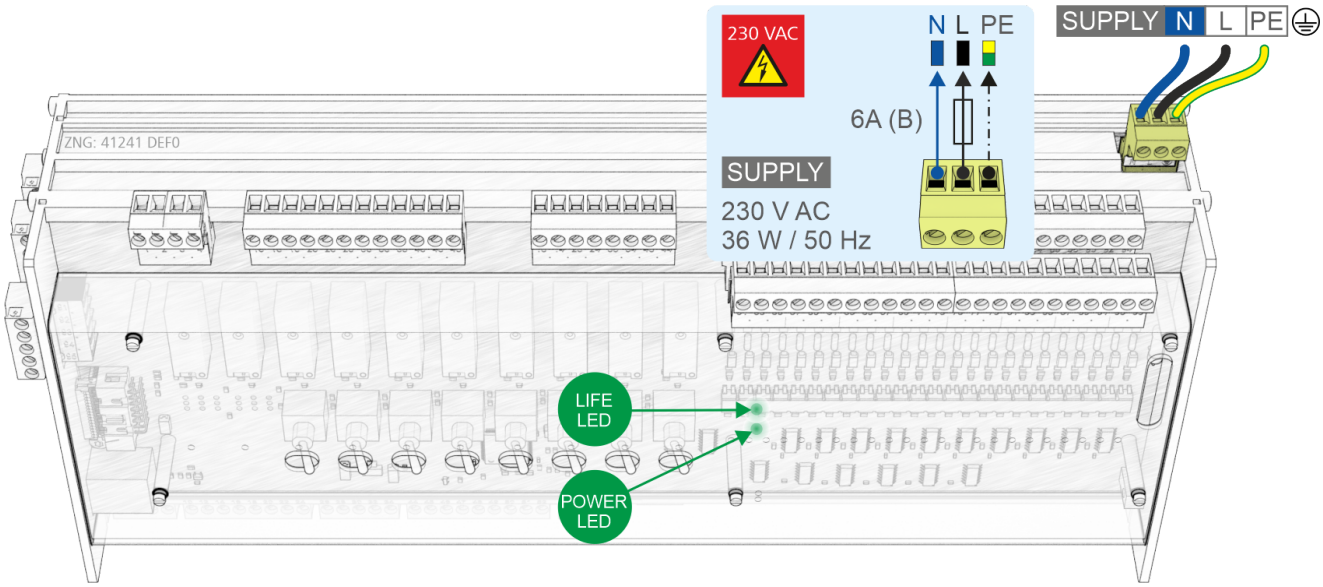
6.3.6 Power Supply

DANGER

Warning about dangerous electrical voltage! Danger to life - Danger of electric shock! BEFORE connection and disconnection, it **must** be checked that the 230 V AC power supply cable is **disconnected from the power supply**! The controller is only permitted to be connected to the intended operating voltage of 230 V AC!

ATTENTION

A circuit breaker **must** be used to protect the mains cable and must not interrupt the earth conductor (PE).



The controller can be put into operation after completion of the mechanical and electrical installation. After connecting to the power supply, the green LED (POWER) lights briefly after switching on.

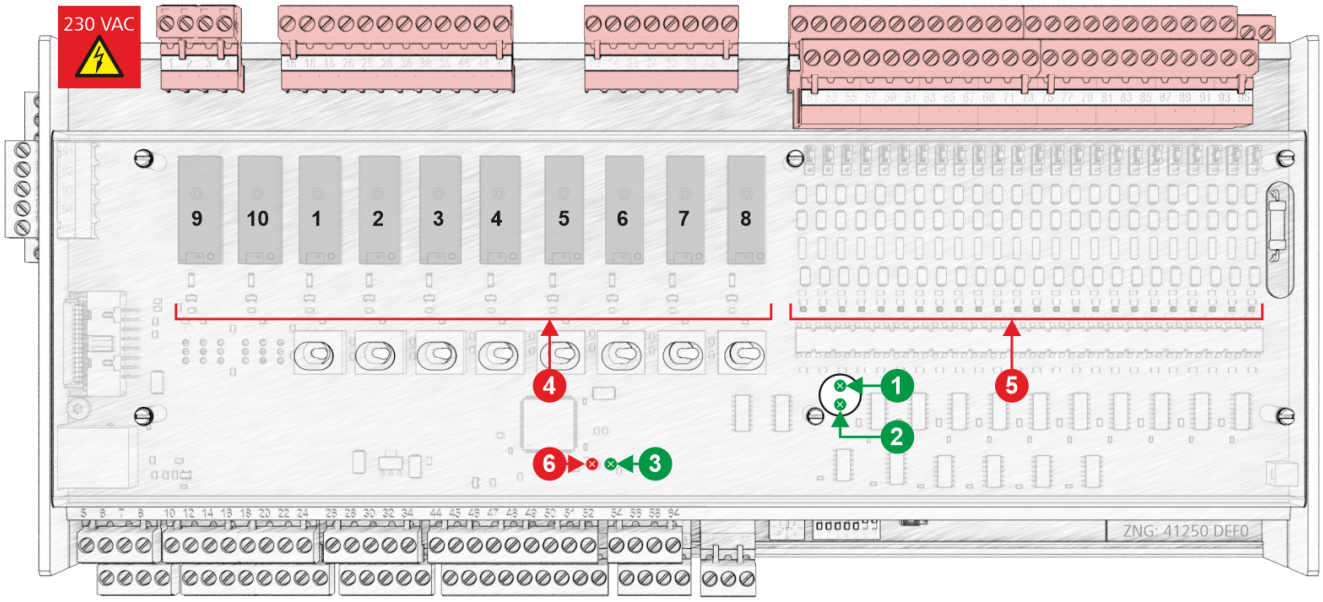
Note: As the controller itself does not have a switch for switching on or off, it **must** be disconnected from the power supply for e.g. a Restart for approx. 2 seconds (switch on/off the circuit breaker).

For details see chapter Assignment for 230 V AC Power Supply and Status LEDs.

6.3.6.1 Status LEDs

DANGER

Warning of dangerous electrical voltage! Danger to life - Danger of electric shock! BEFORE connecting and disconnecting, it must be checked that the terminals are **disconnected from the 230 V AC**! External voltage 230 V AC may be present at these terminals!



	Function	Colour	LED	Description
Lower board				
1	LIFE	green	LED	FLASHING: Active lamp, board is supplied with power, processor is running OFF: Power supply interrupted or device defective
2	POWER	green	LED	ON: Power supply OK, device is supplied with power, processor is running OFF: Power supply interrupted or device defective
Upper board (internal SIOX)				
3	LIFE	green	LED	FLASHING: Active lamp, board is supplied with power, processor is running OFF: Power supply interrupted or device defective
4	Relay outputs	green	LED1 .. LED10	ON: Relay is activated **ATTENTION:** External voltage can be present at these terminals!
5	Digital inputs	red	LED1 .. LED23	ON: Digital input is activated, voltage is present! **ATTENTION:** External voltage can be present at these terminals!
6	For future functions	red	LED	---

For details about the exact terminal assignment, see Pin Assignments VS 3010 C Base Module / SIOX.

6.4 Basic parameter settings

The parameters listed below must be adjusted in the corresponding operating screens of the controller:

Parameters *System configuration* (menu 3-1)

- *Sensor match*
  The pack controller operates with continuous pressure transmitters with linear characteristic curves. The pressure inputs can be adjusted for various transmitters with linear characteristic curves. Transmitters with both current output (4..20 mA) as well as with voltage output (0…10 V) can be used here.

  > For transmitters with voltage output, appropriate jumpers must be implemented on the controller (see chapter Configuration of the analogue inputs and outputs at the factory)! Analogue inputs in the pack controller are preconfigured as current inputs (4..20 mA) at the factory.

The following parameters are used for adjusting the controller to the pressure transmitter

- 1. *LP-, MP-* and *HP-Transducer*:
  It must be selected here whether the transmitters have a current output or a voltage output.
- 2. LP-*Min*
  Parameter defining the pressure at which the LP transmitter outputs the 4 mA, or 0 V signal.
- 3. LP-*Max*
  Parameter defining the pressure at which the LP transmitter outputs the 20 mA, or 10 V signal.
- 4. *HP-Min*
  Parameter defining the pressure at which the HP transmitter outputs the 4 mA, or 0 V signal.
- 5. *HP-Max*
  Parameter defining the pressure at which the HP transmitter outputs the 20 mA, or 10 V signal.
- 6. MP-*Min*
  Parameter defining the pressure at which the MP transmitter outputs the 4 mA, or 0 V signal.
- 7. *MP-Max*
  Parameter defining the pressure at which the MP transmitter outputs the 20 mA, or 10 V signal.
- *No. comps. (*number of compressor stages)
- *No.cap.stages (*number of capacity stages)
- *No. cond.stages (*number of condenser capacity stages)

menu *3-4 Comp. monitor*

- t_0 *Off Comp (*t_0 limit value for compressor disable)

> The t_0 limit value must be greater than the manually set value on the pressure monitor. Incorrect parametrisation can result in high impairments of the function.

6.5 Start-up of speed-controlled condenser fans / compressors

For the control of speed-regulated fans or compressors, a frequency converter (in the following referred to as FC) or speed controller is required in addition to the controller. Various other measures, particularly for interference suppression of the system, are required for the cabling of a system with FCs / speed controllers.

> **ATTENTION**
>
> 1. All inputs and outputs of low voltage signals of the controller must be contacted using shielded cables. Correct design of this shielding is particularly important for systems with FCs / speed controllers. In the case of inadequate shielding, high impairments of the measured values can occur due to the high interference emission of FCs / speed controllers.
> 2. Care must be taken with all analogue inputs and outputs that there is no connection between the sensor cables and the signal ground or shielding.
> 3. Analogue inputs and outputs are sensitive to external supply and reverse polarity! When connecting the pack controller to the control input of the FC/speed controller, the correct polarity **must be strictly** ensured. FCs / speed controllers also frequently provide a power supply for sensors or potentiometers, using which the speed can be specified.
>   This supply must **never** be connected to any analogue output of the controller. In the event of a faulty connection between the controller and the FC / speed controller, components in the controller can be permanently damaged.

6.5.1 Procedure for the start-up of a system

The following signals from the pack controller are available for the correct control of the FC / speed controller:

1. Enable FC / speed controller
In the case of compressor combined control, the frequency converter is enabled via the relay output for compressor 1 (terminals 13/14). In the case of speed controlled condenser fans, the enable for the FC / speed controller is issued via the relay output for fan 1 (terminals 15/18).

> The FC / speed controller must be configured here so that the enable is issued in the case of closed contact.

2. Speed controller / external alarm fault signal input

A. Speed controlled compressor or condenser control:
The error message output of the FC / speed controller is monitored via digital input 15 (terminals 78/79) of the pack controller during compressor combined control or fan speed control. The message text for the *speed controller / external alarm* input is automatically set to *Speed controller* when continuous control is configured.

> This fault signal is active when there is no voltage at the FC / speed controller input, i.e. the FC / speed controller must be configured and connected so that 230 V AC is present at the input 15 of the pack controller in the good state.

If the compressor control is configured as combined control and the fan control as speed control, the *speed controller / external alarm* input (input 15) monitors the fault signal output of the frequency converter for the compressor control and must be wired accordingly. The fault signal output of the FC / speed controller for the fans cannot then be monitored using the VS 3010 C.

B. Fan combined control
An additional digital input is always required for the monitoring of the FC / speed controller for fan combined control. The input "Motor protection fan" is used which always follows the last used motor protection input. For this control mode, the message text for this input is automatically set to *Speed controller HP*.

Example: number of fans n = 3
Number (n) of the digital inputs for motor protection fan = 3: M1 ... M3
Digital input for monitoring the FC / speed controller (n+1): 4th input (M4)

> The fault signal is active when there is no voltage at the "Motor protection fan" (n+1) input, i.e. the FC / speed controller must be configured and connected so that 230 V AC is applied to this pack controller input in the good state.

3. Analogue compressor speed / fan speed correcting variable

A. Compressor step control
A 0-10 V signal for the speed of the fans is output via analogue output 1 (terminals 53/54).

B. Compressor combined control
A 0-10 V signal for the speed of the fans is output via analogue output 4 (terminals 63/64).
A 0-10 V signal for the speed of the speed-controlled compressor is output via analogue output 1 (terminals 53/54).

> Special precautions must be taken for the connection of these outputs (see Notes, chapter Inbetriebnahme von drehzahlgeregelten Verflüssigerlüftern / Verdichtern).
> For the frequency converter, an adjustment of the operating point of the FC / speed controller must be made in addition to the adjustment of the input to the reception of a 0-10 V signal. A request of the pack controller of 0 V at the analogue output here means minimum speed; a request of 10 V means maximum speed. The FC / speed controller here must be operated in the speed regulation operating mode, i.e. the output speed of the fans / compressors is directly proportional to the output voltage from the pack controller.

4. Relay output for power supply bridging

> It must be strictly ensured that the power supply bridging is also realised in the switch cabinet or that the power supply bridging function is deactivated by setting the parameter t_G-*Max*. to "-", otherwise no more fan capacity is available in the case of too high t_G ($t_G > t_G$-Max.).!

A. For speed-controlled condenser fans
The relay output for fan stage 2 (terminals 28/25) is used for bypassing the FC / speed controller for the speed-controlled fans. If the configurable temperature t_G-*Max*. (menu 3-2-2-1) is exceeded, the enable of the speed controller is withdrawn (terminals 15/18, fan output 1 switches off) and the fan output 2 (terminals 25/28, power supply bridging) is set instead.

B. For fan combined control
The relay output n+1 of the fan stages is used for bypassing the FC / speed controller for fan combined control (see also chapter 4.13.10). If the configurable temperature t_G-*Max*. (menu 3-2-2-1) is exceeded, the enable of the speed controller is withdrawn (terminals 15/18, fan output 1 switches off) and the power supply bridging is set instead.

Example: number of fans n = 3 (stages combined control)
Number (n) of the digital outputs for fans (L) = 3: Outputs for fan 1 … 3
Digital output for power supply bridging (n+1 = 4): Output fan 4

5. Relay output for the base load rotation of the speed-controlled compressor for compressor combined control

As the speed-controlled compressor in the combined control type of control shows the longest operating time, base load rotation of the speed-controlled compressor is performed as well as the base load rotation of the fixed-speed compressors. Compressor 1 and compressor 2 are alternately switched to the frequency converter for this using the configurable cycle time for the base load rotation.
The base load rotation of the speed controlled compressor is triggered via a relay output. Depending on the system configuration, the following relay output is used:
VS 3010 C basic module: relay output 4 (terminals 43/44) with first SIOX extension module relay output 8 (terminals 43/44) with first SIOX extension module relay output 12 (terminals 43/44)
If the contact is closed, it must be ensured by an external circuit that compressor 2 is switched to the frequency converter and compressor 1 is in mains power operation; if the contact is open, compressor 1 is assigned to the frequency converter and compressor 2 to the mains power supply.

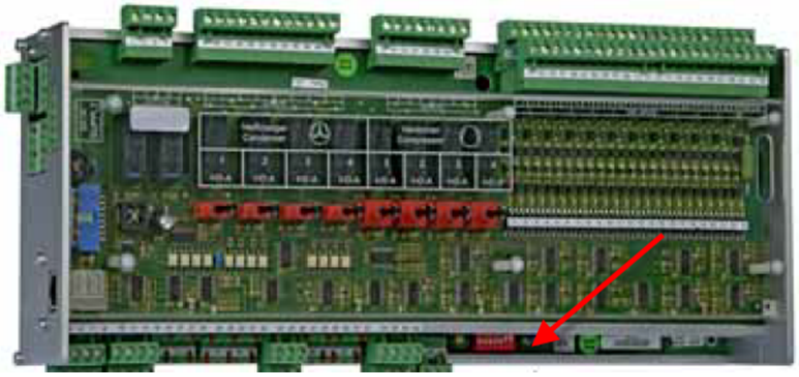
6. Analogue input for retrieval of the analogue control signal of the FC / speed controller
Modern FCs / speed controllers often provide the possibility to output the actual speed or the motor current as an analogue value. This analogue output must then be configured as a current output (4-20 mA) for this.
4 mA at the analogue output here means minimum speed / current; 20 mA means maximum speed / current.
The analogue output signal of the FC / speed controller can then be applied for the logging on the pack controller at the analogue input 2 (terminals 39/40):

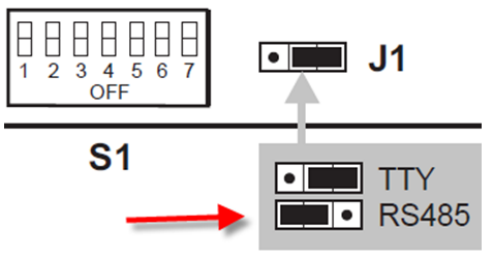
6.6 Commissioning fan control via Modbus

1. Requirements
a. VS 3010 with the part number: 4109475
VS 3010 C with the part number: 4109477

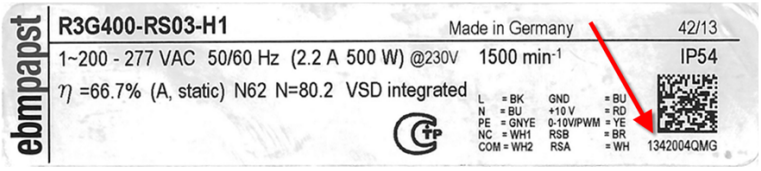
b. Software version V5.53 or higher.

2. Preparation
a. Check jumper J1 of the pack controller and swap to RS485 if necessary.





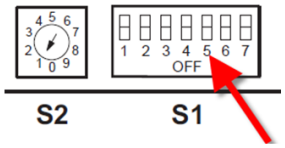
b. Note serial numbers of the fans and desired switching sequence.



Backup setpoints of the VS 3010 C using the LDSWin PC software or make a note of them as the pack controller performs a first start!

3. Modbus fan control activation

a. Switch on DIP switch 5 (Modbus fan control activation)



b. Switch off control voltage of the controller and then switch on again.
The pack controller now performs a first start and detects the fans connected to the Modbus. The process takes about 45 seconds.

c. Restore backed up software to the pack controller using LDSWin or configure the previously noted values.

d. Check fan scan:
Whether the fans on the Modbus have been detected can be recognised in terminal mode on the "Switching Sequence" screen (menu 3-2-2-1). The available fans with their serial numbers are displayed there.

e. The desired switching sequence can be configured in the "Switching Sequence" menu. For two-row condenser / gas cooler, a number can also be allocated twice.

4. Repeat in the case of error

Proceed as follows if not all or no fans have been detected:

a. Check Modbus wiring.

b. For deactivation of the setpoint input lockout
VSC 5x10, CI 5x00, CI 4x00: log in to system centre as "Master" or
CI 3x00: input the Superuser password under "Lock-down".

c. Perform the fan scan again manually using the terminal mode in menu 3-2-2-1 (parameter "*Fan Scan New* = *Y*")
After completion of the scan, the parameter automatically changes from "Y" to "N".

d. Check number of detected fans (as described above).

e. Configure switching sequence as described above.

5. Configuration of controller for fan control

All available types of control for the wired fan control can also be used for the Modbus fan control.
Due to LDSWin, the maximum number of fans, as for the wired fan control, is dependent on the number of SIOX modules.

6. Fan replacement

Proceed as follows to replace a defective fan:
a. Enter the Superuser password under "Lock-down" to deactivate the setpoint input lockout.

b) In the terminal mode in the screen "Switching Sequence" (menu 3-2-2-1), make a note of the switching sequence number of the fan to be replaced and remove the fan from the node table by entering the digit "0".

c. Scan for the replaced fan in the menu 3-2-2-1 (parameter "*Fan Scan Repl. = Y*")
After completion of the scan, the parameter automatically changes from "Y" to "N".

d) The new fan is registered in the fan table with the switching sequence number "-".

e) Enter the desired switching sequence number (e.g. 1) for the new fan.

6.7 Battery replacement

No battery replacement for the device by the user is envisaged as the battery service life is designed for greater than 10 years. **Opening** the device is **not authorised**. If the "*battery voltage*" message is displayed, the device must be sent to Eckelmann AG to guarantee correct replacement of the battery. Replacement of the battery after expiry of the warranty is subject to a charge.

ATTENTION

WEEE Reg. No.
DE 12052799

The device contains a lithium battery that must be correctly disposed of separately! Never dispose of this product with other domestic waste. Please inform yourself about the local regulations for the separated disposal of electrical and electronic products and batteries. The correct disposal of your old equipment protects the environment and people against possible negative consequences.

6.8 Firmware Update

The controller is delivered with the current firmware, ready for operation. Future software releases (e.g. with extended range of functions) can be loaded via a firmware update to update the controller.

> **ATTENTION**
>
> **Damage to the installation and stock loss! Before** the firmware update, the affected system component or the system must be brought into a safe state as the shutdown of the controller during the firmware update can have undesired effects on the system component and/or the system.
> **Caution: data loss!** When changing the firmware version, all adjusted setpoint values are lost. As a precaution, the settings **should** therefore be backed up by saving them using the LDSWin PC software **before** the firmware update. After the firmware update, the saved settings can be reloaded into the controller from LDSWin.

6.8.1 Installation of the update software on the PC

The following steps must be performed for the installation of *LDS download software*:

> Administrator rights are required for installation under Windows 2000, Windows XP, Vista and Windows 7 / 10.

1. Using *Explorer*, open the data carrier (CD ROM, diskette, network drive) where the *LDS Download Software* update software is located.
2. Double click on *setup.exe* to start the installation.

3. Follow the further instructions of the installation routine.
4. Finish the installation.

> The list and the version states of the installable components can vary depending on the version of the LDS Download Software.

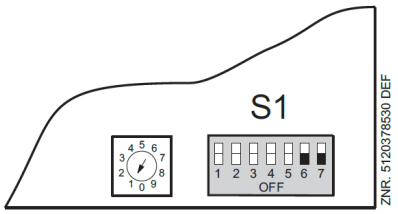
For updating the firmware, the *LDS Download Software* must now be started using

- *Start - All Programs - LDS Download - Download all LDS components* or
- *Start - Run - C:\DL\Start\dload.exe*

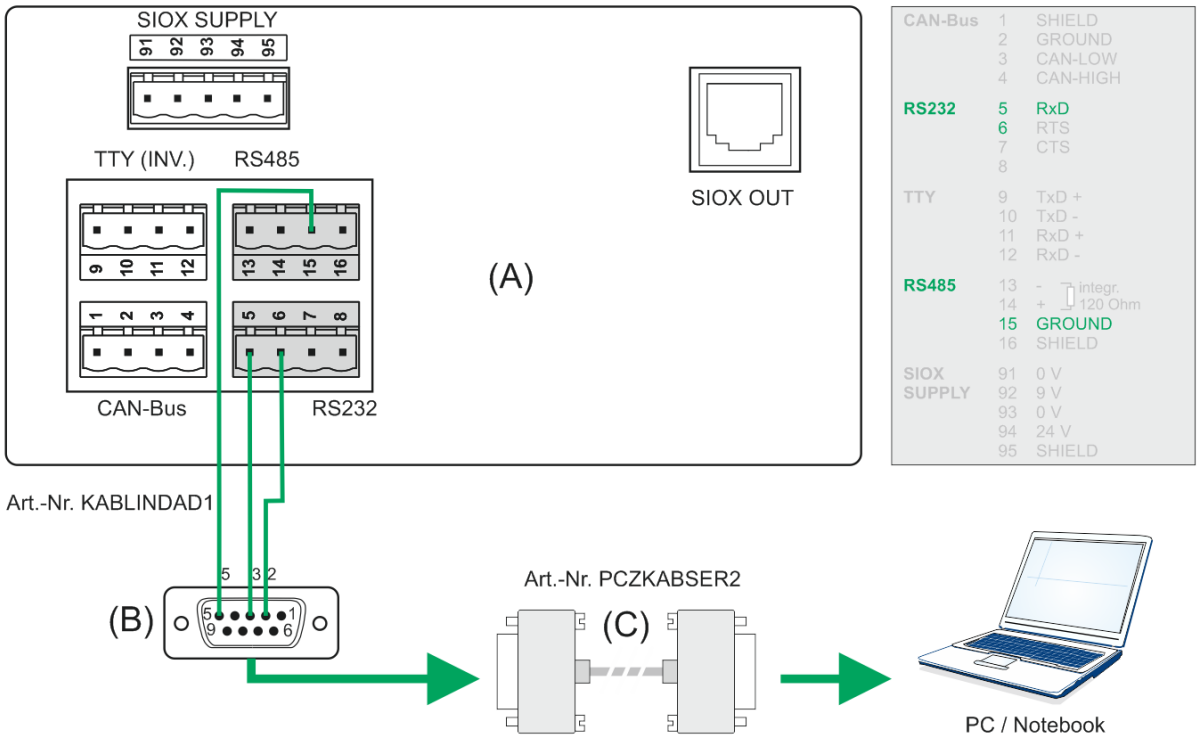
so that the current firmware update can be loaded into the pack controller.

6.8.2 Update of the current firmware

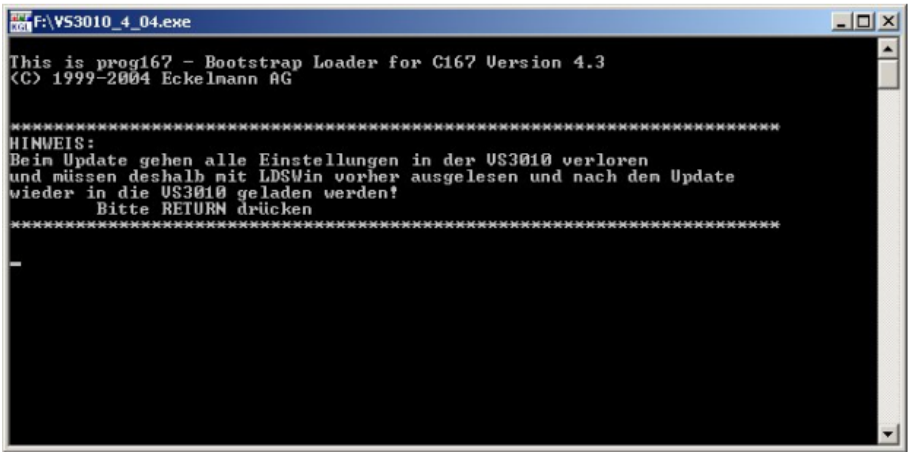
The firmware update is performed using a PC or laptop that is connected to the pack controller via the COM port. The following steps must also be **strictly** performed and observed:
1. Strictly disconnect pack controller from the mains power supply (there **must** be absence of voltage)
2. Set DIP switch S1 coding switches 6 and 7 to OFF, see Basic settings with S1:



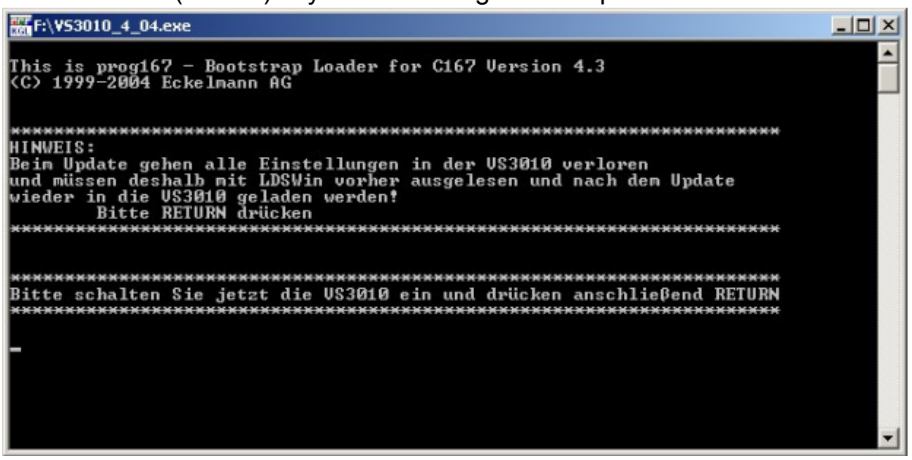
3. Connect pack controller (A) to flash cable (B) (both 4-pin plug connectors at the terminals 5/6/7/8 and 13/14//15/16.
4. Connect flash cable (B) to null modem cable (C).
5. Connect null modem cable to COM port of the PC.



6. Unpack ZIP file *VS3010CTVx.xxVx_EAG.zip*. In Windows Explorer, run the unpacked file *VS3010CTVx.xx.exe* by double clicking on it and select the COM port on the screen.
The following screen opens:



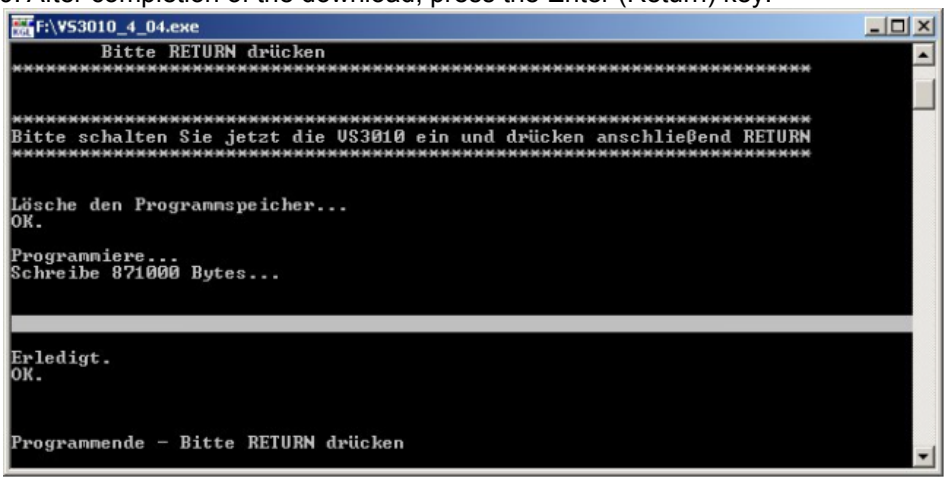
7. Press Enter (Return) key. The following screen opens:



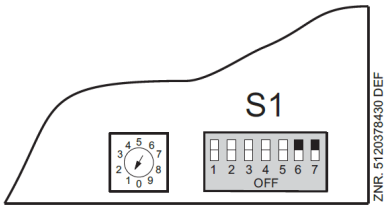
8. Now switch on the pack controller again. Then start the download by pressing the Enter (Return) key:

ⓘ The bar at the bottom indicates the progress of the download.

9. After completion of the download, press the Enter (Return) key:



10. Close the screen by pressing the Return key after completion of the firmware update.
11. Set DIP switch S1 coding switches 6 and 7 back to ON, see Basic settings with S1:

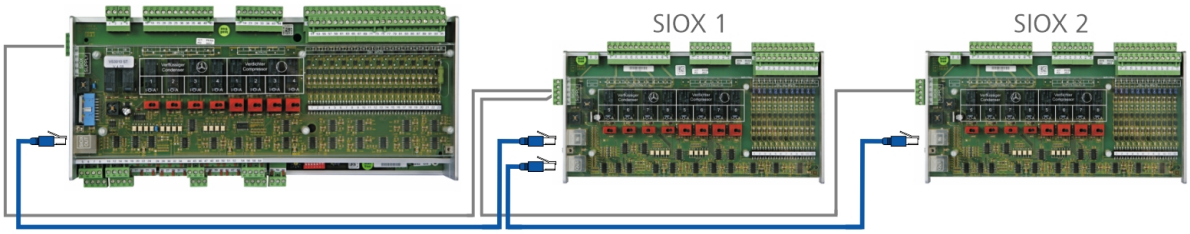


12. The controller must be disconnected from the power supply for a short time after the firmware update.

> In normal operation, the coding switches 6 and 7 of the DIP switch S1 are always in the ON position! After changing the switch positions of both S1 and S2, the controller must be disconnected from the power supply for a short time so that the new settings will be adopted!

7 Connection and terminal assignment of VS 3010 C

The following figures and tables show the terminal assignments of the basic module and the SIOX extension modules.



Basic module in full extension with max. 2 SIOX extension modules.

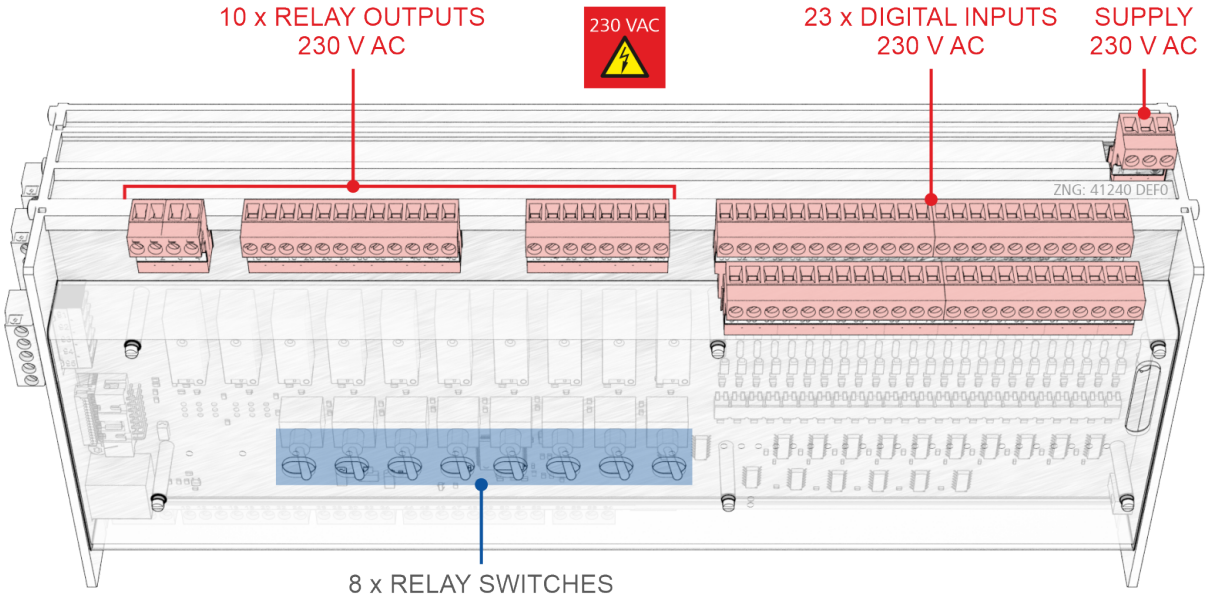
DANGER

Warning of dangerous electrical voltage! Danger to life - risk of electric shock or malfunction!
The following points must be **strictly** observed when wiring:

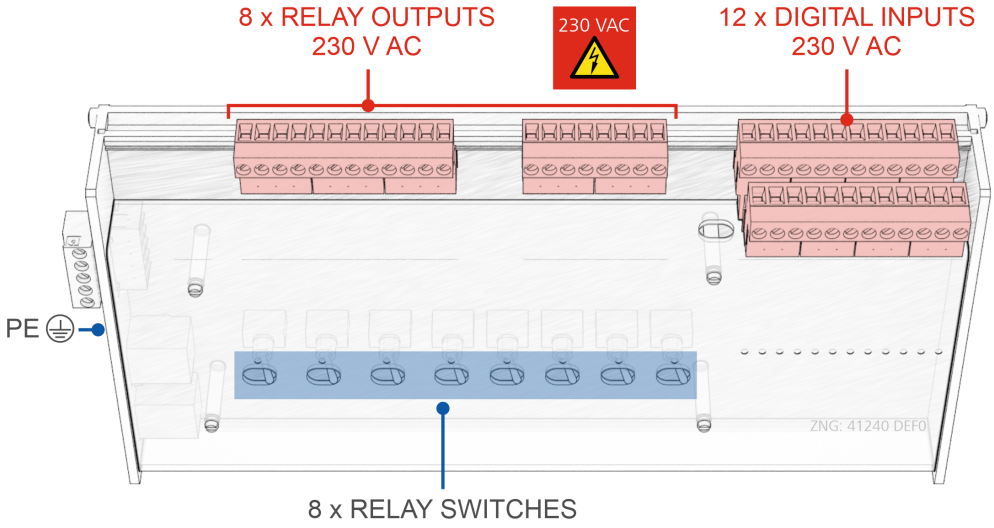
- **Before** loosening or inserting plug contacts on the controller, the system must be **disconnected from the power supply**!
- For **analogue inputs and outputs** with current or voltage interface (4..20 mA / 0..10 V), it is essential to ensure **correct polarity**. Short circuits or a faulty power supply can result in impairments of the function or even destruction of components of the controller.
- **All connection cables** from and to the controller - with the exception of the relay outputs and digital inputs - must be **shielded**. Otherwise malfunctions, e.g. faulty measurements, cannot be ruled out.

7.1 Pin Assignments VS 3010 C Base Module / SIOX

Basic Module



SIOX Extension Module



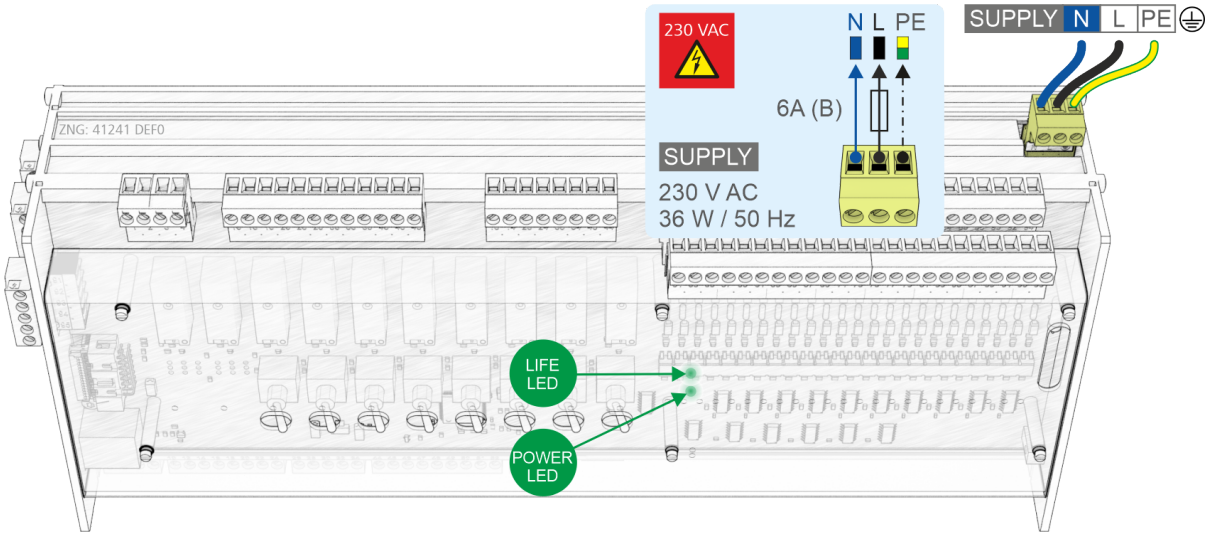
7.2 Terminal Diagrams for Basic Module and SIOX

7.2.1 Assignment for 230 V AC Power Supply

DANGER

Warning of dangerous electrical voltage! Danger to life - Danger of electric shock! BEFORE connecting and disconnecting, it must be checked that the 230 V AC power supply cable is **disconnected from the power supply**! The controller is only permitted to be connected to the intended mains power supply!

Connection: Only on base module - terminal block, upper right at the back



SUPPLY			
Designation	**Terminal No.**	**Connection**	**Function**
230 V AC	N L PE	Neutral conductor Phase 230 V AC Protective conductor	Power supply

Connection to the power supply

In order to fuse the mains power line, a circuit breaker with the following characteristics **must** be used:

- Rated current for 230 V AC: 6 A
- Tripping characteristic (type): B

After applying the 230 V AC power supply, the green POWER LED flashes; for details see chapter Status LEDs.

Requirements for the connecting cable

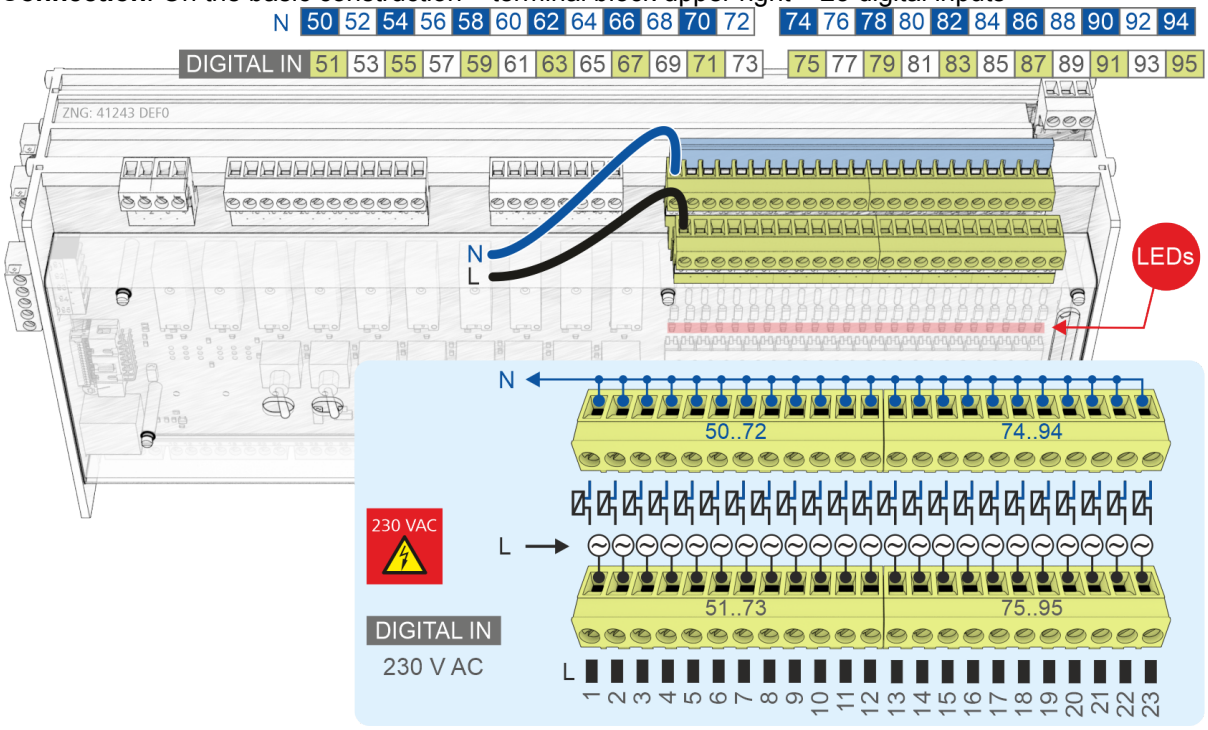
Since the controller does not have an integrated disconnecting device in the form of a mains switch,
a) a switch or circuit breaker must be present in the system or building installation,
b) this must be suitably located and easily accessible to the user, and
c) this must be marked as the disconnecting device for the unit.

7.2.2 Assignment of the digital inputs - 230 V AC

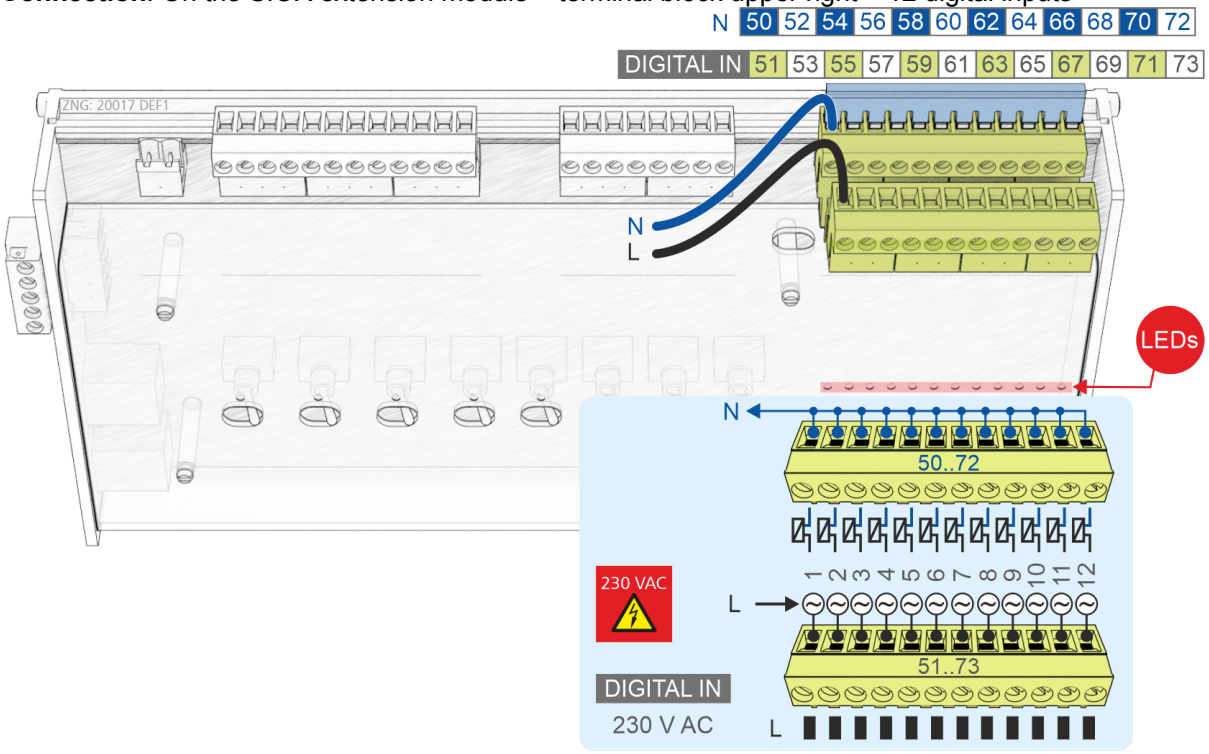
DANGER

Warning of dangerous electrical voltage! Danger to life - Danger of electric shock! BEFORE connecting and disconnecting, it must be ensured that **no voltage** is present at all connections of the controller.

Connection: On the basic construction – terminal block upper right – 23 digital inputs



Connection: On the SIOX extension module – terminal block upper right – 12 digital inputs



Terminal No.			Function
Basic module	**SIOX 1**	**SIOX 2**	
50, 51	-	-	High pressure limiter
52, 53	-	-	Low pressure monitor
54, 55 58, 59 62, 63 66, 67	-	-	Oil differential pressure / HP switch for compressor 1 * Oil differential pressure / HP switch for compressor 2 * Oil differential pressure / HP switch for compressor 3 * Oil differential pressure / HP switch for compressor 4 *
-	50, 51 54, 55 58, 59 62, 63	-	Oil differential pressure / HP switch for compressor 5 * Oil differential pressure / HP switch for compressor 6 * Oil differential pressure / HP switch for compressor 7 * Oil differential pressure / HP switch for compressor 8 *
-	-	50, 51 54, 55 58, 59 62, 63	Oil differential pressure / HP switch for compressor 9 * Oil differential pressure / HP switch for compressor 10 * Oil differential pressure / HP switch for compressor 11 * Reserved

* Digital inputs can be configured as:

- oil differential pressure switch for compressor or
- HP limiter for compressor or
- oil differential pressure / HP switch for compressor

Terminal No.			Function
Basic module	**SIOX 1**	**SIOX 2**	
56, 57 60, 61 64, 65 68, 69	-	-	Motor overload cut-out, compressor 1 Motor overload cut-out, compressor 2 Motor overload cut-out, compressor 3 Motor overload cut-out, compressor 4
-	52, 53 56, 57 60, 61 64, 65	-	Motor overload cut-out, compressor 5 Motor overload cut-out, compressor 6 Motor overload cut-out, compressor 7 Motor overload cut-out, compressor 8
-	-	52, 53 56, 57 60, 61 64, 65	Motor overload cut-out, compressor 9 Motor overload cut-out, compressor 10 Motor overload cut-out, compressor 11 Reserved
70, 71	-	-	Condenser fan 1 motor overload cut-out 1 * or ECO compressor FC fault
72, 73	-	-	Condenser fan 2 motor overload cut-out * or ECO compressor LP limiter
74, 75	-	-	Condenser fan 3 motor overload cut-out * or ECO compressor 1 oil/HP fault
76, 77	-	-	Condenser fan 4 motor overload cut-out * or ECO compressor 1 motor protection
-	66, 67 68, 69 70, 71 72, 73	-	Motor overload cut-out, condenser 5 * Motor overload cut-out, condenser 6 * Motor overload cut-out, condenser 7 * Motor overload cut-out, condenser 8 *
-	-	66, 67 68, 69 70, 71 72, 73	Motor overload cut-out, condenser 9 * Motor overload cut-out, condenser 10 * Motor overload cut-out, condenser 11 * Motor overload cut-out, condenser 12 *
78, 79	-	-	External alarm or speed controller fault with activated compressor combined control
80, 81	-	-	Fast unload - external OFF
82, 83 84, 85	-	-	Load shedding stage 1 Load shedding stage 2
86, 87	-	-	Load shedding stage 3 or emergency operation
88, 89	-	-	Setpoint shift (day / night operation)
90, 91	-	-	Heat recovery
92, 93	-	-	Rupture disk
94, 95	-	-	Level control (refrigerant low liquid level)

*** Special features for the digital inputs for control of the fans:**

1. When HP combined control is active, the digital inputs of the motor overload cut-outs for the fans can be used for monitoring the HP speed controller.

2. For "parallel" or "stages" combined control, the digital input of the motor overload cut-out n (n = number of fans +1) is used for the monitoring of the FC speed controller. This only applies if ebmpapst fans are deactivated.
3. If DIP switch S1 coding switch 5 is set to ON, the ebmpapst fans connected to the Modbus are controlled for the regulation. The digital inputs on the basic module and the SIOX are then available for other functions.

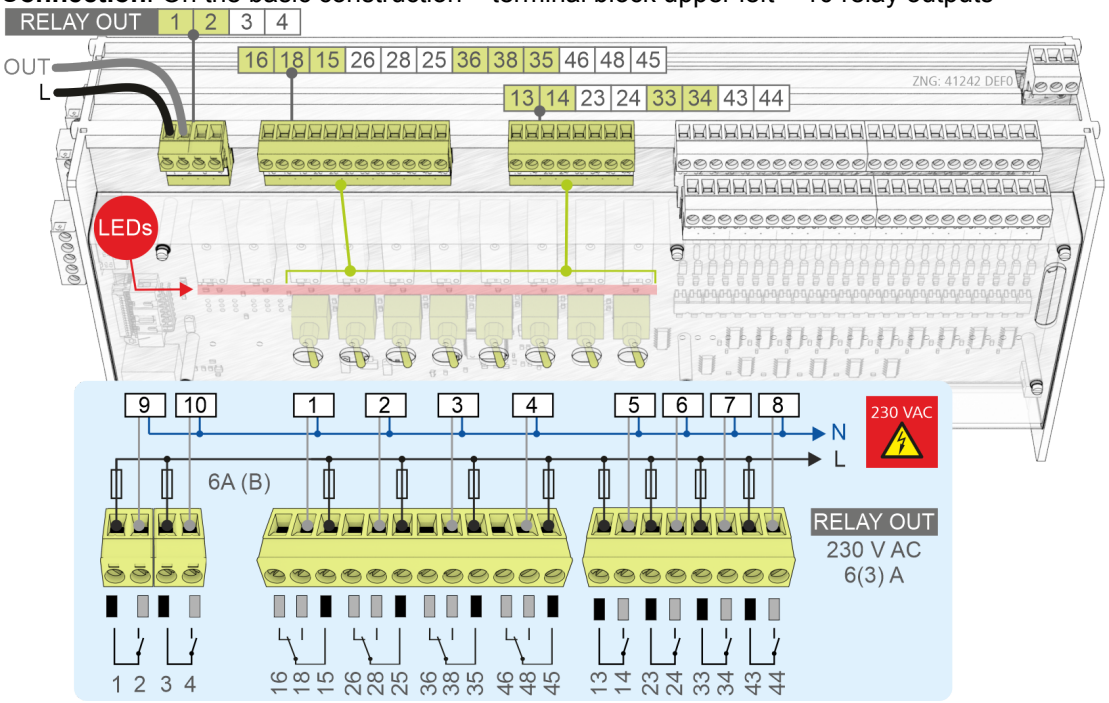
If the digital input Fast unload / External OFF (terminals 80/81) is used for any safety-critical application, additional measures for the monitoring must be taken.

7.2.3 Assignment of the relay outputs - 230 V AC

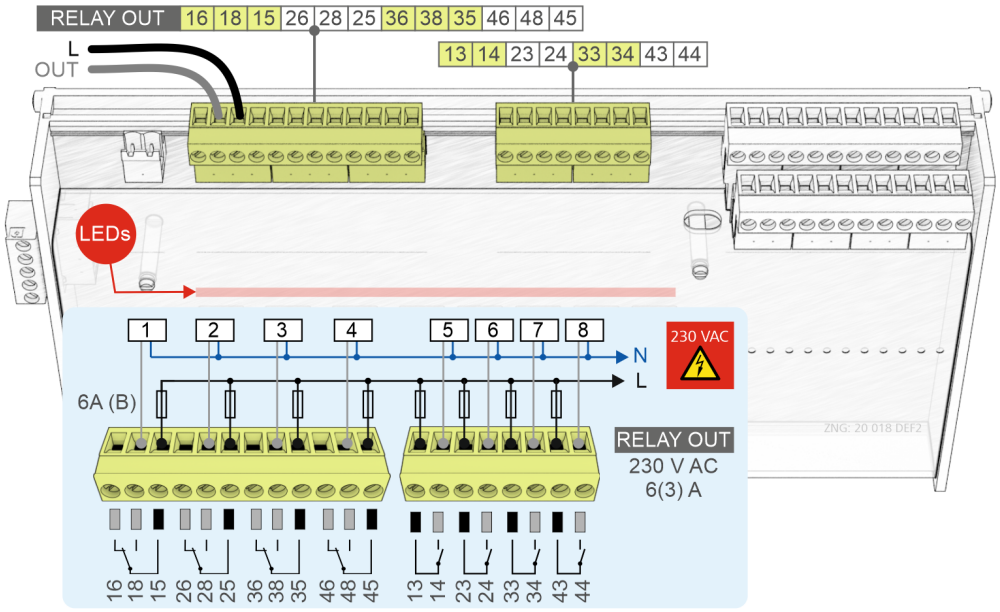
DANGER

Warning of dangerous electrical voltage! Danger to life - Danger of electric shock! BEFORE connecting and disconnecting, it must be checked that **no voltage is present** at the 230 V AC relay outputs! Low voltage **and** extra-low voltage must **not** be applied at the relay outputs!

Connection: On the basic construction – terminal block upper left – 10 relay outputs



Connection: On the SIOX extension module – terminal block upper left - 8 relay outputs



Terminal No.			Function
Basic module	**SIOX 1**	**SIOX 2**	
1, 2		-	Pressure maintenance
3, 4		-	ECO operation or hot gas bypass or suction gas injection
13, 14 23, 24 33, 34	-	-	Compressor 1 control Compressor 2 control Compressor 3 control
43, 44	-	-	Compressor 4 control or or FC compressor switching for compressor combined control (without SIOX extension module)
-	13, 14 23, 24	-	Compressor 5 control Compressor 6 control
-	33, 34	-	Compressor 7 control or Spray-System S1 (function only available with a SIOX)
-	43, 44	-	Compressor 8 control or spray system S2 (function only available with a SIOX) or FC compressor switching for compressor combined control (function only available with a SIOX)

Terminal No.			Function
Basic module	**SIOX 1**	**SIOX 2**	
-		13, 14 23, 24	Compressor 9 control Compressor 10 control
-	-	33, 34	Compressor 11 control or spray system S1 (function only available with second SIOX)
-	-	43, 44	Spray system S2 (function only available with second SIOX) or FC compressor switching for compressor combined control (function only available with second SIOX)
15.16, 18	-	-	Fan 1 control * or ECO compressor 1 (enable of the frequency converter for the ECO compressor) *
25, 26, 28 35, 36, 38 45, 46, 48	-	-	Fan 2 control 2 * Fan 3 control * Fan 4 control 4 *
-	15,16, 18 25, 26, 28 35, 36, 38 45, 46, 48	-	Fan 5 control * Fan 6 control * Fan 7 control * Fan 8 control *
-	-	15,16, 18 25, 26, 28 25, 26, 28 45, 46, 48	Fan 9 control * Fan 10 control * Fan 11 control * Fan 12 control *

*** Special features for the relay outputs for control of the fans:**

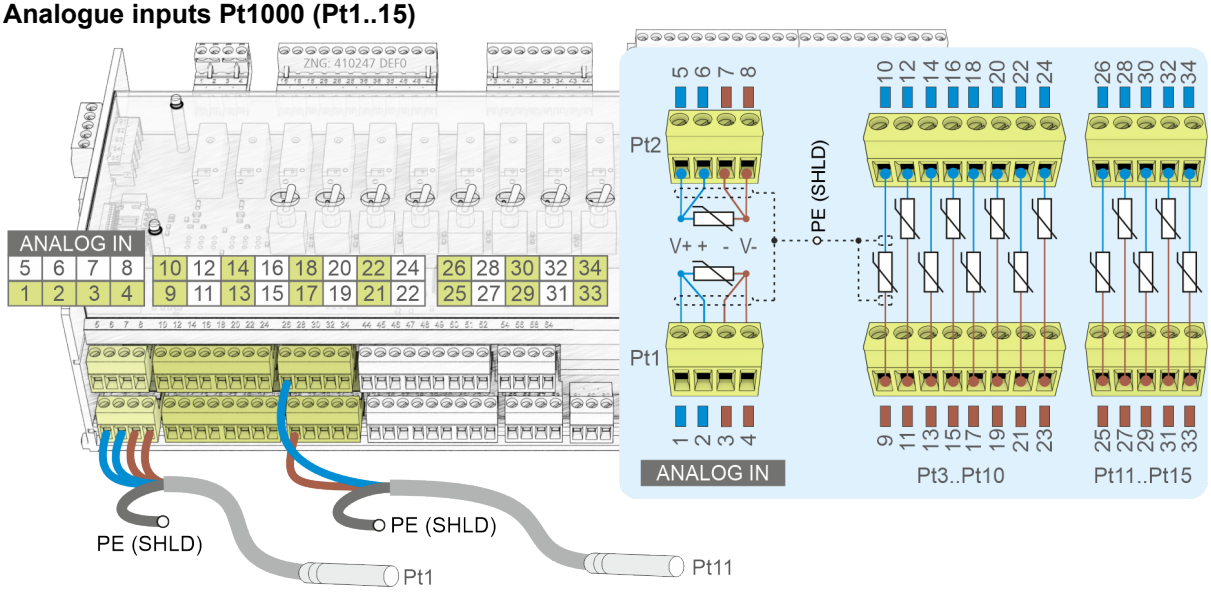
1. With activated HP combined control, the relay outputs of the motor overload cut-outs for the fans can be used for monitoring the HP speed controller.
2. If DIP switch S1 coding switch 5 is set to ON, the ebmpapst fans connected to the Modbus are controlled for the regulation. The fan relays on the basic module and the SIOX are then available for other functions.

7.2.4 Assignment of the analogue inputs

DANGER

Warning of dangerous electrical voltage! Danger to life - Danger of electric shock! If supply voltage is connected to the analogue inputs, there is a risk of personal injury as the analogue inputs are not galvanically isolated from other system components (e.g. pressure transmitters). Furthermore, this will destroy the controller!

Analogue inputs Pt1000 (Pt1..15)



ATTENTION

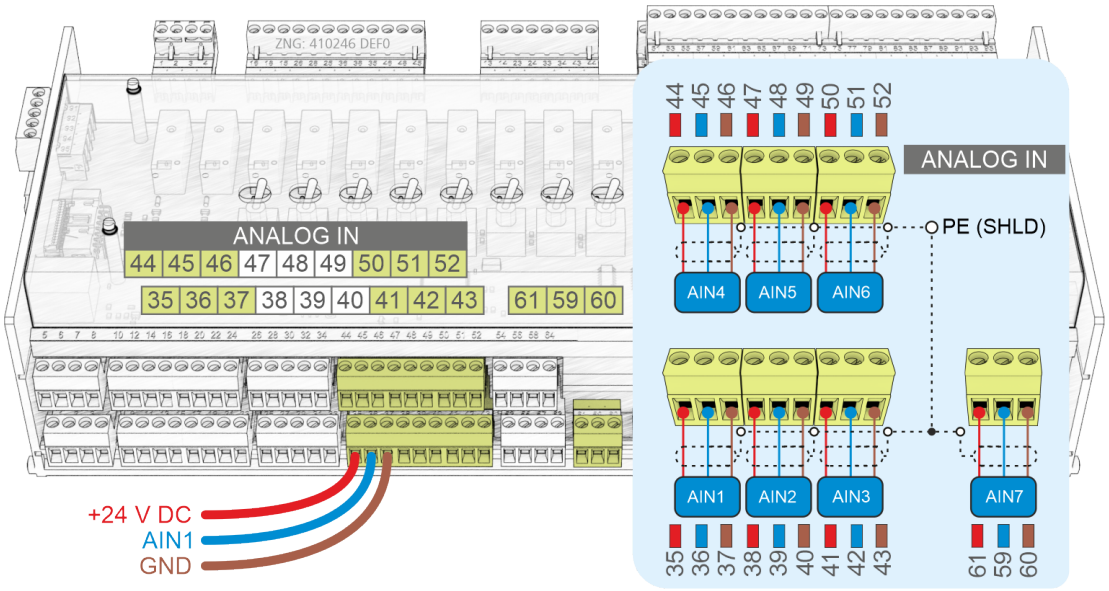
Malfunction due to interference! All supply lines from and to the controller (with the exception of the 230 V supply and signal lines) must be shielded (cable type: LiYCY)! This particularly applies for the analogue inputs and outputs (e.g. sensor supply lines). As a general rule, care should be taken to ensure that signal cables and cables carrying mains voltage are routed in separate cable ducts. Furthermore, the following must be observed when installing the analogue inputs:

- Correct sensor positioning
- Correct fixing of the sensors by using metal clamps and thermally conductive paste
- Insulation of the sensors (e.g. protect sensors against direct exposure to sunlight)

Terminal No.	Function
Basic module	
	2 x Pt1000 4-wire temperature sensor
1, 2, 3, 4	Outdoor temperature V+ / + / - / V-
5, 6, 7, 8	Room temperature V+ / + / - / V-

	13 x Pt1000 2-wire temperature sensor
9, 10 11, 12 13, 14 15, 16 17, 18 19, 20 21, 22	Cylinder head temperature C1 Cylinder head temperature C2 Cylinder head temperature C3 Cylinder head temperature C4 Cylinder head temperature C5 Cylinder head temperature C6 Cylinder head temperature C7
23, 24	Cylinder head temperature C8 or sucttion gas temperature for ECO compressor (only possible for systems with ≤ 7 compressors)
25, 26	Cylinder head temperature C9 or hot gas temperature COP monitoring (only possible with systems with ≤ 8 compressors)
27, 28	Cylinder head temperature C10 or suction gas temperature V (V = on the pack side)
29, 30	Cylinder head temperature C11 or heat recovery mode outlet temperature
31, 32	Gas cooler outlet temperature
33, 34	Suction gas temperature K (K = on the case side)

Analogue inputs (AIN1..7)



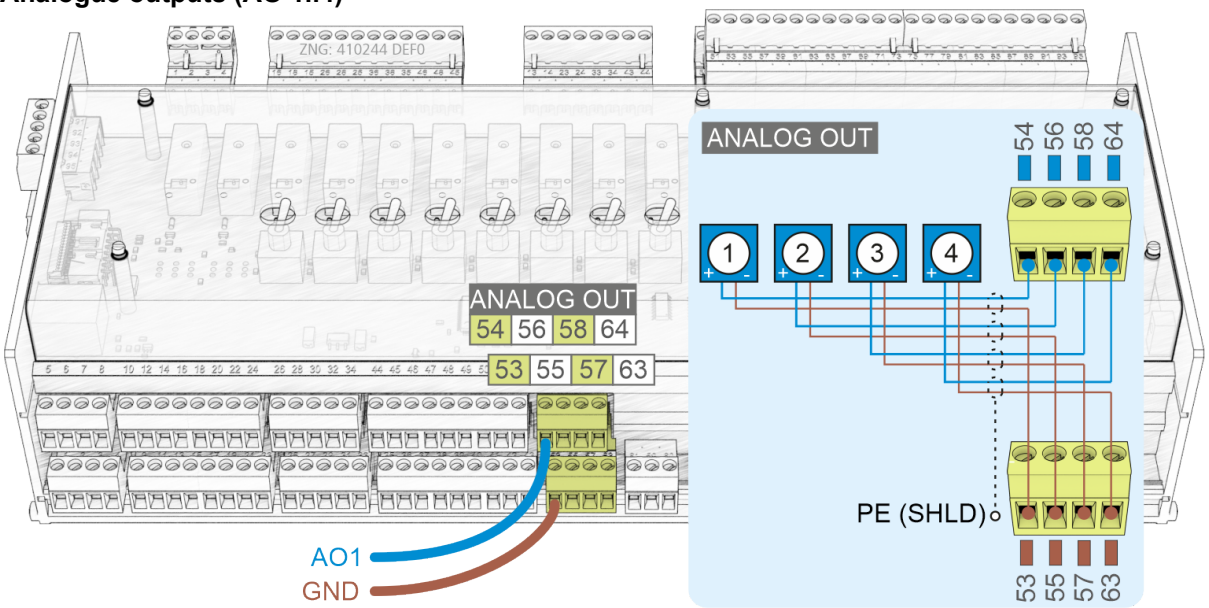
	7 x sensors / other
35 36 37	Low pressure transmitter + 24 V DC 4..20 mA GND
38 39 40	Reading back of the FC output for compressor control for the output of the current or the frequency + 24 V DC 4..20 mA GND
41 42 43	Low pressure transmitter Z2 + 24 V DC 4..20 mA GND
44 45 46	High pressure transmitter + 24 V DC 4..20 mA GND
47 48 49	Medium pressure transmitter + 24 V DC 4..20 mA GND
50 51 52	HRC request or external t0-Schiebung + 24 V DC 0..10 V GND
61 59 60	Humidity sensor +24 V DC 4..20 mA GND

7.2.5 Assignment of the analogue outputs

DANGER

Warning about dangerous electrical voltage! Danger of electric shock! If supply voltage is connected to the analogue inputs, there is a risk of personal injury as the analogue inputs are not galvanically isolated from other system components (e.g. pressure transducers). Furthermore, this will destroy the controller!

Analogue outputs (AO 1..4)



ATTENTION

Malfunction due to interference sources! All supply lines from and to the WRG 3010 E (with the exception of the 230 V power supply and signal cables) must be shielded (cable type: LiYCY)! This particularly applies for the analogue inputs and outputs (e.g. sensor supply cables) as well as the CAN bus cabling (see Basics and General Safety and Connection Instructions). As a general rule, care should be taken to ensure that signal cables and cables carrying mains voltage are routed in separate cable channels.

Terminal No.	Function (0..10 V)
Basic module	
53 54	Speed controlled fan control (for compressor step control) or Speed controlled compressor control (for compressor combined control) GND +0..10 V
55 56	Medium pressure valve (MPV) control GND +0..10 V
57 58	High pressure valve (HPV) control GND +0..10 V
63 64	Speed controlled fan control (for compressor combined control) or for the speed of the FC-controlled ECO compressor* GND +0..10 V

*** Special features for the analogue inputs:**

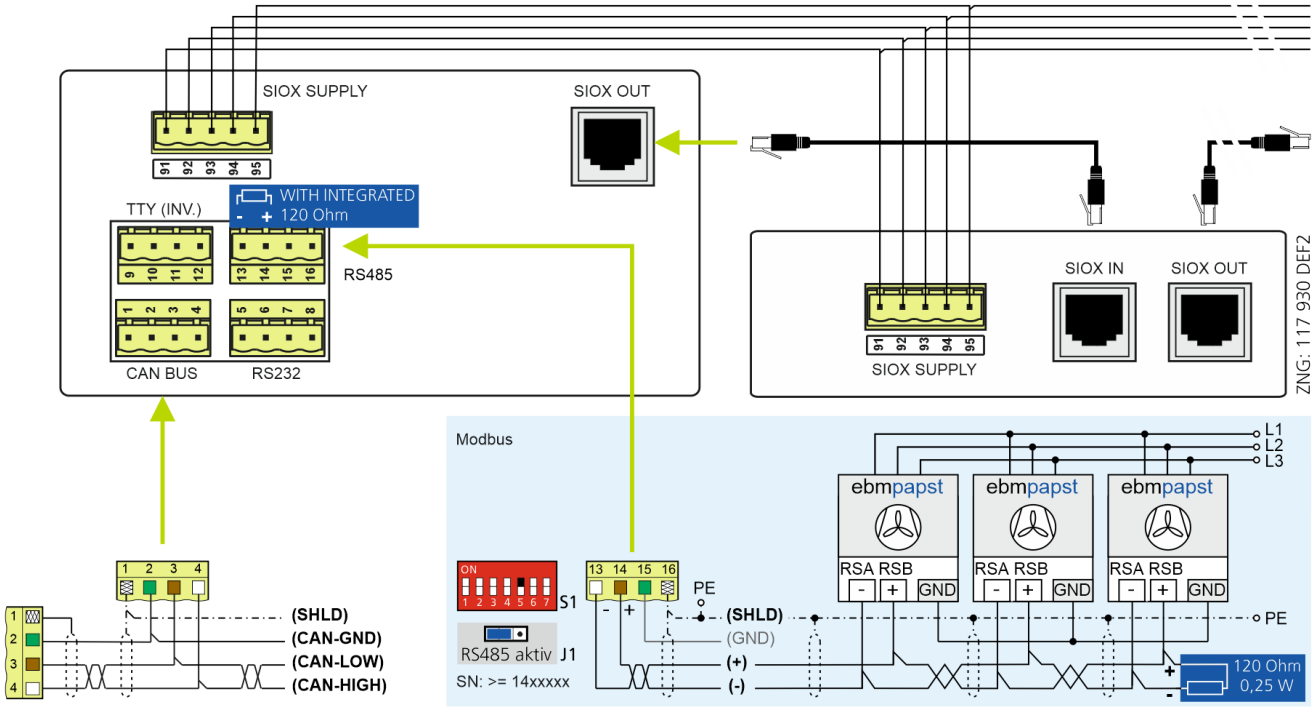
1. If DIP switch S1 coding switch 5 is set to ON, the ebmpapst fans connected to the Modbus are controlled for the regulation. The analogue input 4 on the basic module is available for other functions.

7.2.6 CAN bus, SIOX and Modbus (ebmpapst fans) terminal assignment

DANGER

Warning of dangerous electrical voltage! Danger to life - Danger of electric shock! BEFORE connecting and disconnecting, it must be ensured that **no voltage** is present at all connections of the controller.

Connection: On the basic construction and SIOX extension module - connections on the left side



ATTENTION

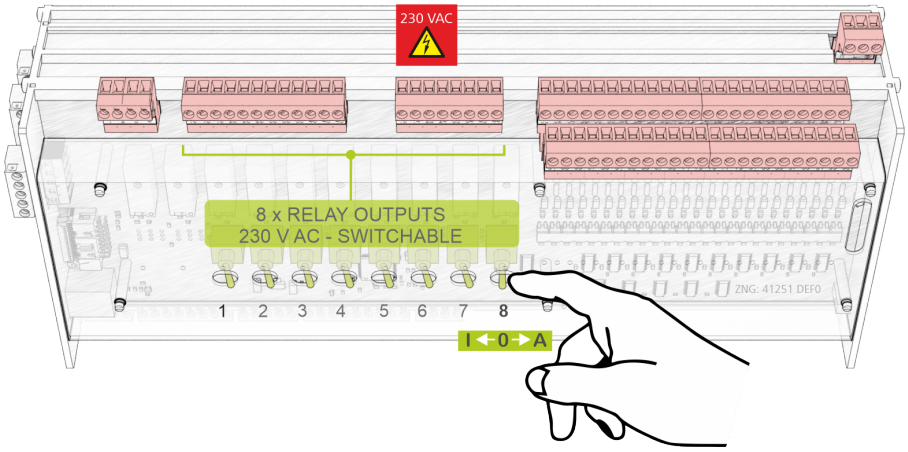
Danger of destruction of components! The connection of SIOX extension modules with each other or to the controller may only be performed when no voltage is present! In the event of any mix-up of the SIOX data cable (RJ45) with an Ethernet network cable with PoE (Power over Ethernet), involved network devices can be damaged! As a general rule, care should be taken to ensure that signal cables and cables carrying mains voltage are routed in separate cable channels.
CAN bus: supply lines must be shielded (cable type: LiYCY)!
Modbus: supply lines must be shielded (cable type: J-Y(ST)Y)!

Terminal No.		Function
Basic module	**SIOX**	
1 2 3 4	-	CAN bus SHIELD GND CAN-L CAN-H
5, 6, 7, 8	-	RS232
9, 10, 11, 12	-	TTY
13 14 15 16	-	Modbus RS485* (-) (+) GND SHIELD Terminals 13 /14 with integrated 120 ohms terminating resistor Note: a 120 ohms terminating resistor must be connected at the end of the Modbus! * For details about the setting, see chapter Setting of the interface RS485/TTY using jumper J1
-	SIOX IN	SIOX data cable - input
SIOX OUT	SIOX OUT	SIOX data cable - output
91 92 93 94 95	91 92 93 94 95	SIOX SUPPLY - power supply cable GROUND of 9 V +9 V DC GROUND of 24 V +24 V DC SHIELD

8 Operating modes of VS 3010 C

8.1 Manual / automatic emergency mode selection

Emergency operation of the compressor pack after a controller failure is possible using the manual / automatic selection. The manual / automatic selection is realised at a relay level that is subordinate to the electronic controller.
The manual / automatic switching of each compressor, gas cooler and fan is performed using the switches located on the circuit board:



ATTENTION

Only SIOX extension modules with manual control switch may be connected. SIOX extension modules **without manual control switch are not authorised**! The Manual OFF and Manual ON positions override the state desired by the software! The manual / automatic switching is available in the same way for the basic module as well as for the SIOX extension module.

The following switch positions are possible:

- **A: Automatic ON (default switch position)**
  If any switch is in the A position, the controller registers the logical AUTOMATIC OPERATION state:
  The connected equipment is controlled **as the software envisages**.
- **O: Manual OFF**
  If any switch is in the 0 position, the controller registers the logical MANUAL OPERATION OFF state:
  The connected equipment is **not controlled** - even if the software envisages this,
  e.g. fan remains off continuously!
- **I: Manual ON**
  If any switch is in the I position, the controller registers the logical MANUAL OPERATION ON state:
  The connected equipment is **always controlled** - even if the software does not envisage this,
  e.g. fan remains on continuously!

8.2 Service Mode

After selection of the pack controller *Service Mode* (menu 8), all compressors and fan outputs are reset step by step.
Then all controller functions are inactive so that each digital and analogue output can be set manually. The controller registers the *Service Mode* by the entry of a message in the log memory. Transmission is performed according to priority selection.

> In the *service mode* the switching commands to the relays or the specifications to the analogue outputs (voltage 0..10 V or current 4..20 mA) are performed immediately!
> The digital and analogue inputs (motor overload cut-out, oil pressure difference switch, pressure transmitter etc.) are not taken into account.

8.3 Display of the operating states

Some rows of the display have additional symbols before the operating states of the system measured value. The following additional symbols are displayed.

- Display of the suction pressure trend:
  Shows whether compressor capacity stages should be loaded, unloaded or not switched after expiry of the delay times.

  t_{0_Ist} X -20 °C
  $ND_{\_Ist}$ X 2.34 b
  ⇓
  ↑ Compressor capacity stages will be loaded.
  ↔ No switching of compressor capacity stages is performed. $ND_{\_Ist}$ in neutral zone.
  ↓ Compressor capacity stages will be unloaded.
  Note: NZ/2 only with step control

- Display of the gas cooler outlet temperature trend:
  Shows whether fan capacity stages should be loaded, unloaded or not switched after expiry of the delay times.

  t_{G_Ist} X 30 °C
  ⇓
  ↑ Fan capacity stages will be loaded. $t_{G\_Ist} > t_{G\_Soll} + \frac{NZ}{2}$
  ↔ No switching of fan capacity stages is performed. t_{G_Ist} in neutral zone.
  ↓ Fan capacity stages will be unloaded. $t_{G\_Ist} < t_{G\_Soll} - \frac{NZ}{2}$

- Display of the setpoint characteristic:

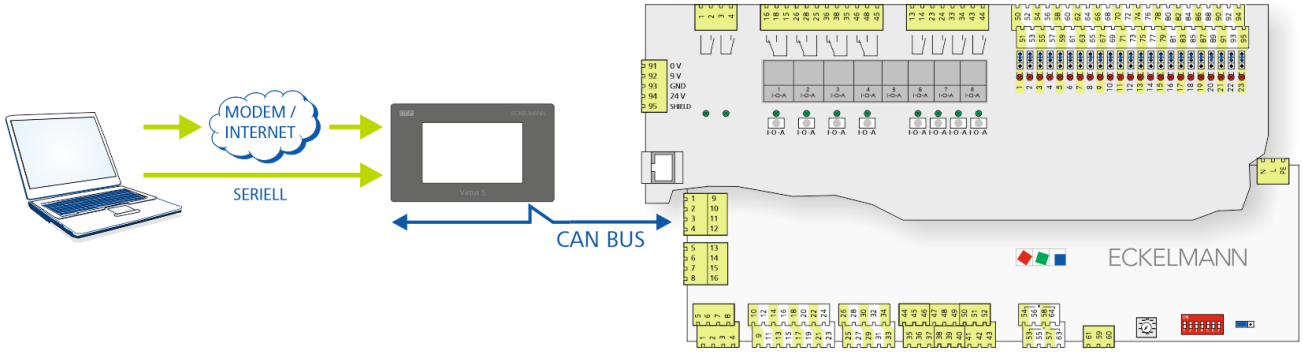
  t_{0_Soll} X -20 °C
  $ND_{\_Soll}$ X 2.34 b
  t_{G_Soll} X 30 °C
  $HD_{\_Soll}$ X 15.45 b
  ⇓
  T The controller operates with the parameters for day operation.

N The controller operates with the parameters for night operation.
WRG The controller operates with the parameters for heat recovery operation.

9 Operation of VS 3010 C

Operation of the pack controller is possible via the CAN bus interface, the system centre, a store computer or an operator terminal whereby these can be configured. No operation at the pack controller itself is possible apart from the manual / automatic mode selection (see Operating modes of VS 3010 C).

The connection of LDSWin to the system centre (that functions as gateway for the controller) can either be made remotely (via modem or via the network) or directly on-site (via a serial connection):



Details for the connection of LDSWin to the E*LDS system can be found in the LDSWin operating manual.

9.1 Operation possibilities

The controller provides menus and screens for the display and adjustment of values. However, no operation for this is provided on the controller itself. The actual operation of these menus is performed externally using the following possibilities:

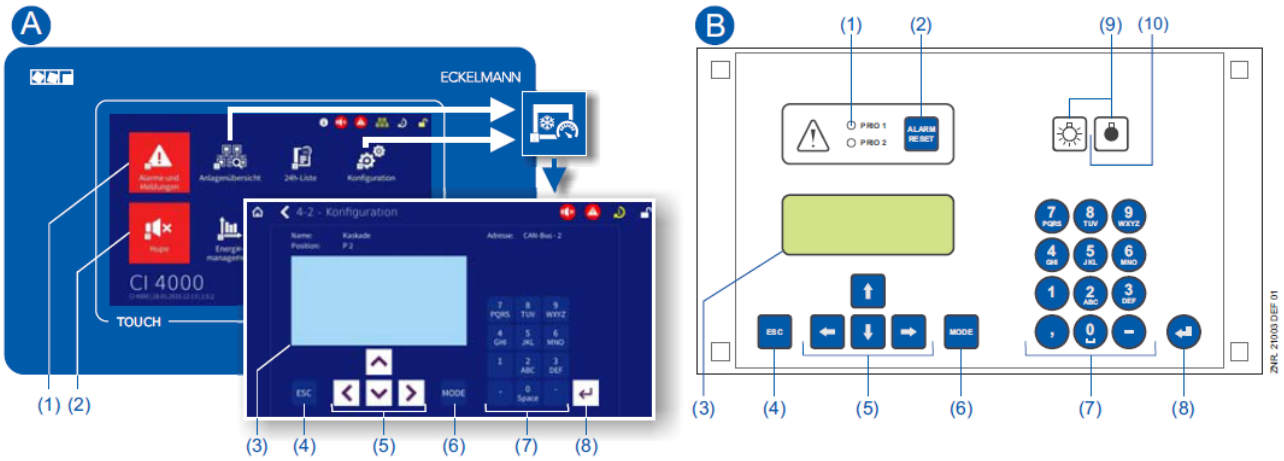
- **Remote control via the terminal:** The controller can be operated remotely (e.g. from the machine room) using the system centre, a store computer or an operator terminal. The communication with the controller is performed via the CAN bus; for details about the operation, see Remote control using a terminal.

- **Remote control with PC software LDSWin:** A PC with LDSWin installed is connected to the system centre or the store computer. The connection can be made here, for example, via the serial or USB interface, a modem, a network or the PC-CAN bus adapter. In this way, the controller can be operated very conveniently with the PC software and its powerful functions such as controller analysis, evaluations, storing parameter sets, creating lists, etc. See the LDSWin operating manual for further details about the range of functions.

9.2 Remote control using a terminal

Further details for the operation of a system centre, store computer or operator terminal can be found in their operating manuals.

For the remote control of a controller, it makes no difference whether this is done with a system centre **(A)**, a store computer or with an operator terminal **(B)** as the user interfaces on the terminals are almost identical and the same functions are available.
The system centre only emulates the "hardware front" of its "store computer" predecessor or of the operator terminal by software on its touch screen which is demonstrated by the following comparison between the terminals of the CI 4x00 and CI 3x00 / AL 300:



(1) CI 4x00: "Alarms and messages" button in the main menu for display of whether alarms are pending. Alarms are acknowledged in the "alarm list".
CI 3x00 / AL 300: red LED signal lamps to indicate whether alarms are pending.

(2) CI 4x00: "Horn" button in the main menu for muting of the buzzer and for reset of the AUX relay.
CI 3x00 / AL 300: button for muting of the buzzer, for reset of the AUX relay* and for acknowledgement of alarms.

(3) Display (4 lines x 20 characters) for display of the menu of the controller.

(4) **ESC** button

(5) Cursor buttons

(6) **MODE** button for, e.g. toggle upper case / lower case for text input.

(7) Alphanumeric keypad

(8) **ENTER** button (↵)

Only CI 3x00 / AL 300:
(9) On/Off button for, e.g. lighting

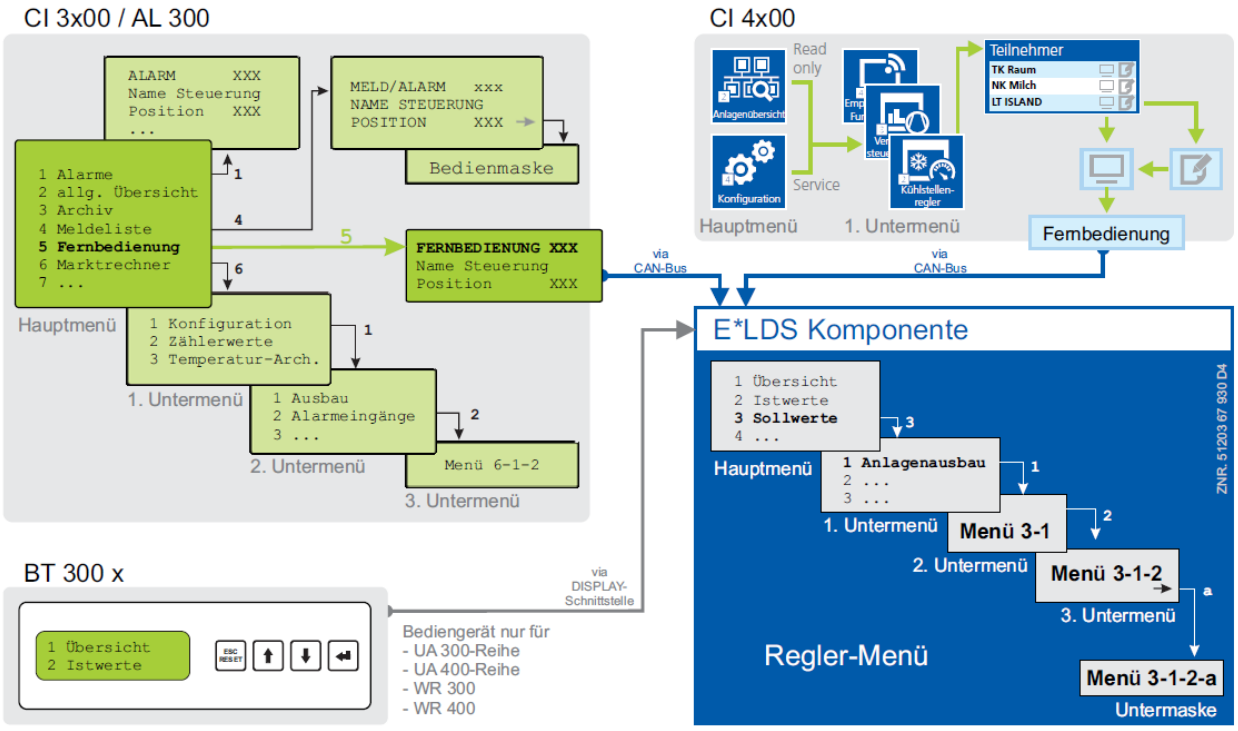
(10) Green LED signal lamp for status indicator whether the button is activated (then green) or deactivated.

9.2.1 Menus and operating screens

> If the system centre, store computer or operator terminal remain locked down, settings on the controller are read-only. Changes and inputs are not possible. However, if any parametrisation is required, the input lock must be deactivated, see Deactivating the input lock.

Numbering of menus and screens
Every menu in the menu tree can be reached using a specific number and every operating screen in a menu can be reached using a specific selection in the menu. This is identified in the operating manual by a unique identifier of digits (and letters if necessary) in the menu tree (e.g. menu 3-1-2-a). Thereby, the digits 1, 2, .. stand for the identification of the corresponding menu, and the letters a, b, .. stand for the sequence of the corresponding operating screens in the menu.

Example for the numbering of a menu / screen
Any reference to, for example **Menu 3-1-2** in the operating manual means that the required menu of the E*LDS component is called by entering the digits or selection of **"3 - 1 - 2"** via the remote control in the system centre, store computer, operator terminal or terminal device. The menu item "Remote control" is the interface for the E*LDS controller; for details, see chapter Call controller menu using remote operation.
If any letter is appended (e.g. **menu 3-1-2-a**), this means that another submenu (operating screen or selection list) can be reached using the cursor right button (). The letters indicate their sequence in the screen.
If any menu or operating screen consists of more lines than are possible in the display, scrolling is possible using the cursor buttons (↑) and (↓).



> In contrast to the system centre, store computer or operator terminal, the menu of the controller is displayed directly on the terminal device.

Menus
A menu can contain up to ten menu items (0 .. 9; 0 for menu item 10). After the selection of an element using the cursor buttons (↑) and (↓) and tapping the **ENTER** button (↵) or by tapping the buttons 0..9, further submenus or operating screens are provided.

Selection of the menu items
Each line of this selection list in the display has a digit between 1 and 9 and 0 for menu item 10 with the associated name of the corresponding menu item. The various menu items can be selected directly by tapping the digit buttons 0 .. 9.
f a menu provides more than 3 submenus, the cursor buttons (↑) and (↓) can be used for scrolling in the menu to display the remaining menu items.

> A menu item does not have to be displayed to select it using a numeric button.

Operating screens
An operating screen contains values for output and/or values for input. More values for output and/or input can be available than can be shown on the display. In this case, these values can be displayed by scrolling. If an operating screen contains several pages, these can be paged through.

> If it is possible to scroll or page in a menu or an operating screen, this is indicated by direction arrows on the right in the display.

Scrolling
Using the cursor buttons (↑) and (↓),

- scrolling can be line by line, e.g. for selection of a variable in a line from a list of predefined variables.
- scrolling can be block by block so that values can be shown that cannot be displayed with the others due to the limited capacity of the display.

Paging
If an operating screen contains multiple pages (e.g. the alarm list), these can be paged through using the cursor buttons (↑) and (↓). In menus that provide more than 3 submenus, these can be paged through using the cursor buttons (↑) and (↓) to display the remaining menu items.
The button combinations
MODE + 9 can be used in the operating screens to scroll three lines upwards and
MODE + 3 to scroll three lines downwards.

Input of values and text
Select the required line using the cursor buttons (↑) and (↓) and then tap the **ENTER** button (↵). The cursor jumps to the input field. Values can now be entered and changed here using the cursor buttons (↑) and (↓) or the digit buttons.
If the cursor buttons are kept tapped, the adjustment is made in high speed mode.

Delete input text
The **MODE** button and **-** must be tapped simultaneously to delete the complete text line. A character is deleted using the button combination **MODE** and **,**.

Cancelling an entry
The entry of a value can be cancelled by tapping the **ESC** button. The value is not applied.

Text input
For fields that enable input of texts, the text input is also possible using the alphanumeric keyboard. Letters are generated by multiple tapping of the digit buttons. To accept the entered value / text, tap the **ENTER** button (↵).

ENTER button	Letters / characters
0	äöüß0, space character
1	1
2	2ABC
3	3DEF
4	4GHI
5	5JKL
6	6MNO
7	7PQRS
8	8TUV
9	9WXYZ
-	. _ -
,	Insert space character

Upper case and lower case can be toggled by tapping the **MODE** button.

Exit from the menus and operating screens
Tap the ESC button to exit from menus and operating screens. This returns to the next higher-level menu. All menus and operating screens are exited automatically 10 minutes after the last time any button was tapped. A jump to the main menu or to the alarm menu if any error message is pending (only store computer / operator terminal) is performed here.

9.2.2 Call controller menu using remote operation

If the system centre, store computer or operator terminal remains locked down, settings on the controller are read-only. Changes and inputs are not possible.
However, if any parametrisation is required, the input lock must be deactivated, see Deactivating the input lock.
Tip: Detailed descriptions for the basic configuration of the controller, name of the controller and its position designation or about the settings of important parameters can be found in chapter Basic parameter settings.

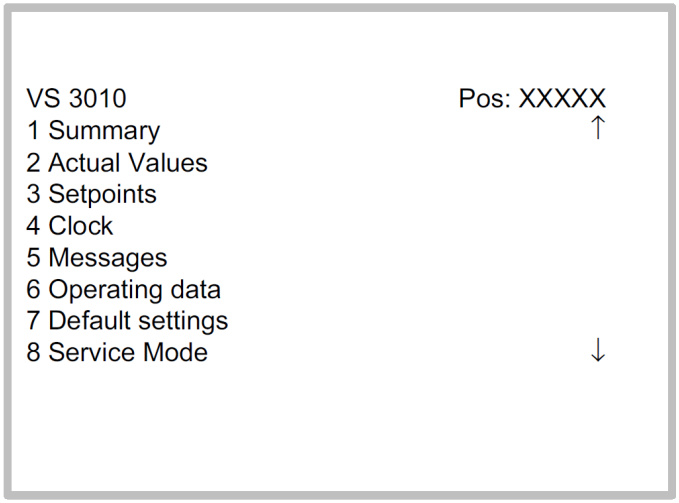
9.2.2.1 CI 4x00 System Centre - Remote control

The terminal for remote control of the controller (menu 2-2 or menu 4-2) is called in the system centre as follows:

Step 1: Tap "**2 - System overview**" or **"4 - Configuration**" in the main menu. If "2" is selected, the values below are only displayed as read-only; for "4", the input lock must be previously deactivated by logging in (see Deactivating the input lock), so that the settings below can be made.

Step 2: Tap "**2 Case controllers**" and select the required controller in the list that is then displayed using the cursor buttons (↑) and (↓). In the screen that opens, the name, position designation and the alarm priority of the controller can be input as required.

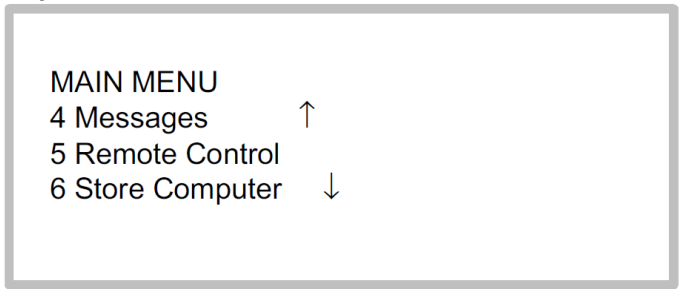
Step 3: The main menu of the controller is then displayed by tapping the "Remote control" button:



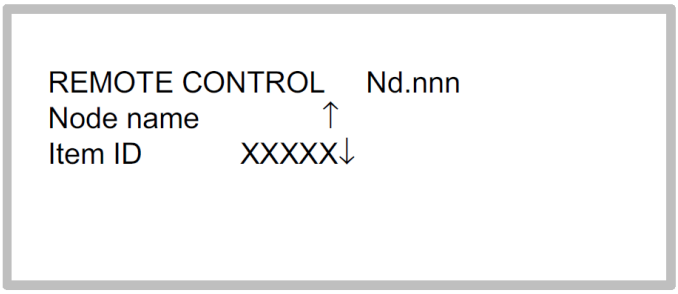
9.2.2.2 CI 3x00 store computer / AL 300 operator terminal - remote control

The main menu of the controller is called in the store computer or operator terminal via the remote control as follows:

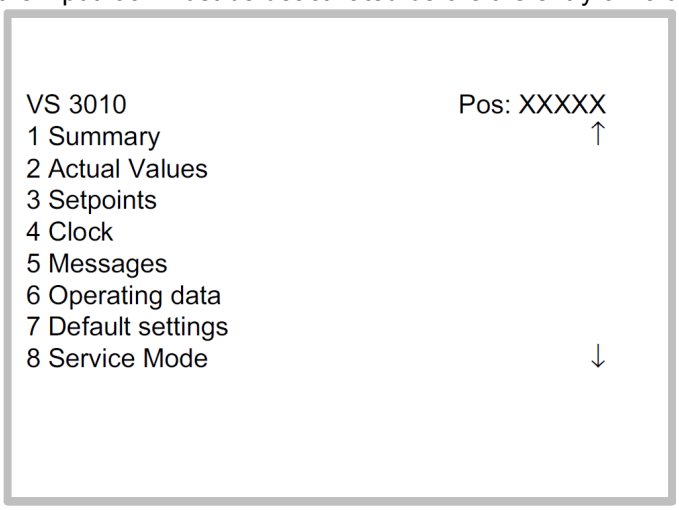
Step 1: Select the submenu "5 Remote control" in the main menu (see graphic).



Step 2: Select the required controller using the cursor buttons (↑) and (↓) or by input of the CAN bus address (node number *nnn*) using the digit buttons. Thereby, the following screen is displayed:



Step 3: the main menu of the controller is displayed on the terminal by tapping the **ENTER** button (if necessary, the input lock must be deactivated before the entry of values; see Deactivating the input lock).



9.2.3 Deactivating the input lock

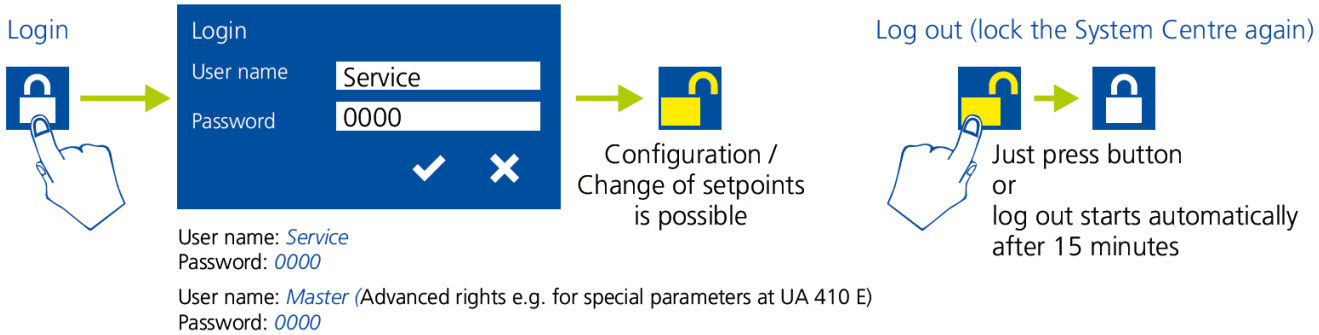
Operation via system centre, store computer or operator terminal is only possible for controllers with CAN bus connection; the removal of the lock-down is then applicable for all components in the CAN bus system. The lock-down is automatically reactivated 15 minutes after the last button tap.

> The deactivation of the lock is exclusively reserved for service personnel!

Before entering values, the input lock-down must be deactivated.

9.2.3.1 CI 4x00 system centre - login and logout

Login to and logout (unlock and lock-down) of the system centre:



User name: *Service*
Password: *0000*

User name: *Master* (Advanced rights e.g. for special parameters at UA 410 E)
Password: *0000*

9.2.3.2 CI 3x00 store computer / AL 300 operator terminal - unlock

Before entering values, the input lock on the store computer or operator terminal must be deactivated as follows:

Step 1: Select menu item 9 "Parametrisation" in the main menu.

Step 2: Select menu item 3 "Lock-down" in this menu.

Step 3: A. Unlocking store computer (standard) Tap the **ENTER** button (↵) to set the marker (√). The lock-down has now been deactivated and it is possible to make settings. **or B. Unlocking store computer and activating Superuser mode (Superuser permissions)** Input current date backwards (nothing is shown on the display). **Example:** The current date is April 17, 2016, i.e. 17/04/16; the required input for enabling Superuser permissions is then 614071.
Confirm the input with the **ENTER** button (↵); an "S" is shown on the display.

Step 4: Exit the operating screen and return to the main menu by tapping the ESC button twice.

> **Tip:** If you are already in the user interface of a CAN bus node but have forgotten to deactivate the input lock-down, you can unlock the input lock-down for this controller using the button combination **MODE** and **,**. The input lock-down is active again as soon as you exit the user interface of the controller.

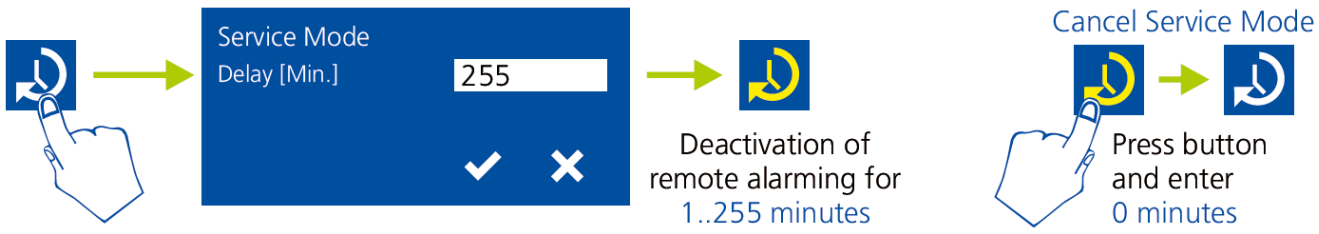
9.2.4 Activating service mode

For repair and maintenance work, service personnel can deactivate the remote alarm function of the system centre and of the store computer for a limited period using the service mode.

> The service mode is exclusively reserved for service personnel! If there are still pending alarms (with the priority 1..99) after the time for the service mode has elapsed, the audible warning devices and the alarm relays are activated and the alarms are forwarded using the automatic transmission of alarms.

9.2.4.1 CI 4x00 system centre service mode

Activating/deactivating service mode



> The service mode can only be activated if the system centre has previously been unlocked; see Deactivating the input lock.

9.2.4.2 CI 3x00 store computer - service mode

Activating/deactivating service mode

Step 1: Select menu item 9 "Parametrisation" in the main menu.

Step 2: Select menu item 3 "Lock-down" in this menu.

Step 3: Tap the buttons **MODE** and **ENTER** (↵) simultaneously to open the screen for the suppression of the remote alarm signalling and input the service mode duration (1..255 minutes). The service mode is now activated for the duration entered above.

Step 4: The service mode can be reset / revoked again by the input of 0 minutes.

10 Menu structure of VS 3010 C

The pack controller must be parametrised using a connected operator terminal. The parametrisation is performed via the CAN bus interface using which the communication with the pack controller takes place. It makes no difference for the operation of the pack controller whether this is done with a system centre, a store computer or an operator terminal; see chapter System design VS 3010 C.

10.1 Menu tree

Main menu	Submenu 1	Submenu 2	Screen number	Screen name
			-	VS3010C
Summary	Display of actual values		1	
Actual values			2	Actual values
	Analogue values		2-1	ANALOG VAL
		Cyl.Temp	2-1-a	ANALOG VAL
	Compressor		2-2	COMP. IO
	Condenser fan		2-3	COND FAN
	System		2-4	SYSTEM
			2-5	
	COP		2-6	COP
	Cond. mon.		2-7	COND. MON
Setpoints			3	SETPOINTS
	System config.		3-1	CONFIG
		Refrigerant	3-1-a	REFRIGT
		Sensor match	3-1-b	TRANSDUCER
		Oil eq. line	3-1-c	T.Oil/HP-F
		MP const.valve	3-1-d	ENABL.COMP
		HotGasByp.	3-1-e	ENABL.COND
	Control type		3-2	SETPOINTS
		LP-Control	3-2-1	LP-Control
		HP-Control	3-2-2	HP-Control
		MP-Control	3-2-3	MP CONT
		ECO-Mode	3-2-4	ECO
		Spray-System	3-2-5	SPRAY
	Comp. monitor		3-3	COMP MON
	Liq.level monitor		3-4	REFR. MON
	Ext. alarms		3-5	EXT. ALARM
	Base load		3-6	BASE LOAD
	Messages		3-7	Messages
			3-8	

	Cond. mon.		3-9	COND. MON
Clock			**4**	**CLOCK**
	Setpoint toggle		4	CLOCK
	Current time		4-a	CLOCK
	Toggle time		4-b	CLOCK
Messages			**5**	**Messages**
	Displays		5-1	Messages
	Delete		5-2	Messages
Operating data			**6**	**OP DATA**
	On time		6-1	OP DATA
		Compressor	6-1-1	OP DATA
		Compressor fan	6-1-2	OP DATA
	History		6-2	HISTORY
		Run times	6-2-1	HISTORY
		Switching pulses	6-2-2	HISTORY
		Duty rating	6-2-3	HISTORY
Default settings			**7**	**VS3010C**
Service Mode			**8**	**SERVICE**
	Analogue values		8-1	SERVICE
	Compressor		8-2	SERVICE
	Condenser fan		8-3	SERVICE
	System		8-4	SERVICE

ⓘ The condenser monitoring function in menu 2-7 and menu 3-9 must be deactivated (menu 3-9a set to "OFF")!

10.1.1 Menu 0 Main menu

VS3010C POS: XXX	
1 Overview	Continue to menu 1
2 Actual values	Continue to menu 2
3 Setpoints	Continue to menu 3
4 Clock	Continue to menu 4
5 Messages	Continue to menu 5
6 Operating data	Continue to menu 6
7 Basic settings	Continue to menu 7
8 Service mode	Continue to menu 8

10.1.2 Menu 1 Summary

Act. to +/-/= XXX °C	LP evaporation temperature actual value
Setp. to N/D XXX °C	Calculated t_0 LP evaporation temperature setpoint
Act. HD XXX b	High pressure (HP) actual value
Setp. HD XXX b	Calculated high pressure setpoint (HP)

N = night operation
D = day operation
H = heat recovery operation

10.1.3 Menu 2 Actual values

ISTWERTEPOS:xxxxx	
1 Analogue values	Continue to menu 2-1
2 Compressors	Continue to menu 2-2
3 Fans	Continue to menu 2-3
4 System	Continue to menu 2-4
5	-
6 COP	Continue to menu 2-6
7 Condenser monitoring	Continue to menu 2-7

- Menu 2-1 Analogue values

ANALOG VAL POS:XXXXX	**Display of the archived refrigeration point data in the store computer**
Act. LP +/-/= X.XX b	Current evaporation pressure
Setp.LP D/N X.XX b	Evaporation pressure setpoint for comparison
Act. to +/-/= XX °C	Current evaporation temperature
Setp. to D/N XX °C	Evaporation temperature setpoint for comparison
SuctGasTemp-C XXX °C	Current suction gas temperature - case side
Superheat-C XXX K	Current suction gas superheat - case side
SuctGasTemp-P XXX °C	Current suction gas temperature - pack side
Act OH-P XXX K	Current suction gas superheat - pack side
Room temp. XXX °C	Current room temperature
Ext.to-shift XXX %	Current specification for to-Schiebung via external 0..10 V signal
Act. HP X.XX b	Current high pressure
Setp. HP H X.XX b	High pressure setpoint for comparison
Act. tc XXX °C	Current condensation temperature (indicates --- in the transcritical range)
Outdoor temp. XXX °C	Current outdoor temperature (option)
Act.t-HRC-out XX °C	Current HRC outlet temperature

ANALOG VAL POS:XXXXX	Display of the archived refrigeration point data in the store computer
HP ctrl.valve XX %	Current opening degree of the high pressure control valve
Act. MP XXX b	Current medium pressure
Setp. MP XXX b	Setpoint medium pressure for comparison
Act. tG XXX °C	Current gas cooler temperature
Act. Ctrl. +,=,- XX °C	Actual value currently used for the fan control (gas cooler outlet temperature tG or condensation temperature tc) (with trend indication)
Setp. tG HRC XX °C	Gas cooler temperature setpoint for comparison (with indication of control or heat recovery setpoint)
MP-Control XX %	Current opening degree of the medium pressure control valve
Humidity XXX%	Current humidity
Cyl.temp. →	Analogue cylinder temperature values, continue to screen 2-1a
Act. LP Z2 XXX b	Current low pressure Z2
Act. t0 Z2 XXX°C	Current low pressure temperature Z2
HR-setpoint x %	Analogue input for HRC setpoint shift
AnalogOut.FC XXX%	The frequency or the current consumption of the FC can be output via a configurable output of the FC. This output can be read back using the analogue current / voltage input 2 (terminals 38-40) and displayed here (only visible if ND-Regelungsart in screen 3-2-1-a is configured as combined control).
Setp. FC XXX %	Currently transmitted control variable for compressor speed in percent (only visible when no min. and max. FC frequencies are entered. 100% corresponds to 10 V at the analogue output)
Setp. FC OH	Currently transmitted control variable for compressor speed scaled in Hz (only visible when no min. and max. FC frequencies are entered)
Setp. FC Fan XXX %	Currently output correcting variable in percent for fan speed (100% corresponds to 10 V at the analogue output)

- Screen 2-1-a Cylinder head temperatures analogue values

ANALOG VAL POS: XXXXX	
Cyl. Temp. V1XX °C	Cylinder head temperature display for first compressor
...	Only the actual number of compressors is displayed
Cyl. Temp. V9XX °C	Cylinder head temperature display for ninth compressor

Compressors:
VS 3010 C basic module: 1 - max. 4 compressors
with first SIOX extension module 1 - max. 8 compressors
with second SIOX extension module 1 - max. 12 compressors

- Menu 2-2 Compressors

COMP. IO POS: XXXXX	
M. cutout C 1 XXX	Compressor 1 motor overload cut-out digital input (only displayed if parametrised in the system configuration - menu 3-1)
HP cutout C 1 XXX	Compressor 1 high pressure limiter digital input (only displayed if parametrised in the system configuration - menu 3-1)
Man.sw. C 2 XXX	ON-OFF-AUTOMATIC compressor manual control switch

COMP. IO POS: XXXXX	
Comp. C 2 XXX	Capacity stage 1 digital output
...	Only the actual number of compressors is displayed
Comp. C 12 XXX	Compressor 9 motor overload cut-out digital input (only displayed if parametrised in the system configuration - menu 3-1)
HP cutout C 12 XXX	Compressor 9 high pressure limiter digital input (only displayed if parametrised in the system configuration - menu 3-1)
Man.sw. C 12 XXX	ON-OFF-AUTOMATIC compressor manual control switch
Comp. C 12 XXX	Capacity stage 12 digital output

Compressors:
VS 3010 C basic module: 1 - max. 4 compressors
with first SIOX extension module 1 - max. 8 compressors
with second SIOX extension module 1 - max. 9 compressors
Compressor capacity stages:
VS 3010 C basic module: 1 - max. 4 capacity stages
with first SIOX extension module 1 - max. 8 capacity stages
with second SIOX extension module 1 - max. 12 capacity stages

- Menu 2-3 Fans

COND FAN POS: XXXXX	
M. cutout F 1 XXX	Fan 1 motor overload cut-out digital input
Fan F 1 XXX	Fan 1 digital output
Stat. xxxxxxxx *	Status of the ebm fan with the switching sequence 1. aa = Modbus address xxxxxx = status register. Everything is OK if the register has the value "000000". Refer to the manual of the ebmpapst fans for details.
Fast speed F 1 XXX	Switch from star operation (K = low speed) to delta operation (G = high speed) for fan motor 1 (only displayed if star-delta switching is activated 3-2-2-1-b *Switching mode KKGG* or *KKKG* selected)
...	Only the actual number of fans is displayed
M. cutout F 12 XXX	Fan 12 motor overload cut-out digital input
Fan F 12 XXX	Fan 12 digital output
Stat.aa xxxxxxxx *	Status of the ebm fan with the switching sequence 12. aa = Modbus address xxxxxx = status register. Everything is OK if the register has the value "000000". Refer to the manual of the ebmpapst fans for details.
Fast speed F 6/11 * XXX	Switch from star operation (K = low speed) to delta operation (G = high speed) for fan motor 12 (only displayed if star-delta switching is activated 3-2-2-1-b *Switching mode KKGG* or *KKKG* selected)

*: These actual values are only visible if DIP switch 5 = ON

VS 3010 C basic module: 1 - max. 4 fans
with first SIOX extension module 1 - max. 8 fans
with second SIOX extension module 1 - max. 12 fans

- The high speed is only possible up to stage 6 in the KKGG operating mode and up to stage 11 in the KKKG operating mode.
- Menu 2-4 System actual values

SYSTEM POS: XXXXX	
HP cutout XXX	HP limiter digital input
LP cutout XXX	LP monitor digital input
Burst disk XXX	Rupture disk digital input
Low liq. level XXX %	Refrigerant level monitoring
Ext. alarm XXX	External alarm digital input
Setp. toggle XXX	Setpoint shift digital input
Heat recovery XXX	Heat recovery digital input
Comp/cond OFF XXX	External return digital input Rücklauf
Load shed 1 XXX	Load shedding 1 digital input
Load shed 2 XXX	Load shedding 2 digital input
Load shed 3 XXX	Load shedding 3 digital input
Cons.enab.CAN XXX	Consumer enable via CAN bus
toggle Comp. XXX	Status digital output for FC compressor base load rotation for compressor combined control (only visible if compressor combined control is activated: parameter Regelungsart on Combined Control menu 3-2-1-1-a)
Const.Press.V. XXX	Status of the digital output for the pressure maintenance valve
Bypass-valve XXX	Status of the digital output for the bypass valve

- Menu 2-5 - Menu item is hidden
- Menu 2-6 COP

COPPOS: XXXXX	
COP Cool. X.XX	COP in cooling mode - updating only in cooling mode
COP HR X.XX	COP in heat recovery mode - always the current value
COP efficien. X.XX	COP efficiency rating

- Menu 2-7 Condenser monitoring

> The condenser monitoring function must be deactivated (menu 3-9a set to "Off")!

- Menu 2-7a Condenser monitoring

> The condenser monitoring function must be deactivated (menu 3-9a set to "Off")!

10.1.4 Menu 3 Setpoints

SETPOINTS POS: XXXXX	
1 System config.	Continue to menu 3-1
2 Control type	Continue to menu 3-2
3 Compressor monitoring	Continue to menu 3-3
4 Liquid level monitoring	Continue to menu 3-4
5 External alarm	Continue to menu 3-5

SETPOINTS POS: XXXXX	
6 Base load	Continue to menu 3-6
7 Messages	Continue to menu 3-7
8	-
9 Condenser monitoring	Continue to menu 3-9

- Menu 3-1 System configuration

CONFIG POS: XXXXX		Input	Default	Dim.
Refrigerant R744	Refrigerant R744 (CO_2)	-	R744	-
Sensor match →	Calibration of the pressure transmitters	→	Screen 3-1-b	
Oil eq. line X	Block / enable oil balancing YES/NO	Y/N	N	-
MP const.valve	Medium pressure maintenance valve present YES/ NO	Y/N	N	-
HotGasByp.	Hot gas bypass available YES/NO	Y/N	Y	-
No. comps. XX	Entry of the number of compressors	1..4/8/12	4/8/12	-
Diff.comp. X	Unequal compressors (only visible with step control)	Y/N	N	-
Nr comp multist XX	Entry of the number of compressors with capacity stages	0..6	0	-
No.cap.stages XX	Entry of the number of capacity stages / compressors	1..3	1	-
Bypass invert. X	Bypass stages inverted (if yes, the actuation of the relay outputs for the compressor capacity stages is inverted) If applicable, coupling relays can be dispensed with for the bypass valves)	Y/N	N	-
Mot.cutout C X	Enable motor overload cut-out YES/NO	Y/N	N	-
Motor protect. X	Enable motor overload interlock YES/NO (only visible if Motorsch. Verd. YES)	Y/N	Y	-
Oil pr. cutout X	Oil pressure difference switch / HP switch compressor YES/NO	Y/N	N	-
Text Oil/HP-F →	Selection of the message text that will be output in the case of oil pressure or high pressure compressor fault	→	Screen 3-1-c	
Del.Oil/HP-F. xxm	Delay time for the messages from menu 3-1-c	0..10	0	Min.
Enable comp.stages →	Display of the capacity stages	→	Screen 3-1-d	
Emerg. working X	Emergency operation YES/NO	Y/N	N	-
No.emerg.stages X	Number of capacity stages for emergency operation (only visible if emergency mode is YES)	1..3/7/11	3/7/11	-
CompOFF.w.LdSh X	In the case of load shedding and system configuration with capacity-controlled compressors, one complete compressor (with capacity stages) per load shedding stage is unloaded (only visible for system configuration with capacity-controlled compressors: No.cap.stages > 1)	Y/N	N	-
No. cond.stages X	Number of condenser stages	1..4/8/12	4/8/12	-
Enable cond.stages →	Display of the condenser stages	→	Screen 3-1-e	

CONFIG POS: XXXXX		Input	Default	Dim.
External fan X	External fan enable YES/NO (only required when using a common condenser for 2 compressor packs)	Y/N	N	-
Main fan X	Enable fan master YES/NO (only visible if External fan YES)	Y/N	N	-
CAN-Adr. fan --	Entry of CAN Bus address: compressor pack that provides the external fans (only visible if External fan YES)	1..9, -	-	-
Outdoor temp. XXX	Enable outdoor temperature sensor ON/OFF	ON/OFF	ON	-
Room temp. XXX	Enable room temperature sensor ON/OFF	ON/OFF	ON	-
Humidity X	Enable humidity sensor ON/OFF	ON/OFF	OFF	-
Node-Nr Env.dat XX	CAN bus address (node number) of the pack controller of which the ambient data should be used.	1..9, -	-	-
Transducer Z2 X	Pressure transmitter for Z2 available?	Y/N	N	-
signal setvalue X	Setpoint shift signal 0 = Low active 1 = High active	0/1	1	-
COP sensor h1 →	Selection of the sensor for determining the h1 enthalpy	→	Screen 3-1-f	
COP sensor h2 →	Selection of the sensor for determining the h2 enthalpy	→	Screen 3-1-g	
COP sensor h3 →	Selection of the sensor for determining the h3 enthalpy	→	Screen 3-1-h	
COP_HG_Offset 0K	Offset for the measured value of the h2 enthalpy of the hot gas sensor in Kelvin	0..50	0	K
COP CompRunTime XXs	Minimum compressor runtime according to which its cylinder head temperature can be used for the COP calculation	0..300	30	sec.

- Screen 3-1-a - Screen not available!
- Screen 3-1-b Transmitter / sensor calibration

TRANSDUCER POS: XXXXX		Input	Default	Dim.
LP-Transducer →	Selection of signal interface pressure transmitter LP (4..20 mA or 0..10 V)	→	Screen 3-1-b-a	
LP-Min XXX b	Pressure at 4 mA or 0 V at the output of the LP pressure sensor	0..2.0	1.0	bar
LP-Max XXX b	Pressure at 20 mA or 10 V at the output of the LP pressure sensor	25.0..80.0	60.0	bar
HP-Transducer →	Selection of signal interface pressure transmitter HP (4..20 mA or 0..10 V)	→	Screen 3-1-b-b	
HP-Min XXX b	Pressure at 4 mA or 0 V at output of HP pressure sensor	0..2.0	1.0	bar
HP-Max XXX b	Pressure at 20 mA or 10 V at output of HP pressure sensor	100.0..200.0	140.0	bar
MP-Transducer →	Selection of signal interface pressure transmitter MP (4..20 mA or 0..10 V)	→	Screen 3-1-b-c	

TRANSDUCER POS: XXXXX		Input	Default	Dim.
MP-Min XXX b	Pressure at 4 mA or 0 V at the output of the MP pressure sensor	0..2.0	1.0	bar
MP-Max XXX b	Pressure at 20 mA or 10 V at the output of the MP pressure sensor	23.0..80.0	60.0	bar
tG Offset X K	tG Offset	-6..1K	0	K
p m.Meas.err XXb	Limit value for the monitoring of the LP, MP and HP pressure transmitters. If the respective pressure of a pressure transmitter falls below this limit value, a message is generated for the associated measuring circuit.	---, 0.0..5.0	2.0	bar

Practical tip using the example of the "connection of a pressure transmitter -1 .. 7 bar": The indication on the pressure transmitter here (> -1 bar) is obviously relative to the ambient pressure. The adjustment of the pressure transmitter in the controller is carried out using absolute pressure values (the absolute pressure cannot be negative). In order to parametrise the above pressure transmitter with the relative pressure indication - 1 bar (at 4 mA or 0 V) and 7 bar (at 20 mA or 10 V), the ambient pressure (1 bar) must be added. The input in this example is thus: 0..8 bar.

- Screen 3-1-b-a LP transducer

TRANSD.LP POS: XXXXX		Input	Default	Dim.
4-20 mA √	4..20 mA at the output of the LP pressure sensor	√	√	-
0-10 V	0..10 V at the output of the LP pressure sensor		-	-

- Screen 3-1-b-b HP transducer

TRANSD.HP POS: XXXXX		Input	Default	Dim.
4-20 mA √	4..20 mA at the output of the HP pressure sensor	√	√	-
0-10 V	0..10 V at the output of the HP pressure sensor		-	-

- Screen 3-1-b-c MP transmitter

TRANSD.MP POS: XXXXX		Input	Default		Dim.
4-20 mA √	4..20 mA at the output of the MP pressure sensor	√	√	-	-
0-10 V	0..10 V at the output of the MP pressure sensor		-	-	-

- Screen 3-1-c Selection of text in event of oil/HP fault

T.Oil/HP-F POS: XXXXX		Input	Default	Dim.
Oil diff. pr. Cx	The selected message text is output in the event of any fault detected via the compressor x oil / HP fault digital inputs	√		-
HP-Fault Cx √			√	-
Oil/HP-Fault Cx			-	-

- Screen 3-1-d Enable of the capacity stages

ENABL.COMP POS: XXXXX		Input	Default	Dim.
Comp. stage 1 XXX	Capacity stage 1	ON/OFF	ON	-
...	Only the available capacity stages (depending on configuration) are displayed.			
Comp. stage 11 XXX	Capacity stage 11	ON/OFF		-

VS 3010 C basic module: 1 - max. 4 capacity stages
with first SIOX extension module 1 - max. 8 capacity stages
with second SIOX extension module 1 - max. 11 capacity stages

- Screen 3-1-e Enable of the condenser stages

ENABL.COND POS: XXXXX		Input	Default	Dim.
Cond. stage 1 XXX	Condenser stage 1	ON/OFF	ON	-
...	Only the available condenser stages (depending on configuration) are displayed.			
Cond. stage 12 XXX	Condenser stage 12	ON/OFF	ON	-

VS 3010 C basic module: 1 - max. 4 capacity stages
with first SIOX extension module 1 - max. 8 capacity stages
with second SIOX extension module 1 - max. 12 capacity stages

- Screen 3-1-f COP sensor h1

SENSOR H1 POS: XXXXX		Input	Default	Dim.
to	Low pressure transmitter	√		-
Suct.GasTemp. √	Suction gas temperature sensor		√	

- Screen 3-1-g COP sensor h2

SENSOR H2 POS: XXXXX		Input	Default	Dim.
tc	High pressure transmitter	√		-
Cyl.HeadTemp.	Cylinder head temperature sensor			
HotGasTemp √	Hot gas temperature sensor		√	

- Screen 3-1-h COP sensor h3

SENSOR H3 POS: XXXXX		Input	Default	Dim.
tc	High pressure transmitter	√		-
t_sc √	Subcooler / liquid temperature sensor		√	

- Menu 3-2 Regulation

SETPOINTS POS: XXXXX	
1 LP-Control	Continue to menu 3-2-1
2 HP-Control	Continue to menu 3-2-2
3 MP-Control	Continue to menu 3-2-3
4 ECO-Mode	Continue to menu 3-2-4

SETPOINTS POS: XXXXX	
5 Spray-System	Continue to menu 3-2-5

- Menu 3-2-1 LP control

LP-Control POS: XXXXX	
1 Control	Continue to menu 3-2-1-1
2 to-adjustment	Continue to menu 3-2-1-2

LP-Control POS: XXXXX	
3 LP-Control Day	Continue to menu 3-2-1-3
4 LP-Control Night	Continue to menu 3-2-1-4

- Menu 3-2-1-1 Control

CONTROL POS: XXXXX		Input	Default	Dim.
Control type →	Selection list of the LP type of control	→	Screen 3-2-1-1-a	
Min. speed XXX%	Minimum speed of the FC compressor for combined control (only visible when the combined control type of control has been selected - screen 3-2-1-1-a)	↑, ↓, 0..15	0	%
M.com.out.reg. X	Capacity controlled switching of fixed-speed compressors: No: Always completely load and unload capacity-controlled fixed-speed compressors (basic and output stages together) Yes: Load and unload base load and capacity stages of the capacity-controlled fixed-speed compressors individually (only visible when combined control type of control has been selected - screen 3-2-1-1-a)	Y/N	N	-
Diff.Power XX %	Capacity overlap when switching a compressor capacity stage on or off. The capacity overlap determines which speed setpoint for the FC compressor will be output after the loading / unloading of a compressor capacity stage (only visible if combined control type of control has been selected - screen 3-2-1-1-a and the parameter NetzVerdLgereg is set to Yes)	0..40	5	%
MaxFreq.FC[Hz] ---	Scaling of the analogue output for the compressor speed: the frequency output by the FC for 10 V correcting variable is adjusted here.. This setting value must correspond to the value set on the FC (only visible if the combined control type of control has been selected - screen 3-2-1-1-a).	---,55..90	-	Hz
MinFreq.FC[Hz] ---	Scaling of the analogue output for the compressor speed: the frequency output by the FC for 0 V correcting variable is adjusted here.. This setting value must correspond to the value set on the FC (only visible if the combined control type of control has been selected - screen 3-2-1-1-a).	---,15..55	-	Hz
U.WorkFreq[Hz]	Upper operating frequency of the FC compressor for compressor combined control (only visible if the combined control type of control has been selected - screen 3-2-1-1-a, the parameter U.WorkFreq is set to Yes and the parameters MaxFreq.FC and MinFreq.FC are set to a value other than "--").	55..90	87	Hz
L.WorkFreq[Hz]	Lower operating frequency of the FC compressor for compressor combined control (only visible when the combined control type of control has been selected - screen 3-2-1-1-a and the parameters MaxFreq.FC and MinFreq.FC are set to a value other than "--").	15..45	30	Hz
Min. speed X. XX	Minimum correcting variable in % for the compressor speed (only visible if the combined control type of control has been selected - screen 3-2-1-1-a and no values have been entered for MaxFreq.FC and MinFreq.FC).	0..15	0	%

CONTROL POS: XXXXX		Input	Default	Dim.
RunTimeSlwSpeed XXm	Maximum compressor runtime at low speed after that the automatic increase rpm function starts	10..60	15	Min.
Freq.-shift XXHz	Frequency that will be driven by automatic increase rpm function	20..60	--	Hz
t Freq.-shift XXs	Duaration of automatic increase rpm function	5..60	15	sec.
p-factor X.X	P-factor for PI controller for compressor speed control (only visible if the combined control type of control has been selected - screen 3-2-1-1-a).	0.0..3.0	0.7	-
i-factor X.XX	I-factor for PI controller for compressor speed control (only visible if the combined control type of control has been selected - screen 3-2-1-1-a).	0.00..1.00	0.05	-
Timeb.I-fact. I X	Time interval for calculation of the I-component for PI controller for compressor speed control (only visible when the combined control type of control has been selected - screen 3-2-1-1-a).	1..30	1	-
Del.FC-Comp. XXXs	Delay time until increase of the FC speed (after loading a fixed-speed compressor)	1..250	1	sec.
Man. op. XXX%	Manual setting of the speed of an FC compressor ("---" = automatic)	0..100	--	%

- Screen 3-2-1-1-a Type of control

CONTROL POS: XXXXX		Input	Default	Dim.
Step controller √	Selection list LP type of control	√	√	-
Combi controller		√		

- Menu 3-2-1-2 to-adjustment

to-adjust. POS: XXXXX		Input	Default	Dim.
to-adjustment →	Selection list t_0-adjustment	→	Screen 3-2-1-2-a	
Max.LoadLevel XXX%	Minimum speed of the FC compressor for combined control (only visible when t_0 via consumer)	70..100	85	%
Min.LoadLevel XX%	Speed controller adjusting speed (I-Factor), (only visible when to-shift via consumer)	10..80	60	%
Increment XX.XK	t_0-adjustment increment for increasing and reducing (only visible when t_0-adjustment via consumer)	0.0..10.0	1.0	K
Decrement XXXK	t_0-adjustment step size (only visible when t_0-adjustment via consumer) ---: Deactivates the setting of the t_0-adjustment increment; can only be set using Schrittw.Abs."	---,		K
Interval XXm	t_0-adjustment interval (only visible when to-shift = consumer)	1..20	5	Min.
Off.Ext.Sig. XX%	Offset for external signal for the to-adjustment (only visible when to-adjustment = Ext.Signal)	0..25	0	%

- Screen 3-2-1-2-a t_0-adjustment

to-adjust. POS: XXXXX		Input	Default	Dim.
Room temp.	t_0-adjustment via room temperature	√		-
Consumer √	t_0-adjustment via consumer		√	
CAN-BUS	t_0-adjustment via CAN bus			
Ext.Signal	t_0-adjustment via external signal			

- Menu 3-2-1-3 LP-Control day

LP CONT D POS: XXXXX		Input	Default	Dim.
to-max. XXX °C	Max. t_0 setpoint for setpoint shift	-50..10	-8	°C
tr_min. XXX °C	Minimum room temperature for setpoint shift (only visible if t_0-adjustment via room temperature - screen 3-2-2-a)	-25..20	15	°C
to-min. XXX °C	Min. t_0 setpoint for setpoint shift	-50..10	-12	°C
tr-max. XXX °C	Max. room temperature for setpoint shift (only visible if t_0-adjustment via room temperature - screen 3-2-2-a)	-18..35	25	°C
humid. adapt. X	Humidity shift activated YES/NO	Y/N	N	-
Basic load time →	Display basic times t_b ON	→	Screen 3-2-1-3-a	
Vari. load time →	Display of the variable times t_v ON	→	Screen 3-2-1-3-b	
Basic unload time →	Display basic times t_b OFF	→	Screen 3-2-1-3-c	
Vari. unload time →	Display of the variable times t_v OFF	→	Screen 3-2-1-3-d	
Dead band XX K	Switching hysteresis with step control	1..10	4	K
NZ speed con. 0K	Neutral zone for the loading and unloading of fixed-speed compressors during combined control	0..6	0	K
Control const. XX K	Max. control error for variable switching times	1..15	10	K
Contr.w.C.OFF X	High presure control will be deactivated after last compressor switched off	Y/N	N	-

- Screen 3-2-1-3-a Basic time capacity stage ON

B. LOAD T POS: XXXXX		Input	Default	Dim.
Bas Load T C 1 XXX s	Only the available capacity stages are displayed.	0..250	30	sec.
Bas Load T C 2 XXX s	3..250	60	sec.	
Bas Load T C 3 XXX s	3..250	90	sec.	
Bas Load T C 4 XXX s	3..250	120	sec.	
Bas Load T C 5 XXX s	3..250	150	sec.	
Bas Load T C 6 XXX s	3..250	180	sec.	
...				

B. LOAD T POS: XXXXX		Input	Default	Dim.
Bas Load T C12 XXX s	3..250	180	sec.	

VS 3010 C basic module: 1 - max. 4 capacity stages
with first SIOX extension module 1 - max. 8 capacity stages
with second SIOX extension module 1 - max. 12 capacity stages

- Screen 3-2-1-3-b Variable time capacity stage ON

V. LOAD T POS: XXXXX		Input	Default	Dim.
Vas Load T C 1 XXX s	Only the available capacity stages are displayed.	0..250	250	sec.
Vas Load T C 2 XXX s		3..250	250	sec.
...				
Vas Load T C12 XXX s		3..250	250	sec.

VS 3010 C basic module: 1 - max. 4 capacity stages
with first SIOX extension module 1 - max. 8 capacity stages
with second SIOX extension module 1 - max. 12 capacity stages

- Screen 3-2-1-3-c Basic time capacity stage OFF

B. UNLO T POS: XXXXX		Input	Default	Dim.
Bas Unlo T C 1 XXX s	Only the available capacity stages are displayed.	3..250	5	sec.
Bas Unlo T C 2 XXX s		3..250	10	sec.
Bas Unlo T C 3 XXX s		3..250	20	sec.
Bas Unlo T C 4 XXX s		3..250	30	sec.
...				
Bas Unlo T C12 XXX s		3..250	30	sec.

VS 3010 C basic module: 1 - max. 4 capacity stages
with first SIOX extension module 1 - max. 8 capacity stages
with second SIOX extension module 1 - max. 12 capacity stages

- Screen 3-2-1-3-d Variable time capacity stage OFF

V. UNLO T POS: XXXXX		Input	Default	Dim.
Var Unlo T C 1 XXX s	Only the available capacity stages are displayed.	3..250	20	sec.
Var Unlo T C 2 XXX s		3..250	40	sec.
Var Unlo T C 3 XXX s		3..250	60	sec.
Var Unlo T C 4 XXX s		3..250	80	sec.
Var Unlo T C 5 XXX s		3..250	100	sec.
Var Unlo T C 6 XXX s		3..250	120	sec.
...				
Var Unlo T C12 XXX s		3..250	120	sec.

VS 3010 C basic module: 1 - max. 4 capacity stages
with first SIOX extension module 1 - max. 8 capacity stages
with second SIOX extension module 1 - max. 12 capacity stages

- Menu 3-2-1-4 LP-Control night

LP CONT N POS: XXXXX		**Input**	**Default**	**Dim.**
to-max. XXX °C	Max. t_0 setpoint for setpoint shift	-50..10	-6	°C
tr_min. XXX °C	Minimum room temperature for setpoint shift (only visible if t_0-adjustment via room temperature - screen 3-2-1-2-a)	-25..20	15	°C
to-min. XXX °C	Min. t_0 setpoint for setpoint shift	-50..10	-10	°C
tr-max. XXX °C	Max. room temperature for setpoint shift (only visible if t_0-adjustment via room temperature - screen 3-2-1-2-a)	-18..35	25	°C
humid. adapt. X	Humidity shift activated YES/NO	Y/N	N	-
Basic load time →	Display basic times t_b ON	→	Screen 3-2-1-4-a Screen 3-2-1-4-b Screen 3-2-1-4-c Screen 3-2-1-4-d	
Vari. load time →	Display of the variable times t_v ON	→		
Basic unload time →	Display basic times t_b OFF	→		
Vari. unload time →	Display of the variable times t_v OFF	→		
Dead band XX K	Switching hysteresis with step control	1..10	4	K
NZ speed con. 0K	Neutral zone for the loading and unloading of fixed-speed compressors during combined control	0..6	0	K
Control const. XX K	Max. control error for variable switching times	1..15	10	K
Contr.w.C.OFF	High presure control will be deactivated after last compressor switched off	J/N	N	-

- Screen 3-2-1-4-a Basic time capacity stage ON

Basisz.EIN POS: XXXXX		**Input**	**Default**	**Dim.**
Bas Load T C 1 XXX s	Only the available capacity stages are displayed.	0..250	60	sec.
Bas Load T C 2 XXX s		3..250	140	sec.
Bas Load T C 3 XXX s		3..250	200	sec.
Bas Load T C 4 XXX s		3..250	250	sec.
...				
Bas Load T C12 XXX s		3..250	250	sec.

VS 3010 C basic module: 1 - max. 4 capacity stages
with first SIOX extension module 1 - max. 8 capacity stages
with second SIOX extension module 1 - max. 12 capacity stages

- Screen 3-2-1-4-b Variable time capacity stage ON

V. LOAD T POS: XXXXX		Input	Default	Dim.
Vas Load T C 1 XXX s	Only the available capacity stages are displayed.	0..250	250	sec.
Vas Load T C 2 XXX s		3..250	250	sec.
...				
Vas Load T C12 XXX s		3..250	250	sec.

VS 3010 C basic module: 1 - max. 4 capacity stages
with first SIOX extension module 1 - max. 8 capacity stages
with second SIOX extension module 1 - max. 11 capacity stages

- Screen 3-2-1-4-c Basic time capacity stage OFF

Basisz.AUSPOS: XXXXX		Input	Default	Dim.
Bas Unlo T C 1 XXX s	Only the available capacity stages are displayed.	3..250	5	sec.
Bas Unlo T C 2 XXX s		3..250	10	sec.
Bas Unlo T C 3 XXX s		3..250	15	sec.
Bas Unlo T C 4 XXX s		3..250	20	sec.
...				
Bas Unlo T C12 XXX s		3..250	20	sec.

VS 3010 C basic module: 1 - max. 4 capacity stages
with first SIOX extension module 1 - max. 8 capacity stages
with second SIOX extension module 1 - max. 12 capacity stages

- Screen 3-2-1-4-d Variable time capacity stage OFF

V. UNLO T POS: XXXXX		Input	Default	Dim.
Var Unlo T C 1 XXX s	Only the available capacity stages are displayed.	3..250	20	sec.
Var Unlo T C 2 XXX s		3..250	40	sec.
Var Unlo T C 3 XXX s		3..250	60	sec.
Var Unlo T C 4 XXX s		3..250	80	sec.
Var Unlo T C 5 XXX s		3..250	100	sec.
Var Unlo T C 6 XXX s		3..250	120	sec.
...				
Var Unlo T C12 XXX s		3..250	120	sec.

VS 3010 C basic module: 1 - max. 4 capacity stages
with first SIOX extension module 1 - max. 8 capacity stages
with second SIOX extension module 1 - max. 12 capacity stages

- Menu 3-2-2 HP-Control

HP CONT POS: XXXXX	
1 Control type	Continue to menu 3-2-2-1
2 Setpoints	Continue to menu 3-2-2-2

- Menu 3-2-2-1 Control type

HP CONT POS: XXXXX		Input	Default	Dim.
Control type →	Selection list HP type of control	→	Screen 3-2-2-1-a	
Switch mode →	To the submenu for defining the switching sequence.	→	Screen 3-2-2-1-b	
EBM Manual Run →	To the submenu for manual mode.	→	Screen 3-2-2-1-c	
Min. speedXXX%	Min. fan speed (only visible when the speed controller type of control has been selected - screen 3-2-2-1-a)	0..50	0	%
Max. speed D	Max. fan speed calculated by controller in the day	50..100	100	%
Max. speed N	Max. fan speed calculated by controller in the night	30..100	100	%
p-factor X.X	P-factor (amplification factor) for fan speed control signal (only visible if speed controller or combined control type of control has been selected - screen 3-2-2-1-a)	0.1..5.0	1.0	-
p-factor p X.X	Pressure-dependent P-factor (amplification factor) for fan speed control signal (only visible if speed controller or combined control type of control has been selected - screen 3-2-2-1-a)	0.1..2.0	0.0 -	-
i-factor X.XX	I-factor (integral factor) for fan speed control signal (only visible if speed controller or combined control type of control has been selected - screen 3-2-2-1-a)	0.00..1.00	0.03	-
Interval I XX s	Time interval for calculation of I-component for fan speed control signal (only visible if speed controller or combined control type of control has been selected - screen 3-2-2-1-a)	1..60	10	s
Offset XX%	Offset for fan speed correcting variable (only visible if the speed controller or combined control type of control has been selected - screen 3-2-2-1-a)	1..50	10	%
Switch mode →	Fan control / star-delta operation switching type (only visible if step controller type of control has been selected - screen 3-2-2-1-a)	→	Screen 3-2-2-1-d	
Fast speed N X	High speed (delta operation) also permitted for night setpoint Y/N (only visible if step controller type of control (screen 3-2-2-1-a) has been selected and parameter *Schaltart* KKGG or KKKG has been selected (screen 3-2-2-1-b)	Y/N	Y	-
Del. slow speed XX s	Delay of loading a fan stage in star operation after it has been unloaded from delta operation (only visible if *step controller* type of control (screen 3-2-2-1-a) has been selected and *Schaltart* KKGG or KKKG has been selected (screen 3-2-2-1-b)	0..30	5	s
tG-Max XX°C	Max. gas cooler outlet temperature for switching to power supply bridging	---, 25..56	28 -	-
Fan off w/comp X	Switch off fans with compressors YES/NO	Y/N	N	-
Fan off by al. X	Switch off fans when motor overload cut-out is tripped YES/NO	Y/N	Y	-

HP CONT POS: XXXXX		Input	Default	Dim.
Mon.OFF w.Fan X	Fans are not monitored for their motor protection in standstill.	Y/N	Y	-
Fan OFF w.Byp.	A GLT controller activates the gas cooler bypass. This is signalled to the pack controller via CAN bus. If the parameter is set to Y, all fans in this operating state are switched off.	Y/N	N	-
Fan Scan Repl.	"Partial Search": only new fans added to the Modbus are searched for here, e.g. in the case of replacement of a defective fan. Condition: the new fan must have the Modbus address 1 (factory setting). If this is not the case, the "Manual Search" (recommended) or the "Complete Search" must be performed	Y/N	N	-
Fan Scan New	"Complete Search": all fans on the Modbus are searched for and reconfigured (recommended for initial commissioning) Note: the configuration of the switching sequence is lost for the complete search and must be checked / defined. Only visible if authorisation = Master	Y/N	N	-
New SNr:	"Manual Search": an ebmpapst fan can be added by entering its serial number (e.g. *1703000103*).	10-digit number	-	-
DEBUG EBM	This screen is for the Modbus diagnostics of ebmpapst fans and is not described in detail. Can only be set if authorisation = Master			

- Screen 3-2-2-1-a Control type

CONTROL POS: XXXXX		Input	Default	Dim.
Step controller √	Selection list HP type of control	√	√	-
Speed controller				-
Combi-cont.parall				-
Combi-cont.stages				-

- Screen 3-2-2-1-b Switching sequence

FAN.ORD. POS: XXXXX		Input	Default	Dim.
xxxxxxxxxx A:aa x	The switching sequence (of the stages in the gas cooler package) for the controllers of the pack controller are set in the submenu. The switching sequence must be assigned to the physical position in the gas cooler package. -- : Switching sequence has not been assigned and a message is output. This state is not permissible; the fan must be disconnected from the power supply otherwise it will run with 80% of its output in emergency operation. 0*: fan is removed from the switching sequence list * Can only be set if authorisation = Master	1..24	-	-
xxxxxxxxxx A:aa x	Switching sequence of the second fan			

- Screen 3-2-2-1-c EBM Manual ON

EBM-Vent POS: XXXXX		Input	Default	Dim.
xxxxxxxxxx A:aa x ...	Manual operation of ebm papst fans. Each fan can be manually controlled between 0..100%. -- : Manual mode deactivated - the fans are controlled via the controller (automatic)	--, 0..100	--	%

- Screen 3-2-2-1-d Type of control HP - star/delta operation

Schaltart POS: XXXXX		Input	Default	Dim.
Direct √	Loading and unloading of fan stages sequentially - default operating mode. Star-delta operation is deactivated	√	√	-
SSFF	Star-delta operation: Fans start one after the other at low speed (S) and then switch one after the other to the high speed (F)			-
SSSF	Star-delta operation: Fans start one after the other at low speed (S) and then all switch simultaneously to the high speed (F)			-

- Menu 3-2-2 Setpoints

HP CONT POS: XXXXX		Input	Default	Dim.
tG-Min XX°C	Min. t_G setpoint for setpoint shift	-10..35	8	°C
tod-min XX°C	Min. outdoor temperature for setpoint shift	0..15	2	°C
tG-Max XX°C	Max. gas cooler outlet temperature for setpoint shift via outdoor temperature	-10..45	22	°C
tod-Max XX°C	Max. outdoor temperature for setpoint shift	16..45	18	°C
tG Offset N XX K	t_G offset in night operation	0..15	0	K
Max. HP XXX b	Maximum HP setpoint for setpoint shift above gas cooler outlet	80..105	95	b
Min. HP XX b	Minimum HP setpoint for setpoint shift above gas cooler outlet	30..60	45	b
Neutr.Zone HP 1.0b	Neutral zone for regulating the high pressure valve	0.0...3.0	1.0	b
Offset HPV XX%	Offset for HP valve control variable	0..50	5	%
HP-Ramp/m XXX b	Setting of the ramp speed for the HP valve setpoint	---, 0.1..6.0	4.0	b
subcooling X K	Supercooling for the setpoint shift above gas cooler outlet	0..9	3	K
subcool. HRC X K	Supercooling for the setpoint shift above gas cooler outlet during heat recovery mode	0..20	6	K
p-factor XXX	Amplification factor Vp PI controller for HP control valve [V/bar]	0.00...5.00	0.40	-
i-factor XXX	Amplification factor Vi PI controller for HP control valve [V/s*bar]	0.00..0.99	0.05	-
Interval X	Interval for calculating the I-component for the control of the HP valve	1..30	10	sec.
Man. op. XXX %	Manual setting of the HP control valve ("---" = automatic)	---, 0..100	-	%
HPV off w/comp X	Close HP valve when switching off the last of the running compressors Yes/No	Y/N	N	-
Min contr val. XX	Minimum control signal for the HP control valve	0..60	0	-

HP CONT POS: XXXXX		Input	Default	Dim.
Bas. load time F →	Setting of the basic times t_b ON	→	Screen 3-2-2-2-a Screen 3-2-2-2-b Screen 3-2-2-2-c Screen 3-2-2-2-d	
Var. load time F →	Setting of the variable times t_v EIN	→		
Bas.unload time F →	Setting of the basic times t_b OFF	→		
Var.unload time F →	Setting of the variable times t_v OFF	→		
Neutr.Zone F XX K	Fan control switching hysteresis for step control	1..20	4	
NZ speed con. X K	Neutral zone for fan speed / combined control	0..8	2	K
Control const. XX K	Max. control error for variable switching times	1..15	10	

- Menu 3-2-2-2-a Basic load time

B. LOAD T POS: XXXXX		Input	Default	Dim.
B. load t. F 1 XXX s	Only the available condenser capacity stages are displayed.	3..250	5	sec.
B. load t. F 2 XXX s		3..250	30	sec.
B. load t. F 3 XXX s		3..250	60	sec.
B. load t. F 4 XXX s		3..250	90	sec.
...				
B. load t. F12 XXX s		3..250	60	sec.

VS 3010 C basic module: 1 - max. 4 capacity stages
with first SIOX extension module 1 - max. 8 capacity stages
with second SIOX extension module 1 - max. 12 capacity stages

- Menu 3-2-2-2-b Var. load time F

V. LOAD T POS: XXXXX		Input	Default	Dim.
V. load t. 1 XXX s	Only the available condenser capacity stages are displayed.	3..250	20	sec.
V. load t. 2 XXX s		3..250	120	sec.
V. load t. 3 XXX s		3..250	180	sec.
V. load t. 4 XXX s		3..250	250	sec.
...				
V. load t.12 XXX s		3..250	250	sec.

VS 3010 C basic module: 1 - max. 4 capacity stages
with first SIOX extension module 1 - max. 8 capacity stages
with second SIOX extension module 1 - max. 12 capacity stages

- Screen 3-2-2-2-c Basic unload time

B. UNLO T POS: XXXXX		Input	Default	Dim.
B. unlo t. 1 XXX s	Only the available condenser capacity stages are displayed.	3..250	5	sec.
B. unlo t. 2 XXX s		3..250	20	sec.

B. UNLO T POS: XXXXX		Input	Default	Dim.
B. unlo t. 3 XXX s		3..250	30	sec.
B. unlo t. 4 XXX s		3..250	40	sec.
...				
B. unlo t.1 2XXX s		3..250	40	sec.

VS 3010 C basic module: 1 - max. 4 capacity stages
with first SIOX extension module 1 - max. 8 capacity stages
with second SIOX extension module 1 - max. 12 capacity stages

- Menu 3-2-2-2-d Variable unload time

V. UNLO T POS: XXXXX		Input	Default	Dim.
V. unlo t. 1 XXX s	Only the available condenser capacity stages are displayed.	3..250	30	sec.
V. unlo t. 2 XXX s		3..250	40	sec.
V. unlo t. 3 XXX s		3..250	60	sec.
V. unlo t. 4 XXX s		3..250	90	sec.
...				
V. unlo t. 12 XXX s		3..250	90	sec.

VS 3010 C basic module: 1 - max. 4 capacity stages
with first SIOX extension module 1 - max. 8 capacity stages
with second SIOX extension module 1 - max. 12 capacity stages

- Menu 3-2-2-3 Heat recovery

HR POS: XXXXX		Input	Default	Dim.
Ht. rec. mode X	Activate/deactivate heat recovery mode	Y/N	N	-
The following parameters are only visible when paramter "Ht. rec. mode" is set to Y				
Run Time HRC XX h	Maximum operating time in HRC mode	1..10, -	-	h
Off Time HRC XX m	Standstill time after disable via max. operating time monitoring	1..180	60	Min.
Setp.shift. X	Setpoint shift	Y/N	N	-
Off.Ext.Sig X%	Offset for HRC setpoint shift	0..25	0	%
Defr.Temp.X	Defrost end temperature setpoint in WP mode	5..20	8	°C
HRC-Pump X	HP setpoint shift via CAN bus	Y/N	N	-
p-corr.HRC XXB	Correction factor for high pressure setpoint calculation in HRC mode	0..10	0	b
HP-Max.HRC XXb	Maximum high pressure in HRC operation	75..95	82	b
HP-Min.HRC XXb	Minimum high pressure in HRC operation	50..80	75	b

- Menu 3-2-3 MP-Control

MP CONT POS: XXXXX		Input	Default	Dim.
Setp. MP XX b	Setpoint for medium pressure control	32..37	34.5	b
Dif. MP XX b	Difference from MP setpoint for activation of the pressure maintenance	1.5..6.0	1.5	b
OH-P-Incr./m X.XXb	Ramp speed for increasing MP setpoint when superheat is too small on the pack side	0.00..0.50	0.00	b
OH-O-Decr./m X.XXb	Ramp speed for lowering MP setpoint when superheat is large enough again on the pack side	0.03..0.50	0.10	b
OH-C-Ramp/m X.XXb	Ramp speed for MP setpoint shift when superheat is too small on the case side	0.01..0.50	0.02	b

MP CONT POS: XXXXX		Input	Default	Dim.
p-factor XX b	Amplification factor Vp PI controller for MP control valve	0.0..5.0	0.7	-
i-factor XXX b	Amplification factor Vi PI controller for MP control valve	0.00..0.99	0.8	-
Timeb.I-fact. X s	Time interval for calculation of the I-component for PI controller for MP-Valve control	1..10	1	sec.
Man. op. XXX b	Manual setting of the MP control valve ("---" = automatic)	---, 0..100	-	%

- Menu 3-2-4 ECO-Mode

ECO POS: XXXXX		**Input**	**Default**	**Dim.**
ECO-Mode X	Activation of the ECO operation (YES)	Y/N	N	-
Temp.ECO ON XX °C	Switch-on temperature for the ECO operation solenoid valve --: The switch-on temperature for the HRC ECO operation solenoid valve is ignored.	--, 20..40	29	°C
Temp.ECO ON HRC XX °C	Switch-on temperature for the HRC ECO operation solenoid valve when gas cooler bypass is active --: The switch-on temperature for the HRC ECO operation solenoid valve is ignored.	--, 15..40	29	°C
Hysteresis XX K	Difference for the ECO operation switch-on temperature, using which the temperature for the shutdown of the ECO operation is defined.	2..10	4	K
Min.op.deg.MPV	Minimum opening degree of the medium pressure valve for the enable of the ECO compressors	10..80	60	%
ECO Idletime XXX s	Minimum standstill time of the ECO compressor	10..360	300	sec.
En.ECO comp. *	Activation of the ECO compressors YES: ECO compressors are controlled via the VS 3010 C NO: ECO compressors are controlled via a separate VS 3010	Y/N	N	-
The following parameters are only visible if "ECO-Verdichter" = Yes				
No.ECO comp.	Number of ECO compressors	1	1	-
Basic load time →	Display basic times t_b ON	→	Screen 3-2-4-a Screen 3-2-4-b Screen 3-2-4-c Screen 3-2-4-d	
Vari. load time →	Display of the variable times t_v ON	→		
Basic unload time →	Display basic times t_b OFF	→		
Vari. unload time →	Display of the variable times t_v OFF	→		
Control const. XX K	Max. control error for variable switching times	1..15	3	K
Enab.Mot.Prot.	Enable for the motor protection monitoring of the ECO compressors	Y/N	Y	-
Enab.Oil/HP-C.	Enable for the oil/HP monitoring of the ECO compressors	Y/N	Y	-
p-factor X.X	P-factor of the combined control for the ECO compressors Example: for control error of 1 K with a P-Wert of 1, the P-component is 1 V	0.0..3.0	0.7	V/K
i-factor X.XX	I-factor of the combined control for the ECO compressors Example: for control error of 1 K with an I-Wert of 0.5, the I-component changes with 0.05 V per cycle time (1 second) of the controller **Attention:** The set value is reduced by a factor of 10!	0.00..1.00	0.10	V/K.s
MP-Offset X.Xb	Offset to the setpoint of the medium pressure valve regulation	0.5..2.5	1.0	bar

* The parameter is only displayed if the DIP switch S1 coding switch is set to ON.

- Menu 3-2-4-a Basic load time

B. LOAD T POS: XXXXX		Input	Default	Dim.
Bas Load T C 1 XXX s	Only the available capacity stages are displayed.	0..250	30	sec.
Bas Load T C 2 XXX s	3..250	60	sec.	
Bas Load T C 3 XXX s	3..250	90	sec.	
Bas Load T C 4 XXX s	3..250	120	sec.	
Bas Load T C 5 XXX s	3..250	150	sec.	
Bas Load T C 6 XXX s	3..250	180	sec.	
...				
Bas Load T C12 XXX s	3..250	180	sec.	

VS 3010 C basic module: 1 - max. 4 capacity stages
with first SIOX extension module 1 - max. 8 capacity stages
with second SIOX extension module 1 - max. 12 capacity stages

- Menu 3-2-4-b Variable load time

V. LOAD T POS: XXXXX		Input	Default	Dim.
Var Load T C 1 XXX s	Only the available capacity stages are displayed.	0..250	250	sec.
Var Load T C 2 XXX s		3..250	250	sec.
...				
Var Load T C12 XXX s		3..250	250	sec.

VS 3010 C basic module: 1 - max. 4 capacity stages
with first SIOX extension module 1 - max. 8 capacity stages
with second SIOX extension module 1 - max. 12 capacity stages

- Screen 3-2-4-c Basic unload time

B. UNLO T POS: XXXXX		Input	Default	Dim.
Bas unlo T C 1 XXX s	Only the available capacity stages are displayed.	3..250	5	sec.
Bas unlo T C 2 XXX s		3..250	10	sec.
Bas unlo T C 3 XXX s		3..250	20	sec.
Bas unlo T C 4 XXX s		3..250	30	sec.
...				
Bas unlo T C 12 XXX s		3..250	30	sec.

VS 3010 C basic module: 1 - max. 4 capacity stages
with first SIOX extension module 1 - max. 8 capacity stages
with second SIOX extension module 1 - max. 12 capacity stages

- Menu 3-2-4-d Variable unload time

V. UNLO T POS: XXXXX		Input	Default	Dim.
Var unlo T C 1 XXX s	Only the available capacity stages are displayed.	3..250	20	sec.
Var unlo T C 2 XXX s		3..250	40	sec.
Var unlo T C 3 XXX s		3..250	60	sec.
Var unlo T C 4 XXX s		3..250	80	sec.
Var unlo T C 5 XXX s		3..250	100	sec.
Var unlo T C 6 XXX s		3..250	120	sec.
...				
Var unlo T C12 XXX s		3..250	120	sec.

VS 3010 C basic module: 1 - max. 4 capacity stages
with first SIOX extension module 1 - max. 8 capacity stages
with second SIOX extension module 1 - max. 12 capacity stages

- Menu 3-2-5 Spray-System

SPRAY POS: XXXXX		Input	Default	Dim.
Spray-System X	Activation of spray system Y/N	Y/N	N	-
Night-Op. X	Spray system active in night operation Y/N	Y/N	N	-
Temp. S1 Min. XX °C	Gas cooler outlet temperature at which stage 1 of the spray system is switched on	20..40	32	°C
Min. ON S1 XX m	Minimum switch-on time for stage 1 of the spray system	30..180	60	Min.
TempDiff.S2 ON X K	Temperature difference above switch-on temperature for stage 1 at which stage 2 is switched on	2..10	2	K
Hysteresis XX K	Temperature difference below switch-on temperature for stage 1 at which stage 1 is switched off again	7..10	7	K

- Menu 3-3 Compressor monitoring

COMP MON POS: XXXXX		Input	Default	Dim.
Comp. OFF temp XXX °C	Disable compressor if temperature too high	80..180	145	°C
Comp. ON temp XXX °C	Enable compressor after temperature too high	50..120	110	°C
Comp temp del. XX m	*ZylTemp. zu hoch Vx*	0..5	3	Min.
Inj.Temp XXX °C	Suction gas injection: Limit value of the cylinder head temperature at which injection is performed or the valve is operated in normal operation. Parameter only visible when • Menu 3-1: *"Heissgas-Bypass*" set to N • Menu 3-2-4: "ECO-Betrieb" must be set to N or ECO operation is activated (Yes) and parallel compressors are activated (Yes)	---, 80..140	140	°C

COMP MON POS: XXXXX		Input	Default	Dim.
Inj.Temp.HR XXX °C	Suction gas injection: Limit value of the cylinder head temperature at which injection is performed or the valve is operated in HRC operation. Parameter only visible when • Menu 3-1: *"Heissgas-Bypass*" set to N • Menu 3-2-4: "ECO-Betrieb" must be set to N or ECO operation is activated (Yes) and parallel compressors are activated (Yes)	---, 90..150	140	°C
Dif.Inj.Temp XX K	Suction gas injection: Hysteresis for switching off the suction gas injection. The limit value for switching off the suction gas injection is calculated with this: Limit value = "Einsp.Temp" - "Dif.Einsp.Temp" or Limit value = "Einsp.Temp.WRG" - "Dif.Einsp.Temp" Parameter only visible when • Menu 3-1: *"Heissgas-Bypass*" set to N • Menu 3-2-4: "ECO-Betrieb" must be set to N or ECO operation is activated (Yes) and parallel compressors are activated (Yes)	5..20	20	K
HP Off Comp XXXb	tc- limit value for compressor shutdown	80..103	98	b
HP On Comp XXXb	tc- limit value for compressor enable	70..100	88	b
Weighting C.OF XX%	Weighting for the HP monitoring	5..98	90	%
HP EMERG.-OFF XXXb	High pressure limit, above which all compressors are unloaded immediately	30..106	101	bar
MP Off Comp XXXb	MP limit value for compressor shutdown	37.5..41.0	39	bar
MP On Comp XXXb	MP limit value for compressor enable	36..37.5	36	bar
Min MP/LP Diff X.Xb	Minimum difference between medium and low pressure	2..8	5.0	bar
Nr.Com.MP-Al XXX b	Number of running compressors that are still permitted to run in the event of medium pressure alarm (parameter "MD AUS Verd XXXb" has been exceeded)	1..12	2	-
to max. diff.	Maximum permissible to control error. If this is exceeded for 10 minutes, signals for the load shedding are ignored.	---, 3..8	---	K
to Comp OFF XXX °C	t_0 limit value for compressor lock	-50..2	-25	°C
Del. to OFF XXX m	Time delay for message *LP too low*	0..60	10	Min.
LP Max.	Limit value which signals the alarm "*ND too high*" when exceeded.	20..60	44.5	bar
Del. tc/HP OFF XXX m	Time delay for message *tc/HP too high*	0..60	1	Min.
Min.tG/to Diff XX K	Minimum permitted difference between tG actual value and to setpoint. When undercut, the to setpoint is lowered.	---,5..15	8	K
Starts/h XXX	Number of compressor switching operations per hour	4..16	6	-
Off Time S1 XXXs	Minimum Off Time S1 (for capacity or speed controlled compressors)	10..250	140	s

COMP MON POS: XXXXX		Input	Default	Dim.
Min.Superht.-C XX K	Minimum permissible superheat on the case side. The valve for suction gas injection is switched off if the minimum superheat undercuts this limit value	5..15	4	K
min OH-P XX	Minimum permissible superheat on the pack side. The valve for suction gas injection is switched off if the minimum superheat undercuts this limit value.	2..15	4	K
Del.Min.OH-C XXX s	Alarm delay for minimum superheat of the refrigeration points (fault message: "Superheat too small")	1..30	10	s
Del.Min.OH-P XXX s	Alarm delay for minimum superheat of the pack (fault message: "Superheat too small")	1..30	10	s
Dif.Superheat XK	Hot gas bypass valve superheat difference (when the hot gas bypass function is activated) or hysteresis for switching on the suction gas injection valve (when the suction gas injection function is activated): Limit value = "Min. ÜH-K" + "Dif. ÜH" or Limit value = "Min. ÜH-V" + "Dif. ÜH"	1..10	2	K
Oil equ time Xm	Standstill time for oil balancing	2..9	2	Min.

- Menu 3-4 Liquid level monitor

REFR. MON POS: XXXXX		Input	Default.	Dim.
Interval XX m	Interval for refrigerant monitoring	2..60	30	Min.
threshold XX %	Limit value for alarm	20..99	50	%

- Menu 3-5 External alarms

EXT. ALARM POS: XXXXX		Input	Default	Dim.
Time delay XXX s	Time delay in seconds for *External Alarm* message	3..250	5	sec.
Alarm message:				
XXXXXXXXXXXXXXXXXX	Text that is displayed when external alarms occur: Default text: *External Alarm* or *Speed Controller*	Text		

- Menu 3-6 Base load

BASE LOAD POS: XXXXX		Input	Default	Dim.
Cycle time C. XXX m	Cycle time for the compressor base load rotation	5..720	45	Min.
BaseLoadRot.FC Y/N	Activate base load rotation for fans (only visible when the *speed controller* type of HP control has been selected - screen 3-2-2-1-a)	Y/N	N	-
BaseLoadRot.F Y/N	Query for run time equalisation (only visible if *"Umsch.Lüfter* is set to *Y*)	Y/N	N	-
Cycle time F. XXX m	Cycle time for the fans base load rotation (only visible if *"Umsch.Lüfter* is set to *Y*)	5..720	720	Min.

- Menu 3 -7 Messages

Messages POS: XXXXX		Input	Default
Mot. cutout C XX	Compressor motor overload cut-out tripped	-, 0..99	2
Mot. cutout F XX	Fan motor protection (also alarms from ebmpapst fans) tripped	-, 0..99	2
Oil diff. pr. XX	Compressor oil differential pressure switch / HP monitor tripped	-, 0..99	2
Cyl. temp XX	Cylinder head temperature limit value exceeded	-, 0..99	2
HP cutout XX	High pressure limiter tripped	-, 0..99	1
LP cutout XX	Low pressure limiter tripped	-, 0..99	2
Low LP XX	Lower limit value t_0 undercut	-, 0..99	2
High HP XX	Upper limit value t_c exceeded	-, 0..99	2
Meas.err.cyl. XX	Fault in cylinder head temperature measuring circuit	-, 0..99	2
Meas. error HP XX	Fault in high pressure measuring circuit	-, 0..99	2
Meas. error LP XX	Fault in low pressure measuring circuit	-, 0..99	2
Meas. error tod XX	Fault in outdoor temperature measuring circuit	-, 0..99	2
Meas. error tr XX	Fault in room temperature / evaporator measuring circuit	-, 0..99	2
Meas.err.humid. XX	Fault in humidity sensor measuring circuit	-, 0..99	0
Power failure XX	Start-up after power failure	-, 0..99	0
First start XX	First start-up of the controller	-, 0..99	2

Messages POS: XXXXX		Input	Default
Burst disc XX	Rupture disk input tripped	-, 0..99	-
External alarm XX	External alarm input tripped	-, 0..99	2
I/O module error XX	SIOX I/O module failed	-, 0..99	2
Service mode XX	Service mode has been activated	-, 0..99	0
Comp/cond unload XX	Ext. return activated	-, 0..99	0
Load shed X	Compressor locked due to load shedding	-, 0..99	0
Low liq. level XX	Refrigerant level switch tripped	-, 0..99	2
RAM error XX	The internal data memory is defective	-, 0..99	2
EEPROM error XX	EEPROM (parameters memory) is defective	-, 0..99	2
RTC error XX	Fault in the real-time clock	-, 0..99	2
Setpoint changed XX	Setpoint adjustment	-, 0..99	0
Max. speed F XX	Threshold value for speed controller exceeded	-, 0..99	0
Battery voltage XX	Internal battery fault	-, 0..99	2
Manual OFF XX	Compressor manual control switch OFF	-, 0..99	0
Manual ON XX	Compressor manual control switch ON	-, 0..99	0
External fan XX	External fan	-, 0..99	2
Emerg. working XX	Emergency operation	-, 0..99	0
Sens type change XX	Sensor calibration change	-, 0..99	0
Comp auto disabl XX	Automatic compressor lock	-, 0..99	2
Meas. error MP XX	Fault in medium pressure measuring circuit	-, 0..99	1
Meas err.gas.out XX	Fault in gas cooler outlet temperature measuring circuit	-, 0..99	1
too many start XX	Switching frequency too high (LP combined control)	-, 0..99	0
no load level XX	No load level received (t_0-adjustment)	-, 0..99	0
Alarm HP-Valve XX	Fault in the high pressure valve	-, 0..99	0
High MP XX	Medium pressure too high	-, 0..99	2
Speed ctrl. HP XX	HP speed controller fault for HP combined control	-, 0..99	2
Meas.err.HRC-out XX	Fault in the heat recovery temperature measuring circuit	-, 0..99	-
M.err.SuctTemp-C XX	Measuring circuit error in the suction gas temperature sensor for establishing the superheat on the case side	-, 0..99	0
Low Superheat-C XX	Suction gas superheat too small on the case side	-, 0..99	0
Alarm MP-Valve XX	Fault in the medium pressure valve	-, 0..99	0
NT-Cascade XX	NT controller not accessible or faulty	-, 0..99	2
Meas. err. LP Z2 XX	Low pressure Z2 measuring circuit error	-, 0..99	2
Fan Act. high XX	Condenser utilisation too high - condenser soiled	-, 0..99	0
Low Superheat-P XX	Suction gas superheat too small on the pack side	-, 0..99	0

Messages POS: XXXXX		Input	Default
M.err.SuctTemp-P XX	Measuring circuit error in the suction gas temperature sensor for establishing the superheat on the pack side	-, 0..99	0
Ext.to-shift XX	Measuring circuit error for external to setpoint shift	-, 0..99	2
M.err.extHPshift XX	Measuring circuit error for external HP setpoint shift in HRC mode (HRC Mode and ext. HP-Shifting must be activated)	-, 0..99	2
HP EMERG.-OFF XX	The EMERGENCY STOP limit value for the high pressure has been exceeded and all compressor stages are shut down immediately.	-, 0..99	2
high LP XX	Message for low pressure too high, the limit value has been exceeded	-, 0..99	2
to diff. high XX	The to deviation is too high	-, 0..99	2

- Menu 3-8 - Menu item is hidden
- Screen 3-9 Condenser monitoring

> The condenser monitoring function must be deactivated (menu 3-9-a set to "Off").

COND. MON POS: XXXXX		Input	Default/dimension	
Mon. Mode →	Operating status of the condenser monitoring	→	Screen 3-9-a	
RefBl.Status →	Signal for recognition of the store operating status (open or closed)	→	Screen 3-9-b	
Cond. tol. X	Tolerance for the learned reference value	0..100	15	%
Start time X	Monitoring start time	0..23	10	hour
End time X	Monitoring end time	0..23	22	hour
Av. util. →	Average of the quotas calculated from QuoteHäufig and Quote Summe (learned values)	→	Screen 3-9-c	
Freq. util. →	Sum of quotas with different delta Ta (learned values)	→	Screen 3-9-d	
Tot. util. →	Frequencies of summed quotas (learned values)	→	Screen 3-9-e	

- Screen 3-9-a Monitoring mode

MON-MOD POS: XXXXX		Input	Default	Dim.
Off √	Condenser monitoring deactivated	√	√	-
Teach	Condenser monitoring in the learning phase		-	-
Monitor	Condenser monitoring active		-	-

- Screen 3-9-b Blind signal

Source-blinPOS: XXXXX	Input	Default	Dim.
CI3000 √	√	√	-
DDC1		-	-
DDC2		-	-
DDC3		-	-
DDC4		-	-
DI set.switch		-	-
DI burst.pl.		-	-

- Screen 3-9-c Quota average

COND. MON POS: XXXXX		Input	Default	Dim.
Av.at.dT- 0 X.XX	Average value for delta T at 0 Kelvin	-	-	-
...	-		-	-
Av.at.dT-30 X.XX	Average value for delta T at 30 Kelvin		-	-

- Screen 3-9-d Quota frequency

VERF.ÜB POS: XXXXX		Input	Default	Dim.
Av.at.dT- 0 X	Frequency for delta T = 0 Kelvin	0..100	-	-
...		0..100	-	-
Av.at.dT-30 X	Frequency for delta T = 30 Kelvin	0..100	-	-

- Screen 3-9-e Quota sum

VERF.ÜB POS: XXXXX		Input	Default	Dim.
Freq.at.dT- 0 X.XX	Quota sum for delta T = 0 Kelvin	0..100	-	-
...		0..100	-	-
Freq.at.dT-30 X.XX	Quota sum for delta T = 30 Kelvin	0..100	-	-

10.1.5 Menu 4 Clock

CLOCK POS: XXXXX		Input	Default/dimension	
Setpoint toggle XXX	External setpoint shift or using internal clock	INT/EXT	EXT	-
Current time →	Display of current date / current time	→	Screen 4-a	
Toggle time →	Entry of changeover times (only visible if setpoint shift *INT* is selected)	→	Screen 4-b	

- Screen 4-a Current time

UHR POS: XXXXX		Input	Default	Dim.
Date: xx dd.mm.yy	current weekday, date	Number	Date	-
Time: hh:mm	current time	Number	Time	-
Auto daylt. savg X	Automatic summer / winter time changeover (YES/NO)	Y/N	Y	-

- Screen 4-b Toggle time

TOGGLE POS: XXXXX		Input	Default/dimension	
dd hh:mm dd hh:mm	Entry in each case of up to 7 changeover times for second setpoint ON (only visible if setpoint shift *INT* is selected - menu 4)	↑, ↓ Mon-Sun Mon-Fri Mon-Sat Sat-Sun ----- Mon, Tue, Wed, Thu, Fri, Sat, Sun, number	Mon 00:00 Mon 00:00	-
...				
dd hh:mm dd hh:mm		as above		-

10.1.6 Menu 5 Messages

MESSAGES POS: XXXXX	
1 Displays	Continue to menu 5-1
2 Delete	Continue to menu 5-2

- Menu 5-1 Messages Display

MESSAGES POS: XXXXX	
Message text dd/mm/yy hh:mm ON/OFF	Message text with date and time
...	Other messages

- Menu 5-2 Delete Messages

MESSAGES POS: XXXXX	
Delete? Are you sure? NO: ESC YES: ↵	Prompt to confirm deletion of messages

10.1.7 Menu 6 Operating data

OP DATA POS: XXXXX	
1 On time	Continue to menu 6-1
2 History	Continue to menu 6-2

- Menu 6-1 Display of the operating hours

OP DATA POS: XXXXX	
1 Compressor	Continue to menu 6-1-1
2 Condenser fan	Continue to menu 6-1-2

- Menu 6-1-1 Compressor

OP DATA POS: XXXXX		Input	Default	Dim.
On time C 1 XXXX h	Display and input of the compressor run times. Only the available compressor stages are displayed.	↑, ↓ 0..9999	0h	Hour
...				
On time C12 XXXX h		as above	0h	Hour

VS 3010 C basic module: 1 - max. 4 capacity stages
with first SIOX extension module 1 - max. 8 capacity stages
with second SIOX extension module 1 - max. 12 capacity stages

- Menu 6-1-2 Condenser fan

OP DATA POS: XXXXX		Input	Default	Dim.
On time F 1 XXXX h	Display and input of the fan run times. Only the available fans are displayed.	↑, ↓ 0..9999	0h	Hour
...				
On time F12 XXXX h		as above	0h	Hour

VS 3010 C basic module: 1 - max. 4 fan run times
with first SIOX extension module 1 - max. 8 fan run times
with second SIOX extension module 1 - max. 12 fan run times

- Menu 6-2 History - Archive

HISTORY POS: XXXXX	
1 Run times	Continue to menu 6-2-1
2 Compressor starts	Continue to menu 6-2-2
3 Activity	Continue to menu 6-2-3

- Menu 6-2-1 Run times

HISTORY POS: XXXXX		Input
Date: dd/mm/yy	Date	
Run times → ↓	The run times of the date of row 1 are displayed by tapping the arrow - selection max. 31 days in the past using ↑, ↓	Screen 6-2-1-a

- Screen 6-2-1-a Run times

RUN TIMES POS: XXXXX		/Dimension	
		Default	Dim.
Comp. stage 1 hh:mm	daily compressor (stage) run times. Only the actual number of compressor stages is displayed.	00:00	-
...			
Comp. stage12 hh:mm		00:00	-

VS 3010 C basic module: 1 - max. 4 capacity stages
with first SIOX extension module 1 - max. 8 capacity stages
with second SIOX extension module 1 - max. 12 capacity stages

- Menu 6-2-2 Compressor starts

HISTORY POS: XXXXX	
Date: dd/mm/yy	Date
Compressor starts → ↓	The run times of the date of row 1 are displayed by tapping the arrow - selection max. 31 days in the past using ↑, ↓

- Screen 6-2-2-a Compressor switching pulses

STARTS POS: XXXXX		Default	Dim.
Comp. stage 1 X	daily compressor (stage) switching pulses. Only the actual number of compressor stages is displayed.	0	-
...			
Comp. stage12 X		0	-

VS 3010 C basic module: 1 - max. 4 capacity stages
with first SIOX extension module 1 - max. 8 capacity stages
with second SIOX extension module 1 - max. 12 capacity stages

- Menu 6-2-3 Activity

ARCHIV POS: XXXXX	
Date: dd/mm/yy	Date
Activity XXX % ↓	The duty quotas in % (pack utilisation) The run times of the date of row 1 are displayed by tapping the arrow - selection max. 31 days in the past using ↑, ↓

10.1.8 Menu 7 Basic settings

All parameters of the pack controller are reset to the factory settings. The following screen is displayed:

VS3010 C POS: XXXXX	
Load basic settings? Are you sure? NO: ESC YES: ↵	Confirmation prompt for loading the basic parameters

Warning about system damage! The basic settings should not be loaded as the controller will be reset to values that usually have nothing to do with the real system configuration!
After kloading the basic settings, the system-specific configuration of the pack controller **must** be performed!

10.1.9 Menu 8 Service mode

SERVICE POS: XXXXX	
1 Analogue values	Continue to menu 8-1
2 Compressor	Continue to menu 8-2
3 Condenser fan	Continue to menu 8-3
4 System	Continue to menu 8-4

- Menu 8-1 Default Analogue values

SERVICE POS: XXXXX		Input	Default	Dim.
AnalogOut1 X.X V	Voltage at the analogue output 1 (terminals 53, 54)	0.0..10.0	0.0	V
AnalogOut2 X.X V	Voltage at the analogue output 2 (terminals 55, 56)	0.0..10.0	0.0	V
AnalogOut3 X.XX V	Voltage at the analogue output 3 (terminals 57, 58)	0.0..10.0	0.0	V
AnalogOut4 X.XX V	Voltage at the analogue output 4 (terminals 63, 64)	0.0..10.0	0.0	V

- Menu 8-2 Compressor defaults ON/OFF

SERVICE POS: XXXXX		Input	Default	Dim.
Comp. C 1 XXX	Switching state of the respective compressor (stage) ON or OFF. Only the actual number of compressors is displayed.	ON/OFF	OFF	-
...				
Comp. C12 XXX		ON/OFF	OFF	-

VS 3010 C basic module: 1 - max. 4 capacity stages
with first SIOX extension module 1 - max. 8 capacity stages
with second SIOX extension module 1 - max. 12 capacity stages

- Menu 8-3 Fan defaults ON/OFF

SERVICE POS: XXXXX		Input	Default	Dim.
Fan F 1 XXX	Switching state of the respective fan ON or OFF. Only the actual number of fans is displayed. If ebmpapst fans are used for the gas cooler regulation, the switching states have the following meanings: ON: ebmpapst fan is 100% controlled OFF: ebmpapst fan is 0% controlled (is off)	ON/OFF	OFF	-
...				
Fan F12 XXX		ON/OFF	OFF	-

VS 3010 C basic module: 1 - max. 4 fans

with first SIOX extension module 1 - max. 8 fans
with second SIOX extension module 1 - max. 12 fans

- Menu 8-4 System defaults

SERVICE POS: XXXXX		**Input**	**Default**	**Dim.**
Cons.enab.Rel. XXX	Digital output *Enable consumer* ON or OFF	ON/OFF	OFF	-
toggle Comp. XXX	Digital output *FC compressor switching* ON or OFF	ON/OFF	OFF	-

11 Decommissioning and disposal

11.1 Decommissioning / Dismantling

The dismantling of the equipment may only be performed by authorised and trained personnel.

DANGER

Warning of dangerous electrical voltage! Danger to life - danger of electric shock!
During dismantling, the same safety instructions and hazard warnings must be observed as for installation, putting into service and maintenance, see chapter Safety instructions.

ATTENTION

For dismantlement, follow the steps for assembly in reverse order, see chapter Installation and Start-Up.

11.2 Disposal

NOTICE

WEEE Reg. No.
DE 12052799

Negative consequences for humans and the environment possible through environmentally unfriendly disposal!
The symbol for the separate disposal of electrical and electronic equipment represents a crossed-out wheeled trash bin and indicates that an electrical or electronic equipment marked with this symbol may not be disposed of with household waste at the end of its service life, but must be taken for separate disposal by the end user.

- In accordance with the contractual agreement, the customer is obliged to dispose of electrical and electronic waste in compliance with the statutory regulations based on the „Directive 2012/19/EU of the European Parliament on waste electrical and electronic equipment“.
- This device contains a lithium battery (for details see chapter Electrical data), which must be disposed separately!
    - **Devices with battery holder:** The battery **must** be removed from the device by the end user and **must** be disposed separately, for details see chapter Battery replacement.
    - **Devices without battery holder:** The battery contained in the device **cannot** be removed by the end user, as it is permanently installed in the device and there is no provision for battery replacement.
- Dispose the packaging, the product and its components in an environmentally friendly manner at the end of their service life. Follow the national guidelines and laws that apply to you.

Users have the option of returning a B2B device distributed by us to us at the end of its service life. Please contact your customer service representative at Eckelmann AG to arrange for the device to be taken back and disposed of properly. Please inform yourself about the local regulations for the separate disposal of electrical and electronic products and batteries. Further information on the Electrical and Electronic Equipment Act can be found at www.elektrogesetz.de.

12 Alarms and messages VS 3010 C

12.1 Message system

A number of messages are recognised by the system and stored with date, time and the priority in the internal log memory of the system. *Received / sent messages* are stored in the log memory. The time resolution is one minute. The messages are stored in the log memory in the chronological order of their generation. The log memory has a capacity of 200 entries. If the log memory is filled, the latest message overwrites the oldest entry (ring buffer).

> The log memory is buffered so that no messages are lost in the event of power failure. The messages can be retrieved using the operator terminal. The latest message is output as the first one. The contents of the log memory can be deleted using the operator terminal. Messages are also sent via the CAN bus to display the current message using the operator terminal and thus the system centre can establish a central fault message memory for the complete refrigeration pack system.

12.2 Structure of the messages

Messages consist of date, time, the priority and message-specific plain text. They are shown on the display of the operator terminal in 3 lines of 20 characters each. One line is used for the display of the active controller.

Line	Example	Data
1	Messages Pos: xxxxx	active controller
2	Motor overload cut-out C1	Message text
3	20/5/98 10:20 ON	Date and time of the message
4	20/5/98 10:25 OFF	Clearance of the fault

Up to 100 alarm priorities are provided. Possible priorities for alarms and messages have now been raised from the previous ---, 0, 1 and 2 to 99. This priority range is divided into 10 alarm groups (decades).

- The 1 and 2 priorities (1,11,21,...91 and 2,12,22,...92) are reserved for high priority alarms which activate the alarm relays "PRIO1" and "PRIO2" as well as the LEDs "PRIO1" and "PRIO2" on the front of the store computer.
- The highest priority number in each group (9,19,29,...99) is reserved for low priority alarms which should only generate local alarm signalling (e.g. open cold room door).
- All other priority numbers are designed for low priority alarms.
- The lowest priority number in each group (0,10,20,..90) is reserved for messages which are only recorded in the message list.
- If the priority is set to "-", no message is generated.

This division into alarm groups (decades) facilitates maintenance group oriented alarm management.

> The alarm priorities --, 0..2 correspond to the remote alarm messaging concept of older store computer versions with firmware versions <5.0. If priorities from 3..99 are configured in the controller then the store computer must be updated to a firmware version of 5.0 or higher. Further information is provided in the store computer operating manual.

For Version 2.0 and higher, an automatically generated message with the specified priority 0 (only archived in the message list) is sent with the following text when any message priority is changed:
Prio M xxx: *p1 > p2*
whereby xxx = message number
p1: old message priority
p2: new message priority

12.2.1 Automatic Prioritisation

In the event of a compressor fault, an alarm is automatically priority 1 if 50% of the compressors have failed and the number of compressors is greater than two (parameter *No. comps.* in menu 3-1).
If an alarm priority has been selected for a maintenance group other than refrigeration technology (Prio. 0..9 - in the decade 2x with e.g. alarm priority 20), automatic prioritisation causes the priority to be automatically raised to 21, which only then results in the generation of an alarm signal. Here the message priority remains in the pre-selected decade (maintenance group). Further information is provided in the store computer operating manual.

12.3 Overview of all alarms and messages

EPROM and RAM errors are fatal errors and cause the controller to go into the HALT state as correct program execution can no longer be expected. Output signals are reset.

In the event of any *fault in the high pressure measuring circuit*, condenser stages are switched off for stopped compressors and switched on for running compressors. If compressors have been switched on manually, capacity stages are also loaded. A switching process is performed after expiry of the basic time. The variable times are not taken into account.

In the event of any *fault in the low pressure measuring circuit*, compressor capacity stages are loaded or unloaded until approx. 50% of all available compressor capacity stages are in operation. A switching process is performed after expiry of the basic time. The variable times are not taken into account. In the event of occurrence of all other *measuring circuit errors*, operation continues with the last valid value for the duration of the fault.

No.	Message text	Message
Hardware error		
2	RAM Fault	The internal data memory is defective
4	EEPROM Fault	The internal EEPROM (parameters memory) is defective
8	RTC Fault	Error in the real-time clock of the controller
9	• Failure int SIOX • Failure ext. SIOX x	• Internal SIOX extension module has failed • External SIOX extension module No. x has failed
10	Battery voltage	Internal battery fault
16	Watchdog	Internal watchdog of the pack controller deactivated (DIP switch S1 coding switch 6 = OFF, see chapter Basic settings with S1)
Messages		
50	First start	First start of the controller with loading of default parameters
51	Power failure	Restart of the controller after a power failure
139	Low Superheat-P	Minimum superheat undercut, minimum superheat too small on the pack side
140	M.err.SuctTemp-P	Fault in the measuring circuit for measurement of the suction gas temperature on the pack side
142	Low Superheat-C	Minimum superheat undercut, minimum superheat too small on the case side (consumer)
150	Mot. cutout Cx	Compressor Cx motor overload cut-out tripped

No.	Message text	Message
153	• Mot. cutout fan x • Comm.Error Fx • Comm.Error F1..12	• Condenser fan x motor overload cut-out tripped • EBM-Papst fans - no EBM fans available or - at least one switching sequence of an EBM-Papst fan is configured as "-" • Fault in the Modbus communication with an EBM-Papst fan (1..12)
154	• Oil diff. pr. Cx • HP-Cutout Cx • Oil/HP-Fault Cx	• Compressor Cx oil differential pressure switch or • Compressor Cx HP monitor or • Compressor Cx combination HP/oil monitoring tripped The message text is displayed according to text preselection via parameters in men3-1: Oil diff. pr. Cx, HP-Cutout Cx or Oil/HP-Fault Cx
157	H. cyl.t. comp. Cx	Cylinder head temperature for compressor Cx upper limit value exceeded
160	• HP cutout • HP EMERG.-OFF	• High pressure limiter tripped • High pressure has exceeded the limit value of the "HP EMERG.-OFF" parameter
161	LP cutout	Low pressure limiter tripped
164	Low LP	Lower limit value t0 undercut
167	High HP	Upper limit value tc exceeded
168	Meas.err.cyl. Cx	Fault in the measuring circuit for measurement of the compressor x cylinder head temperature
171	Meas. error HP	Fault in the measuring circuit for measurement of the high pressure
172	Meas. error LP	Fault in the measuring circuit for measurement of the low pressure
173	Meas. err. LP Z2	Fault in the low pressure Z2 measuring circuit
175	Meas. error tod	Fault in the measuring circuit for measurement of the outdoor temperature
176	Meas. error tr	Fault in the measuring circuit for measurement of the room temperature
177	Meas.err.humid.	Fault in the measuring circuit for measurement of the air humidity
178	Burst disk	Rupture disk digital input tripped
179	• External alarm • Speed Controller	• Digital input External alarm Fault • Digital input Compressor speed controller Fault
180	Service Modus	Service mode has been activated
181	Comp/cond. unload	External return
182	Load shed x	Compressor has been disabled by load shedding - load shedding input x is active
185	ruunLow liq. level	Refrigerant level switch tripped
186	Max. speed	Upper threshold value for speed controller exceeded
187	Manual OFF Sx	Toggle to Manual OFF - compressor stage Sx
188	Manual ON Sx	Toggle to Manual ON - compressor stage Sx
192	External fan	Currently not used
193	Emergency operation	Emergency operation / load shedding digital input 2 is active and emergency operation is enabled
203	Sensor type change	A parameter for calibration of the pressure transmitters has been changed

No.	Message text	Message
204	Auto disable Cx	Compressor stage x has been automatically locked (5x cylinder temperature too high per day)
219	Meas. error MP	Fault in the measuring circuit for the medium pressure
220	Meas.err.gas c.out	Fault in the measuring circuit for the gas cooler outlet temperature
221	too many starts/h	Switching frequency too high for compressor combined control
222	no load level	No load level information received for t0 shift via consumer
225	M.err.Suct.temp-C	Fault in the measuring circuit for measurement of the suction gas temperature
231	Ext.to-shift	The signal for external t0-Schiebung (via CAN bus or analogue input 6, terminals 51/52) is faulty. The to shift is not performed correctly.
232	M.err.ext.HP-shift	The signal for HP setpoint shift in HRC operation(via analogue input 6, terminals 51/52) is faulty. The HP setpoint shift is not performed correctly.
233	High MP	Medium pressure too high
235	Meas.err.HRC-out	Fault in the measuring circuit for the HRC outlet temperature
236	M.err.Suct.temp-C	Fault in the measuring circuit for the suction gas temperature
237	Alarm HP-Valve	Fault in the high pressure valve
238	Alarm MP-Valve	Fault in the medium pressure valve
240	Setpoint changed	A setpoint has been changed
247	Speed controller HP	Fault in the speed controller during high pressure combined control
250	default loaded	All parameters of the pack controller have been reset to the factory settings, see Operating modes of VS 3010 C

13 Technical Data VS 3010 C

13.1 Electrical Data VS 3010 C

DANGER

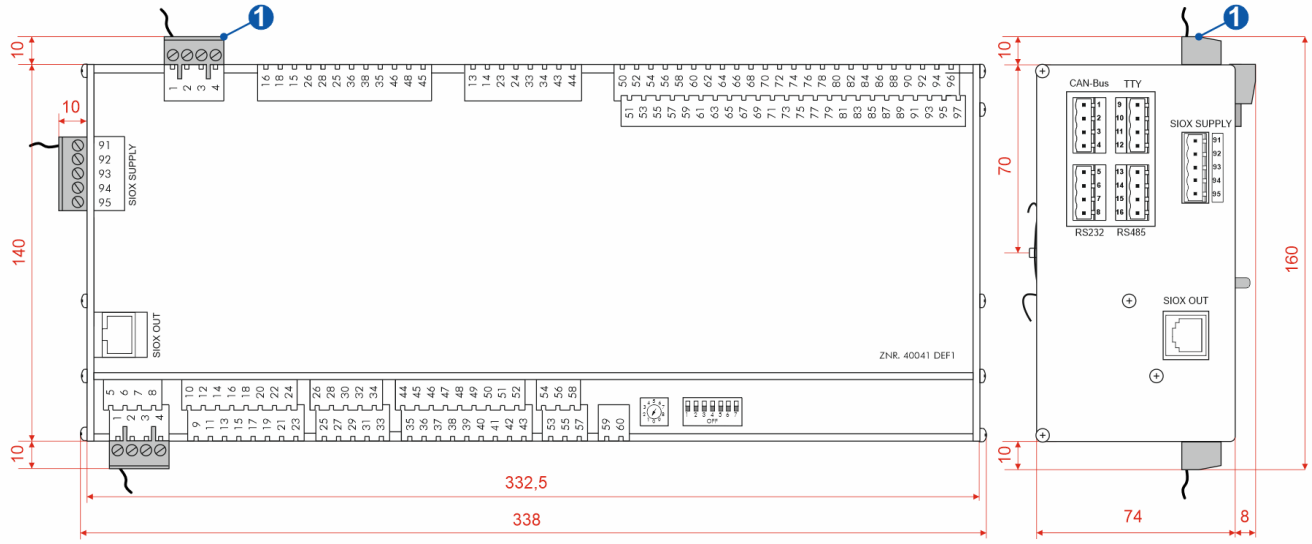
Overvoltage category III / contamination degree 2:
All connections of the device provided for operation with 230 V AC supply voltage **must** be wired with the same phase conductor. 400 V AC between neighbouring connection terminals is **not** permitted!
Overvoltage category II / contamination degree 2 or
overvoltage category II / contamination degree 1:
Different phase conductors may be used. 400 V AC between neighbouring connection terminals is permitted!

	Basic module
Operating voltage	230 V AC, 200 ... 265 V AC, 50/60 Hz
Rated power	24 VA
Leakage current over PE (protective earth)	max 1 mA
Digital inputs	23 x optionally 230 V AC or 24 V AC/DC, floating
Relay outputs	10 x 230 V AC, max. 6 A / min. 10 mA (6 NO contacts, 4 changeover contacts), floating
Manual control switch	The pack controller as well as the extension modules have manual control switches so that the regulation can be manually overridden in emergency operation.
Analogue inputs [1)]	13 x Pt1000 2-wire temperature sensor 2 x Pt1000 4-wire temperature sensor
	7 x 4..20 mA (resistance 400 ohm) / 0..10 V
Analogue outputs [1)]	4 x 0..10 V (load min. 1 kΩ) / 4..20 mA (resistance max. 800 ohm)

[1)] Supply cables to analogue inputs / outputs must be shielded. The number of analogue inputs/outputs depends on the factory setting, see chapter Configuration of the analogue inputs and outputs at the factory.

	Basic module
Field bus interface	CAN bus, zero potential
Data interfaces	SIOX OUT: Data interface for SIOX
	2 x serial RS232/RS485 1 x TTY (passive)
Other interfaces	SUPPLY: Power supply for SIOX
Real-time clock	With power reserve, lithium cell Type CRC 2450 N / 3 V Lithium Battery life 10 years Accuracy typically 12 minutes / year at 25 °C
Archive memory	Compressor run times, switching pulses, quotas, messages
Monitoring function	Watchdog
Environmental conditions	
Temperature range	Transport: -20 °C ... +80 °C Operation: 0 °C ... +50 °C
Temperature change	Transport: max. 20 K/h Operation: max. 10 K/h
Relative humidity (non-condensing)	Transport: 8% ... 80% Operation: 20% ... 80%
Shock according to DIN EN 60068-2-27	Transport and operation: 30 g
Vibration 10-150 Hz according to DIN EN 60068-2-6	Transport and operation: 2 g
Atmospheric pressure	Transport: 660 hPa ... 1060 hPa Operation: 860 hPa ... 1060 hPa
Weight	approx. 1600 g
Standards and Directives	
Protection rating	IP20
CE conformity	• Low Voltage Directive 2014/35/EU; Official Journal of the EU L96, 29/03/2014, pages 357-374 • EMC Directive 2014/30/EU; Official Journal of the EU L96, 29/03/2014, pages 79-106 • RoHS Directive 2011/65/EU; Official Journal of the EU L174, 01/07/2011, pages 88-110

13.2 Mechanical Data VS 3010 C



Basic module, all dimensions in mm.

(1) = mating connector and cable