Kuhnke Electronics
Instruction Manual

Ventura Smart Solution
Power Heat Controller

E 774 GB   30.06.2014 / xxxxxx

Table of Contents

1 Modification History

Version	Date	Subject
E774D	31/08/2010	Initial release based on the tailored power heat controller model
E774D	09/12/2010	Addenda to the installation and change of fuse sections Details about the PROFIBUS fieldbus interface
E774D	12/05/2011	New / changed functions at migration from software release SW 2.01 to SW 2.02 or SW 1.04 of hardware HW 1.0x 7.5.1 Channel Error at Pilot Stage 7.5.3 Error Suppression at Soft Start 8.1 Module State (ModuleWarning freewheeling)
E774D	01/06/2011	Status indicators 7.5.3 Error Suppression at Soft Start
E774D	01/08/2011	Use of inhibit signal at start-up in units running software 2.03 7.5.3 Error Suppression at Soft Start
E774D	01/08/2011	7.6.2 Power Mains Disturbances
E774D	01/08/2011	0 Half sine wave control is intended to separately control each of multiple continuously operated IR lamps. After the soft start stage, the thermo-controller automatically sets itself to the specified heat output. As opposed to phase-fired control, half sine wave control is based on complete half-cycles. Interconnecting 3 output channels allows complete sine waves to be picked off the mains, thereby substantially reducing harmonic perturbations of the electrical power mains. Load power variation between 0...100% in steps of 1%. Mains Voltage Correction
E774D	01/08/2011	8.8 Module Control Information about actively selecting error suppression using the inhibit signal, cf. 7.5.3 Error Suppression at Soft Start
E774D	01/11/2011	Legibility improved by clearing up the layout and removing errors
E774D	01/11/2011	7.4 Power Output Fuses Fuse type changed from 16A to 20A
E774D	13/12/2011	7.4 Power Output Fuses Fuse type changed from 16A to 20A
E774D	13/12/2011	Legal notice added to document: EtherCAT® is a registered trademark and patented technology, licenced by Beckhoff Automation GmbH, Germany.
E774D	15/06/2012	5.3 Auxiliary Supply "24VDC", X10 Advanced Instructions for the auxiliary supply in UL applications or machine.
E774D	10/09/2012	6.7 Output Branch Circuit protection according UL 508A Call to action for use in UL member territories
E774D	13/12/2011	7.4 Power Output Fuses Fuse type changed for UL marked units from 20 A to 16 A
E774D	17/01.2013	6.5 Power Supply Definition of the power supply and power form for USA
E774D	17/01/2013	8.9 Notes on parameter "Voltage Tolerance"
E774D	05.03.2013	6.7.3 Requirements for the output lines Guidance on minimum requirements.
E774	18.04.2013	5.7 Output Channel Terminals, X1 … X6 7.4.3 Allocation of Fuses and Output Channels

Version	Date	Subject
		Correction of the phase assignment at the output terminals
E774	06.08.2013	Extension of the manual with UL requirements
E774	03.03.2014	Extension Accessories, Fuse Adapter
E774	24.04.2014	5.3 Auxiliary Supply "24VDC", X10 (extension "fuse according UL 248)
E774	19.05.2014	7.5.4 Half sine wave control Improvement of the Declaration on control method of the power outputs.
E774	17.06.2014	6.6 Protective Earth Conductor Described additional ground connection at the bottom of the unit
E774	30.06.2014	8.9 Parameters Software 2.05, Mains Voltage extension

2 Introduction

General functionality

The 9-channel thermo-controller is a power controller with the ability to actuate ohmic consumers. Ohmic consumers are normally contact heaters or infrared radiators (IR radiators).

The thermo-controller needs less space in the switching cabinet than solid state relays and is a cheaper alternative to the classic PLC-based control, specifically when it comes to detecting failing consumers.

Intelligent soft start by phase-fired controller reduces the inrush load on the mains when energising the unit.

Multi-talented application

Put the thermo-controller to use wherever you need to discretely adapt the heat from heating panels made up of several radiators or groups of radiators.

Various areas of mechanical engineering will benefit from this application. Examples:

- thermoforming machine
- PET stretch blow moulding machine
- drying or curing (e.g. of paint)
- discrete heating of materials.

3 Reliability, Safety

3.1 Intended Use

The thermo-controller is designed as operating equipment in industrial environments and for connection to non-public mains.

All other applications need to be discussed with the factory first. The manufacturer shall neither be liable for any other than the intended use of our products nor for any ensuing damages. The risk shall be borne by the operator alone. The use as intended includes that you read and apply all information and instructions contained in this manual.

3.2 Target Group

This instruction manual contains all information necessary for the use of the described product (control device, control terminal, software, etc.) according to instructions. It is written for design, project planning, servicing and commissioning experts. For proper understanding and error-free application of technical descriptions, instructions for use and particularly of notes of danger and warning, extensive knowledge of automation technology is compulsory.

3.3 Reliability

Reliability of Kuhnke products is brought to the highest possible standards by extensive and cost-effective means in their design and manufacture.

These include:

- selecting high-quality components,
- quality agreements with our suppliers,
- actions to avoid static charges when handling MOS circuits,
- worst case planning and design of all circuits,
- visual inspections at various stages of fabrication,
- computer-aided tests of all assemblies and their interaction in the circuit,
- statistical assessment of the quality of fabrication and of all returned goods for the immediate taking of appropriate corrective actions.

3.4 Symbols

Despite the actions described in section 2.3, the occurrence of faults or errors in electronic control units - even if most highly improbable - must be taken into consideration.

Please pay particular attention to the additional notices which we have marked by symbols throughout this instruction manual. While some of these notices make you aware of possible dangers, others are intended as a means of orientation. They are described further down below in descending order of importance.

3.4.1 Danger

This symbol warns you of dangers which may cause death or grievous bodily harm if operators fail to implement the precautions described.

3.4.2 Attention

This symbol draws your attention to information you must take a look at to avoid malfunctions, possible material damage or dangerous states.

3.4.3 Note

This symbol draws your attention to additional information concerning the use of the described product. This may include cross references to information found elsewhere (e.g. in other manuals).

3.4.4 Under Construction

This symbol tells you that the function described was not or not fully available at the time this document went to press.

3.4.5 Instruction

Wherever you see these symbols in the left margin, you will find a list of steps instructing you to take the appropriate computer or hardware actions.

They are intended as a means of orientation wherever working steps and background information alternate (e.g. in tutorials).

3.5 Safety

Our products normally become part of larger systems or installations. The information below is intended to help you integrate the product into its environment without dangers to humans or material/equipment.

To achieve a high degree of conceptual safety in planning and installing an electronic controller, it is essential to exactly follow the instructions given in the manual because wrong handling could lead to rendering measures against dangers ineffective or to creating additional dangers.

3.5.1 Project Planning and Installation

- 24 VDC power supply: generate as electrically safely separated low voltage. Suitable devices include split-winding transformers built in compliance with European Standard EN 60742 (corresponds to VDE 0551).
- Power breakdowns or power fades: the program structure is to ensure that a defined state at restart excludes all dangerous states.
- Emergency-off installations must comply with EN 60204/IEC 204 (VDE 0113). They must be operative at any time.
- Safety and precautions regulations for qualified applications have to be complied with.
- Please pay particular attention to the notices of warning which, at relevant places, will make you aware of possible sources of dangerous mistakes or faults.
- Relevant standards and VDE regulations are to be complied with in every case.
- Control elements are to be installed in such a way as to exclude unintended operation.
- Lay control cables such that interference (inductive or capacitive) is excluded if this interference could influence controller operation or its functionality.

3.5.2 Maintenance and Servicing

- Precautions regulation VBG 4.0 to be observed when measuring or checking a controller after power-up. This applies to section 8 (Admissible deviations when working on parts) in particular.
- Repairs must be carried out by specially trained Kuhnke staff only (usually in the main factory in Malente). Warranty expires in every other case.
- Spare parts:
- Only use parts approved of by Kuhnke. Only genuine Kuhnke modules must be used in modular controllers.
- Modular systems: always plug or unplug modules in a power-down state. You may otherwise damage the modules or (possibly not immediately recognisably!) inhibit their functionality.
- Always dispose of (rechargeable) batteries as hazardous waste.

3.6 Electromagnetic Compatibility

3.6.1 Definition

Electromagnetic compatibility is the ability of a device to function satisfactorily in its electromagnetic environment without itself causing any electromagnetic interference that would be intolerable to other devices in this environment.

Of all known phenomena of electromagnetic noise, only a certain range occurs at the location of a given device. These kinds of noise are specified in the applicable standards.

Refer to IEC 61131-4, User's Guideline, for general installation instructions to be complied with to ensure that hardware interface factors and the ensuing noise voltages are limited to tolerable levels.

3.6.2 Interference Emission

DIN EN 6100-6-4

3.6.3 General Notes on Installation

As component parts of machines, facilities and systems, electronic control systems must comply with valid rules and regulations, depending on their field of application.

General requirements concerning the electrical equipment of machines and aiming at the safety of these machines are contained in Part 1 of European Standard EN 60204 (corresponds to VDE 0113).

For safe installation of our control system please observe the information contained in the next chapters (→ 2.6.4 ff).

3.6.4 Electrical Immission Safeguard

To bleed electromagnetic interference, connect the controller to operative earth and ensure best-practice wiring.

Susceptibility to noise

Electromagnetic Compatibility (EMC) - Part 6-2: Generic standards - Immunity for industrial environments (IEC 61000-6-2:2005);

3.6.5 Cable Routing and Wiring

Keep power circuits separate from control circuits:

- DC voltages   60 V ... 400 V
- AC voltages   25 V ... 400 V

Joint laying of control circuits is allowed for:

- shielded data signals
- shielded analogue signals
- unshielded digital I/O lines
- unshielded DC voltages < 60 V
- unshielded AC voltages < 25 V

3.6.6 Location of Installation

Ensure that temperatures, contaminations, impact, vibration or electromagnetic interference are no impediment to the installation.

3.6.6.1 Temperature

Consider heat sources such as general heating of rooms, sunlight, heat accumulation in assembly rooms or control cabinets.

3.6.6.2 Contamination

Use suitable casings to avoid possible negative influences due to humidity, corrosive gas, liquid or conducting dust.

3.6.6.3 Impact and Vibration

Consider possible influences caused by motors, compressors, transfer lines, presses, ramming machines and vehicles.

3.6.6.4 Electromagnetic Interference

Consider electromagnetic interference from various local sources: motors, switching devices, switching thyristors, radio-controlled devices, welding equipment, arcing, switched-mode power supplies, converters / inverters.

3.6.7 Particular Sources of Interference

3.6.7.1 Inductive Actuators

Switching off inductances (such as from relays, contactors, solenoids or switching magnets) produces surge voltages. It is necessary to reduce these extra voltages to a minimum.
Throttling elements could be diodes, Z-diodes, varistors or RC elements. Their rating should conform to the specifications provided by the manufacturer or supplier of the actuators.

4 System Description

4.1 Overview

Description of functionality

The 9-channel thermo-controller is a power controller with the ability to actuate ohmic consumers. Ohmic consumers are normally contact heaters or IR radiators.

Load voltages can be fed through a bus bar. Separate fuses are thus unnecessary which minimises the amount of space and time needed for installation.

Super-fast blow-out fuses in the thermo-controller protect both, actuated outputs and antiphase. Consumers can thus be directly connected without any need for separate fusing.

Intelligent soft start by phase-fired controller reduces the inrush load on the mains when energising the unit.

EtherCAT®[1] fieldbus interface
Ethernet Control Automation Technology

EtherCAT® is the most powerful Ethernet-based fieldbus system currently available on the market. EtherCAT® puts up the top speed mark, and its flexible topology and simple configuration make it the perfect means of controlling extremely fast processes. To give you a clue: 1000 I/Os can be addressed in 30 µs.

Because of its high performance, the simple wiring and its open protocol support, EtherCAT® is often used as a fast motion control and I/O bus driven by an industrial PC or in conjunction with control technology on a smaller scale. EtherCAT® moves beyond the limits of conventional fieldbus systems. Its interconnections between the controller at one end and both the I/O modules and drives at the other are as fast as those of a backplane bus. EtherCAT® controllers thus nearly act like centralised control systems, overcoming the issue of bus transfer times that conventional fieldbus systems are burdened with.

Integrated functions

- Extensive diagnostic options provide quick information about the thermo-controller and the load users need to efficiently locate problems.
  - Load failure
  - State of fuse
  - Power supply failure
- A software function module for CoDeSys controller programs helps users integrate the controller into the control system.
- Parameter setup and actuation data is exchanged via an EtherCAT® fieldbus which supports networks of hundreds of thermo-controllers.
- LEDs for optional output status indication help locating faults immediately at the switching cabinet

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[1]EtherCAT® is a registered trademark and patented technology, licenced by Beckhoff Automation GmbH, Germany.

4.2 Ventura Thermo-controller Hardware Design

Block diagram

4.3 Technical Properties

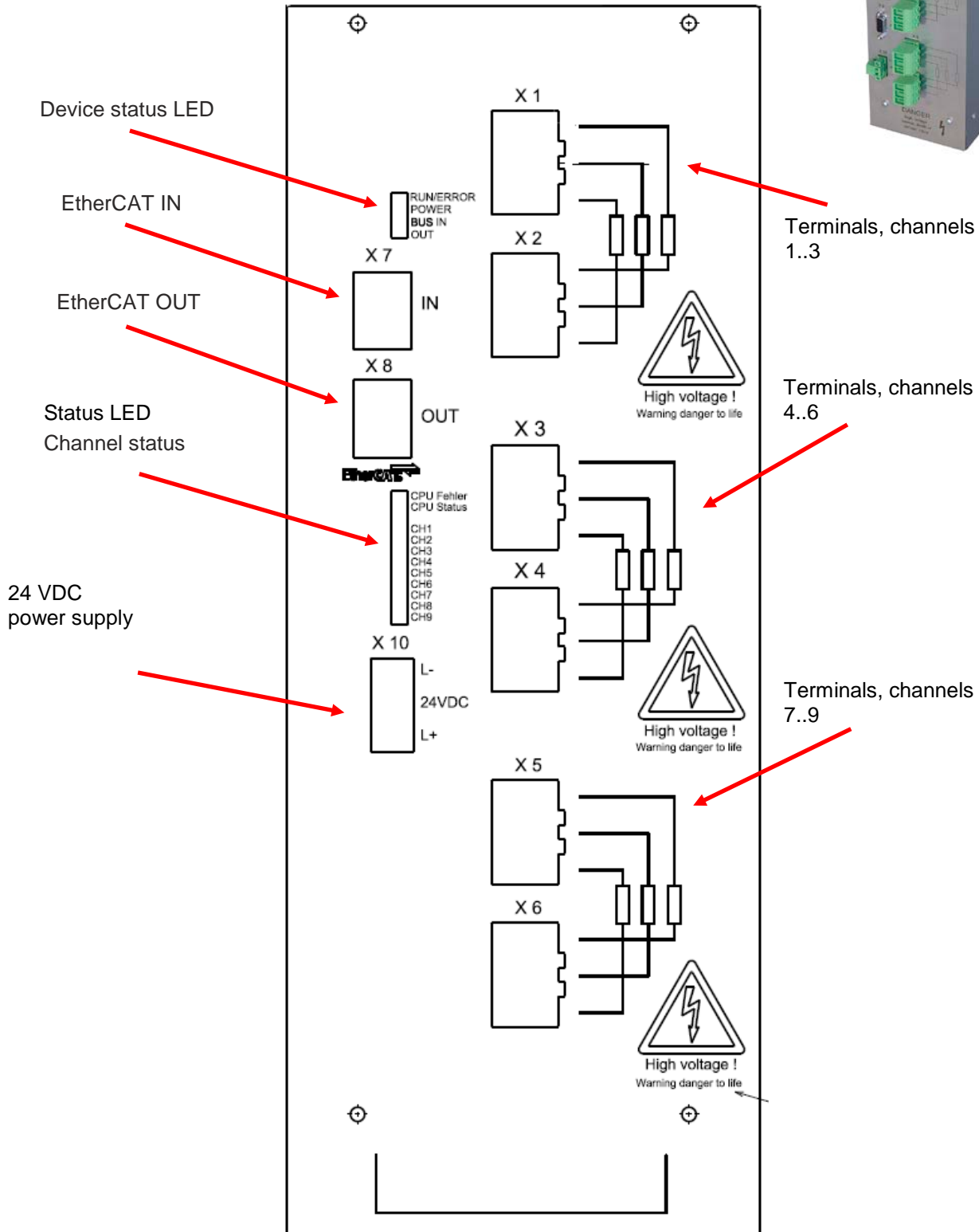| VENTURA Smart Solution	
Power controller	**9-channel thermo-controller**
Load current	9 x 4000 W (each channel carrying max. 10A)
Load type	resistive
Mains voltage	3 x 400 VAC (±10%) without N wire
Mains types	**For Europe:** 3 x 400 V AC (± 10%) without N conductor, to the TT, TN-C or TN **Network identification / network configurations in the USA** 400Y/230 V (solidy grounded wye, 3 phase, 4 wire)
Current consumption	3 phase max. 54 A
Mains frequency	50/60 Hz
Short Circuit Rating (SSCR)	50 kArms / 400V (see chapter 6.5 for details)
Adjustment range	0% … 100%
Aux supply voltage	24 VDC /18 V - 32 V to electronic circuitry Current consumption 0.5 A
Cooling	active by two redundant axial fans
Status indication by LEDs	EtherCAT® RUN / ERROR POWER BUS 1 / 2 CPU failure / status CH1 … CH9 status
Fieldbus	EtherCAT® IN/OUT PROFIBUS DP, addressable
Serial ports	RS 232 service port
Functions	soft start multi-cycle control mains voltage correction
Housing made of	stainless steel
Degree of protection	IP20, unit for installation in closed, metal switching cabinets For use in pollution degree 2 environment only
Power loss	Max. 105 W
Ambient temperature Operation	vertical installation: 0°C to 55°C relative humidity 25% to 80% at 25°C (no condensation)
Ambient temperature In transit and storage	temperature -25...+70 °C relative humidity 5% to 95% at 25°C (no condensation)
Approval	CE, UL recognized component (E 339947)
Dimensions (H x W x D)	285 mm x 100 mm x 175 mm

5 Pin Wiring

5.1 Power Heat Controller on EtherCAT®

All plug-type ports are lo-
cated at the front panel of
the thermo-controller.

5.1.1 Connectors

Device status LED

EtherCAT IN

EtherCAT OUT

Status LED
Channel status

24 VDC
power supply

Terminals, channels
1..3

Terminals, channels
4..6

Terminals, channels
7..9

5.2 Auxiliary Supply "24VDC", X10

The thermo-controller features an on-board power supply unit designed for an input voltage of 24 VDC (18V ... 32V). The power supply unit is internally protected against polarity reversal and limits the inrush current. It supplies power to the thermo-controller's circuitry and is required to measure the mains voltage.

Be sure to connect the supply voltage to PE since this is required for making measurements for line voltage compensation. Both the cord and the power supply unit must have external protection against short circuit and overload. For UL applications / machines use a listed DC branch circuit protection of max 4A. The admissible diameter of the cord connecting the 24 VDC power is between 0.75 mm2 and 2.5 mm2.

Connector   2-pin, male, 2.5 mm^2

Use male connector FKC 2.5/ 2-STF-5.08 (1873207)

Connector included in package.
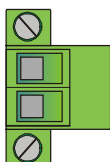
Connector X10 wiring:

X9		
Phoenix MSTB 2.5/2-G-5.08	**L-**	external power supply, GND (PE/N potential)
	L+	external power supply 24 VDC (18V ... 32V)

Only attach the unit to a 24 VDC power supply source if the source is guaranteed to meet safe extra low voltage requirements (SELV) as defined in IEC / EN / DIN EN / UL corresponds 60950-1.

For UL applications / machines:
Please use for the auxiliary supply a listed DC branch circuit protection of max 4A min 30VDC, fuse in accordance with UL 248.

To make the phase fired controller work properly; pin L- must have the same potential as the neutral point of the power supply.
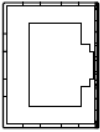
5.3 Device with EtherCAT® Fieldbus Port, X7, X8

5.3.1 EtherCAT® Fieldbus Port X7, X8

Connector X7/X8/   wiring:
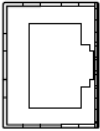
X7/X8	PIN	Function
RJ45	1	TX+
	2	TX-
	3	RX+
	4	75 Ohm
	5	75 Ohm
	6	RX-
	7	75 Ohm
	8	75 Ohm

5.3.2 Device and EtherCAT® Status

5.3.2.1 "EtherCAT®" LED (RUN/ERROR)

The LED labelled "EtherCAT®" indicates the state of the EtherCAT® ASIC.

State	LED flash code	Explanation
Init	Red, on	Initialising, no data exchange
Pre-Op	Red/green, 1:1	Pre-operational, no data exchange
Safe-Op	Red/green, 3:1	Safe operation, inputs readable
Op	Green, on	Operational, unrestricted data exchange

5.3.2.2 "POWER" LED

State	LED flash code	Explanation

5.3.2.3 LED "BUS IN" , LED "BUS OUT"

The "In" and "Out" LEDs indicate the physical state of the Ethernet port they are allocated to.

State	LED flash code	Explanation
Not connected	Off	No Ethernet connection
Connected	Green, on	Connected to Ethernet
Traffic	Green, flashing	Exchanging telegrams

5.4 Output Channel Terminals, X1 … X6

Connector   3-pin, male, up to 6 mm^2 , Connector included in package
Use male connector SPC 5/ 3-ST-7.62 (1996029)
Max. lead length to consumer location: 30m

The operation of the Power Heat Controller without connectors X1 ... X6 (6 pieces) is prohibited.
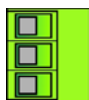
X1	Phase		
PC 4 HV/ 3-ST-7.62	1		Channel 1.1
	2	L2	Channel 2.1
	3		Channel 3.1

X2	Phase		
PC 4 HV/ 3-ST-7.62	1		Channel 1.2
	2	L1	Channel 2.2
	3		Channel 3.2
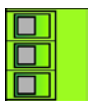
X3	Phase		
PC 4 HV/ 3-ST-7.62	1		Channel 4.1
	2	L3	Channel 5.1
	3		Channel 6.1

X4	Phase		
PC 4 HV/ 3-ST-7.62	1		Channel 4.2
	2	L2	Channel 5.2
	3		Channel 6.2

X5	Phase		
PC 4 HV/ 3-ST-7.62	1		Channel 7.1
	2	L1	Channel 8.1
	3		Channel 9.1
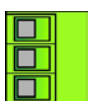
X6	Phase		
PC 4 HV/ 3-ST-7.62	1		Channel 7.2
	2	L3	Channel 8.2
	3		Channel 9.2

The lead connecting the consumer and the thermo-controller to be no longer than 30 m.

5.5 Operative Earth / Protective Earth
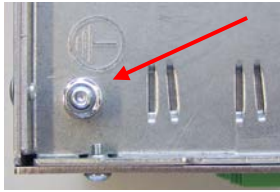
Connect operative earth/protective earth to the protective earth conductor of the switching cabinet or the system that the thermo-controller is installed in. Connection is made to the bolt on top of the device.

The minimum cross section must be no less than 4 mm^2 if leads are laid in a non-protected manner. Try to keep the lead to the cabinet terminal as short as possible.

A low-impedance earth conductor improves the dissipation of interference received via external power supply cables, signal cables or cables of peripheral units.

6 Mounting - Installation - Start-up

6.1 General

Technically skilled handling of the equipment and compliance with the applicable regulations are prime requirements for reliably excluding all dangers for humans and property when working with electric energy.

Specifically, qualified persons only to be trusted with installing, servicing, modifying and re-fitting in conformity with the general setup and safety regulations on working with power installations, taking heed of the state of the art and the interaction of components. Parts open to touch during assembly and servicing to be reliably free from power at all times. Ensure that connections are tightened at the specified tightening torques at intermediate pressure, that the correct fitting is used and that all means of protection against touch are properly installed. Check and re-tighten all connections after transportation as necessary.

Use and operate the products according to their intended use only.

Take note of the technical description as well as the mounting instructions in the product manual and keep at hand for later servicing, modifications and re-fitting. Subject to modifications for further development and technological advancement.

Warning
Dangerous electric voltage!
May cause electric shock and burns.
Before installing the unit, disconnect both the system and device from the mains.

6.2 Installation

6.2.1 Place of Installation

The thermo-controller is designed for installation in an enclosed switching cabinet or in similar closed operating rooms. Switching cabinet design and build are crucial to meeting EMC requirements. Please take heed of the following recommendations.

- Use an earthed switching cabinet.
- Use conducting profiles or other conducting material for the seals. Keep openings and cable ducts as small as possible.
- Use a braided earth strap to connect to ground and to reduce HF resistance.
- Use short earth conductors or suitable earth straps to connect the installed devices to earth.

6.2.2 Preparatory Steps

Attention:
To avoid accidents, disconnect unit from the mains prior to installing or servicing it. Install the units in a suitable housing and protect them against dirt. Only qualified persons to set up and service the unit!

Take heed of the following regulations:

DIN VDE 0100, part 460	DIN VDE 0100, part 725
DIN VDE 0113, part 1	DIN VDE 0160
DIN VDE 660, part 100	DIN VDE 0660, part 102
DIN EN 50178	IEC 947-4-1

Mounting instruction:
You are recommended to install the units vertically on a horizontal bus rail system.

6.2.3 Installation Using the Mounting Rail Adapter

The rail adapter attaches the thermo-controller to 60 mm bus bar systems, and the combination foot fits onto 5 mm and 10 mm thick double-T or triple-T bus bars between 12 mm and 30 mm wide.
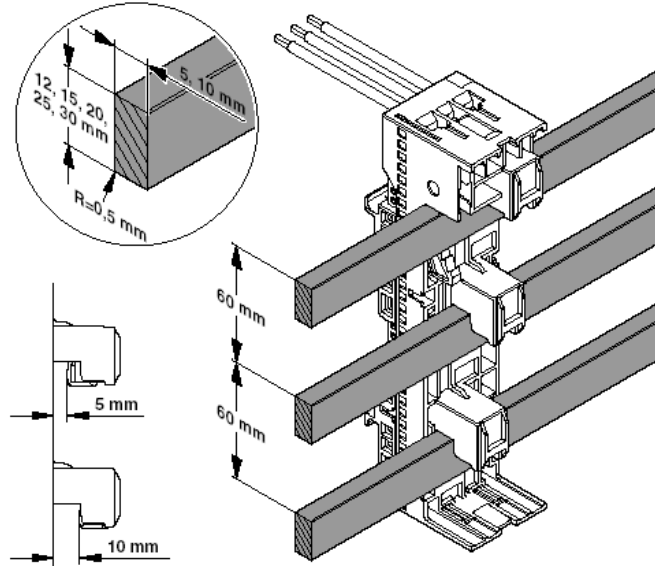
Resetting the adapter from 5 mm rails to 10 mm rails
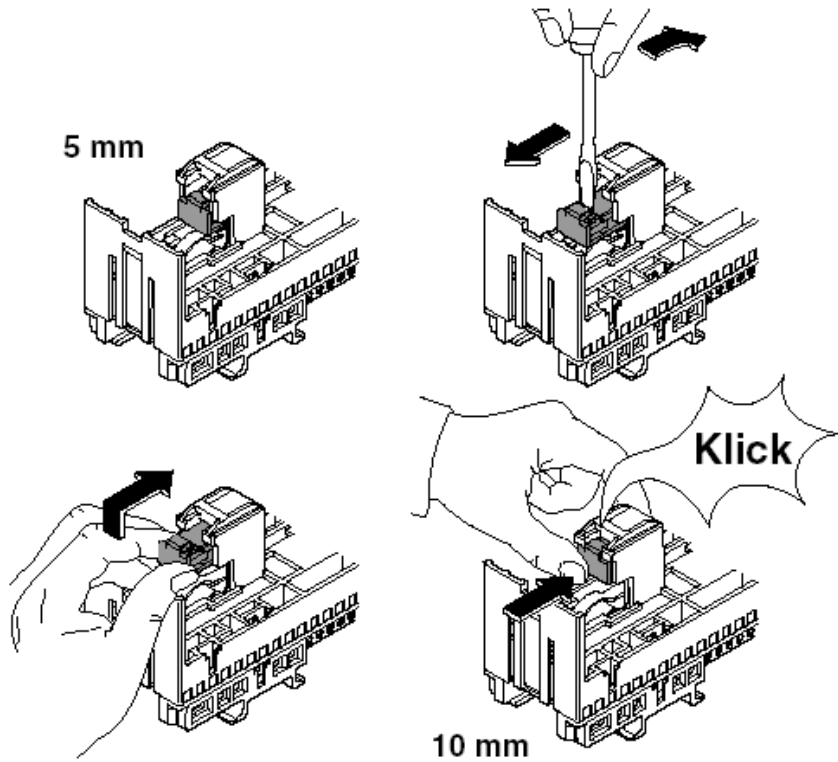
To mount the unit onto the rail

- Prior to mounting the adapter, verify that the blue rail lock has snapped out.
- Place the unit on the rail and push it down until you here it go click.
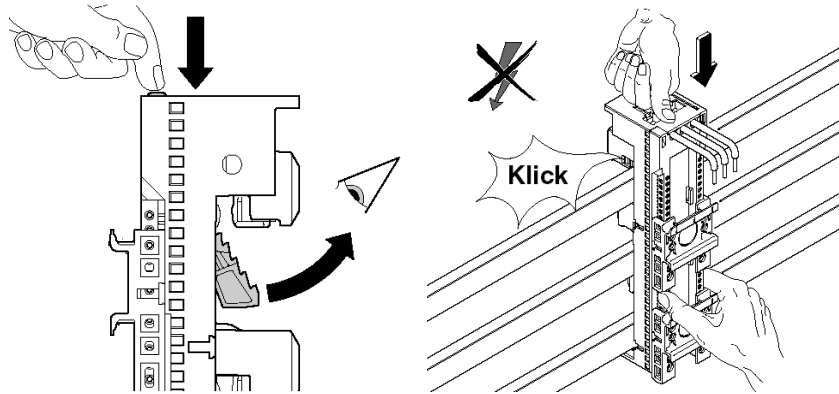
Note: The drawing shows a rail adapter without any electronic components

6.2.4 Removing from the Rail Adapter

- Use the blade of a screwdriver to push down the blue release button in the adapter's front panel.
- Slightly lift up the unit, then pull it out of the switching cabinet.
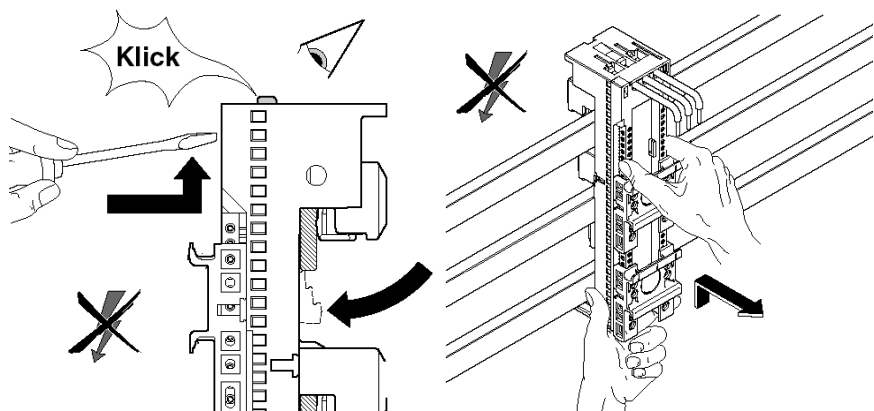
Note: The drawing shows a rail adapter without any electronic components

6.3 Power Supply

Power is supplied through the mounting rail adapter.

The power supply must meet the following criteria:

For Europe:

3 x 400 V AC (± 10%) without N conductor, to the TT, TN-C or TN

Network identification / network configurations in the USA

400Y/230 V (solidy grounded wye, 3 phase, 4 wire)

The thermo-controller is only designed for non-public mains connected to the public medium-voltage to high-voltage grid.

In order to operate the thermo-controller on public mains, external noise suppression and limited parameter value will help to conform to IEC 61000-3-12. Please contact Product Management at our central office.

## 6.3.1 Short circuit Rating (SSCR)

Suitable For Use On A Circuit Capable Of Delivering Not More Than 50,000 rms Symmetrical Amperes, 400 Volts Maximum when each heater load output is protected by a Class CC fuse rated 600V, max. 12 A in each of the power lines, see wiring diagram. (note chapter 6.7.2)

The Wöhner bus bar adapters shall be protected by Class J fuses rated 600V, max. 150A

6.4 Protective Earth Conductor

The thermo-controller is designed for installation in a switching cabinet whose IP 20 housing provides sufficient protection against direct contact.

Attach a protective earth conductor to provide for protection against indirect contact in case of a fault to frame. Connection is made to the 4 mm bolt on the top or on the bottom of the device. Be sure to use a matching eyelet connector with an inside diameter of 4.3 mm to DIN 46234.

Ground connection top side

Ground connection bottom side

The connections are marked with the following symbol

The cross-section of the PE conductor not to be less than:

- 2.5mm² Cu or 16mm² Al if protection against mechanical damage is included,
- 4mm² Cu or 16mm² Al if protection against mechanical damage is NOT included.

Try to keep the lead to the earthing terminal as short as possible.

Installation to conform to the protective earth connection regulations of EN 50178!

6.5 Output

6.5.1 Branch Circuit protection according UL 508A

UL 508A specifies how output wires for use are to be protected. Compliance with the following points is mandatory.

- Every PHC output wire shall be protected (UL 508 31.2.1) because it is energized towards the ground potential.

- Fuses shall be easily accessible and replaceable at no risk for the operator (UL 31.2.3).

- The maximum fuse value of each channel is 12 A.

- Use only UL Class CC fuses with a voltage of 600VAC and a breaking capacity of 200 kArms.

6.5.2 Lead fuses

The standard demands the use of Class CC fuses at a rated voltage of 600 VAC and a rated interruption capacity of 200 kA_{rms}. Fuses shall be UL listed.

Example fuse: KLKR015 Class CC Fuse.
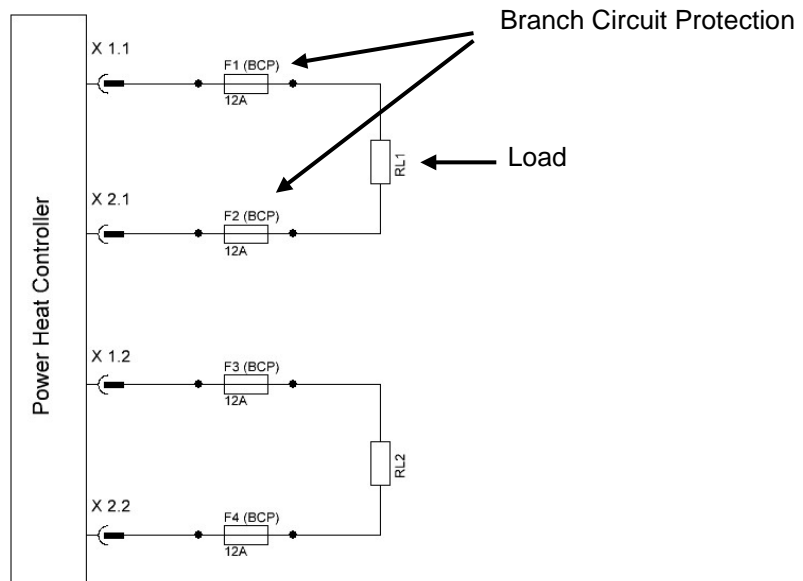
Wiring diagram with additional Branch Circuit protection for CH1 and CH2

6.5.3 Requirements for the output lines

The output lines must meet the general requirements.
In particular, **however**, to note:

- The maximum cable length between the consumer and the heater manufacturer shall not exceed 30 m.
  Interpretation of the output lines to UL 508A

- The cross-section of the connecting cable of the load must not be less than 14 AWG (2.1 mm ²) copper.

Use 60°C/75°C Conductors, sized min. 14AWG for the Heater load outputs

6.6 Mounting Lid

There is an opening on the right-hand side of the primary enclosure which is required for production-stage installation of the thermo-controller. In all devices, this opening is firmly covered with a lid attached by the appropriate screws. In case the lid has been removed by mistake, make sure it is properly replaced in order to ensure safe and proper operation of the unit.
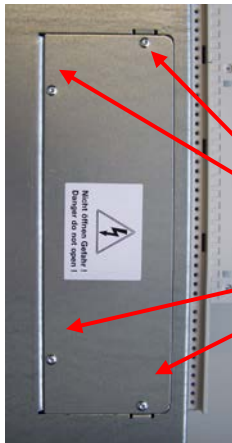
Keep firmly closed at all times!

7 Thermo-controller Operation

Do not plug, mount, unplug or touch the connectors during operation!
You may otherwise provoke destruction or malfunction. Turn off all power sources before working on the modules. This also applies to any peripherals connected such as encoders, programming devices with external power source, etc.

7.1 Starting up

Before supplying power, again check that all connectors are properly wired and that the polarity is not reversed.

Switching on

The thermo-controller has no power switch of its own.
The unit is turned on either together with the system or by connecting a power supply.

Switching off

To turn off the thermo-controller either turn off the system or disconnect the unit from its own power supply.

7.2 Indicators

7.2.1 Status Indicators

CPU FEHLER
CPU STATUS

CH1
CH2
CH3
CH4
CH5
CH6
CH7
CH8
CH9
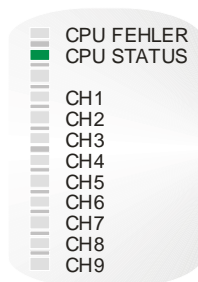
The LED next to "**CPU STATUS**" on the module indicator panel tells you the current status of the power element.
The following flash codes are shown

CPU STATUS	Thermo-controller status
▪	The heat controller is "operationaly"; apart from the conditions for "ready to turn on", check that bit "radiator master ON/OFF" in the ControlWord is set.
	Note:
	This indicator is also active if one channel fails, other channels can be actuated without any errors
☀▪▁▁	Thermo-controller "ready to turn on"
	- Mains voltage in correct range
	- Mains frequency successfully detected
	- No module errors
☀▪▁▁	Thermo-controller initialising
	- all conditions of operation are checked
	parameters
	mains voltage
	mains frequency
▫	Thermo-controller "not ready"

The LED next to "**CPU Error**" outputs various flash codes to indicate errors in the thermo-controller power drive, 'flash code' meaning a number of flash pulses within an interval followed by a pause, in this case.

If an error is limited to one or several heating channels, only the LEDs of the affected channels will flash the same code.

CPU ERROR / code		Description
	-	No error
	1	Invalid parameter settings
	2	24V power supply error
	3	Watchdog
	4	Fault in at least one channel, see Channel Status section
	5	Corrupt fan
	6	Maximum heat sink temperature exceeded
	7	Phase voltages L1 or L2 or L3 out of set tolerance bounds for more than 2 s.
	8	Unable to detect mains frequency Frequency out of supported working limits

Check LEDs CH1 ... CH9 to know the status of the selected channels.

The following errors are detectable without first setting bit "radiator master ON/OFF"; they are indicated by the CPU Error and Channel LEDs.

- Fuse (phase) defective
- Triac failure
- Load failure

7.3 Status Signalling by Thermo-controller

7.3.1 Module State

The thermo-controller continuously returns the "Module State" via the Ether-CAT® bus which outputs it to the status indicator.

Module state (word)

Signal	Value	Function
Ready to turn on	1	24 VDC power supply OK 3x 400V power supply OK Mains frequency detected
Ready to operate	1	Next to "ready to turn on", flag heating master "ON" is set in the control word. (A channel need not be selected yet)
Error	1	Module error detected. Module Error Word shows the active module error for diagnosis. All active channels are turned off.

Control bit 15 of the control word can reset a module error. This requires the error to be removed first. The unit returns to state "ready to turn on". Actuated power output will only be re-activated by a positive of control bit "heating master ON".

7.3.2 Channel State

The thermo-controller returns the state of every actuated channel.

Signal	Value	Function
Chn_ON	1	The channel has been activated by the control word and outputs the specified power or is still warming up.
Chn_Startup	1	The channel has been activated and power is supplied to the load by phase control. (Warming up)
Chn_Err	1	Channel error detected. The channel concerned is turned off. Bits 8 ... 12 of the Channel State word provide more error details.

The appropriate channel control bit of the control word can reset a channel error. The error signal is cleared. Error control restarts when the channel is re-activated. Any active error found will be indicated by the Channel State word. In case the Master signal is set to OFF, channel errors will be retained for diagnosis by the Channel State word until the Channel control bit is cleared.

An error signal is returned only if a channel has been activated by the control word. This is independent of signal Master ON/OFF. This feature allows the state of the channels and their load to be verified prior to switching on.

7.4 Power Output Fuses

Every output channel has its own two-way fuse. The Channel State word indicates the state of the fuses.

In case of an error, qualified persons may replace the fuse in conformity with ESD directives.

Qualified persons only to be trusted with installing, servicing, modifying and re-fitting in conformity with the general setup and safety regulations on working with power installations,

Components at risk of electrostatic exposure:
Only touch the circuit board and connector pins with your fingers and tools in conformity with ESD directives.

ESD-compliant handling of circuit boards is described in DIN EN 61340-5-1 Electrostatics - Part 5-1: Protection of electronic devices from electrostatic phenomena.

7.4.1 Replacing the Fuses

Safety first! Turn off the power supply of the thermo-controller before replacing the fuses.

The output channel fuses are located on a circuit board inside the device. To replace the fuses, remove the 4 screws holding the front panel. Then pull the PCB stack out of the device frame.

Screws holding the front panel

Pull out this way
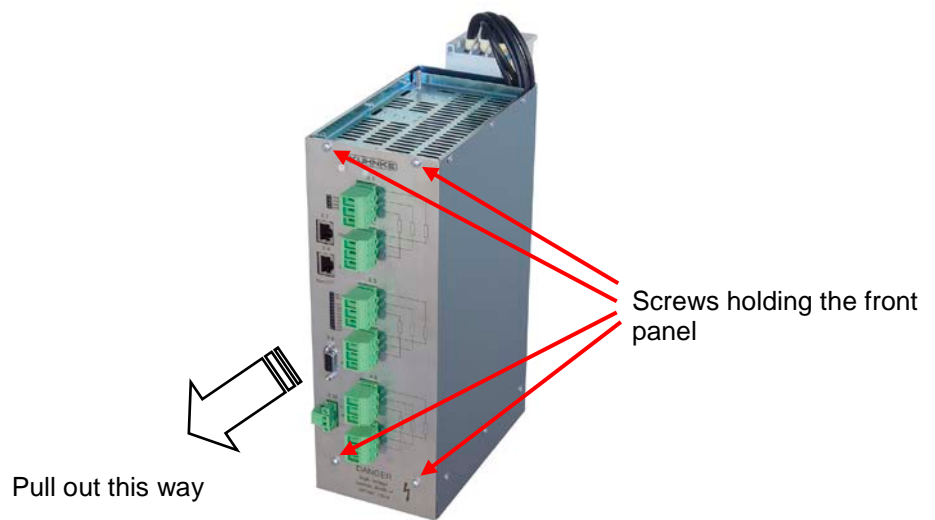
Safety first! After replacing the PCB stack to the device frame and before restarting the thermo-controller, firmly tighten all four screws to put the front panel back into place.
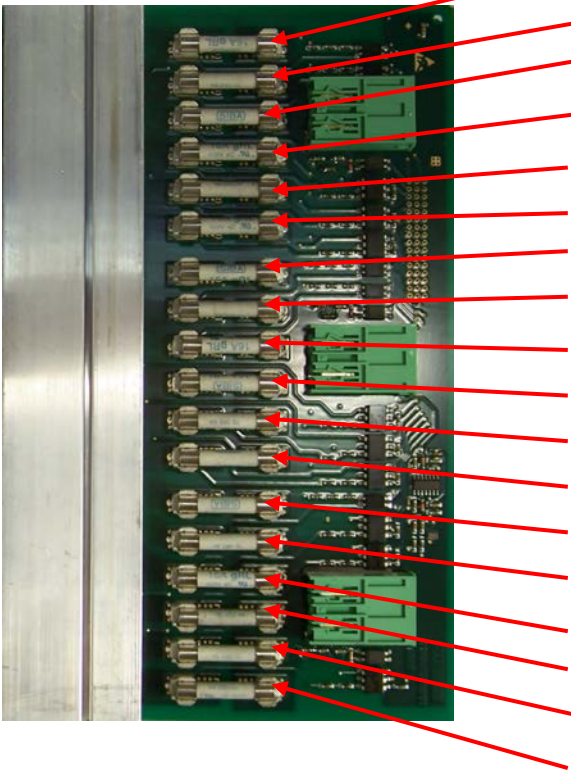
7.4.2 Type of Fuse

SIBA Type 7006584.20

6.3 mm x 32 mm

20A super-fast, UL-approved (file number E180726)

For UL marked units please only use:

SIBA Type 7006584.16

16 A super-fast, UL-approved (file number E180726)

i *Do not use any other than the above type of fuse.*

7.4.3 Allocation of Fuses and Output Channels

Fuse	Phase	Channel	Trm.
F1 (1)	L2	Channel 1.1	X1.1
F2 (2)	L2	Channel 2.1	X1.2
F3 (3)	L2	Channel 3.1	X1.3
F4 (1)	L1	Channel 1.2	X2.1
F5 (2)	L1	Channel 2.2	X2.2
F6 (3)	L1	Channel 3.2	X2.3
F7 (4)	L3	Channel 4.1	X3.1
F8 (5)	L3	Channel 5.1	X3.2
F9 (6)	L3	Channel 6.1	X3.3
F10 (4)	L2	Channel 4.2	X4.1
F11 (5)	L2	Channel 5.2	X4.2
F12 (6)	L2	Channel 6.2	X4.3
F13 (7)	L1	Channel 7.1	X5.1
F14 (8)	L1	Channel 8.1	X5.2
F15 (9)	L1	Channel 9.1	X5.3
F16 (7)	L3	Channel 7.2	X6.1
F17 (8)	L3	Channel 8.2	X6.2
F18 (9)	L3	Channel 9.2	X6.3

High voltage!

Warning

danger to life

7.5 Thermo-controller Operation

7.5.1 Channel Error at Pilot Stage

If the channel is enabled and Master=OFF, EtherCAT® signals errors "fuse (phase) defective", "triac failure" and "load failure" within 250 ms; faults in the heating circuit can thus be detected without starting the heating cycle first.

We recommend the following heater start-up procedure:

- Use bits 4 to 12 of the control word to enable all channels used
- Wait for 250 ms
- Check channel state (bit 2) for errors
- If no errors are found, use bit 0 (Master ON) of the control word to start the heating cycle.

7.5.2 Soft Start

In order to limit the inrush current and extend the IR radiators' plant life, the cold radiator is started by a soft start circuit.
After the set starting time, 100% of heat output are available and the thermo-controller automatically changes from phase-fired control to multi-cycle control.

7.5.3 Error Suppression at Soft Start

Thermo-controller operation experience has shown that, specifically at start-up, a bad mains quality may provoke alerts and error messages. Any thermo-controller enabled and connected to the AC potential may generate these messages.

Software release 2.02 and higher suppresses all controller channel errors and channel alerts as well as the frequency error for 65 seconds after the signal starting a channel. In order to prevent the thermo-controllers mutually affect one another, they should complete their soft start stage during that time. After that time, all failure detection and signalling is re-enabled.

Software release 2.03 and higher supports PLC-controlled error suppression via bit 13 of the control word. This requires you to enable this function by setting bit 14 first. As long as bit 14 =0, the thermo-controller will act like a device running SW release 2.02 (set error suppression for 65s during start-up).

A power supply failure may be caused by either voltage or current or frequency errors. Such power supply failures may be attributable to the operation's power distribution grid, the consumers, or the electric utility company.

7.5.4 Half sine wave control

Half sine wave control is intended to separately control each of multiple continuously operated IR lamps. After the soft start stage, the thermo-controller automatically sets itself to the specified heat output.

As opposed to phase-fired control, half sine wave control is based on complete half-cycles. Interconnecting 3 output channels allows complete sine waves to be picked off the mains, thereby substantially reducing harmonic perturbations of the electrical power mains.

Load power variation between 0...100% in steps of 1%.

7.5.5 Mains Voltage Correction

In order to accurately adjust the heat output, the controller verifies the supply voltage of each of the phases and automatically adapts the setpoint heat output to each change in voltage. Parameter "**NominalVoltage**" is available to set the "nominal voltage".

The phase-to-phase voltage is computed from the phase voltages measured separately.

Several cycles are measured to obtain an average phase-to-phase voltage which is then compared to the value computed previously. Where the average voltage differs by more than 3V from the voltage determined before, each channel's heating power will be computed again and the control values of all channels adapted to the mains voltage.

The control value set for every channel is sent to the control unit as "**ActualControlValue**" for verification.

System constraints do not allow mains voltage correction to obtain control values above 100%. This particularly applies to high control values at low mains voltages.
If the thermo-controller fails to correct the mains voltage, channel state bit 12 "power correction error" of the affected channels will be set.

7.5.6 Fan

The thermo-controller has two speed-controlled axial fans. For about 2 seconds after power-on, the fans run at full load and the power consumption is checked.

When the measured values are in the correct range, fan output is adapted to the heat sink temperature. The fans turn off if the heat sink temperature drops below 28°C. At temperatures above 30°C, the fans run at no less than 25% of their output capacity. A hysteresis of 2°C prevents the fans from being turned on and off at quick alternations.
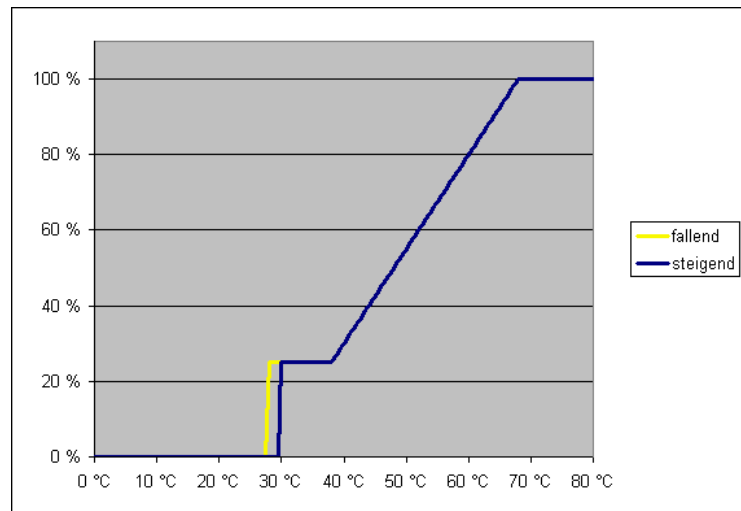
If the checkup process reveals that the fans are blocked or that no power is consumed, the "CPU ERROR" LED will output an error code.

If one fan fails, the other fan will make up by working more and a warning will alert the control unit.

If the heat sink temperature is measured to be 80°C or higher, the Power Heat Controller will set itself to Failure and output an Over-temperature error.

7.6 Malfunctions

7.6.1 Faults

The following faults will automatically turn off the heater channels:

- Error in at least one heater channel
- Maximum driver temperature exceeded for longer than 200 ms
- Bus communication failure (EtherCAT® / RS232)
- 24V supply low for longer than 50 ms
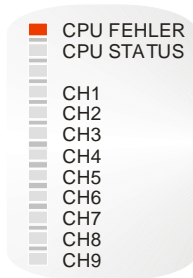- Mains voltage out of range admissible for operation (nominal voltage + 10% -30%)

To restart the heater after a problem, bit "reset error" must be set to return the control unit to normal operation. After that, a positive edge of bit "heater ON / OFF" is to restart the power drive.

7.6.2 Power Mains Disturbances

As of SW release 2.02, major disturbances on the 400V mains no longer make the thermo-controller start error mode automatically. If one of the phases no longer allows the zero point to be reliably detected, that phase will start freewheel mode, i.e. the time of subsequent zero points will be predicted with reference to the last zero points measured reliably and assuming that the frequency is stable. Freewheel mode is indicated by the appropriate alert bit. Frequency variations may cause the computed zero points to differ from actual zero points if freewheel mode goes on for longer uninterrupted periods of time which, in case of large differences, may cause the triacs to misfire and a discrepancy between target and actual heating power to ensue. Check the phase shift alert bit to know about differences between assumed and actual frequencies.

During operation and given that there is no other possibility of monitoring the process quality, you should respond to an extended phase shift bit alert.

Moreover, in freewheel mode, channel errors will not be indicated for the radiators connected to the phase affected, nor will fault messages be generated to indicate a major phase shift.

However, assuming there is a complete zero point failure during a heating cycle (as may occur when the main contactor turns off), the system will still indicate a fault and set the frequency error bit. The same applies to major phase shifts with none of the phases being in freewheel mode caused, for example, by wrong wiring or extremely asymmetrical loads.

7.6.3 Troubleshooting

Refer to section 2.5 Safety.
Contact our Customer Service if the actions described below fail to solve the problem.

Problem	Possible Cause	Recommended Action
Device Failure mode. All active channels turned off.	Module error detected. Module Error Word shows the active module error for diagnosis.	Check mains voltage. Check voltage supply to electronic circuitry. Clean fans.
Voltage indicated for L1/L2/L3 is OK but the frequency is =0	Mains voltage not correct, zero points not measurable or implausible readings are taken. The values measured for the indicated voltage should be used on if there are neither frequency nor phase errors.	Check mains connection

7.7 Preventive Maintenance

Before working on the modules, turn off the power supply to the power elements and the electronic circuitry.

Periodically check the fans of the thermo-controller for dirt. Use compressed air to remove any dirt and dust. This is facilitated by removing the PCB stack from the unit first. Dirt and dust on the heat sink of the power element can also be removed using compressed air.

7.7.1 Disposal

Disassembly

Disposal requires the device to be disassembled and entirely taken apart. All metal components can be given to metal recycling.

Electronic scrap

Electronic components such as circuit boards etc. are kept and disposed of separately.
For details on proper disposal please check your national laws and regulations making sure that your method of disposal complies with them.

8 EtherCAT® Process Data and Parameters

8.1 Module State

ModuleState (word)

Bit	Signal	Function
0	Ready to turn on	Module ready *Controller ready to turn on and waiting for start bit*
1	Ready to operate	Module up and running *Controller ready and waiting for set-points*
2	Error	Module error detected *Controller waiting for ClearErr bit*
3	Restart lock	SW release 2.03 or higher Controller restart lock Waiting for clearing of start bit
4	f50Hz	50Hz mains detected
5	f60Hz	60Hz mains detected
8	ECAT operational	Defaults via EtherCAT®, V24 defaults disabled
12	ERRORQUIT	Enabled if command "reset error", bit 15 of the ControlWord is detected.

ModuleError (word)

Bit	Signal	Function
0	L1VoltErr	
1	L2VoltErr	Phase voltage out of set tolerance bounds for longer than 2 s
2	L3VoltErr	
3	FreqErr	Frequency out of supported working range (DC voltage supply) No zero points found for 200 ms. Excessive phase shift for longer period. (Check supply voltage)
4	KKTmpErr	Output stage temperature above top limit
5	Fan1Err	Fan 1 error
6	Fan2Err	Fan 2 error
7	ChannelErr	Error in at least 1 channel
8	ParameterErr	Invalid parameter settings
9	CtrSpgErr	24V power supply error
10	HW_WatchDog	HW_WatchDog error
11	HardwareErr	Hardware error
12	ECAT_WatchDog	ECAT_WatchDog error
13	ECAT_EEPROMErr	EEPROM configuration data error
14	-	-
15	-	-

ModuleWarning (word)

Bit	Signal	Function
0	L1VoltWarn	Phase voltage out of set tolerance bounds
1	L2VoltWarn	
2	L3VoltWarn	
3	FreqWarn	Aperiodic zero points (disturbance); Frequency out of supported range; phase shift No zero points for 200 ms.
4	KKTmpWarn	Output stage temperature above warning threshold
8	Freewheel1*	Valid zero points not detectable, phase 1 uses computed zero points (phase 1 freewheeling)
9	Freewheel2*	Valid zero points not detectable, phase 2 uses computed zero points (phase 2 freewheeling)
10	Freewheel3*	Valid zero points not detectable, phase 3 uses computed zero points (phase 3 freewheeling)
11	PhaseShiftErr*	Phase shift alert > 500µs shift between ideal and real zero point

* Function available with SW release 2.02 or higher

You can use this information to tell if and when a phase is freewheeling for longer periods - i.e. the thermo-controller is no longer detecting valid zero points - and remedy the situation. Freewheeling, even for longer periods, does not generate an error.

The potential risk is that a wrong trigger point may result in, say, 5% output instead of 100%. One method of telling whether the freewheeling phase is still at the correct phase position is to check the phase shift alert bit.

A permanent alert output by these bits justifies the assumption that the AC voltage supply is of a bad quality.

8.2 Channel State

ChannelState_1 … ChannelState_9 (9xWord)

Bit	Signal	Function
0	Chn_ON	Channel enabled
1	Chn_Startup	Warming up (phase-fired)
2	Chn_Err	Channel has at least 1 error
3	Chn_ON	Channel request enabled and remains enabled even if an error provoked automatic shut-down.
…	…	…
8	Fuse1Err	Fuse defective (triac)
9	Fuse2Err	Fuse defective (phase) *
10	TriacErr	Triac defective *
11	LoadErr	Load failure detected
12	CorrErr	Power correction error

* Fuse2Err will set together with TriacErr only, that is to say, it is impossible to say whether an error is caused by the blown fuse upstream the triac or by a triac being permanently blocked

Notes on fault detection

Faults can be detected as follows, depending on the actual value of the control variable:

Control variable 1-99% (detected after max. 0.99s)
All errors

Control variable 0% / radiator master OFF:
Fuse (phase) defective
Triac failure
Load failure

Control variable 100%:
Fuse (phase) defective
Fuse (triac) defective or triac triggered
Combined load failure **and** fuse (triac) defective if the fuse (triac) failure occurs after the load failure.

Priority of error:
If multiple problems occur at the same time, only the error of the highest priority may be indicated, depending on whether it occurs at the OFF or ON switching stage:
Triac should be off:
1st Fuse (phase)
2nd Triac failure
3rd Load

Triac should be on:
1st Fuse (phase)
2nd Fuse (triac) or triac or load

8.3 Actual Control Values

ActualControlValue1 … ActualControlValue9, (9 x word)
Actual control values of each channel (9x 16 bit)
(shown as 0..100 %)

8.4 Phase Voltage

ActualPhaseVoltage1 … ActualPhaseVoltage3 (3x word)
Actual phase voltage 1 / 2 / 3 (3x 16 bit)
(RMS reading between two phases; shown in volt)

MinPhaseVoltage1 … MinPhaseVoltage3 (3x word)
Minimum phase voltage 1 / 2 / 3 (3x 16 bit)
(RMS reading between two phases; shown in volt)

MaxPhaseVoltage1 … MaxPhaseVoltage3 (3x word)
Maximum phase voltage 1 / 2 / 3 (3x 16 bit)
(RMS reading between two phases; shown in volt)

**ToleranceExceedingPhaseVoltage1 …
ToleranceExceedingPhaseVoltage3 … (3 x word)**
Number of times the phase voltage exceeds the tolerance limits (3x 16 bit)
(reset by turning on the radiator master On / Off)

8.5 Mains Frequency

ActualLinefrequency (word)
Current mains frequency (16 bit)
(shown in 0.1Hz)

MinLinefrequency (word)
Minimum mains frequency (16 bit)
(shown in 0.1Hz)

MaxLinefrequency (word)
Maximum mains frequency (16 bit)
(shown in 0.1Hz)

ToleranceExceedingLinefrequency (word)
Number of times the mains frequency exceeds the tolerance limit (16 bit)
(reset by turning on the radiator master On / Off)

8.6 Output Stage

OutputStageTemperature (word)

Temperature of output stage (16 bit)

(shown in 1/10°C)

OutputStageExceedings (word)

Number of times the output stage exceeds the temperature warning threshold (16 bit)

(reset by turning on the radiator master On / Off)

SpeedSetpointFan1, SpeedSetpointFan2 (2 x word)

Setpoint speed of fan 1 / 2 (2x 16 bit)

(shown in % of maximum speed)

8.7 Version

HardwareVersion (word)

Hardware release (16 bit)

SoftwareVersion (word)

Firmware release (16 bit)

8.8 Module Control

ControlWord (word)

Bit	Signal	Function
0	Radiator master On / Off	Turns off all channels or turns on all selected channels
-	--	-
4	Channel 1	Every channel can be separately turned on or off if the radiator is generally turned on by signal "Radiator master On / Off" (master switch)
5	Channel 2	
6	Channel 3	
7	Channel 4	
8	Channel 5	
9	Channel 6	
10	Channel 7	
11	Channel 8	
12	Channel 9	
13	InhibitChnError	Enabling channel error suppression available together with bit 14 only
14	define ManualChnInhibi	0 = Set error suppression, 65s after start-up, same as software release 2.02 1 = Control option by InhibitChnError (bit 13).
15	Reset errors	Returns the control unit from error mode to operational mode

MasterControlValue (word)

Master heating power setpoint:
Default value for evenly scaling all channel control values
(0..1000 %; 1% steps)

ChannelControlValue1 … ChannelControlValue9 (9x word)
Values controlling the heating power output of all 9 channels:
default value for separately scaling the channels
(0..1000 %; 1% steps)

ⓘ *MasterControlValue and ChannelControlValue1 setup*

The MasterControlValue is multiplied by the ChannelControlValue_n.

$$\frac{MasterControlValue \times ChannelControlValuen}{100} = Heizleistung$$

The maximum heating power of each channel is of course 100%.
It is further limited by MaxHeatingPower.

Example
MaxHeatingPower = 90
MasterControlValue = 1000
ChannelControlValue_n = 50
Thus, the channel's heating power is:
*(1000%*50%)/100=500% limited to 90%*

MaxHeatingPower = 90
MasterControlValue = 200
ChannelControlValue_n = 5
Thus, the channel's heating power is:
*(200%*5%)/100= 10%*

MaxHeatingPower = 90
MasterControlValue = 10
ChannelControlValue_n = 200
Thus, the channel's heating power is: 200% of 10% = 20%
*(10%*200%)/100= 20%*

8.9 Parameters

Parameter	
Range [Default]	Description / note
NominalVoltage	**(word)**
360 ... 440V [400]	Sets the nominal voltage between two phases of the three-phase current, this voltage becoming the reference for voltage correction. The setting can be fine-tuned to steps of 1V.
VoltageTolerance	**(word)**
0 ... 100V [0]	Tolerance (±), with reference to the nominal voltage, which is to provoke a warning if exceeded. **Note:** The limits of the rated voltage 400 V AC ± 10% (360 V AC / 440 V AC) can not be exceeded and will always lead to an error message. The setting can be fine-tuned to steps of 1V. **From software 2:05** Mains voltage extension 350 ... 450 VAC: From the voltage 400 V AC ± 10% (360 V AC / 440 V AC), a module warning is issued. An error message and shutdown occurs from 350 V AC or 450 V AC.
MaxPhaseAngle	**(word)**
20 ... 170° [90]	Maximum phase cutting angle. (180° - setting) The setting can be fine-tuned to steps of 1 degree.
RunupTime	**(word)**
1000 ... 20000ms [0]	Time set for phase-fired start of radiators. (soft start) The setting can be fine-tuned to steps of 1ms.
MinHeatingPower	**(word)**
0 ... 100% [0]	Rock-bottom control value regardless of default. The setting can be fine-tuned to steps of 1%.
MaxHeatingPower	**(word)**
0 ... 100% [0]	Absolute peak control value regardless of default. The setting can be fine-tuned to steps of 1% and must needs be greater than MinHeatingPower. Note: If this parameter is set to 99%, errors "open load" and "TRIAC failure" can be detected.

9 Maintenance

Servicing

Only have qualified persons service the thermo-controller, especially if it involves opening the unit's housing!

Before starting any maintenance work, read section *2 Reliability, Safety*, focussing on section *2.5 Safety*.

Do not remove any housing covers if power is still supplied to the unit!
Risk of coming into contact with parts carrying high voltage.
You may suffer death, serious injury or serious material damage.
Do not remove the housing covers until the thermo-controller is definitely unplugged from its power supply.

Servicing your thermo-controller may cause damage if

- metal objects such as screws, nuts, tools or other conductive objects drop on any of the circuit boards;
- leads are made to come loose, are removed or plug in wrongly.

After servicing

Before restarting the thermo-controller after servicing, ensure that

- no foreign objects are inside it;
- all connectors are plugged in correctly;
- protective earth (PE) is correctly attached.

Carefully close all covers of the thermo-controller before restarting the unit!

10 CoDeSys Library for the Thermo-controller (EtherCAT®)

10.1 CoDeSys

Create a separate HC-type instance for every thermo-controller.

Example
VAR
HC1: HC; (thermo-controller instance *)*
END_ VAR

Pointers to the input/output ranges of the EtherCAT® variables to be allocated to every instance (COMPULSORY!).

Range names are
Input variables: Boxn_Modulestate (n=no. of thermo-controller)
Output variables: Boxn_Controlword (n=no. of thermo-controller)

Example
(pointers to input/output ranges of thermo-controller #1 *)*
HC1.pInput   := ADR(Box1_Modulestate);
HC1.pOutput   :=ADR(Box1_ControlWord);

The pointers provide direct access to the variables.
Example:
*/ Example: Get current mains frequency reading *)*
ALF := HC1.pInput^.ActualLineFrequency;

*/ Example: Write nominal voltage set-point *)*
HC1.pOutput^.NominalVoltage := NNV ;

10.2 Output Variables

ModuleState	/ module state
ModuleError	/ module error
ModuleWarning	/ module warning
ChannelState :ARRAY[1..9]	/ channel state
ActualControlValue : ARRAY[1..9]	/ channel control value
ActualPhaseVoltage : ARRAY[1..3]	/ actual phase voltage
MinPhaseVoltage: ARRAY[1..3]	/ minimum phase voltage
MaxPhaseVoltage : ARRAY[1..3]	/ maximum phase voltage
ToleranceExceedingPhaseVoltage : ARRAY[1..3]	/ no. of times tol. limits are exceeded
ActualLineFrequency	/ current mains frequency
MinLineFrequency	/ minimum mains frequency
MaxLineFrequency	/ maximum mains frequency
ToleranceExceedingLineFrequency	/ no. of times the frequency exceeds the tolerance limit
OutputStageTemperature	/output stage temperature
OutputStageExceedings	/ no. of times temp. exceeds tolerance limits
SpeedSetpointFan1	/ setpoint speed, fan 1
SpeedSetpointFan2	/ setpoint speed, fan 2
HardwareVersion	/ hardware release
FirmwareVersion	/ software release

10.3 Input Variables

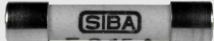|	
ControlWord	/ control word
MasterControlValue	/ master setpoint
ChannelControlValue :ARRAY[1..Max_No_Channel]	/ channel setpoints
NominalVoltage	/ nominal voltage
VoltageTolerance	/ voltage tolerance
FrequencyTolerance	/ frequency tolerance
RunupTime	/ run-up time
MinHeatingPower	/ minimum heat output

11 Appendix

11.1 Technical Data

11.1.1 Basic Units

| Ventura Smart Solution		
Power Heat Controller EtherCAT®	**610.441.31**	
9-channel thermo-controller Power controller for ohmic consumers and IR radiators, 9 x 4000W (max. 16 A current load on each channel), mains voltage 3 x 400 VAC (±10%), no N-wire, power supply through contact rails,		

11.1.2 Accessories

Ventura Smart Solution		
Fuse Adapter BCP	**610.441.70**	
The Fuseadapter BCP (Branch Circuit Protection) allows the additionally protection of heating cables according to UL guidelines. The fuse adapter carries 18 fuse holders. Each output line of the PHC can be protected by a fuse max. 12 A Class CC with a voltage rating of 600 VAC and a breaking capacity of 200 kArms.		
Channel fuse	**610.441.40**	
Box of 10 spare 16A fuses for Power Heat Controller.		

11.2 Dimensions

11.2.1 Power Heat Controller with Bus Bar Adapter
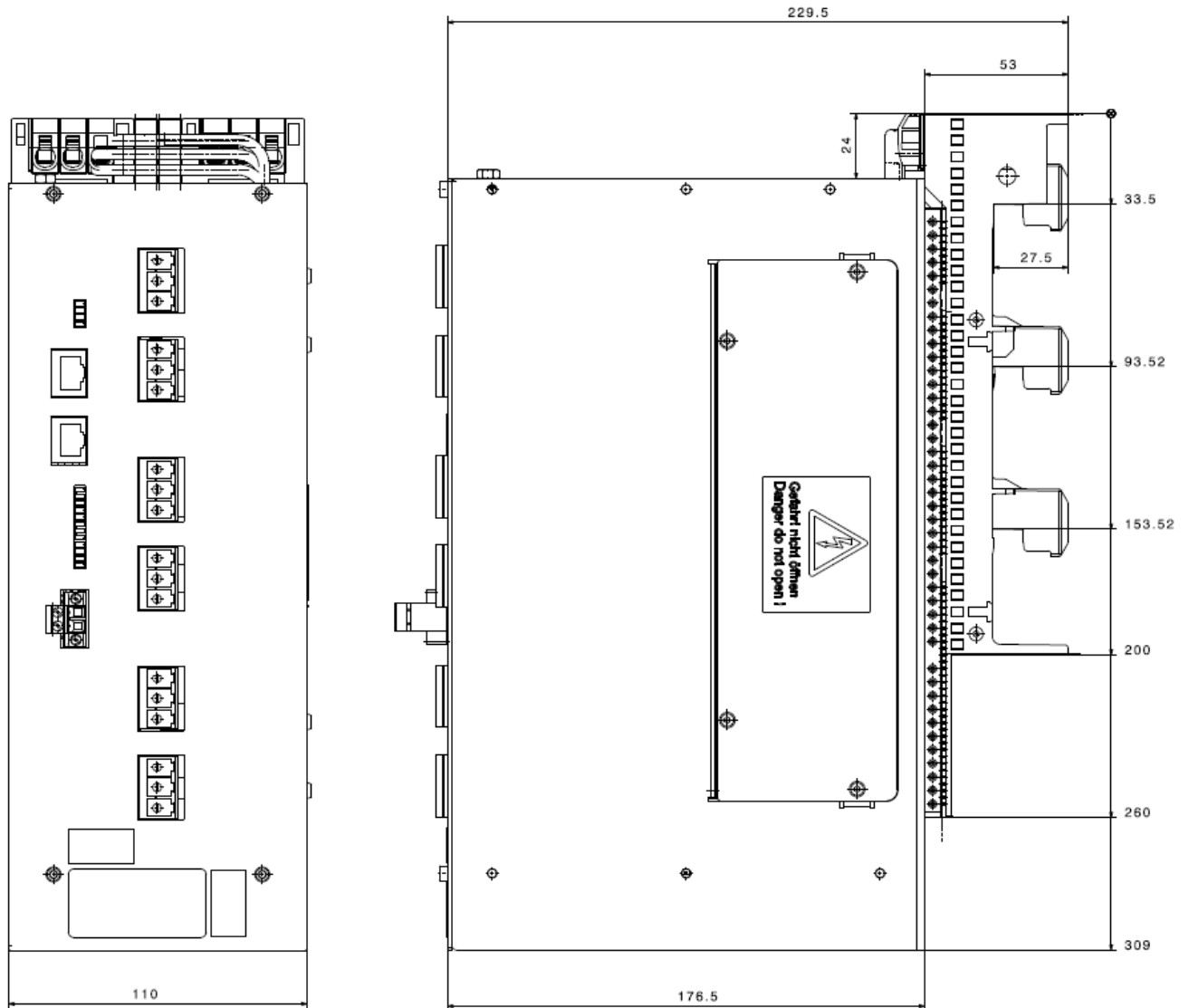
11.3 Sales & Service

Please visit our Internet site to find a comprehensive overview of our sales and service network including all the relevant addresses. Feel free to also contact us at our headquarters in Malente/Germany:

11.3.1 Malente Headquarters

Kendrion Kuhnke Automation GmbH
Industrial Control Systems
Lütjenburger Straße 101
23714 Malente, Deutschland

Tel. +49 4523 402-0
Fax +49 4523 402-201

E-Mail   sales-ics@kendrion.com
Internet www.kuhnke.de

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