KENDRION

PROFINET®

EtherCAT®

CANopen®

User Guide

Modular Heating System

MHS Controller

E 850 GB 25.05.2022

PRECISION. SAFETY. MOTION.

Table of Contents

1 Preface

1.1 Legal Notice

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1.1.1 Version Details

Modification History	
Date	**Comments / Modifications**
24.10.2019	Preliminary version
25.02.2020	Section 4.3.4: CAN port wiring added
18.08.2020	Section 6.4 Input Data. New: Resonance frequency per zone
17.08.2021	IT security
25.05.2022	EtherCAT & CANopen configurations expanded

1.2 About this Manual

This technical information is primarily directed to system designers, project engineers and device developers. It does not contain any availability information. We reserve the rights for errors, omissions and modifications. Pictures are similar.

1.2.1 Limitation of Liability

Specifications are for description only and are not to be understood as guaranteed product properties in a legal sense. Exact properties and characteristics shall be agreed in the specific contract. Claims for damages against us - on whatever grounds - are excluded, except in instances of deliberate intent or gross negligence on our part.

1.2.2 Terms of Delivery

The general conditions of sales and service of Kendrion Kuhnke Automation GmbH shall apply.

1.2.3 Copyright

1.2.4 Warranty

Warranty is subject to the provisions of the conditions of sale of Kendrion Kuhnke Automation GmbH or any contractual agreements between the parties.

1.3 Reliability, Safety

1.3.1 Applicability

For reasons of personal safety and to avoid material damages when working with or handling this Kuhnke product, you are advised to take heed of the notes and information contained in this instruction manual.

1.3.2 Target Group of the Instruction Manual

This instruction manual contains all information necessary for the use of the described product (control unit, 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.

1.3.3 Intended Use

Kuhnke's products are designed, developed and manufactured for standard industrial use. They must not be used for any other purposes than the ones specified in the catalogue or the associated technical documentation. Proper and safe operation depends on the products being transported, stored, lined up, mounted, installed, put into service, operated, and serviced correctly. Ambient conditions must be within the admissible limits. Notes and information in the associated documentation apply at all times.

1.3.4 Reliability

Reliability of Kendrion 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.

1.3.5 Hazard and Other Warnings

Despite the actions described in section 1.3, 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.

Every alert and hazard warning is made up as follows:

Type and source of risk

Potential consequences of non-observance

⇨ Preventive measures

	***DANGER***
	A DANGER warning makes you aware of an immediately hazardous situation which WILL cause a serious or fatal accident if not observed.

	***WARNING***
	A WARNING makes you aware of a potentially hazardous situation which MAY cause a serious or fatal accident or damage to this or other devices if not observed.

	***CAUTION***
	A CAUTION alert makes you aware of a potentially hazardous situation which MAY cause an accident or damage to this or other devices if not observed.

	***NOTE***
	A NOTE makes you aware of a potentially hazardous situation which MAY cause damage to this or other devices if not observed.

1.3.6 Other Notices

	***Information***
	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).

1.3.7 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.

	***DANGER***
	Non-observance of the instruction manual *Measures for the prevention of dangerous faults or errors may be rendered ineffective or new hazard sources created.* ⇨ *Thoroughly read the instruction manual*

	⇨ *Take particular heed of the hazard warnings*

	***Information***
	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.

Project Planning

- 24 V DC/AC 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.

Maintenance and Servicing

- Precautions regulation BGV A3 (Elektrische Anlagen und Betriebsmittel) 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.
- Spare parts: Only use parts approved of by Kendrion. Only genuine 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.

1.3.8 IT security

Kendrion Kuhnke products are designed for use in closed (private) industrial network environments.

In case such industrial networks are open to public access (e.g. via fully accessible network interfaces) or otherwise externally accessible (e.g. via data links and public (Internet) traffic), the integrator and operator must take appropriate organisational and technical precautions to protect the in-house network and ensure IT security.

	***Information***
	To find information about how to safely operate equipment, systems and networks, please refer to the texts published by BSI (Federal Office for Information Security), other publicly available sources and IEC 62443.

1.3.9 Electromagnetic Compatibility

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. It is defined in the relevant product standards.

The design and immunity to interference of programmable logic controllers (PLCs) are internationally governed by standard
EN 61326-1 Electrical equipment for measurement, control and laboratory use – EMC requirements

	***Information***
	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.

Interfering emission

Interfering emission of electromagnetic fields, HF
compliant to EN 55011, limiting value class A, Group 1

	***Information***
	If the controller is designed for use in residential areas, high-frequency emissions must comply with limiting value class B as described in EN 55011. *Fitting the controller into earthed metal cabinets and installing filters in the supply lines may produce a shielding compliant to the above standard.*

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 (same as VDE 0113).

Electrical immission safeguard

To eliminate electromagnetic interference, connect the control system to the protective earth conductor. Practice best cable routing.

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

Location of installation

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

Temperature

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

Contamination

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

Impact and vibration

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

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.

Particular sources of interference

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.

Reducing elements may be diodes, Z-diodes, varistors or RC elements. Their rating should conform to the specifications provided by the manufacturer or supplier of the actuators.

2 Product Description

2.1 General Description

The induction heating technology uses the eddy current losses to quickly and directly heat metallic materials.

Heat is available rapidly and is induced into the material fairly evenly.

Benefits include:

- rapid heating and cooling
- highly dynamic control response
- energy efficiency

Kendrion's unitised inductive heating system

2.2 MHS Controller

Kendrion's modular heating system controller is a fieldbus-ready unit for actuating up to 7 Kendrion MHS-series power output stages directly integrated using the module bus.

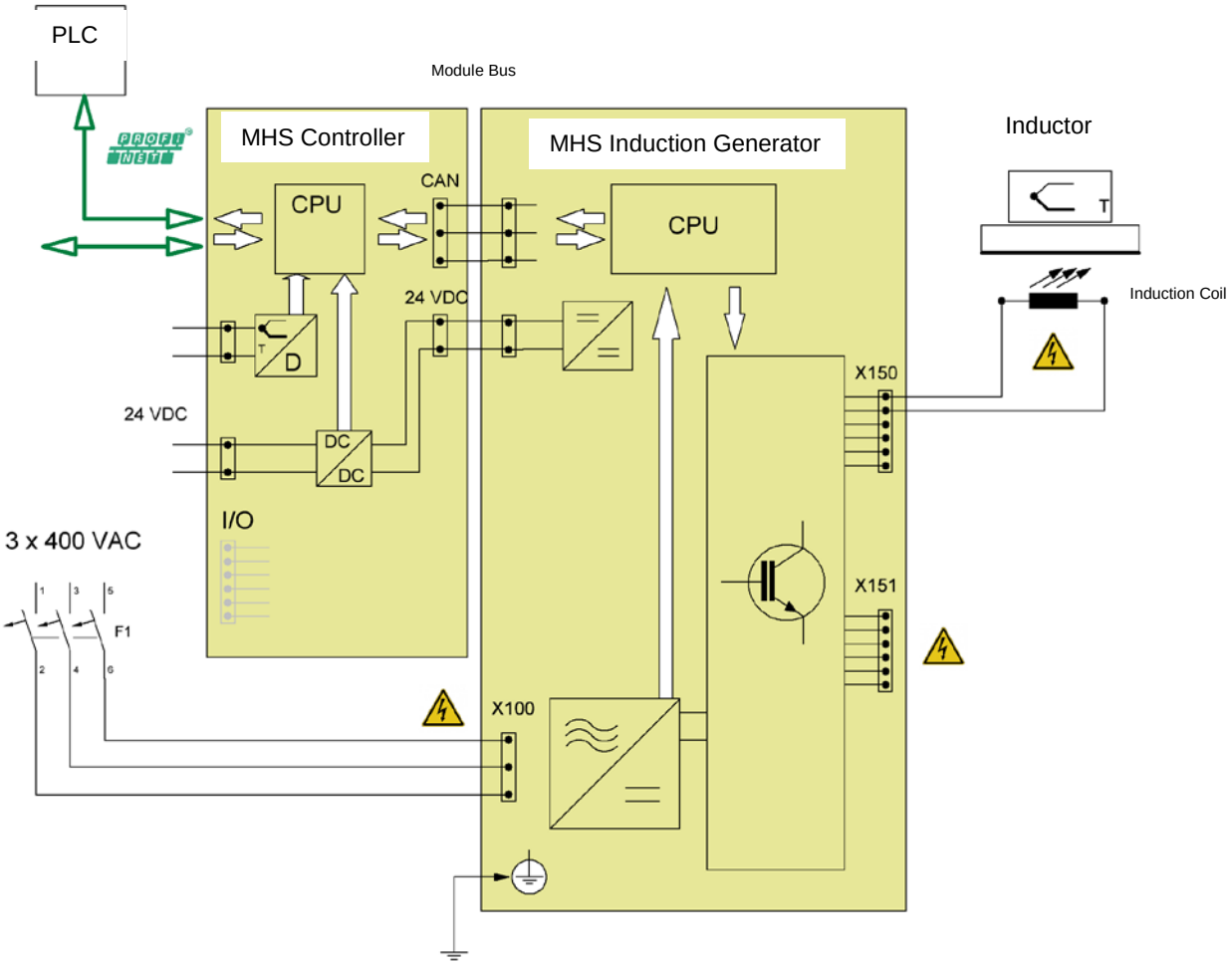
Apart from monitoring the system, the MHS Controller can also actuate or control each of the output channels. It receives the measuring values either directly via the CAN fieldbus or indirectly via a higher-level control unit.

Putting into service is quick and easy thanks to a wide range of diagnostic features and integrated inputs and outputs.

Properties

- Various software packages for variability
- Fieldbus technology
- Distinct control of up to 7 MHS output stages
- System monitoring, temperature control
- Integrated I/Os and CAN system bus

2.3 System View



2.4 Application

2.4.1 Intended Use

The units are designed for on-site use in industrial environments immediately at the machine.

Install the MHS Controller and at least one MHS output stage in the switching cabinet.

2.4.2 Foreseeable Misuse

Place of installation

Both the MHS Controller and the MHS output stage provide IP 20 protection and should be protected against humidity and dirt.

The units emit exhaust hot air into the ambient space. Verify that the place of installation is ventilated properly. Refer to section Technical Data for waste heat details.

	***NOTE***
	Damage to the unit
	Choosing the wrong place of installation may cause damage to the unit.
	⇨ Check section Technical Data for the admissible ambient conditions and the unit's mounting position.

Connection

The MHS Controller will only operate in conjunction with one of Kendrion's MHS output stages. Running it with a third-party unit is not supported.

	***NOTE***
	Damage to the unit
	A wrong combination of units may destroy the device.
	⇨ Mind to run the admissible combinations of units only.

Design constraints for high-risk activities

The product is not fault tolerant and has neither been designed nor manufactured for applications requiring faultless operation during which a failure of the product would cause fatality, serious personal injury or serious material or environmental damage ("high-risk activities").

	***DANGER***
	Danger caused by malfunctions
	Fatality, serious personal injury or serious material or environmental damage
	⇨ Do not use the product for applications requiring faultless operation during which a failure of the licenced product would cause fatality, serious personal injury or serious material or environmental damage.

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2.5 Technical Data

2.5.1 General MHS Controller Specifications

General Specifications	
Product name	MHS Controller
Article number	610 610 XX
Processor	STM32F7 (ARM® Cortex®-M7 core)
Ports	1x Ethernet 100 Mbit – RJ45 (optional), CAN
Fieldbus interface	PROFINET IO slave, EtherCAT, CANopen (one fieldbus is supported per variant)
Fieldbus interface (Master)	1x CANopen (not available on 'CANopen' fieldbus variants)
Power supply	24 VDC / -10% +10% (21.6 V – 26.4 V) max. interruption: 10 ms
Power consumption (logic circuit)	Controller: 150 mA (@ 24 VDC) + max 4 A (@ 24VDC) sensor power at X24
Output	Controller: approx. 4 W (@ 24 VDC)
Fusing	max. 12 A
Power consumption (module bus)	Max 4 A (@ 24 VDC)
Fusing	max. 12 A
Noise immunity	Zone B to EN 61131-2, mount on MHS generator in earthed switching cabinet
Service conditions	
Ingress protection	IP20 (mounted on MHS generator)
Mounting position	Vertical, stackable
Storage temperature	-25 °C...+70 °C
Operating temperature	0 °C...+40 °C
Rel. humidity	5% … 95%, non-condensing
Degree of contamination	2
Working altitude above msl	max. 2000 m
Vibration	5 Hz to 8.4 Hz: +/- 3.5 mm amplitude, 8.4 Hz to150 Hz: 10 m/ s2 (1g) to IEC 60068-2-6, Fc test
Shock	150 m/s2 (15g), 11 ms semi-sinusoidal wave to IEC 60068-2-27
Mechanical properties	
Installation	mount on MHS generator in earthed switching cabinet
Dimensions	451 mm x 44 mm x 286 mm (W x H x D)
Housing mount	Steel sheet with stainless steel cover

2.5.2 PROFINET Fieldbus Interface – Device Variant

PROFINET interface	
Quantity	2
Junction	RJ-45 100BaseTX, male, copper lead
Speed	up to 100 Mbps in full-duplex or half-duplex mode
Model	PROFINET IO device
Conformance class	B
Update rate	1 ms
Number of supported application relations (AR)	2
PROFINET protocols	LLDP, MRP Client, DCP, DCE-RPC
Other protocols	SNMP v1, HTTP, TFTP, FTP

2.5.3 EtherCAT Fieldbus Interface – Device Variant

EtherCAT interface	
Quantity	2
Junction	RJ-45 100BaseTX, male, copper lead
Baud rate	100 Mbps
Type and length of lead	CAT5 max.100 m

2.5.4 CANopen Fieldbus Interface – Device Variant

CANopen interface	
Quantity	1
Junction	Connector, copper cable
Baud rate	Set by DIP switch, 125 kbit/s – 1 Mbit/s
Type and length of lead	CAN bus lead, min. 2 x 0.22 mm² / 20 m – 1000 m (varies with baud rate)
Addresses	Set by DIP switch, 1 - 63
Bus termination	120 ohm, installed in controller

2.6 Dimensions

Refer to section 7 for exact dimensions

3 Construction and Functionality

3.1 Brief Description

MHS PROFINET Controller

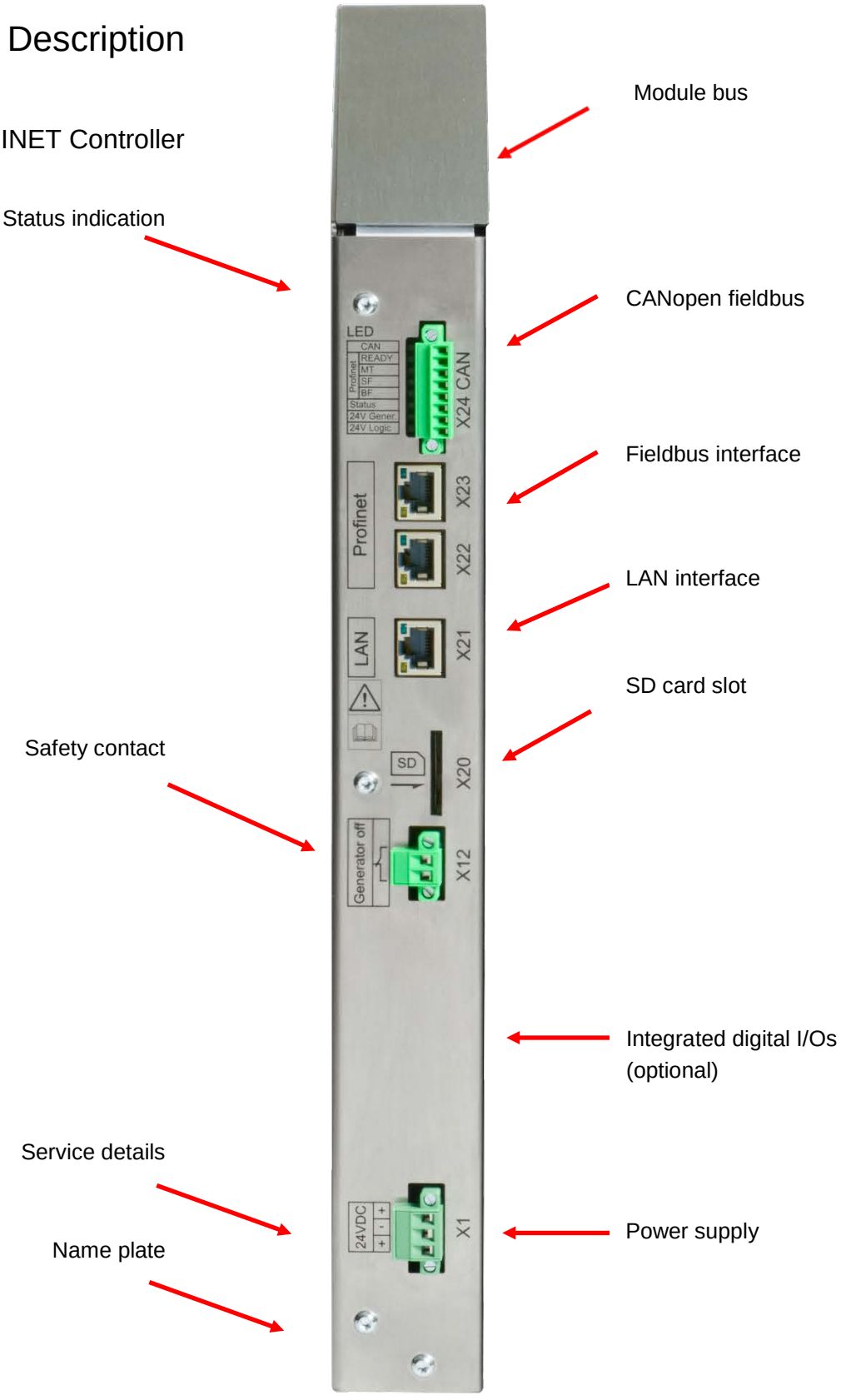
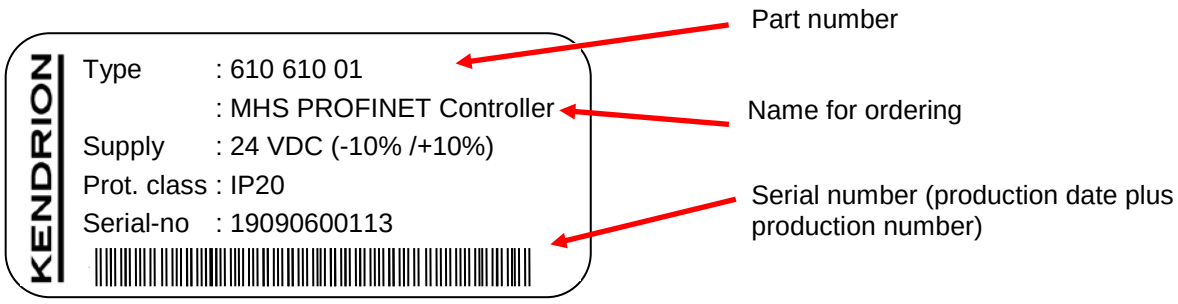


Illustration similar to real-life model

3.2 Labelling and Identification

Name plate (example)



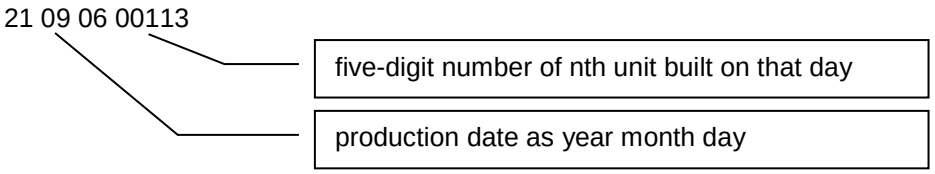
Serial number

The numerical code incorporates the production date and a serial number. Kendrion Kuhnke can use the numerical code to distinctly identify the model, software and hardware release date. It is a means of traceability.

Make-up of serial number:

YY MM DD NNNNN

Example:
The unit shown above is number 00113 manufactured on 06th September 2019.



Manufacturer and service details

Look at the device trough to find the manufacturer's address and other service details of the unit.

3.3 Contents of Package

The control unit package contains:
Main unit (in ESD-compliant bag)
Mating connector (as agreed)
Mounting material
Stuffing
Module bus lead for 4 or 7 output stages (as agreed)



3.4 Transport and Storage

Despite the unit's rugged construction, its components inside are still sensitive to impact and vibration. Transport and keep the unit in its original packaging and ensure that the ambient conditions are as specified at all times during transport and storage. Refer to manual section → 2.5.1 General MHS Controller Specifications for admissible ambient and transport condition details.

	NOTE
	Humidity
	Damage to the unit
	⇨ Verify that no moisture (condensation) is able to collect on the unit when transporting it in cold temperatures or if it is exposed to extremely varying temperatures. Allow the unit to slowly warm up to room temperature before putting it into operation.

	NOTE
	ESD
	Damage to the unit
	⇨ Even very small electrostatic discharge (ESD) will cause defects that may shorten the life of electronic components. Use the original package to transport the unit and install the units in an ESD-compliant manner.

NOTE

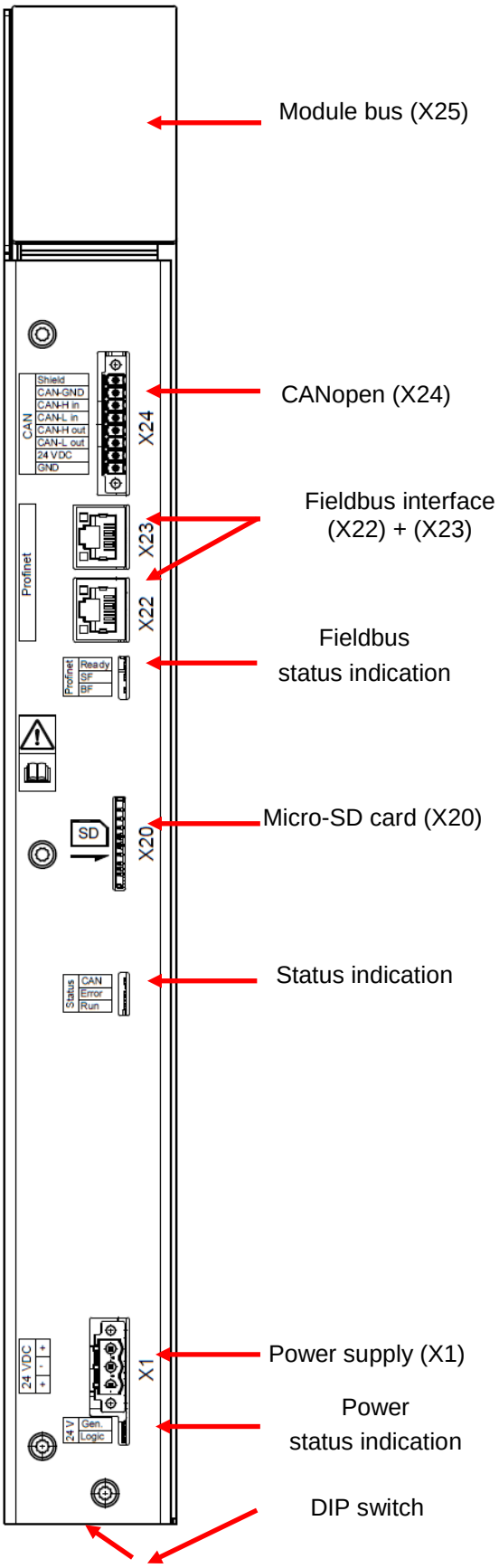
Damage

Damage to the unit

⇨ In case you discover traces of damage on the outer package, immediately open the package and inspect the unit. If you find any damages, do not put the unit into operation.

3.5 Control Unit Layout

All external connectors are located at the front of the unit. All connectors are of the plug-in type.

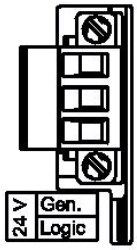


3.5.1 Power Supply "24 V", (X1)

Power supply

The unit houses a power supply unit (PSU) designed for an input voltage of 24 V DC. The PSU is protected against reverse polarity.

Both the cord and the power supply unit must have external protection against short circuit and overload triggering at max. 12 A.



Male part with bolt flange

Max. cross-section, flexible wire: 2.5 mm²

X1	24 VDC Power Supply	
Male plug	**Pin**	Function
Phoenix MSTB Part no.: 1777992 spcg. 5.08	**1**	"Logic" power supply 24 VDC (-10 %/+10 %)
	2	Power supply, GND
	3	"Generator" power supply 24 VDC (24 VDC -10%/+10%)

Technical data

Power supply	
Voltage interruption	max. 10 ms
Rated current (UL/CSA)	10 A

3.5.2 Digital Output (DO), (X10) – Device Variant

Male part with bolt flange

Max. cross-section, flexible wire: 1.5 mm²

X10	24 V Output	
Male plug	**Pin**	**Function**
Phoenix MC Part no.: 1847181 spcg. 3.5	**1**	DO1
	2	DO2
	3	DO3
	4	DO4
	5	DO5
	6	DO6
	7	DO7
	8	DO8

Technical data

Digital Outputs	
Quantity	8
Cable	max. 30 m
Switching voltage	24 VDC
Switching current	0.5 A (short-circuit-proof)
Load type	resistive, inductive
Electrical insulation	none

3.5.1 Digital Inputs (DI)(X11) – Device Variant

Male part with bolt flange

Max. cross-section, flexible wire: 1.5 mm²

X11	Digital Inputs	
Male plug	**Pin**	Function
Phoenix MC Part no.: 1847181 spcg. 3.5	1	DI 0 (3ms)
	2	DI 1 (3ms)
	3	DI 2 (3ms)
	4	DI 3 (3ms)
	5	DI 4 (3ms)
	6	DI 5 (3ms)
	7	DI 6 (3ms)
	8	DI 7 (3ms)

Technical data

Digital Inputs	
Quantity	8
Signal	24 VDC
Status indication	LED located next to the terminal
Input delay	3 ms
Signal voltage (0)	DC −3 V … +5 V
Signal voltage (1)	DC 15 V … 30 V
Electrical insulation	no electrical insulation
Cable	max. 30 m

3.5.2 Generator Off (X12) – Device Variant

Male part with bolt flange

Max. cross-section, flexible wire: 2.5 mm²

X12	Generator OFF	
Male plug	**Pin**	Function
Phoenix:MSTB Part no.: 1777989 spcg. 5.08	**1**	Breaks the connection between Pin1 / 2 and turns off the 24 V module bus supply of the generators.
	2	

3.5.3 SD Card "SD", (X20)

The control unit features a SD card slot. A SD icon marks the slot.

It accepts SD (SD 1.0 or SD 1.1) and SDHC (SD 2) cards at up to 32 Gb capacity run at maximum transfer speed (Class 10).

The file system is FAT32.

Gold-plated contacts ensure that contact resistance is low and that the drive lasts for up to 10,000 plug/unplug action cycles.

The SD card slot has a push-in/push-out plug & eject mechanism.

Use SD cards supporting fast read and/or write speeds at random memory access. This will stop long memory access times from affecting the control functionality.

Use "industrial grade" memory cards based on the SLC memory technology. These cards have warranted technical properties and an extended market availability.

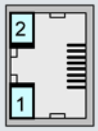
	NOTE
	Electrostatic discharge (ESD)
	Inappropriate handling will destroy the memory card
	⇨ SD/micro-SD cards are susceptible to electrostatic discharge (ESD). Please take account of the instructions on how to handle memory cards.

	Information
	The SD card slots have no hot-plug capability. They will therefore detect cards only if they were plugged in at the time of booting the unit. SD cards cannot be swapped while the unit is running.

3.5.4 Ethernet "LAN" (X21) – Device Variant

The on-board 10/100 Mbit base-T Ethernet adapter attaches the unit to a network through its RJ-45 connector. The LEDs labelled "LNK" and "RCV" tell you whether the unit is properly connected to the network.

Pin wiring:

X21	LAN	
Male plug	**Pin**	Function
 RJ45	**1**	TX+
	2	TX-
	3	RX+
	4	75 Ohm
	5	75 Ohm
	6	RX-
	7	75 Ohm
	8	75 Ohm
LED "LNK"	**green**	Data link
LED "RCV"	**yellow**	Transfer rate / activity

Technical data

LAN	
Quantity	1
Signal	RS 232
Baud rate	10/100 Mbit/s, auto-negotiation
Functions	Automatic polarity detection and correction Fast Ethernet 10 BASE-T Status LEDs
Electrical insulation	galvanic

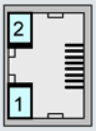
	NOTE
	Unauthorised access to the computer *Unit is destroyed* ⇨ Integration in networks granting public access requires the user to take appropriate measures aimed at preventing unauthorised access.

3.5.5 Fieldbus Interface (X22) + (X23)

PROFINET (PN)

The PROFINET interface links the MHS system to the industrial fieldbus standard for automation. In a PROFINET IO environment, the MHS Controller maps the connected MHS generators as remote field devices and the system therefore interprets it as an IO device. The integrated 2-port switch allows you to build line topologies without any need for further components.

Pin Wiring:

X22, X23	PROFINET	
Male plug	**Pin**	Function
 RJ45	**1**	Transmit data +
	2	Transmit data -
	3	Receive data +
	4	NC
	5	NC
	6	Receive data -
	7	NC
	8	NC
LED "LNK"	**green**	Indicates a link to the physical network (Link).
LED "ACT"	**yellow**	Indicates activity on the network.

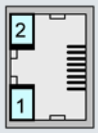
Technical data

PROFINET	
Quantity	2
Male plug	RJ-45 100 BaseTX
Communication speed	up to 100 Mbps in full-duplex or half-duplex mode
Functions	integrated switch
Wiring	IEC 61784-5-3

EtherCAT (ETH)

The EtherCAT interface links the MHS system to the industrial fieldbus standard for automation. Connector X23 (EtherCAT IN) and X22 (EtherCAT OUT) route the fieldbus system through. The MHS system functions are explained in the device description. The control unit's EtherCAT Configurator tool is used for configuring.

Pin Wiring:

X22, X23	PROFINET	
Male plug	**Pin**	Function
 RJ45	**1**	Transmit data +
	2	Transmit data -
	3	Receive data +
	4	NC
	5	NC
	6	Receive data -
	7	NC
	8	NC
LED "LNK"	**green**	Indicates a link to the physical network (Link).
LED "ACT"	**yellow**	Indicates activity on the network.

Technical data

EtherCAT	
Quantity	2
Male plug	RJ-45
Communication speed	up to 100 Mbps
Length of lead	Max. 100 m between any two devices
Type of lead	CAT5

3.5.6 CANopen (X24)

Male part with bolt flange

Max. cross-section, flexible wire: 2.5 mm²

Pin wiring

X7 CAN Interface			
Male plug	Pin	Function	
Phoenix MC Part no.: 1847181 spcg. 3.5	8	Shield	
	7	CAN_GND	
	6	CAN_H in	Optional for second bus termination
	5	CAN_L in	
	4	CAN_H out	
	3	CAN_L out	
	2	+24VDC_Out sensors (max 4 A)	
	1	GND	

Technical data

24 V Sensor Power Supply	
Quantity	1
Signal	24 VDC
Current rating	4 A
Functions	Short-circuit-proof

CAN	
Quantity	1
Protocol	CANopen
Signal	RS 485
Baud rate	max. 500 kbps
Electrical insulation	galvanic
Termination	hard-wired (2 x 120)

3.5.7 Module Bus (X25)

20-pin box header connector on circuit board

System link between the MHS Controller and up to 7 MHS generator modules. Only use the module bus cable from the package.

3.5.8 Operative Earth

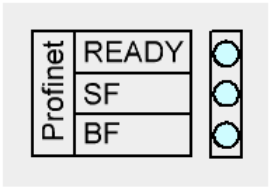
Electrical shields connect to the earth potential through a mechanical link to the MHS Induction Generator.

	Information
	A low-impedance earth conductor improves the dissipation of interference received via external power supply cables, signal cables or cables of peripheral units. If operating the unit in industrial environments, attach the earth connector to contact pin X12. Because of the contact resistance, it is not enough to earth the unit by connecting the housing trough to the earthed DIN rail.

3.5.9 Indicators and Controls

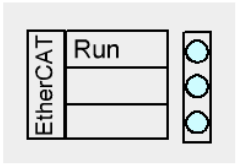
Check the indicators to know what status the unit is in.

Status indication by "PROFINET" fieldbus



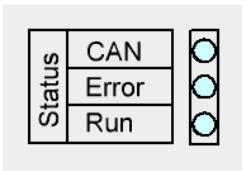
LED Description		
Designation	**LED**	**Explanation**
PROFINET Ready Device Ready	Off	TPS-1 has not started correctly
	Green, flashing	TPS-1 is waiting for the synchronization of the Host CPU
	Green	TPS-1 has started correctly
PROFINET SF System Fail	Off	No PROFINET diagnostic
	Red	PROFINET diagnostic exists
PROFINET BF Bus Communication	Off	The PROFINET Controller has an active communication link to this PROFINET Device
	Red	No link status available
	Flashing red	Link status ok: no communication to a PROFINET controller

Status indication by "EtherCAT" fieldbus

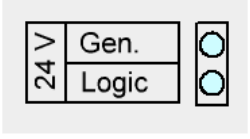


LED Description		
Designation	**LED**	**Explanation**
Run	Off	Initialising, no data exchange
	Off/green, 1:1	Pre-operational, no data exchange
	Off/green, 5:1	Safe operation, inputs readable
	Green, on	Operational, unrestricted data exchange

Device status "Status"



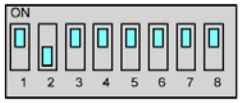
LED Description		
Designation	**LED**	**Explanation**
CAN	Off	CAN communication errors
	Flashing yellow	data is exchanged properly
Error	Off	no error
	Red	Fault detected by controller or a generator connected to it.
	Flashing red	A new programme is loading up to the control unit
Run	Off	Desired operation not possible
	Green	Unit is operating properly



LED Description		
Designation	**LED**	**Explanation**
24 V, Gen.	Off	24 V power not supplied
	Blue	24 V power supplied
24 V Logic	Off	24 V power not supplied
	Blue	24 V power supplied

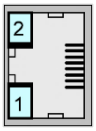
DIP switch – device variant

Switch for setting the CAN addresses in CANopen Slave device variant



DIP Switch	
Pin	Function
1	Addressing, binary coded Addresses 1 – 63
2	
3	
4	
5	
6	
7	Baud rate 00 = 125 kbps; 10 = 250 kbps 01 = 500 kbps; 11 = 1 Mbps
8	

Ethernet "LAN" (X21) – device variant



LED Description for LAN		
Designation	LED	Explanation
1	Off	no connection
	Green	link activity
2	Off	10 Mbps
	Yellow	100 Mbps

4 Installation and Putting into Service

	***Information***
	Before installing, servicing or putting the basic module and the display into operation, please also read the safety information in the preface of this document.

4.1 Mechanical Installation

General

- Use suitable tools to avoid damages when mounting and plugging the connectors.
- Before installing the unit, check that it is undamaged and free from foreign objects

Environment of installation

Protect the units against inadmissible contamination. Do not allow the units to contaminate more than specified for degree II in IEC 60664.

Whereas an enclosure providing IP 54 protection (e.g. an appropriate control cabinet) ensures that degree of contamination II is complied with, please consider that operation under condensing humidity is NOT allowed.

	***WARNING***
	Potentially hazardous failures due to contamination
	Contaminations more severe than those described for degree of contamination II of IEC 60664 may cause potentially hazardous failures.
	⇨ Do ensure that the operating environment complies with at least IP 54, e.g. by installing the unit in a suitable control cabinet.

4.1.1 Mounting Position

The unit is intended for mounting vertically in the switching cabinet with its socket assemblies pointing to the front. The MHS Controller itself has no means of attachment. Screw the MHS Controller to the MHS Induction Generator such that the MHS Induction Generator holds the MHS Controller.

To ensure that enough air gets in, leave at least 30 mm to the top and 30 mm to adjacent devices or cabinet surfaces below. Leave at least 20 mm of lateral distance to third-party units and cabinet surfaces.

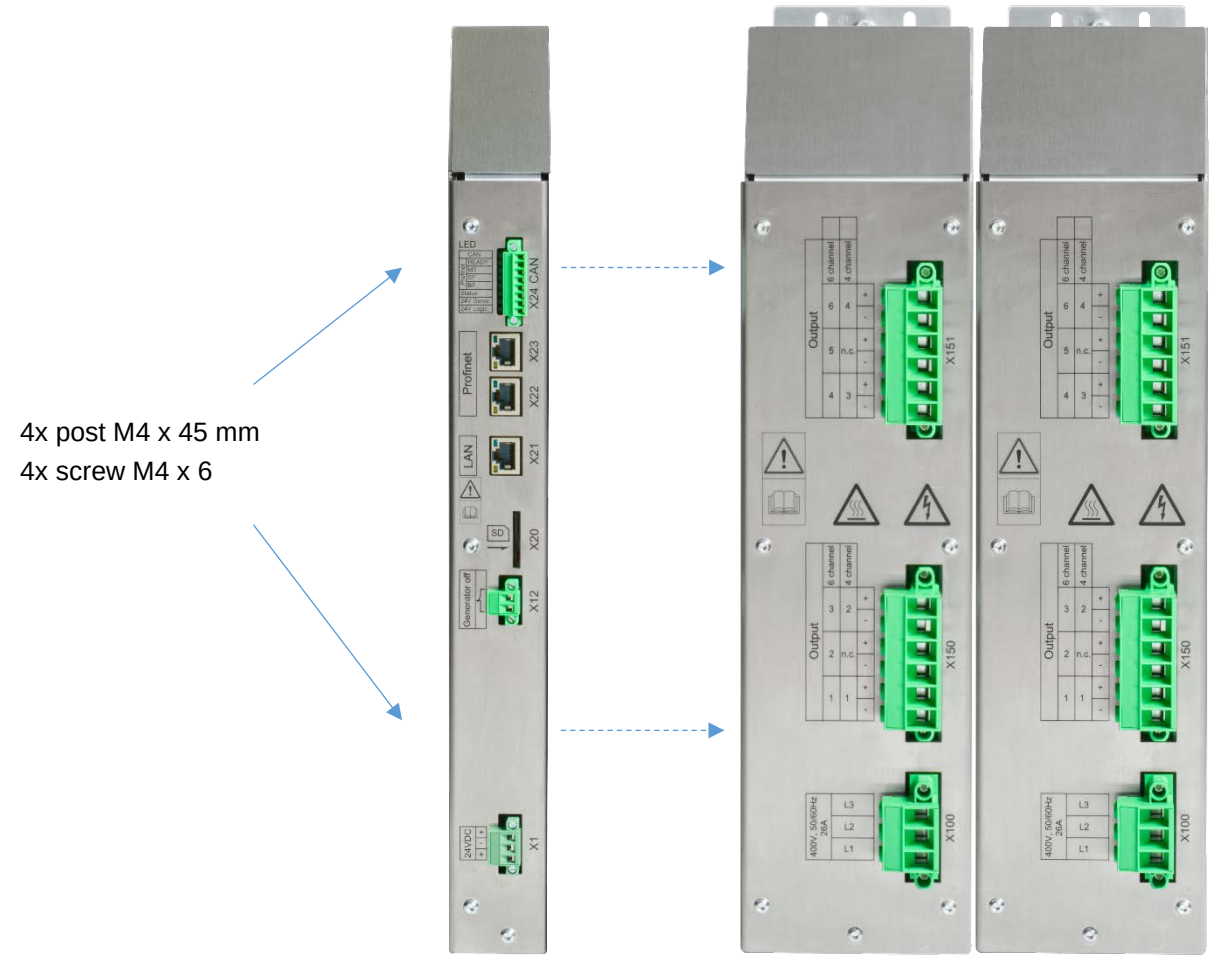
4.1.2 Free Ambient Space

To ensure that enough air gets in, leave at least 30 mm to the top and 30 mm to adjacent devices or cabinet surfaces below. Leave at least 20 mm of lateral distance to third-party units and cabinet surfaces.

4.1.3 Mounting the Controller on the Power Module

The MHS Controller mounts on the first MHS Power Module on the left side of the switching cabinet. The first step is to firmly screw the mounting posts from the Controller package to the MHS Power Module's side wall (tightening torque approx. 1 Nm). Now slide the MHS Controller onto the bolts and use the screws from the package to firmly attach the MHS Controller to the MHS Power Module (tightening torque approx. 1 Nm).

4x post M4 x 45 mm
4x screw M4 x 6



4.2 Electrical Installation

4.2.1 General

Only qualified persons are allowed to perform the electrical installation. Check that the unit is de-energised before installing it.

4.2.2 Line Interfacing

General instructions

- Only use approved and undamaged mating connectors for the electrical installation.
- The screw fitting on the flange ensures that the connector is tightly and reliably attached.
- Use suitable tools to avoid damages when mounting and plugging the connectors.
- Verify that the leads make tight and reliable contact in the mating connector.
- To unplug a connector, do not pull the cable but hold the connector by its housing.

	***NOTE***
	To avoid excessive force being exerted on the board, do not expose the connectors to inadmissibly high tension / pressure. ⇨ One reason for too much pulling force is the wiring being too short.

- The unit's connectors are not designed for use as a strain relief. To ensure that the connector contacts remain reliably attached in the long run, relieve the strain exerted on cables and leads by both dynamic and static loads inside the control cubicle.

4.2.3 Earthing / Functional Earth

Functional earth dissipates HF currents and supports the unit's immunity to noise. HF interference is dissipated internally from the electronics board to the metal housing. Check that the metal housing is properly connected to the earthed MHS power output stage.

4.2.4 Shielding

Shielding is a means of mitigating (damping) magnetic, electric or electromagnetic noise fields. The shield bus and its conductive link to the housing will discharge interfering currents on the cable shields into earth.

Use meshed leads wherever possible. Verify that the shield covers more than 80% on the surface.

It is generally recommended to affix the lead shields at both ends. This is the only way of properly suppressing the noise in higher frequency ranges.

Only in exceptional cases should you affix the shield at only one end. However, this will only dampen lower frequencies. Affixing the shield at one end may be advisable if:

- laying a voltage equalising cable is not feasible,
- analogue signals (some mV or mA) are transferred,
- foil screens (static screens) are used.

	***NOTE***
	Signal noise by EMC *Adverse effect on the control functions* ⇨ Use shielded leads for analogue signal lines > 30 m and for data links.

Signal connector, male, 3.5 mm spacing (X10, X11, X24)

General	
Contact termination	Screwed connection with spring bushing
Nominal current I_N	8 A
Nominal cross section	1.5 mm²
Tightening torque	0.25 Nm

Connection Data	
Cross section of rigid wire, min.	0.14 mm²
Cross section of rigid wire, max.	1.5 mm²
Flexible wire cross section, min.	0.14 mm²
Flexible wire cross section, max.	1.5 mm²
Flexible wire cross section w/ connector sleeve w/o plastic sleeve, min.	0.25 mm²
Flexible wire cross section w/ connector sleeve w/o plastic sleeve, max.	1.5 mm²
Flexible wire cross section w/ connector sleeve w/ plastic sleeve, min.	0.25 mm²
Flexible wire cross section w/ connector sleeve w/ plastic sleeve, max.	0.5 mm²
AWG wire cross section, min.	28
AWG wire cross section, max.	16
AWG to UL/CUL, min	30
AWG to UL/CUL, max	14

Signal connector, male, 5.08 mm spacing (X1, X12)

General	
Contact termination	Bolt flange
Nominal current I_N	12 A
Nominal cross section	2.5 mm²
Tightening torque	0.5 Nm

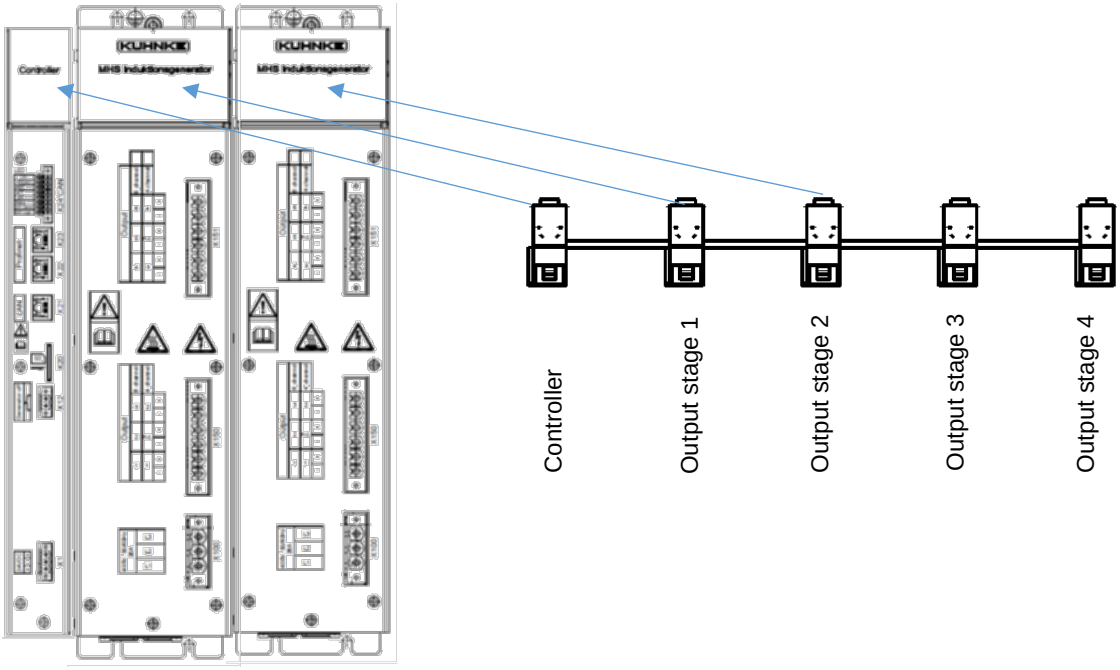
Connection Data	
Cross section of rigid wire, min.	0.2 mm²
Cross section of rigid wire, max.	2.5 mm²
Flexible wire cross section, min.	0.2 mm²
Flexible wire cross section, max.	2.5 mm²
Flexible wire cross section w/ connector sleeve w/o plastic sleeve, min.	0.25 mm²
Flexible wire cross section w/ connector sleeve w/o plastic sleeve, max.	2.5 mm²
Flexible wire cross section w/ connector sleeve w/ plastic sleeve, min.	0.25 mm²
Flexible wire cross section w/ connector sleeve w/ plastic sleeve, max.	2.5 mm²
AWG wire cross section, min.	24
AWG wire cross section, max.	12
AWG to UL/CUL, min	30
AWG to UL/CUL, max	14

4.2.5 Module Connector

The module connector is made up of a 20-pin ribbon cable that starts at the MHS Controller to connect all output stages to the right. To ensure that the cable will properly connect the devices, check that the output stages are not more than 5 mm apart and that their horizontal alignment runs out by not more than 3 mm.

The electrical link is made under the flap on top of the devices. Plug the first socket assembly into the Controller trough, lay the cable to the first output stage and plug it in there. Proceed as before to connect further output stages using the module connector.

In case the module connector has too many lead-outs, simply cut the excess length of cable to be flush with the last socket assembly before you install it. You cannot extend the module bus connector.



4.2.6 Power Supply (X1)

Power to the unit is supplied via terminals + and -. The supply voltage is rated at 24 VDC. Equip the feed line with an external short circuit and overload protection.

Power to the control unit may be supplied by PELV/SELV-ready 24 VDC power supply units to EN50178 / EN60950-1 only.

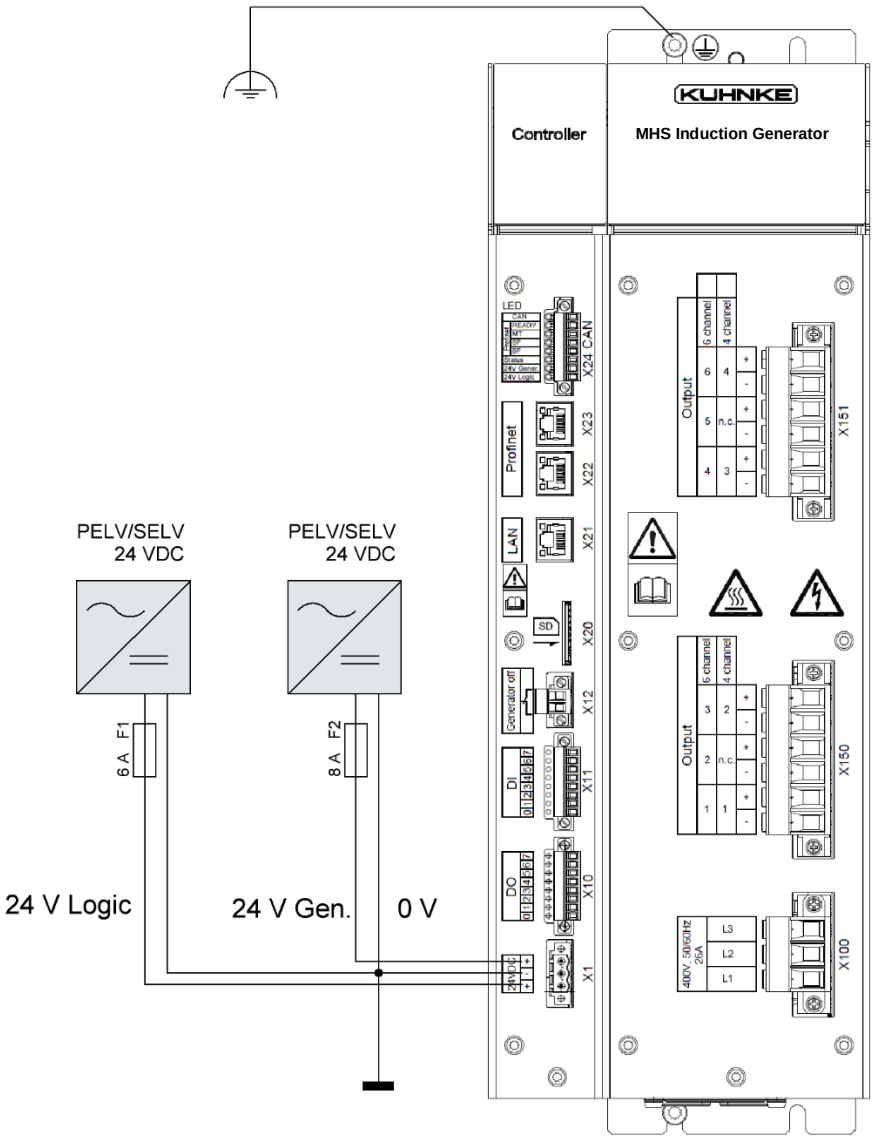
⚠	***WARNING***
	Potentially hazardous failures due to wrong voltages supplied
	Supplying the wrong voltages may damage or destroy the unit and may provoke potentially hazardous failures.
	Preventive measures:
	⇨ Only use PELV/SELV-ready power supply units to EN61010 -2-201 or EN60950-1 for the 24 VDC I/O supply at the unit. ⇨ To ensure that there is as little interference as possible, install a central power supply point and establish a star topology of as short wires as possible.

Power supply fusing

Only attach the unit to a 24 VDC power supply source if the source is guaranteed to meet the safe extra low voltage requirements (SELV) of IEC/EN/DIN EN/UL 60950-1. To avoid damage by short-circuited cables, adapt the wire cross section to the short circuit current of the 24 VDC power source. Only use cable of a minimum cross section of 0.2 mm² (AWG 24) to a maximum cross section of 2.5 mm² (AWG 16).

⚠	***WARNING***
	Risk of fire due to short circuit!
	A short circuit in the module or the power supply lines may cause the system to overheat or provoke a fire.
	Preventive measures:
	⇨ Install a fuse whose tripping current is adapted to the application.

Power supply wiring example



	NOTE
	Recommendation
	⇨ A stable mains power supply cannot be assumed to be available everywhere and at all times. To assure the quality of the power supply, you should therefore use controlled PSUs.
	Separately feed power to the system and the field devices!
	⇨ To ensure that the bus can continue to operate even if there is a short circuit in an actuator, it is best to separately feed power to the system and the field devices.

4.2.7 Generator Off (X12) – Device Variant

Interconnect the contacts for running the device.

An open contact will disconnect the MHS generators from the 24 VDC power supply (module bus). The MHS generators will not generate any induction energy and heat generation will be interrupted.

If the contact is closed, the output stages can be switched out by external hardware. Communication on the MHS Controller's fieldbus will remain active.

4.2.8 Ethernet Connections

Automation technology uses Ethernet connections both for data transfer operations and for fieldbus systems. Please take heed of the information about how to safely operate your Ethernet network.

	Information
	Torsional and permanent tensile stress near the Ethernet cable connector strain the plug connections. An Ethernet connector with too much play and insufficient guidance in its socket will provoke tipping in the plug connections which often causes contact and, thus, fieldbus interruptions.
	Vibration tests show that the robustness of a connection increases with the depth of plugging the connector into the socket. Mechanical requirements of vibration and impact resistance are commonly known to be stricter in industrial environments than in IT environments.
	Depending on the manufacturer and system, the plugging depths of commercially available connectors vary from about 8 mm to almost 12 mm and are rated at about 9 mm for standard connectors. According to manufacturer specifications, connectors designed for industrial environments have a plugging depth of up to 11.8 mm.

4.2.9 Connection of Digital Sensors (X11) – Device Variant

Connector X11 houses the Controller's digital inputs. Power supplied to the sensors must be linked to the Controller's 24 V supply potential.

4.2.10 Connection of Actuators (X10) – Device Variant

Connector X10 allows you to output control signals to actuators such as solenoid valves, contactors or other electrical loads.

4.3 Network & Communication

4.3.1 Ethernet – Device Variant

Ethernet allows devices linked in to a local area network (LAN) to exchange data by means of data frames. The control unit connects to the Ethernet through its Rj45 socket. The on-board 10/100 Ethernet receiver supports fast Ethernet and 10BASE-T networks. Availability of protocol functions depends on which Ethernet stack is used.

	Information
	Refer to the bus specifications for details about bus system requirements.

4.3.2 PROFINET Fieldbus Port – Device Variant

Use the RJ-45 sockets (X22) and (X23) to connect to PROFINET IO. These sockets and the cables listed below physically link the ports of the on-board switch with the network.

The on-board switch runs in cut-through mode. The PHYs of every port support a transfer rate of 10/100 Mbps as well as the transfer modes full-duplex, half-duplex and autonegotiation.

According to specifications, the RJ-45 sockets are wired for 100BaseTX.

The PROFINET standard demands to use a category 5e twisted pair cable as the interconnecting line. Admissible line types are S-UTP (screened-unshielded twisted pair) and STP (shielded twisted pair) providing segments up to 100 m long.

4.3.3 EtherCAT Fieldbus Port – Device Variant

EtherCAT is an industry-grade real-time Ethernet fit for use for both hard and soft real-time requirements of automation technology. Please take heed of the notices below to ensure safe operation of your EtherCAT fieldbus system.

- To connect your EtherCAT devices, only use category 5 (CAT5) Ethernet cables pursuant to EN 50173 or ISO/IEC 11801.
- Owing to the automatic cable detection feature (auto crossing) you can interconnect EtherCAT devices by both symmetrical (1:1) and crossover cables.
- Up to 100 metres length of cable are allowed between any two EtherCAT devices.

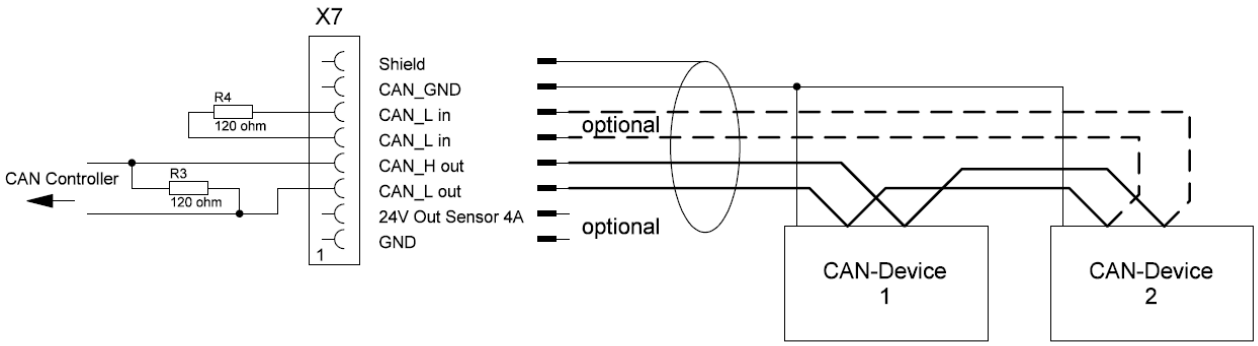
4.3.4 CAN

Termination

For communication via CAN (line topology), the bus is terminated by 120 ohms at both ends of the network. Since the termination is built in in the control unit, the control unit is therefore intended to act as the terminal device.

Another bus termination is provided between pin 5 of connector X7 (CAN_L in) and pin 6 of connector X7 (CAN_H in). This termination is intended for special applications without any other bus termination or in which the bus returns to the Controller and is connected there.

Wiring example



Transfer rates and lead lengths

Transfer rate	Lead length	Time of one bit
1 Mbps	30 m	0.001 ms
800 kbps	50 m	0.00125 ms
500 kbps	100 m	0.002 ms
250 kbps	250 m	0.004 ms
125 kbps	500 m	0.008 ms
62.5 kbps	1000 m	0.020 ms
20 kbps	2500 m	0.050 ms
10 kbps	5000 m	0.100 ms

Type of lead

According to ISO 11898, the specified transfer properties will be provided only if the bus line meets the following parameters:

Impedance: 95 – 140Ω (120Ω)

Capacitance max. 60 nF/km

Conductor resistance (loop) 70 mΩ/m

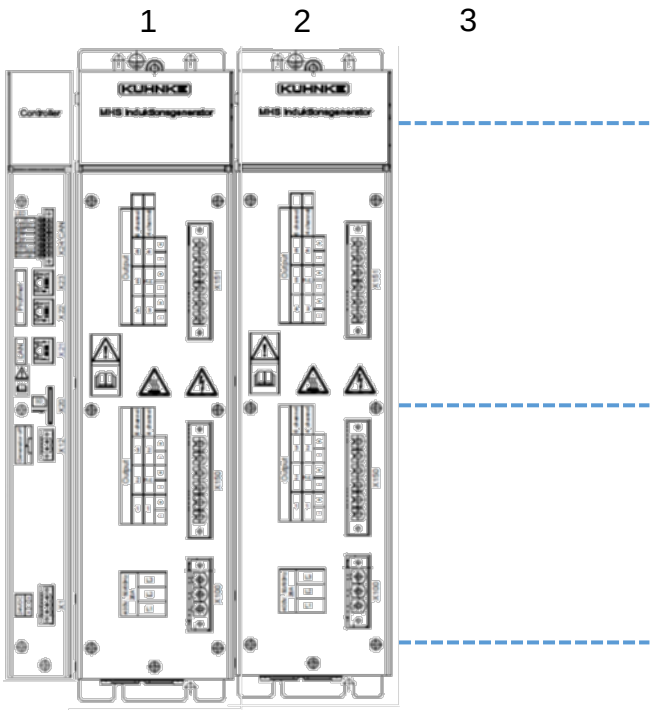
Shielding: copper shielding mesh or shielding mesh and foil screen

	Information
	Refer to the bus specifications for details about bus system requirements.

4.4 Configuration

4.4.1 Module Bus Addresses

The module bus addresses are set by the strands of the module bus connector. Output stage 1 is located to the right of the MHS Controller. The second and further output stages follow on the right-hand side. Every MHS Controller supports up to 7 output stages.



4.4.2 Installing the Software

Only qualified persons are allowed to do the configuring and programming.

A pre-installed boot loader lets you load the control programme from the SD card.

MAC address

The MAC address (Media Access Control Address) is the hardware address of the network chip in the control unit. This unique address identifies the unit in a computer network.

4.5 Putting into Service

4.5.1 General Notes

- Electronic control systems, if run as component parts of machines, facilities and systems, must comply with valid rules and regulations, depending on their field of application.
- Take one step at a time to put the unit into service.
- Verify that all active components respond as they should.
- Run a complete test cycle of the application.

4.5.2 Start-up Prerequisites

- The MHS Controller is hard-wired to the MHS output stage, and the MHS output stage is correctly connected.
- Both the connecting leads and the module bus are correctly connected.
- Power is supplied to the unit.

4.5.3 Turning off the Unit

The unit does not have its own ON/OFF switch but turns ON or OFF by the power supplied (or not supplied) to X1.

4.5.4 PROFINET Fieldbus

GSD file

The GSD file describes the properties of the fieldbus coupler and the I/O modules (length of data package in the process image, parameter data, ...) you will need to set up your project.

This file can be procured from Kendrion Kuhnke's Product Management. You will need it to configure the MHS Controller for exchanging productive data with the machine control unit by having the project planning software read or install it.

The language used in the device description file is GSDML, a language based on XML. Since the structure, content and coding of this device's master data are standardised, your project can be set up by the project planning software of various manufacturers.

Variant	Device Id	GSD File
Modular Heating System	0x1100	GSDML-V2.33-Kendrion Kuhnke-Modular Heating System-20190710.xml GSDML-0360-1100-Modular Heating System.bmp

4.5.5 EtherCAT Fieldbus

The ESI Device Description is an XML file describing the device's properties you need to set up your project. To procure the device description, either browse the download section of Kendrion's Product Finder or contact Product Management directly.

KendrionKuhnkeModularHeatingSystem.xml

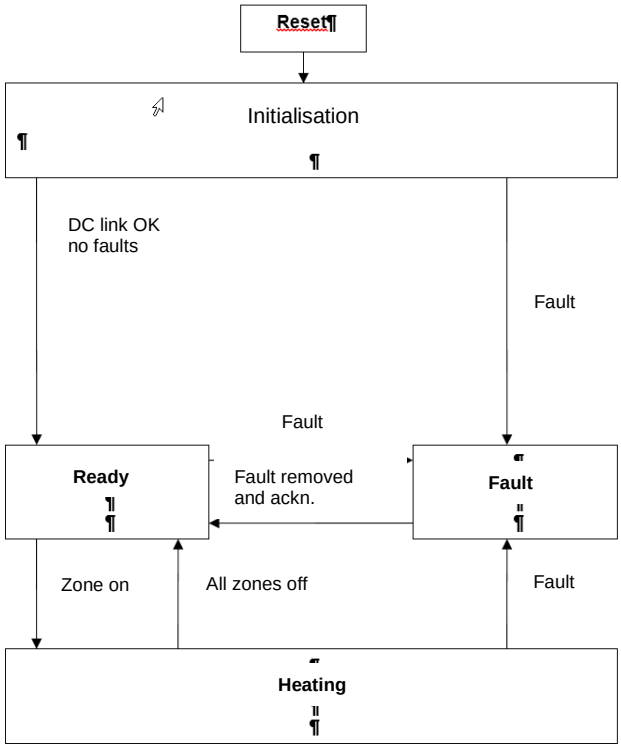
Variant	Device Id	GSD File
Modular Heating System	2FCE3	KendrionKuhnkeModularHeatingSystem.xml

Connecting

Payload data exchange

4.6 Operating Functions

4.6.1 State Machine



4.6.2 Defining the Active Zones

You can enter the number of active channels of every module in the configuration file.
Parameter name: Active channels. Bit-coded value.
A set bit marks an active channel.
Example:
To activate single channels:
1 = channel 1 active,
2 = channel 2 active,
4 = channel 3 active,
8 = channel 4 active,
16 = channel 5 active,
32 = channel 6 active.

To activate multiple channels:
15 = channels 1+2+3+4 active,
63 = channels 1+2+3+4+5+6 active,
9 = channels 1+4 active.

4.6.3 Control Mode

There are 42 configurable PID controllers that define the temperature settings of the output stages.

Whereas the PROFINET/EtherCAT fieldbus provides the setpoints, actual temperatures can be read by electronic Kendrion temperature detectors via the CAN-BUS at X24.

CANopen variant:

This variant does not provide CAN port X24 for connecting external CAN slaves. These units will run in actuation mode only.

Sensor activation and the control parameters are transferred when configuring the generator modules.

Parameter Name	Format	Range/Default	Unit
Temperature sensor present	BYTE	0.. 1 / 1	
Max temperature	WORD	0..3000 / 2300	°C
Kp channel 1	WORD	0.. 1000 / 1	0.1
Ti channel 1	WORD	0.. 10000 / 21	Sec
Td channel 1	WORD	0.. 10000 / 5	Sec

"Temperature sensor present" will activate when 1.

"Max Temperature" is a protective function that is active in control mode only.

It checks measured temperatures for exceeding the MAX temperature. If so, it will generate a fault.
This function protects heated elements against overheating.

4.6.4 Addresses of Temperature Sensors at X24 CAN

Some electronic Kendrion temperature sensors provide the option of automatically allocating the sensor circuitry to the generator modules upon request.

This requires the temperature sensors to be active.

Parameter Name	Format	Range/Default	Unit
Temperature sensor present	BYTE	0.. 1 / 1	

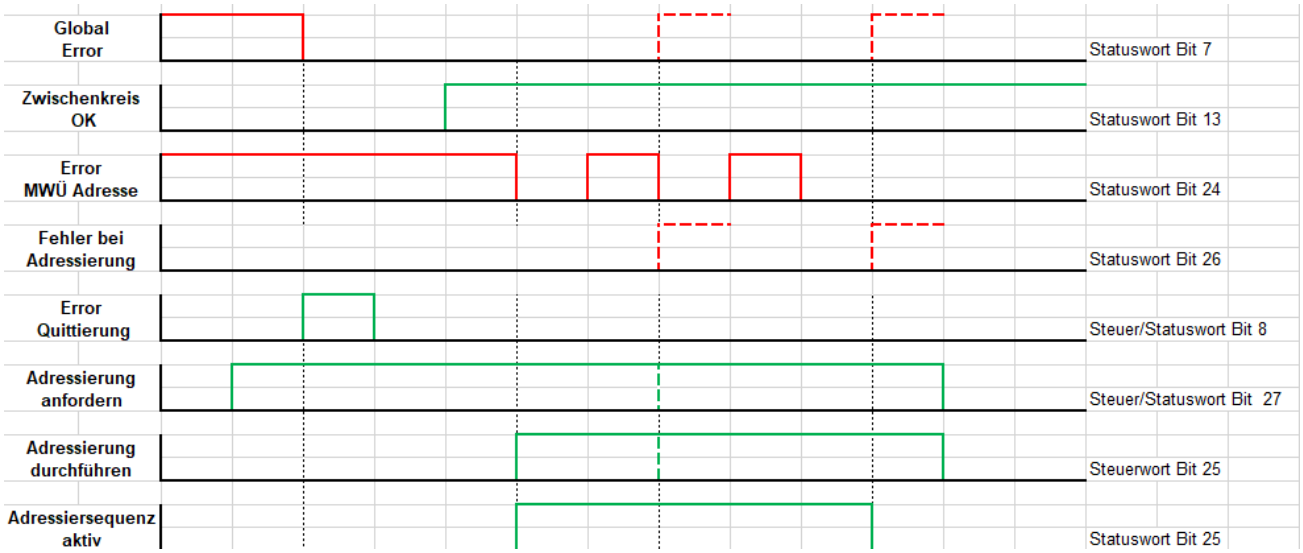
Control word bits need to be set. Do not set bit 25 until you are sure that 400 V are being supplied.

Control Word		
Bit	**IF bit = high**	**IF bit = low**
25	Start temp. sensor allocation	Normal operation/cancel
26		
27	Request temp. sensor allocation	Normal operation/cancel

The status word bits indicate the state of sensor allocation.

Status Word		
Bit	**IF bit = high**	**IF bit = low**
24	temp. sensor not allocated	all temp. sensors allocated
25	allocation enabled	allocation disabled / ready
26	temp. sensor, wrong allocation	allocation ok
27	temp. sensor, allocation requested	Normal operation

Sensor allocation flowchart:



Global error	Status word bit [no.]
DC link ok	Control/status word bit [no.]
MWU address error	
Addressing error	
Error acknowledging	
Request addressing	
Do addressing	
Addressing sequence active	

4.6.5 Calibration

Control mode supports a two-point calibration of measured values.

Parameter Settings per Generator Module			
Parameter Name	**Format**	**Range/Default**	**Unit**
X1 in channel 1	WORD	0..3000 / 20	0.1 °C
X1 out channel 1	WORD	0..3000 / 20	0.1 °C
X2 in channel 1	WORD	0..3000 / 220	0.1 °C
X2 out channel 1	WORD	0..3000 / 220	0.1 °C

Equation for calibration:

a = (X2out – X1out) / (X2in – X1in)

b = (X1out * X2in – X2out * X1in) / (X2in – X1in)

Actual controller value = a * measured sensor value + b

4.6.6 Actuation Mode

You can disable the controllers and directly set the target temperatures (actuation mode).
In this mode, the setpoint is the same as the percentage of the output power in %

Parameter Name	Format	Range/Default	Unit
Temperature sensor present	BYTE	0.. 1 / 1	

In actuation mode, "Temperature sensor present" must be 0.

4.6.7 Power Limitation

There are two ways of limiting the power in percent:

1) Separately for every channel. Control word bit 12=low; the limitation of every channel is derived from the process image
2) Total generator power. Control word bit 12=high; the limitation is the value of channel 1 shown in the process image

Example #1: Separate power limitation for every inductor connected.

Inductors connected: 4

Inductor 1: Limitation 25% →max. 25% of rated power

Inductor 2: Limitation 50% →max. 50% of rated power

Inductor 3: Limitation 100% →max. 100% of rated power

Inductor 4: Limitation 25% →max. 25% of rated power

Example #2: Limited total power

Limitation 50%

Load case 1:

Setpoints =100% for all inductors (set by controller or derived from fieldbus)

Inductor 1: Limitation 50% →max. 50% of rated power

Inductor 2: Limitation 50% →max. 50% of rated power

Inductor 3: Limitation 50% →max. 50% of rated power

Inductor 4: Limitation 50% →max. 50% of rated power

Load case 2:

Setpoints = 100% (inductors 1 – 3), 10% (inductor 4) (set by controller or derived from fieldbus)

Inductor 1: Limitation 60% →max. 60% of rated power

Inductor 2: Limitation 60% →max. 60% of rated power

Inductor 3: Limitation 60% →max. 60% of rated power

Inductor 4: Limitation 10% → limitation disabled

The power of inductor 4 is not needed and is evenly distributed among inductors 1 – 3.

4.7 Diagnosis

4.7.1 Indication by LEDs

Diagnosis at the machine is supported by LEDs that indicate the status of the fieldbus connection or the entire MHS system.

Groups of LEDs are allocated to the diagnostic areas:

PROFINET fieldbus status

Table of Faults		
LED	**Explanation**	**Corrective Action**
PROFINET ready		
green	Successful communication	
green, flashing	Device is waiting for the higher-level control unit to synchronise	
off	No PROFINET communication	
PROFINET SF		
red	PROFINET diagnosis available	
off	PROFINET diagnosis not available	
PROFINET BF		
off	Communication link exists to the higher-level control unit	-
flashing red	ETHERNET link exists to at least one port. No communication link to the higher-level control unit	Check the link between the MHS Controller and the control unit Check whether the correct device name was assigned to the MHS Controller. Check whether the connected network infrastructure supports full-duplex ETHERNET links at 100 Mbps.
red	No ETHERNET link.	Check the network cabling.

Device status

LED	**Explanation**	**Corrective Action**
CAN status		
flashing yellow	data is exchanged properly	-
off		
Error status		
off	No error	-
flashing red	A new programme is loading up to the control unit	
red	Fault detected by controller or a generator connected to it.	
Run status		
green	Unit is operating properly	-
off	Desired operation not possible	

4.7.2 Handshake Monitoring

Both the control word and the status word of every induction generator contain a handshake bit.

This bit monitors the communication between the master and the induction generator for any faults.

Generator and user software in the master control unit check the two bits.

User software:

Compares the bits and toggles the handshake bit in the control word if both bits are the same.

Generator firmware:

Compares the bits and toggles the appropriate handshake bit if both bits differ.
It also enables time monitoring when the first heating cycle starts.
Within 5 seconds, the generator must detect both bits to be the same and toggle its own bit.
After 5 seconds, the monitor will generate a fault.

4.7.3 CAN Module Bus Monitoring

The monitor checks CAN module bus communication for faults. If it detects a fault and fails to connect to a generator module, it sets "CAN Bus Generator Module Fault".

After 5 seconds, the generator modules' handshake monitoring automatically stops the heating cycle.

4.7.4 24V Power Supply Monitoring

Monitors the voltages fed to the Controller.

Generates a low voltage fault if a voltage is found to be below the admissible limits.

If an overcurrent is detected, protective programme blocks temporarily interrupt the current (automatic restart) and generate an error message. It will fail to reliably output a "24V Overcurrent" message because Controller operation stopped when interrupting the current.

Status Word		
Bit	**IF bit = high**	**IF bit = low**
16	control head: low voltage, 24 V	control head: 24 V voltage ok
17	control head: generator voltages low	control head: generator voltages ok
18	control head: 24 V overload	control head: 24 V current ok
19	control head: generator overload	control head: generator current ok 16

4.7.5 Temperature Sensor Monitoring

An electronic Kendrion temperature detector connected to the Controller provides extensive monitoring and diagnostic functions.

Sensor Fault (if "Temperatur Sensor Present = 1")			
Bit	**IF bit = high**	**IF bit = low**	
0	Sensor 1, broken wire	Sensor 1 OK	F
1	Sensor 1, short circuit	Sensor 1 OK	F
2	Sensor 1, loose contact	Sensor 1 OK	F
3	Sensor 2, broken wire	Sensor 2 OK	F
4	Sensor 2, short circuit	Sensor 2 OK	F
5	Sensor 2, loose contact	Sensor 2 OK	F
6	Sensor 3, broken wire	Sensor 3 OK	F
7	Sensor 3, short circuit	Sensor 3 OK	F
8	Sensor 3, loose contact	Sensor 3 OK	F
9	Sensor 4, broken wire	Sensor 4 OK	F
10	Sensor 4, short circuit	Sensor 4 OK	F
11	Sensor 4, loose contact	Sensor 4 OK	F
12	Sensor 5, broken wire	Sensor 5 OK	F
13	Sensor 5, short circuit	Sensor 5 OK	F
14	Sensor 5, loose contact	Sensor 5 OK	F
15	Sensor 6, broken wire	Sensor 6 OK	F
16	Sensor 6, short circuit	Sensor 6 OK	F
17	Sensor 6, loose contact	Sensor 6 OK	F
18	Sensor transmitter timeout	Sensor transmitter OK	F
19	Sensor transmitter fault	Sensor transmitter OK	F
20	Sensor, low voltage	Sensor OK	F
21	CAN bus sensor, no life signal	CAN sensor OK	F
22	Max temperature exceeded	Temperature OK	F
…			F
31			F

4.7.6 Table of Faults

Table of Faults		
Description	**Possible Cause**	**Recommended Action**
Device won't start after update	Wrong file programmed	Check you used the correct file and renamed it to update.hex. Run a text editor tool and open update.con on SD card to check.

4.8 Maintenance / Servicing

4.8.1 General

Only qualified persons are allowed to work on the unit.

	***CAUTION***
	Wrong or excessive supply voltage *Electric shock hazard* ⇨ 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 unit. This also applies to any peripherals connected such as encoders, programming devices with external power source, etc.

Only the manufacturer or customer service providers authorised by the manufacturer are allowed to do repairs and perform corrective maintenance.

4.8.2 Servicing

The device requires neither servicing for the specified service life nor any action if it is kept and operated at the admissible ambient conditions specified in section Technical Data.

4.8.3 Preventive MHS Controller Maintenance

Cleaning

Prevent inadmissible contamination while operating and storing the control unit. Do not use or continue to use the unit in case it has been exposed to inadmissible contamination.

	***CAUTION***
	Unsafe and undefined machine state *Risk of injury* ⇨ You are not allowed to operate an inadmissibly contaminated module. Neither is cleaning the unit allowed.

4.9 Service Life

4.9.1 Repairs / Customer Service

	***Information***
	Only the manufacturer or customer service providers authorised by the manufacturer are allowed to do repairs and perform corrective maintenance.

4.9.2 Warranty

The statutory period and conditions of warranty apply. Warranty expires if unauthorised attempts are made to repair the unit / product or any other intervention is performed.

4.9.3 Taking out of Service / Disposal

Dispose of the control components in conformity with the applicable environmental regulations.

Disposal requires the control component to be disassembled and entirely taken apart.

- Treat the packaging as recyclable paper and cardboard.
- All metal components can be given to metal recycling.

Electronic Scrap

Sort and dispose of electronic components by type. For details on proper disposal please check your national laws and regulations making sure that your method of disposal complies with them.

5 Programming

5.1 Boot Loader

The boot loader is used to transfer the firmware to the basic module.
It is a separate programme stored in sector 0 of the on-board flash memory.
When the unit turns on, the boot loader checks the SD card for a file called **"Update.hex"**.
If the file is not found, the application programme starts at address 0x08008000 (sector 1).
If the hex file is found, it is loaded into the flash memory. Sectors are cleared beforehand.

Addresses in the hex file equal to or greater than 0x90000000 are moved to the QSPI flash memory.

Note that the red LED on the module will flash while programming. The LED will briefly light up green when the data have been transferred correctly.
The new programme starts.

5.2 Firmware Update

Both the Controller and the output stage module can be updated using the SD card.

5.2.1 Updating the Controller

Proceed as follows:

- ⇨ Rename the required software version to "**UPDATE.hex**" and copy it to the SD card.
- ⇨ Insert the SD card in the Controller.
- ⇨ Supply power to the Controller (24 VDC).

The status LED will flash red while the unit is updating.
Afterwards, the status LED lights up green (OK) or red (error) for one second.

- ⇨ Disconnect the Controller from the power supply (24 VDC)

Browse the SD card for a file called "UPDATE.con", which contains details of the updating process:

```
Loader Version 1.0.0.3
----------------------
Open File UPDATE.hex
Erase Flash Sector 1 (08008000)
Start flashing at: 08008000
Erase Flash Sector 2 (08010000)
Erase Flash Sector 3 (08018000)
Erase Flash Sector 4 (08020000)
Stop flashing at: 08035027
Program Flash success
```

5.2.2 Updating an Output Stage Module

Updating takes the following steps:

- ⇨ Rename the required software version to "**UPDATEGEN.hex**" and copy it to the SD card.
- ⇨ Insert the SD card in the Controller.
- ⇨ Supply power to the Controller (24 VDC).

The status LED will flash red while the unit is updating.
Afterwards, the status LED lights up green (OK) or red (error) for one second.

- ⇨ Shut off the 24V and remove the card.

Browse the SD card for a file called "UPDATEGEN.con", which contains details of the updating process:

```
Generator Loader Version 1.0.0.0
----------------------
Open File UPDATGEN.hex
----------------------
Update Generator Module 1
Update Generator Module 2
…
----------------------
Erase Flash Sector 1 (08008000)
Start flashing at: 08008000
Erase Flash Sector 2 (08010000)
Erase Flash Sector 3 (08018000)
Erase Flash Sector 4 (08020000)
Stop flashing at: 08035027
Program Flash success
```

	NOTE
	You may find both files on the SD card. In that case, the Controller module updates first, the generator module(s) update second.

	WARNING
	Loading the wrong files or file versions may provoke an incorrect behaviour and/or damage to the units. ⇨ *Do not install any updates without contacting Kendrion first. Check with the contact person whether your hardware and software versions are compatible.* ⇨ *Mind to rename the correct file because the loader will otherwise load the wrong content.* *Controller:* ***UPDATE.hex*** *Output stage module:* ***UPDATGEN.hex***

6 PROFINET Process Data and Parameters

The MHS Controller adjusts / sets the temperatures of up to 7 MHS generators with 1 to 6 inductors. That makes a total of 42 inductors.
The Controller actuates via PROFINET.
Under the "Set" function, temperature sensors return the temperatures in the heating zones via the CAN1 bus. The CAN1 bus is disabled if "Temperature Sensor Present" is =0 for all generator modules.
Control values transfer to the generator modules via the CAN2 bus (module bus).

6.1 Configuration Data

Parameter Settings per Generator Module

Parameter Name	Format	Range/Default	Unit
Active channels	BYTE	0 …63. /.63	Bit-coded
Temperature sensor present	BYTE	0.. 1 / 1	
MaxTemperatur	WORD	0.. 3000 / 230	0.1 °C
Kp channel 1	WORD	0.. 1000 / 1	0.1
Ti channel 1	WORD	0.. 10000 / 21	Sec
Td channel 1	WORD	0.. 10000 / 5	Sec
X1 in channel 1	WORD	0..3000 / 20	0.1 °C
X1 out channel 1	WORD	0..3000 / 20	0.1 °C
X2 in channel 1	WORD	0..3000 / 220	0.1 °C
X2 out channel 1	WORD	0..3000 / 220	0.1 °C
Kp channel 2	WORD	0.. 1000 / 1	0.1
Ti channel 2	WORD	0.. 10000 / 21	Sec
Td channel 2	WORD	0.. 10000 / 5	Sec
X1 in channel 2	WORD	0..3000 / 20	0.1 °C
X1 out channel 2	WORD	0..3000 / 20	0.1 °C
X2 in channel 2	WORD	0..3000 / 220	0.1 °C
X2 out channel 2	WORD	0..3000 / 220	0.1 °C
Kp channel 3	WORD	0.. 1000 / 1	0.1
Ti channel 3	WORD	0.. 10000 / 21	Sec
Td channel 3	WORD	0.. 10000 / 5	Sec
X1 in channel 3	WORD	0..3000 / 20	0.1 °C
X1 out channel 3	WORD	0..3000 / 20	0.1 °C
X2 in channel 3	WORD	0..3000 / 220	0.1 °C
X2 out channel 3	WORD	0..3000 / 220	0.1 °C
Kp channel 4	WORD	0.. 1000 / 1	0.1
Ti channel 4	WORD	0.. 10000 / 21	Sec
Td channel 4	WORD	0.. 10000 / 5	Sec
X1 in channel 4	WORD	0..3000 / 20	0.1 °C
X1 out channel 4	WORD	0..3000 / 20	0.1 °C
X2 in channel 4	WORD	0..3000 / 220	0.1 °C
X2 out channel 4	WORD	0..3000 / 220	0.1 °C
Kp channel 5	WORD	0.. 1000 / 1	0.1
Ti channel 5	WORD	0.. 10000 / 21	Sec
Td channel 5	WORD	0.. 10000 / 5	Sec
X1 in channel 5	WORD	0..3000 / 20	0.1 °C
X1 out channel 5	WORD	0..3000 / 20	0.1 °C
X2 in channel 5	WORD	0..3000 / 220	0.1 °C
X2 out channel 5	WORD	0..3000 / 220	0.1 °C
Kp channel 6	WORD	0.. 1000 / 1	0.1
Ti channel 6	WORD	0.. 10000 / 21	Sec

Parameter Settings per Generator Module			
Parameter Name	**Format**	**Range/Default**	**Unit**
Td channel 6	WORD	0.. 10000 / 5	Sec
X1 in channel 6	WORD	0..3000 / 20	0.1 °C
X1 out channel 6	WORD	0..3000 / 20	0.1 °C
X2 in channel 6	WORD	0..3000 / 220	0.1 °C
X2 out channel 6	WORD	0..3000 / 220	0.1 °C

6.2 Process Image

The process image is modular. Every generator module (GM) has its own section.

Output Data, 26 Bytes per Generator Module (Control Unit -> Control Head)			
Name	**Format**	**Range**	**Unit**
Control word1 GM1	DWORD		
Set / control GM1 – Z1	WORD	0.. 3000 / 0..100	0.1
Set / control GM1 – Z2	WORD	0.. 3000 / 0..100	0.1
Set / control GM1 – Z3	WORD	0.. 3000 / 0..100	0.1
Set / control GM1 – Z4	WORD	0.. 3000 / 0..100	0.1
Set / control GM1 – Z5	WORD	0.. 3000 / 0..100	0.1
Set / control GM1 – Z6	WORD	0.. 3000 / 0..100	0.1
Target temperature limitation GM1 – Z1	BYTE	0..100	%
Target temperature limitation GM1 – Z2	BYTE	0..100	%
Target temperature limitation GM1 – Z3	BYTE	0..100	%
Target temperature limitation GM1 – Z4	BYTE	0..100	%
Target temperature limitation GM1 – Z5	BYTE	0..100	%
Target temperature limitation GM1 – Z6	BYTE	0..100	%
Resonance frequency	WORD	10..250	0.1
Resonance frequency, temperature	WORD	0.. 3000	0.1 °C
Control word GM2	DWORD		
Set GM2 – Z1	WORD		
…			

6.3 Control Word

Control Word		
Bit	**IF bit = high**	**IF bit = low**
0	heating channel 1 (edge 0->1)	heating channel 1: off
1	heating channel 2 (edge 0->1)	heating channel 2: off
2	heating channel 3 (edge 0->1)	heating channel 3: off
3	heating channel 4 (edge 0->1)	heating channel 4: off
4	heating channel 5 (edge 0->1)	heating channel 5: off
5	heating channel 6 (edge 0->1)	heating channel 6: off
6		
7		
8	acknowledge fault	
9	resonance frequency search: off	resonance frequency search: on
10	frequency adjustment: enabled	frequency adjustment: disabled
11	actuation mode on, target = control	actuation mode off, control enabled
12	power limit. across all channels (from ch1)	power limit. by channel
13		
14		
15	handshake bit	
16		
⋮ ⋮	⋮ ⋮	⋮ ⋮
25	start temp. sensor allocation	normal operation/cancel
26		
27	request temp. sensor allocation	normal operation/cancel
28		
29		
30		
31		

If parameter "Temperature Sensor Present“ = 0, control is never enabled (always actuation mode).
"Temp.Sensor Allocation" is not possible.

6.4 Input Data

Input Data, 50 Bytes per Generator Module (Control Head -> Control Unit)			
Name	**Format**	**Range**	**Unit**
Status word GM1	DWORD		
Actual GM1 – Z1 (control TempSensor = 1) ResFreq – Z1 (control off TempSensor = 0)	WORD	0.. 3000 1000 ..30000	0.1 °C 1.0 Hz
Actual GM1 – Z2 (control TempSensor = 1) ResFreq – Z2 (control off TempSensor = 0)	WORD	0.. 3000 1000 ..30000	0.1 °C 1.0 Hz
Actual GM1 – Z3 (control TempSensor = 1) ResFreq – Z3 (control off TempSensor = 0)	WORD	0.. 3000 1000 ..30000	0.1 °C 1.0 Hz
Actual GM1 – Z4 (control TempSensor = 1) ResFreq – Z4 (control off TempSensor = 0)	WORD	0.. 3000 1000 ..30000	0.1 °C 1.0 Hz
Actual GM1 – Z5 (control TempSensor = 1) ResFreq – Z5 (control off TempSensor = 0)	WORD	0.. 3000 1000 ..30000	0.1 °C 1.0 Hz
Actual GM1 – Z6 (control TempSensor = 1) ResFreq – Z6 (control off TempSensor = 0)	WORD	0.. 3000 1000 ..30000	0.1 °C 1.0 Hz
Target temperature GM1 – Z1	BYTE	0..100	%
Target temperature GM1 – Z2	BYTE	0..100	%
Target temperature GM1 – Z3	BYTE	0..100	%
Target temperature GM1 – Z4	BYTE	0..100	%
Target temperature GM1 – Z5	BYTE	0..100	%
Target temperature GM1 – Z6	BYTE	0..100	%
Heat sink temperature	WORD	0..1000	0.1 °C
Inside temperature sensor (control)	WORD	0..1000	0.1 °C
Circuit board temperature	WORD	0..1000	0.1 °C
Resonance frequency	WORD	1000..30000	1 Hz
Power GM1 – Z1	WORD	0..1000	0.1 kW
Power GM1 – Z2	WORD	0..1000	0.1 kW
Power GM1 – Z3	WORD	0..1000	0.1 kW
Power GM1 – Z4	WORD	0..1000	0.1 kW
Power GM1 – Z5	WORD	0..1000	0.1 kW
Power GM1 – Z6	WORD	0..1000	0.1 kW
DC link voltage	WORD	0..1000	V
Fault in generator module 1	WORD		
Sensor fault (control)	DWORD		
Status word GM2	DWORD		
Actual GM2 – Z1	WORD		
…			

6.5 Status Word

Status Word		
Bit	**IF bit = high**	**IF bit = low**
0	heating channel 1: confirmation	heating channel 1: off
1	heating channel 2: confirmation	heating channel 2: off
2	heating channel 3: confirmation	heating channel 3: off
3	heating channel 4: confirmation	heating channel 4: off
4	heating channel 5: confirmation	heating channel 5: off
5	heating channel 6: confirmation	heating channel 6: off
6		
7	active global error	no error
8	confirm fault acknowledge	
9	resonance frequency search: off	resonance frequency search: on
10	frequency adjustment: enabled	frequency adjustment: disabled
11	actuation mode on, target = control	actuation mode off, control enabled
12	power limit. across all channels (from ch1)	power limit. by channel
13	DC link ok	DC link off
14	initialisation complete (ready)	initialising
15	handshake bit	
16	control head: low voltage, 24 V	control head: 24 V voltage ok
17	control head: generator voltages low	control head: generator voltages ok
18	control head: 24 V overload	control head: 24 V current ok
19	control head: generator overload	control head: generator current ok 16
⋮	⋮	⋮
24	temp. sensor not allocated	all temp. sensors allocated
25	allocation enabled	allocation disabled / ready
26	temp. sensor, wrong allocation	allocation ok
27	temp. sensor, allocation requested	normal operation
⋮	⋮	⋮
31		

6.6 Generator Module Faults

Generator Module Faults			
Bit	**IF bit = high**	**IF bit = low**	**Fault/Warning**
0	heat sink temperature warning	heat sink temperature ok	W
1	heat sink temperature fault	heat sink temperature ok	F
2	-	-	-
3	low voltage, 24 V logic	24 V ok	F
4	low 24 V generator voltage	24 V IGBT ok	F
5	watchdog error	no watchdog error	W
6	DC link fault	DC link ok	W
7	handshake bit fault	handshake ok	F
8	current fault (ResFreq not found)	no current fault	F
9	CAN bus generator module fault	CAN bus generator module ok	F
10	short circuit channel 1	channel 1 ok	F
11	short circuit channel 2	channel 2 ok	F
12	short circuit channel 3	channel 3 ok	F
13	short circuit channel 4	channel 4 ok	F
14	short circuit channel 5	channel 5 ok	F
15	short circuit channel 6	channel 6 ok	F

6.7 Sensor Faults

Sensor Fault (if "Temperatur Sensor Present = 1")			
Bit	**IF bit = high**	**IF bit = low**	**Fault/Warning**
0	Sensor 1, broken wire	Sensor 1 OK	F
1	Sensor 1, short circuit	Sensor 1 OK	F
2	Sensor 1, loose contact	Sensor 1 OK	F
3	Sensor 2, broken wire	Sensor 2 OK	F
4	Sensor 2, short circuit	Sensor 2 OK	F
5	Sensor 2, loose contact	Sensor 2 OK	F
6	Sensor 3, broken wire	Sensor 3 OK	F
7	Sensor 3, short circuit	Sensor 3 OK	F
8	Sensor 3, loose contact	Sensor 3 OK	F
9	Sensor 4, broken wire	Sensor 4 OK	F
10	Sensor 4, short circuit	Sensor 4 OK	F
11	Sensor 4, loose contact	Sensor 4 OK	F
12	Sensor 5, broken wire	Sensor 5 OK	F
13	Sensor 5, short circuit	Sensor 5 OK	F
14	Sensor 5, loose contact	Sensor 5 OK	F
15	Sensor 6, broken wire	Sensor 6 OK	F
16	Sensor 6, short circuit	Sensor 6 OK	F
17	Sensor 6, loose contact	Sensor 6 OK	F
18	Sensor transmitter timeout	Sensor transmitter OK	F
19	Sensor transmitter fault	Sensor transmitter OK	F
20	Sensor, low voltage	Sensor OK	F
21	CAN bus sensor, no life signal	CAN sensor OK	F
22	Max temperature exceeded	Temperatures OK	F
⋮	⋮	⋮	
31			

7 EtherCAT Process Data and Parameters

The MHS Controller adjusts / sets the temperatures of up to 7 MHS generators with 1 to 6 inductors. That makes a total of 42 inductors.

Under the "Set" function, temperature sensors return the temperatures in the heating zones via the CAN1 bus.

Under the "Control" function, the CAN1 bus is disabled if "Temperature Sensor Present" is =0 for all generator modules.

MHS Controller and the generator modules communicate via the CAN2 bus (module bus).

7.1 Configuration

The control unit's EtherCAT Configurator tool is used for configuring the system. The associated XML file defines the properties (KendrionKuhnkeModularHeatingSystem.xml).
The number of generators, i.e. the size of the process image is set by objects 0x1C12 and 0x1C13 of the PDO Assignment. By default, it contains PDOs 1600 and 1A00 which define one generator module.
To add another generator module, include PDOs 1601 and 1A01. Increment the PDO IDs to add further generator modules. The Controller supports up to seven modules (up to 1606 and 1A06).

7.2 Controller

The MHS Controller adjusts / sets the temperatures of up to 7 MHS generator modules with 1 to 6 inductors. That makes a total of 42 inductors.

7.2.1 Process Image

The process image is modular. Every generator module (GM) has its own section.

Output Data, 38 Bytes per Generator Module (Control Unit → MHS Controller)			
Name	**Format**	**Range of values**	**Unit**
Status word GM1	DWORD		
Set / control GM1 – Z1	WORD	0.. 3000 / 0..100	0.1 °C/%
Set / control GM1 – Z2	WORD	0.. 3000 / 0..100	0.1 °C/%
Set / control GM1 – Z3	WORD	0.. 3000 / 0..100	0.1 °C/%
Set / control GM1 – Z4	WORD	0.. 3000 / 0..100	0.1 °C/%
Set / control GM1 – Z5	WORD	0.. 3000 / 0..100	0.1 °C/%
Set / control GM1 – Z6	WORD	0.. 3000 / 0..100	0.1 °C/%
Target temp. limit. GM1 – Z1	BYTE	0..100	%
Target temp. limit. GM1 – Z2	BYTE	0..100	%
Target temp. limit. GM1 – Z3	BYTE	0..100	%
Target temp. limit. GM1 – Z4	BYTE	0..100	%
Target temp. limit. GM1 – Z5	BYTE	0..100	%
Target temp. limit. GM1 – Z6	BYTE	0..100	%
Spec. actual temp. GM1 – Z1	WORD	0.. 3000	0.1 °C
Spec. actual temp. GM1 – Z2	WORD	0.. 3000	0.1 °C
Spec. actual temp. GM1 – Z3	WORD	0.. 3000	0.1 °C
Spec. actual temp. GM1 – Z4	WORD	0.. 3000	0.1 °C
Spec. actual temp. GM1 – Z5	WORD	0.. 3000	0.1 °C
Spec. actual temp. GM1 – Z6	WORD	0.. 3000	0.1 °C
Resonance frequency	WORD	10..250	0.1 kHz
Resonance frequency, temperature	WORD	0.. 3000	0.1 °C
Control word GM2	DWORD		
Set GM2 – Z1	WORD		

7.2.2 Control Word

Control Word		
Bit	**IF bit = high**	**IF bit = low**
0	heating channel 1: confirmation	heating channel 1: off
1	heating zone 2	heating zone 2 off
2	heating zone 3	heating zone 3 off
3	heating zone 4	heating zone 4 off
4	heating zone 5	heating zone 5 off
5	heating zone 6	heating zone 6 off
6	show current	show power
7		
8	acknowledge fault	
9	resonance frequency search: off	resonance frequency search: on
10	frequency adjustment: enabled	frequency adjustment: disabled
11	actuation mode on, target = control	actuation mode off, control enabled
12	power limit., all zones (from Z1)	power limit. by zone
13		
14		
15	handshake bit	
16		
17		
18		
19		
20		
21		
22		
23		
24		
25	start temp. sensor allocation	normal operation/cancel
26		
27	request temp. sensor allocation	normal operation/cancel
28		
29		
30		
31		

7.2.3 Generator Module Faults

Generator Module Faults			
Bit	**IF bit = high**	**IF bit = low**	**Fault/Warning**
0	heat sink temperature warning	heat sink temperature ok	W
1	heat sink temperature fault (80°)	heat sink temperature ok	F
2	inductor fault (e.g. excess temperature)	inductor OK	F
3	24V supply low	24 V ok	F
4	24V supply to IGBT low	24 V IGBT ok	F
5	watchdog error	no watchdog error	W
6	DC link fault	DC link ok	W
7	handshake bit fault	handshake ok	F
8	current fault (ResFreq not found)	no current fault	F
9	CAN bus generator module fault	CAN bus generator module ok	F
10	zone 1, short circuit	zone1 OK	F
11	zone 2, short circuit	zone 2 OK	F

Generator Module Faults			
Bit	**IF bit = high**	**IF bit = low**	**Fault/Warning**
12	zone 3, short circuit	zone 3 OK	F
13	zone 4, short circuit	zone 4 OK	F
14	zone 5, short circuit	zone 5 OK	F
15	zone 6, short circuit	zone 6 OK	F

7.2.4 Sensor Faults

Sensor Fault (if "Temperature Sensor Present = 1")			
Bit	**IF bit = high**	**IF bit = low**	**Fault/Warning**
0	Sensor 1, broken wire	Sensor 1 OK	F
1	Sensor 1, short circuit	Sensor 1 OK	F
2	Sensor 1, loose contact	Sensor 1 OK	F
3	Sensor 2, broken wire	Sensor 2 OK	F
4	Sensor 2, short circuit	Sensor 2 OK	F
5	Sensor 2, loose contact	Sensor 2 OK	F
6	Sensor 3, broken wire	Sensor 3 OK	F
7	Sensor 3, short circuit	Sensor 3 OK	F
8	Sensor 3, loose contact	Sensor 3 OK	F
9	Sensor 4, broken wire	Sensor 4 OK	F
10	Sensor 4, short circuit	Sensor 4 OK	F
11	Sensor 4, loose contact	Sensor 4 OK	F
12	Sensor 5, broken wire	Sensor 5 OK	F
13	Sensor 5, short circuit	Sensor 5 OK	F
14	Sensor 5, loose contact	Sensor 5 OK	F
15	Sensor 6, broken wire	Sensor 6 OK	F
16	Sensor 6, short circuit	Sensor 6 OK	F
17	Sensor 6, loose contact	Sensor 6 OK	F
18	Sensor transmitter timeout	Sensor transmitter OK	F
19	Sensor transmitter fault	Sensor transmitter OK	F
20	Sensor, low voltage	Sensor OK	F
21	CAN bus sensor, no life signal	CAN sensor OK	F
22	Max temperature exceeded	Temperatures OK	F
⋮	⋮	⋮	
31			

7.3 Parameter Settings per Generator Module

Parameter Settings per Generator Module			
Parameter Name	**Format**	**Range/Default**	**Unit**
Active zones	BYTE	0…63 / 63	Bit-coded, see note 1
Temperature Sensor Present	BYTE	0..1 / 1	See note 2
MaxTemperature	WORD	0..3000 / 2300	0.1 °C
Kp zone 1	WORD	0…1000 / 4	0.1
Ti zone 1	WORD	0…10000 / 100	Sec
Td zone 1	WORD	0…10000 / 0	Sec
X1 in zone 1	WORD	0…3000 / 200	0.1 °C

Parameter Settings per Generator Module

Parameter Name	Format	Range/Default	Unit
X1 out zone 1	WORD	0…3000 / 200	0.1 °C
X2 in zone 1	WORD	0…3000 / 2200	0.1 °C
X2 out zone 1	WORD	0…3000 / 2200	0.1 °C
Kp zone 2	WORD	0…1000 / 4	0.1
Ti zone 2	WORD	0…10000 / 100	Sec
Td zone 2	WORD	0…10000 / 0	Sec
X1 in zone 2	WORD	0…3000 / 200	0.1 °C
X1 out zone 2	WORD	0…3000 / 200	0.1 °C
X2 in zone 2	WORD	0…3000 / 2200	0.1 °C
X2 out zone 2	WORD	0…3000 / 2200	0.1 °C
Kp zone 3	WORD	0…1000 / 4	0.1
Ti zone 3	WORD	0…10000 / 100	Sec
Td zone 3	WORD	0…10000 / 0	Sec
X1 in zone 3	WORD	0…3000 / 200	0.1 °C
X1 out zone 3	WORD	0…3000 / 200	0.1 °C
X2 in zone 3	WORD	0…3000 / 2200	0.1 °C
X2 out zone 3	WORD	0…3000 / 2200	0.1 °C
Kp zone 4	WORD	0…1000 / 4	0,1
Ti zone 4	WORD	0…10000 / 100	Sec
Td zone 4	WORD	0…10000 / 0	Sec
X1 in zone 4	WORD	0…3000 / 200	0.1 °C
X1 out zone 4	WORD	0…3000 / 200	0.1 °C
X2 in zone 4	WORD	0…3000 / 2200	0.1 °C
X2 out zone 4	WORD	0…3000 / 2200	0.1 °C
Kp zone 5	WORD	0…1000 / 4	0.1
Ti zone 5	WORD	0…10000 / 100	Sec
Td zone 5	WORD	0…10000 / 0	Sec
X1 in zone 5	WORD	0…3000 / 200	0.1 °C
X1 out zone 5	WORD	0…3000 / 200	0.1 °C
X2 in zone 5	WORD	0…3000 / 2200	0.1 °C
X2 out zone 5	WORD	0…3000 / 2200	0.1 °C
Kp zone 6	WORD	0…1000 / 4	0.1
Ti zone 6	WORD	0…10000 / 100	Sec
Td zone 6	WORD	0…10000 / 0	Sec
X1 in zone 6	WORD	0…3000 / 200	0.1 °C
X1 out zone 6	WORD	0…3000 / 200	0.1 °C
X2 in zone 6	WORD	0…3000 / 2200	0.1 °C
X2 out zone 6	WORD	0…3000 / 2200	0.1 °C

Note 1

Active Zones is bit-coded. A set bit marks an active inductor.
1 = inductor 1, 2 = inductor 2, 4 = inductor 3, 8 = inductor 4, 16 = inductor 5, 32 = inductor 6.
Examples: 15 = inductors 1+2+3+4 active, 63 = inductors 1+2+3+4+5+6 active, 9 = inductor 1+4 active.

Note 2

If "Temperature Sensor Present" = 0, you can specify actual values for set mode. The actual values shown will be copied from the setpoint values.
If "Temperature Sensor Present" = 1, temperature setpoints are disabled. The actual readings of the transducers are shown.
Both modes support the actuation mode (control word bit). In that case, the target value equals the setpoint for actuation levels 0…100%.

8 CANopen Process Data and Parameters

The MHS Controller adjusts / sets the temperatures of up to 7 MHS generators with 1 to 6 inductors. That makes a total of 42 inductors.

Under the "Set" function, temperature sensors return the temperatures in the heating zones via the CAN1 bus.

Under the "Control" function, the CAN1 bus is disabled if "Temperature Sensor Present" is =0 for all generator modules.

MHS Controller and the generator modules communicate via the CAN2 bus (module bus).

8.1 Configuration

The system is configured by means of the EDS file.
Run the CANopen Configurator tool and extend the bus by a module instance for every MHS generator module.
The project therefore has as many CANopen stations as there are generator modules.
Set the MHS Controller's DIP switch to the CANopen address of the first station. Then increment the address by one for every station you are adding.
The MHS Controller adjusts / sets the temperatures of up to 7 MHS generator modules with 1 to 6 inductors. That makes a total of 42 inductors.
Run the "Set" function to enter the temperatures and define them as default actual values.

8.2 CANopen

8.2.1 Addresses

A = DIP switch address (1...63) + n
n = generator module index 0…7

CANopen Control Unit -> Control Head

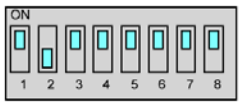
ID	Length	Data 1	Data 2	Data 3	Data 4	Data 5	Data 6	Data 7	Data 8
200 + A	8	Control word				Set / control – I1		Set / control – I2	
300 + A	8	Set / control – I3		Set / control – I4		Set / control – I5		Set / control – I6	
400 + A	8	Actual temp. – I1		Actual temp. – I2		Actual temp. – I3		Actual temp. – I4	
500 + A	7	Actual temp. – I5		Actual temp. – I6		Resonance freq.		Tmp lim	-

MHS Controller → CANopen Control Unit

ID	Length	Data 1	Data 2	Data 3	Data 4	Data 5	Data 6	Data 7	Data 8
180 + A	8	Status word				Gen. faults		Resonance freq.	
280 + A	8	Set – I1	Set – I2	Set – I3	Set – I4	Set – I5	Set – I6	DC link voltage	
380 + A	8	Power – I1		Power – I2		Power – I3		Power – I4	
480 + A	8	Power – I5		Power – I6		Heat sink temp.		PCB temp.	

8.2.2 Setting the Address and Baud Rate

Switch for setting the CAN addresses in CANopen Slave device variant



DIP Switch	
Pin	Function
1	Addressing, binary coded Addresses 1 – 63
2	
3	
4	
5	
6	
7	Baud rate 00 = 125 kbps; 10 = 250 kbps 01 = 500 kbps; 11 = 1 Mbps
8	

8.2.3 Process Image

The process image is modular. Every generator module (GM) has its own section.

Output Data, 31 Bytes per Generator Module (Control Unit → MHS Controller)			
Name	**Format**	**Range of values**	**Unit**
Status word GM1	DWORD		
Set / control – I1	WORD	0..100 / 0..3000	% / 0.1 °C
Set / control – I2	WORD	0..100 / 0..3000	% / 0.1 °C
Set / control – I3	WORD	0..100 / 0..3000	% / 0.1 °C
Set / control – I4	WORD	0..100 / 0..3000	% / 0.1 °C
Set / control – I5	WORD	0..100 / 0..3000	% / 0.1 °C
Set / control – I6	WORD	0..100 / 0..3000	% / 0.1 °C
Actual temperature – I1	WORD	0.. 3000	0.1 °C
Actual temperature – I2	WORD	0.. 3000	0.1 °C
Actual temperature – I3	WORD	0.. 3000	0.1 °C
Actual temperature – I4	WORD	0.. 3000	0.1 °C
Actual temperature – I5	WORD	0.. 3000	0.1 °C
Actual temperature – I6	WORD	0.. 3000	0.1 °C
Target temperature limitation	BYTE	0..100	%
Resonance frequency	WORD	10..250	0.1 kHz

8.2.4 Control Word

Status Word		
Bit	**IF bit = high**	**IF bit = low**
0	heating inductor 1	heating inductor 1 off
1	heating inductor 2	heating inductor 2 off
2	heating inductor 3	heating inductor 3 off
3	heating inductor 4	heating inductor 4 off
4	heating inductor 5	heating inductor 5 off
5	heating inductor 6	heating inductor 6 off
6		
7		
8	acknowledge fault	
9	resonance frequency search: off	resonance frequency search: on

Status Word		
Bit	**IF bit = high**	**IF bit = low**
10	frequency adjustment: enabled	frequency adjustment: disabled
11	actuation mode on, target = control	actuation mode off, control enabled
12	power limitation, all inductors	power limitation, per inductor
13		
14		
15	handshake bit	
16		
17		
18		
19		
20		
21		
22		
23		
24		
25		
26		
27		
28		
29		
30		
31		

8.2.5 Input Data

Input Data, 32 Bytes per Generator Module (Control Head -> Control Unit)			
Name	**Format**	**Range of values**	**Unit**
Status word GM1	DWORD		
Target temperature – I1	BYTE	0..100	%
Target temperature – I2	BYTE	0..100	%
Target temperature – I3	BYTE	0..100	%
Target temperature – I4	BYTE	0..100	%
Target temperature – I5	BYTE	0..100	%
Target temperature – I6	BYTE	0..100	%
Heat sink temperature	WORD	0..1000	0.1 °C
Circuit board temperature	WORD	0..1000	0.1 °C
Resonance frequency	WORD	10..250	0.1 kHz
Power – I1	WORD	0..1000	0.1 kW
Power – I2	WORD	0..1000	0.1 kW
Power – I3	WORD	0..1000	0.1 kW
Power – I4	WORD	0..1000	0.1 kW
Power – I5	WORD	0..1000	0.1 kW
Power – I6	WORD	0..1000	0.1 kW
DC link voltage	WORD	0..1000	V
Generator module fault	WORD		

8.2.6 Status Word

Status Word		
Bit	**IF bit = high**	**IF bit = low**
0	heating channel 1: confirmation	heating channel 1: off
1	heating inductor 2 confirmation	heating inductor 2 off
2	heating inductor 3 confirmation	heating inductor 3 off
3	heating inductor 4 confirmation	heating inductor 4 off
4	heating inductor 5 confirmation	heating inductor 5 off
5	heating inductor 6 confirmation	heating inductor 6 off
6		
7	active global error	no error
8	confirm fault acknowledge	
9	resonance frequency search: off	resonance frequency search: on
10	frequency adjustment: enabled	frequency adjustment: disabled
11	actuation mode on, target = control	actuation mode off, control enabled
12	power limitation, all inductors	power limitation, per inductor
13	DC link ok	DC link off
14	initialisation complete (ready)	initialisation
15	handshake bit	
16	control head: low voltage, 24 V	control head: 24 V voltage ok
17	control head: generator voltages low	control head: generator voltages ok
18	control head: 24 V overload	control head: 24 V current ok
19	control head: generator overload	control head: generator current ok 16
20		
21		
22		
23		
24		
25		
26		
27		
28		
29		
30		
31		

8.2.7 Generator Module Faults

Generator Module Faults			
Bit	**IF bit = high**	**IF bit = low**	**Fault/Warning**
0	heat sink temperature warning	heat sink temperature ok	W
1	heat sink temperature fault	heat sink temperature ok	F
2	-	-	-
3	low voltage, 24 V logic	24 V ok	F
4	low 24 V generator voltage	24 V IGBT ok	F
5	watchdog error	no watchdog error	W
6	DC link fault	DC link ok	W
7	handshake bit fault	handshake ok	F
8	current fault (ResFreq not found)	no current fault	F
9	CAN bus generator module fault	CAN bus generator module ok	F
10	short circuit channel 1	channel 1 ok	F

Generator Module Faults			
Bit	**IF bit = high**	**IF bit = low**	**Fault/Warning**
11	short circuit channel 2	channel 2 ok	F
12	short circuit channel 3	channel 3 ok	F
13	short circuit channel 4	channel 4 ok	F
14	short circuit channel 5	channel 5 ok	F
15	short circuit channel 6	channel 6 ok	F

8.3 Parameter Settings per Generator Module

Parameter Settings per Generator Module			
Parameter Name	**Format**	**Range/Default**	**Unit**
Active zones	BYTE	0…63 / 63	Bit-coded, see note 1
Temperature Sensor Present	BYTE	0..1 / 1	See note 2
MaxTemperature	WORD	0..3000 / 2300	0.1 °C
Kp zone 1	WORD	0…1000 / 4	0.1
Ti zone 1	WORD	0…10000 / 100	Sec
Td zone 1	WORD	0…10000 / 0	Sec
X1 in zone 1	WORD	0…3000 / 200	0.1 °C
X1 out zone 1	WORD	0…3000 / 200	0.1 °C
X2 in zone 1	WORD	0…3000 / 2200	0.1 °C
X2 out zone 1	WORD	0…3000 / 2200	0.1 °C
Kp zone 2	WORD	0…1000 / 4	0.1
Ti zone 2	WORD	0…10000 / 100	Sec
Td zone 2	WORD	0…10000 / 0	Sec
X1 in zone 2	WORD	0…3000 / 200	0.1 °C
X1 out zone 2	WORD	0…3000 / 200	0.1 °C
X2 in zone 2	WORD	0…3000 / 2200	0.1 °C
X2 out zone 2	WORD	0…3000 / 2200	0.1 °C
Kp zone 3	WORD	0…1000 / 4	0.1
Ti zone 3	WORD	0…10000 / 100	Sec
Td zone 3	WORD	0…10000 / 0	Sec
X1 in zone 3	WORD	0…3000 / 200	0.1 °C
X1 out zone 3	WORD	0…3000 / 200	0.1 °C
X2 in zone 3	WORD	0…3000 / 2200	0.1 °C
X2 out zone 3	WORD	0…3000 / 2200	0.1 °C
Kp zone 4	WORD	0…1000 / 4	0.1
Ti zone 4	WORD	0…10000 / 100	Sec
Td zone 4	WORD	0…10000 / 0	Sec
X1 in zone 4	WORD	0…3000 / 200	0.1 °C
X1 out zone 4	WORD	0…3000 / 200	0.1 °C
X2 in zone 4	WORD	0…3000 / 2200	0.1 °C
X2 out zone 4	WORD	0…3000 / 2200	0.1 °C
Kp zone 5	WORD	0…1000 / 4	0.1
Ti zone 5	WORD	0…10000 / 100	Sec
Td zone 5	WORD	0…10000 / 0	Sec
X1 in zone 5	WORD	0…3000 / 200	0.1 °C
X1 out zone 5	WORD	0…3000 / 200	0.1 °C
X2 in zone 5	WORD	0…3000 / 2200	0.1 °C
X2 out zone 5	WORD	0…3000 / 2200	0.1 °C
Kp zone 6	WORD	0…1000 / 4	0.1

Parameter Settings per Generator Module			
Parameter Name	**Format**	**Range/Default**	**Unit**
Ti zone 6	WORD	0…10000 / 100	Sec
Td zone 6	WORD	0…10000 / 0	Sec
X1 in zone 6	WORD	0…3000 / 200	0.1 °C
X1 out zone 6	WORD	0…3000 / 200	0.1 °C
X2 in zone 6	WORD	0…3000 / 2200	0.1 °C
X2 out zone 6	WORD	0…3000 / 2200	0.1 °C

Note 1

Active Zones is bit-coded. A set bit marks an active inductor.
1 = inductor 1, 2 = inductor 2, 4 = inductor 3, 8 = inductor 4, 16 = inductor 5, 32 = inductor 6.
Examples: 15 = inductors 1+2+3+4 active, 63 = inductors 1+2+3+4+5+6 active, 9 = inductor 1+4 active.

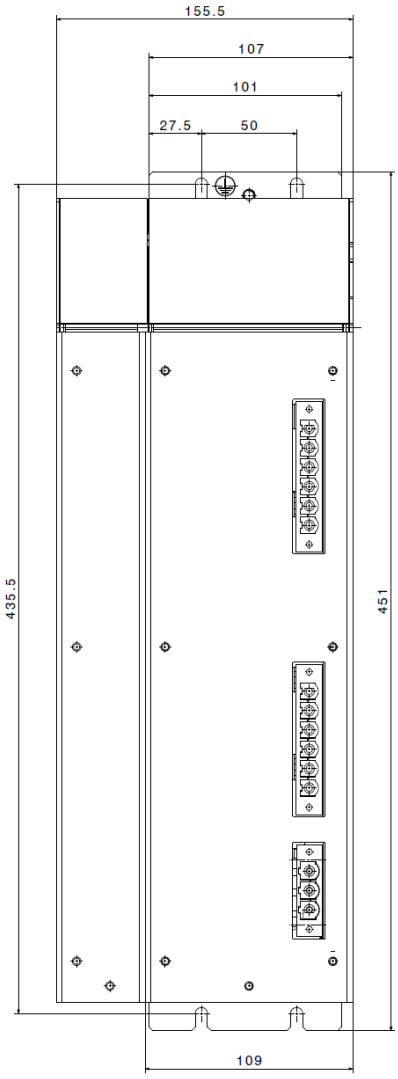
Note 2

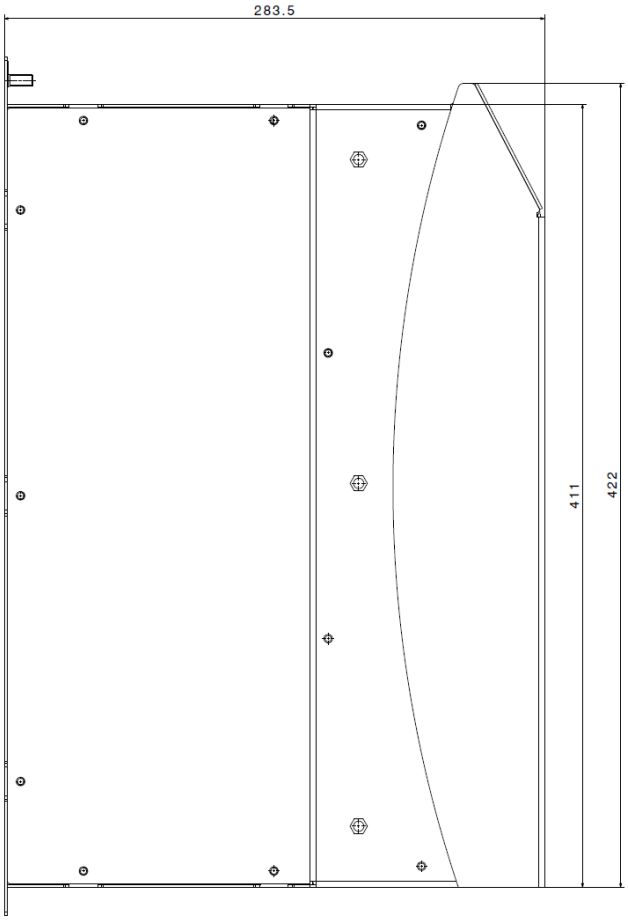
If "Temperature Sensor Present" = 0, you can specify actual values for set mode. The actual values shown will be copied from the setpoint values.
If "Temperature Sensor Present" = 1, temperature setpoints are disabled. The actual readings of the transducers are shown.
Both modes support the actuation mode (control word bit). In that case, the target value equals the setpoint for actuation levels 0…100%.

9 Appendix

9.1 Control Unit Dimensions

9.1.1 Housing Dimensions



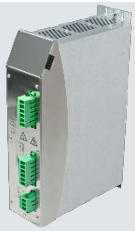


9.3 Certificates

9.4 Order Specifications

MHS PROFINET Controller	610 610 01
MHS IRT Controller PROFINET IO Fieldbus Temperature control, system monitoring, fieldbus communication, power output control, bus coupler for up to 7 MHS output stages, SD for software updates	
MHS CANopen Controller	**610 610 10**
MHS CANopen Controller EtherCAT Fieldbus Temperature control, system monitoring, fieldbus communication, power output control, bus coupler for up to 7 MHS output stages, SD for software updates	
MHS EtherCAT Controller	**610 610 20**
MHS ETH Controller EtherCAT Fieldbus Temperature control, system monitoring, fieldbus communication, power output control, bus coupler for up to 7 MHS output stages, SD for software updates	

9.4.1 Accessories

MHS Induction Generator 6x3 kW	610 660 00
6 x 3 kW, 18 kW continuous rated output On-board performance measurement, short circuit detection, DC link voltage monitoring, automatic frequency adjustment, resonant frequency monitoring	
MHS Induction Generator 4x7.5 kW	**610 640 00**
4 x 7.5 kW, 30 kW total capacity (peak), 26 kW continuous rated output On-board performance measurement, short circuit detection, DC link voltage monitoring, automatic frequency adjustment, resonant frequency monitoring	

9.5 Sales & Service

Please visit us on the Internet 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:

9.5.1 Malente Headquarters

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