FAKULTÄT
FÜR !NFORMATIK
Faculty of Informatics

Integration of a BECKHOFF PLC into an HVAC model plant

BACHELORARBEIT

zur Erlangung des akademischen Grades

Bachelor of Science

im Rahmen des Studiums

Software Engineering

eingereicht von

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an der
Fakultät für Informatik der Technischen Universität Wien

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BACHELOR THESIS

submitted in partial fulfillment of the requirements for the degree of

Bachelor of Science

in

Software Engineering

by

Balazs Bezeczky
Registration Number 9825128

to the Faculty of Informatics
at the Vienna University of Technology

Advisor: Ao. Univ. Prof. Dipl.-Ing. Dr. techn. Wolfgang Kastner
Assistance: Dipl.-Ing. Andreas Fernbach

Vienna, 06.11.2015

(Signature of Author) (Signature of Advisor)

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Abstract

This thesis deals with complementing a demo air ventilation system with a new controlling equipment, a BECKHOFF PLC. It covers the challenges that had to be solved throughout this project such as the system's inventory control, drawing a circuit diagram, building rail mounting modules and wiring the components. Creating a PLC project that controls the system was also part of the project.

Kurzfassung

Diese Bachelorarbeit beschreibt die Ausstattung einer Demo-Lüftungsanlage mit einem neuen Steuer- und Regelgerät der Firma BECKHOFF. Sie behandelt Herausforderungen, die im Rahmen des Projekts gelöst werden mussten. Darunter die Bestandsaufnahme der Anlage, das Zeichnen eines Stromlaufplans, Anfertigen von Hutschienengehäusen und die Verdrahtung der Komponenten. Das Erstellen eines SPS-Projekts zur Steuerung der Anlage ist ebenfalls eine Teilaufgabe gewesen.

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CHAPTER 1

Introduction

1.1 Motivation

Building automation is growing steadily in Austria. The "Ministry for Business, Family and Youth" has released a standardized bill of qualities for building services ("Leistungsverzeichnis für Haustechnik" [4] "LB HT") many years ago, currently revision 10 is being worked on. This bill of qualities deals with the measuring, controlling and regulating technology in the chapters 84, 85, 86 and some parts of 88. Sub paragraphs in these chapters describe automation components (e.g. digital and analog IOs, CPUs, sensors, actuators) neutrally, so that most vendors can submit equal offers to investors.

BECKHOFF Automation GmbH is one of these vendors. Adding its controls to the building automation system seems feasible, because the company is undertaking serious efforts offering components and software products in particular for heating, ventilation and air conditioning (HVAC) systems.

1.2 Objectives

The objective of this thesis is to provide the students a new platform for educational purpose. Besides that, it shall document which efforts are needed when a new control system is integrated into the target system. Documenting the current status and wiring of the target system was among further goals of this thesis. Creating a reference PLC project and demonstrating interfaces of the system, by creating an AJAX based visualization, is a bonus exercise.

1.3 Structure of the work

The thesis is structured in chapters and sub chapters, going from introducing the system in its current status and documenting all the errors and problems, over to explaining the steps that were needed to choose the right components for integration. It also describes the mechanical

work that was necessary to build the rail mount modules for the connections over Centronics connectors, the wiring work to connect the new components to the rail mount modules and creating the documentation in a circuit diagram with sPlan. The work on the circuit diagram also included the creation of templates for the new components - published in a freely available library. An overview of the BECKHOFF company and the new components is part of the thesis as well. A brief introduction to the IEC 61131-3 programming language and BECKHOFF's engineering and runtime software TwinCAT follows. The thesis is concluded by an outlook on future enhancements and possible extensions.

Redrawn and new circuit diagrams, data sheets of all used components are part of the Appendix.

CHAPTER 2

Status Quo

2.1 Analysis

The target system's current status had to be evaluated before the full integration could be done. One of the challenges was to integrate a BECKHOFF PLC, powered by 24V DC into a system that is running on 24V AC.

The target was built sometime back in 2008 and based on Honeywell and T.A.C. components. The temperature signals are provided in NTC20K format. Other analog in- and outputs are based on 0-10V signals. The main idea for the modular construction was that tailored to a versatile platform - offering an easy to use and simple change of different controller types. The controllers are mounted on plexiglass shields and provide a Centronics interface on the back side. These connectors with 36 and 50 pins carry the electric signals from the target over cables with 24, 36 or 50 wires. Most actuators have a digital „enable“ signal and an additional analog control signal in 0-10V format. In case of the ventilators, pumps and heat sources, the implementation was done with a module that has a 0-10V input and a PWM (pulse width modulated) output towards the earlier mentioned components.

The active sensors are powered by 24V AC. They deliver either 0-10V signals (e.g. humidity sensors) or NTC20k temperature values.

2.2 Challenges, problems

When the integration work started, the biggest challenge was to make a system powered by 24V DC work with an existing one that has 24V AC power source. Obviously, when the system was designed it was not taken into account, that industrial automation systems mostly need a 24V DC power source. So various voltage coupling relays had to be planned and installed, that switch the 24V DC output of the BECKHOFF KL2408 modules to 24V AC.

The simulation switches (S01-S06) are exceptions, those contacts were realized as floating contacts.

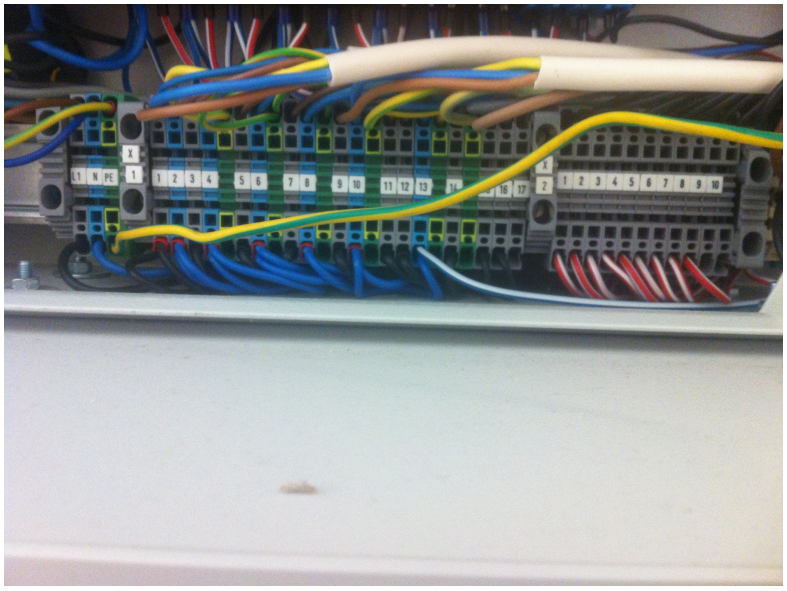


Figure 2.1: Multiple connections on one rail-mounted terminal block

As mentioned earlier, the Honeywell temperature/moisture sensors deliver the temperature in NTC20k format – this is not compatible with BECKHOFF's KL3208 modules [1] (although those terminals support PT1000 and Ni1000 formats; PT100, PT200, PT500, Ni100, Ni120 and resistance measurement up to 1,2/5K are also available). Although the NTC20k signals are also available over a LONMARK network and in the BECKHOFF system there is a LONMARK terminal available, the decision was made to install new PT1000 temperature sensors and re-use the 0-10V moisture sensors. This allows the use of the PT1000 sensors in an already existing Saia-Burgess system as well.

Opening the high-power control cabinet it revealed that there are several construction problems which derive from flicking and patching the cabinet. There is a rail which is not fixed (or it has come loose after time) and which holds several devices. Another concern is that there are several connections to one rail-mounted terminal block (see Figure 2.1). According to DIN EN 60204 13.1.1 [5] "General requirements", "The connection of two or more conductors to one terminal is permitted only in those cases where the terminal is designed for that purpose. However, only one protective conductor shall be connected to one terminal connecting point." These rules are clearly violated, refer to the earth connection on X1 between 6 and 7 in Figure 2.1.

The equipment labels are also missing in several cases or they simply don't match the documentation. The wiring inside the cabinet was probably done in several steps because the wire colors and the wire types are not consistently used. Also, there are cables with double insulation used inside the wire ways, which is not necessary. According to DIN EN 60204 13.1.3 [5], "Conductors of different circuits", it is only stated, that "Conductors of different circuits may

[1] In the meantime, a new version of the KL3208 is available with NTC 1,8 k/2,2 k/3 k/5 k/10 k/20 k/100 k support

be laid side by side, may occupy the same duct (for example conduit, cable trunking system), or may be in the same multiconductor cable provided that the arrangement does not impair the proper functioning of the respective circuits.

Where those circuits operate at different voltages, the conductors shall be separated by suitable barriers or shall be insulated for the highest voltage to which any conductor within the same duct can be subjected, for example line to line voltage for unearthed systems and phase to earth voltage for earthed systems."

The two relays for driving the sunblind's motor are not mutually excluded, so it is possible to switch on both the „UP“ and „DOWN“ contacts (- this means DANGER IN DELAY!) which could lead to fire and the destruction of equipment.

To ease things a bit, this problem was considered with the sunblind's wiring out of the BECKHOFF terminals. The contacts are mutually exclusive, so even switching both contacts on, only one of them will be valid and switch voltage to the motor (refer to the circuit diagram in 6.2 on page 19, KM2652 terminal, number 12).

The same holds true for the three relays controlling the fancoil's three steps/stages. They were also mutually exclusively wired (refer to the circuit diagram in 6.2, p. 6, relays 12K1, 12K2 and 12K3) on the new controller, so that they can only be switched from the PLC code.

2.3 Current state of documentation

The available documentation made the work even more difficult. The whole 230V AC switching cabinet had to be opened and documented. There was an outdated circuit diagram available, which had to be redrawn. The new version can be found in Appendix 6.2. Connections to the controls were incompletely documented in a Microsoft Excel list, those were additional reasons for examining the installations „apart“ and check the wiring in detail.

As mentioned earlier, the equipment labels differ from the ones in the old documentation (compare Figure 2.2 with Appendix 6.1, p. 3). For instance, the first relay labeled with 1K1, documentation says on page 3 it is 3K1.

After double checking the Excel list, the circuit diagram and manually measuring the contacts, it turned out that the order of the equipment after the first three pages were scrambled. Appendix 6.1 holds a consistent overview on the current state.

2.4 Literature studies

Much attention was paid for different control strategies of ventilation systems. Particularly the different available strategies are explained well in the Siemens handbooks for building technologies, e.g. [25].

Much of a help was the "The PID Tuning Blueprint" [26] for finding the perfect values for the PID controllers and have a better understanding of the subject.

Studying some parts of the DIN norm were very informative and of great help when building the Centronics boxes and wiring the BECKHOFF components.

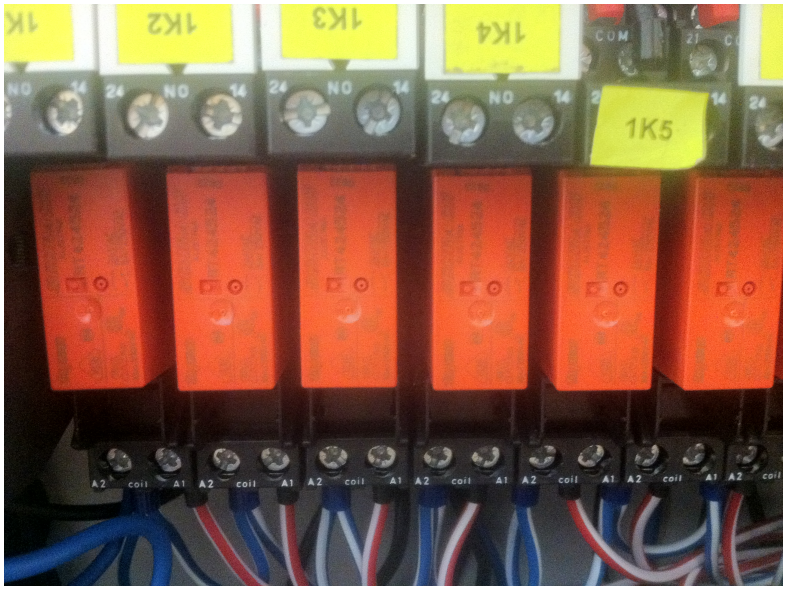


Figure 2.2: Wrong numbering on relays, compare Figure 2.3

2.5 Components overview

The components used in this project are part of a CPU of CX5010-1111 type, which is a 1.1GHz Atom CPU equipped with WinCE 6.0 and a TwinCAT2 PLC runtime.

The bus terminals are of K-Bus type. These terminals provide more building specific types than the EtherCAT ones. A list of all terminals used in the project follows as:

- KL9187 16 channel 24V DC power distribution terminal
- KL9188 8 channel 0V ground distribution terminal
- KL1408 8 channel 24V DC digital inputs
- KL2408 8 channel 24V DC digital outputs
- KL3464 4 channel 0-10V inputs
- KL3208-0010 8 channel PT1000 inputs
- KL6401 LON communication terminal
- KM2652 2 channel manual/auto digital output
- KM4602 2 channel manual/auto 0-10V output
- KL9010 bus end terminal

The terminals' complete documentation can be found in Appendix 6.3.

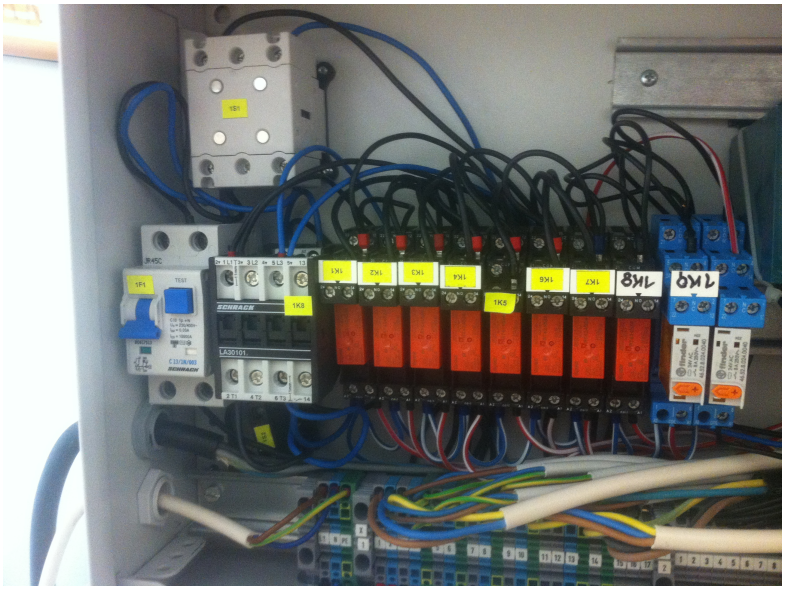


Figure 2.3: Numbering differ on relays and in documentation, compare with 6.1, p. 3

2.6 Further improvements

In order to lift the target to a level which conforms to industry standards, the whole cabling and switching cabinet should be taken apart and get re-wired. Also, a detailed circuit diagram is required before starting with the reconstruction work. It is also suggested to interrupt the enable wires of the ventilators for generating true malfunction messages. As stated above, the fancoil and sunblind contacts has to be wired mutually exclusively to prevent damage of the equipment.

To realize a clean and nice connection with the Centronics connectors, it is suggested to build rail mount connection boxes for them, just like it was done for the backside of the BECKHOFF plate.

Connecting the wires through rail mounted terminal blocks with a fuse inside is a good idea and it protects the equipment from misconnections. But all the rail mount terminals should be moved inside the switching cabinet to protect them against electrical shorts caused by fluids or other materials.

There are pipes on the back side of the target which transport hot and cold water to the heating and cooling exchangers. Instead of the current loose tubes (see Figure 2.4) the piping could be re-done with pipes made of plastic or copper.

That would allow a solid mounting of the pipes on the back of the target and make it less prone to mechanical damages of the pump's contacts. A leak or breakage of the current tubes could cause severe damage to the equipment as the tubes are hanging over the rail mount terminals.

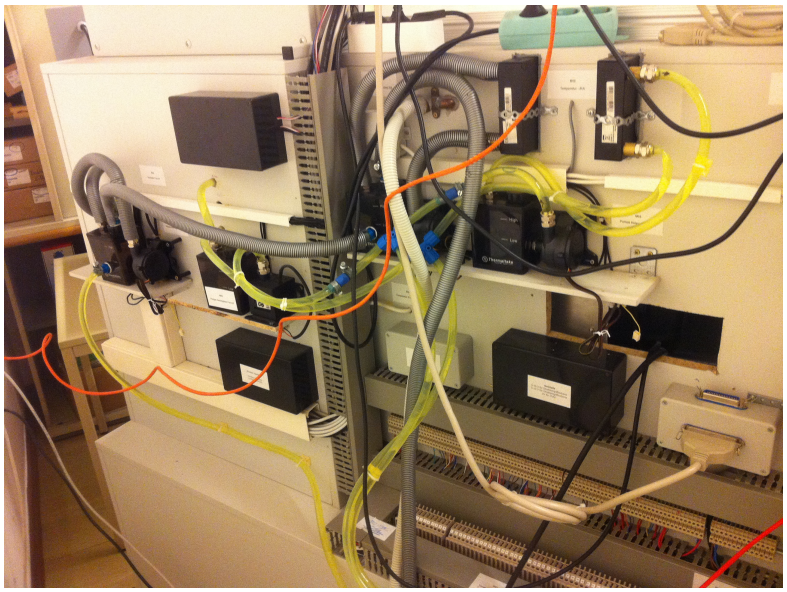


Figure 2.4: Loose tubes on the target's back

CHAPTER 3

BECKHOFF Automation Systems

BECKHOFF's system concept is based on PC based automation. This concept goes back to the 80ies, when the company started to build its first automation devices. There were often requirements like reading/writing data from/to floppy disks and redirecting output to printers. Therefore, the concept was born to move the automation tasks to a PC's CPU, which is idle most of the time. This concept was revolutionary at that time and divided the automation sector into supporters and adversaries. Today, the PC based automation technology is widely accepted.

The BECKHOFF K-Bus system consists of fieldbus-neutral bus terminals which integrate the field signals and run the K-Bus or Klemmen-Bus on the backplane. They can be connected mechanically on a DIN mounted rail. The combination of up to 64 terminals (or 255 with certain extenders) on one bus coupler unit can be realized. The CPU unit can either be a CX railmount embedded-PC, a BC (bus terminal controller) or a BK/EK (bus coupler for K-Bus or EtherCAT terminals). The bus terminals can be divided roughly into eight categories:

- Digital inputs, the numbering starts with a "1", like KL1408 or EL1008
- Digital outputs, the numbering starts with a "2", like KL2408 or EL2008
- Analog inputs, the numbering starts with a "3", like KL3202 or EL3202
- Analog outputs, the numbering starts with a "4", like KL4408 or EL4008
- Position measurement, starting with "5", like KL5001 or EL5001
- Communication and safety, starting with "6", like KL6581 or EL6001
- Motion, starting with "7", like EL7201
- System terminals, starting with "9", like KL9250 or EL9400

The full range of the available terminals can be found on the BECKHOFF homepage [15].

The system requires to have one CPU in the field when it is used with TwinCAT (The Windows Control and Automation Technology) automation software. The terminals can also be used in combination with systems like Siemens S7 (Profibus, Profinet), Allen Bradley by Rockwell Automation (EtherNet/IP, ControlNet, DeviceNet), Phoenix Contact (Interbus), AEG Schneider Automation (Fipio), Mitsubishi Electric Corporation (CC-Link). Connections to Modbus-, SERCOS-, RS232/RS485-, Ethernet TCP/IP-, AS-i, KNX/EIB, LON, DALI, DMX, MP-Bus, M-Bus, SMI, EnOcean and USB-networks exist as well. This setup requires a head-unit (like a bus coupler) equipped with the desired communication protocol.

When used with TwinCAT, the CPU runs a Microsoft Windows operating system (like WinCE 5.0 – 7.0, Windows Embedded Standard 2009 (formerly known as Windows XP Embedded) or Windows Embedded Standard 7). All CE versions are real-time capable, the others are turned into real-time capable operating systems by installing a TwinCAT real-time kernel module.

3.1 History of PC based automation

PCs and PLCs

As mentioned above, the PC based automation goes back to the mid 80ies. Back then, TwinCAT had not been available, the automation programs were written in a software product called S1000. Since then, BECKHOFF evolved into the 2nd biggest industrial PC manufacturer with 70.000 PCs manufactured in 2011. The PCs and mainboards are developed and manufactured in Verl, Germany. In contrary to standard PCs, IPCs have a very narrow jitter (see [31] for definition), with only a small deviation from the desired periodic repetition of a certain task. In TwinCAT, cycle times of max. 12.5μs are possible, as demonstrated at the Hanover Fair in April 2012 [14]. Such fast cycle times require that the CPU can repeat the desired task at a wide temperature range with the same, preferably small jitter. These ranges derive from the great variety of the industrial applications where IPCs are used - often in harsh production environments exposed to heat or cold, dust and fluids. The IPCs have a working temperature range from $0\text{-}45/55\,^{\circ}\mathrm{C}$, the embedded PCs are certified for temperatures between $-25\text{-}60\,^{\circ}\mathrm{C}$. Motherboards with these qualities require carefully chosen components, intense design and testing. Of course, in a building automation system the cycle time requirements are lower. Only the lighting systems require a cycle time of 50ms or less.

IEC 61131-3

The IEC 61131-3 is an IEC standard for a collection of programming languages to program programmable logical controllers (PLCs). It is a company independent standard and describes different languages for application development. It offers Function Block Diagram (FBD), Ladder Diagram (LD), Continuous Function Chart (CFC), Sequential Function Chart (SFC), Instruction List (IL) and Structured Text (ST). 3S-Software, a German software vendor develops and sells their IEC 61131-3 implementation to OEMs. BECKHOFF is one of their biggest customers. The 3S implementation is integrated into the TwinCAT Editor, so BECKHOFF devices can be

programmed with this international standard. Among other 3S-Software customers one can find i.e. ABB Automation Products GmbH, Bachmann Electronic GmbH, Schneider Electric Industries S.A.S. (for complete list refer to [10]). You can find a quick introduction to IEC 61131-3 under [9].

IEC 61499 is an advancement to IEC61131-3. It is complemented with event based triggers in function blocks instead of cyclic execution. Some software vendors for IEC 61499 systems, like nxtControl, use BECKHOFF hardware for deploying their controllers. There is a brief introduction to programming in IEC61131-3 in Chapter 4.4 on page 25.

3.2 Ethernet

The BECKHOFF automation concept is based on one other very important aspect: the interconnection between the soft-PLC and possible remote IOs using the worldwide most often sold cable type, CAT5E. Putting the PC-based automation on the Ethernet communication bus (and on the Windows platform) allows the PLC to use today's networking services, like FTP, SMTP, SQL-databases, SNTP, and even interactions with SAP-systems. Services, that run over the network, but are not available as a function block (FB) from BECKHOFF, can be implemented by the user as a TCP/UDP server/client. Around 2003, BECKHOFF presented at the Hanover Fair a new industrial bus system called EtherCAT. It was designed from scratch, taking the shortcomings of existing bus systems into account. To achieve the unheard speed of EtherCAT, when it comes to remote IOs and bus-participants there is no protocol conversion to a sub-bus after the EtherCAT coupler. Depending on the transmitting medium, the bus coupler can change the medium, for example from fibre optic to copper, but the protocol stays the same. So there is no overhead whatsoever to convert the protocol to an internal bus-protocol, full 100MBit/s Ethernet technology connects every EtherCAT member. This means that every EtherCAT terminal is an EtherCAT slave and up to 65.535 slaves can be integrated into one EtherCAT system.

BECKHOFF describes EtherCAT as follows: "Outstanding performance, flexible topology and simple configuration characterize EtherCAT (Ethernet for control automation technology), the real-time Ethernet technology from Beckhoff. EtherCAT sets new standards where conventional fieldbus systems reach their limits: 1,000 distributed I/Os in 30μs, almost unlimited network size, and optimum vertical integration thanks to Ethernet and internet technologies. With EtherCAT, the costly Ethernet star topology can be replaced with a simple line or tree structure – no expensive infrastructure components are required. All types of Ethernet devices can be integrated via a switch or switch port.

Where other real-time Ethernet approaches require special master or scanner cards, EtherCAT manages with very cost-effective standard Ethernet interface cards." [17]

3.3 BECKHOFF and building automation

The BECKHOFF building automation section characterizes itself on the company homepage as follows: "PC-based control technology from Beckhoff, which has already been used successfully for almost three decades in all areas of industrial automation, has become an integral component of intelligent building automation. The demands on the intelligence of buildings have increased

constantly in recent years, such that the energy efficiency as well as a good 'return on investment' is the priority.

The idea of a 'green building' based on sustainable, energy efficient construction and building use can be realized with intelligent, integral building automation. Beckhoff offers a universal, scalable building automation control system covering PC- and Ethernetbased controllers and a modular I/O system for logging all data points in buildings." [13]

BECKHOFF allows customers to use the hardware and run their own soft-PLC implementations to read and write the field IOs – TwinCAT is not mandatory to program the CPU. This can be done by the implementation of the ADS (Automation Device Specification) (see Figure 3.1) communication protocol. ADS is free, fully disclosed [16] and well documented [18], that makes it a good choice of integration into host-systems. Vendors can also use TwinCAT's real-time capabilities to communicate with IOs and sub-controllers, while the program's logic is implemented in a software of their choice, and the communication to TwinCAT is executed over ADS, OPC-UA or OPC-DA, Modbus, etc.

Following the company's philosophy there are several software-vendors with their own implementation of a standard or non-standard soft-PLC. To mention Austrian companies, which are also relevant in building automation, the following list is provided in alphabetic order:

Company	**Website**	**PLC type**
ABM Systems	http://www.abm-systems.at	TwinCAT, IEC 61131-3
Evon Automation	http://www.evon-automation.com	IEC 61131-3 Function block diagram, .NET
HTC Kral e.U.	http://www.htc-kral.at	C-like, "Structured Text"-like
logiCals	http://www.logicals.com	IEC 61131-3
nxtControl	http://www.nxtcontrol.at	IEC 61499, IEC 61131-3

Table 3.1: Austrian soft-PLC vendors working with BECKHOFF hardware

This diversity of solutions with each having their strengths give investors and users investment safety because even in the worst case, only the software layer has to be touched and the hardware can be fully reused.

The wide range of available components, the constant developments and the openness makes BECKHOFF a reliable partner in building automation projects.

In contrary to other manufacturers' Direct Digital Control (DDC) modules, the BECKHOFF terminals can be used for all different trades in a building: they are suitable for HVAC systems but lighting, sunblinds, security access system and multimedia solutions can be realized as well. The reason for this and one of the most important differences is, like mentioned above, that the cycle times are way faster than those of DDCs. Common DDCs run with cycle times of 1s or more, while the standard cycle times for BECKHOFF systems are 1ms in hard real-time.

Also very important is the standard communication medium, CAT5E cable and Ethernet topology, which is the most often sold cable type all over the world. Besides that, it is available in nearly every room in a modern building. In contrary to EIB/KNX, LON and RS485, Ethernet

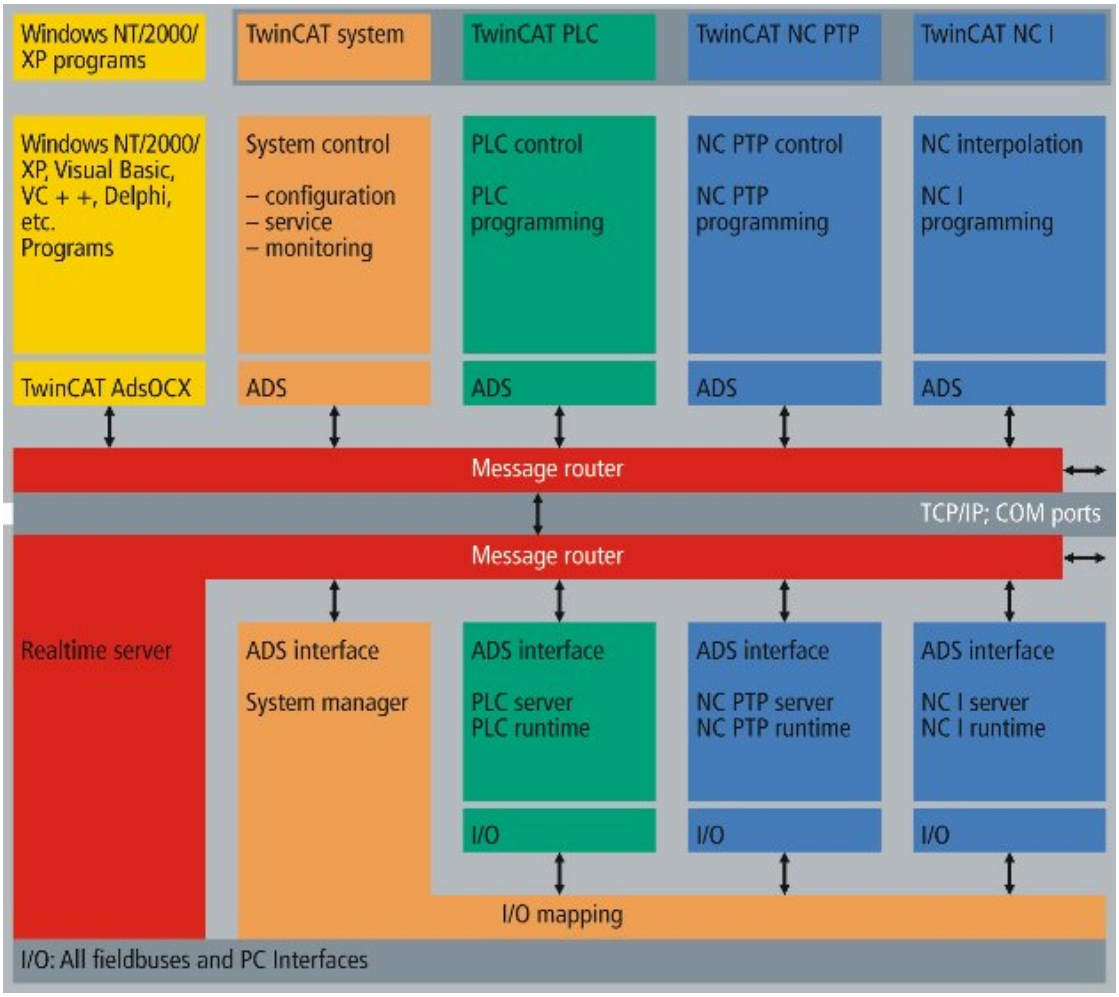


Figure 3.1: TwinCAT ADS system concept with router

does not need special cables (like for example the Belden cable for LON) and it offers 10.000 times higher bandwidth than KNX.

CHAPTER 4

Hardware solution and implementation

4.1 Design methods

Providing a current and detailed circuit diagram has been one of the goals of the project. Therefore, a suitable tool for documentation was required. Three products were evaluated closer:

- ePlan, the de-facto standard for drawing circuit diagrams [19]
- sPlan, a smaller, simple circuit diagram designer tool [8] and
- QelektroTech, an open source software tool [6]

The pro arguments for ePlan were, that it is the most used CAD tool in industry for creating circuit diagrams. The contras were the 40 page limit in the student version and the price for the classroom license. Also, the learning of a highly complex program like ePlan stands against this project's volume – the chosen tool will become the standard documentation tool for circuit diagrams at the institute.

sPlan is a small tool for drawing circuit diagrams and it supports lots of features a small project like this demands. It has parent-child relationship support and allows the creation of new libraries. The biggest contra argument is, that it doesn't support automatically labeled cross references to more than one page. This is required when potential lines are used to carry a certain electrical potential from one page to the other. It is also required that cross reference labels get updated each time the user inserts a new page in the diagram. This feature is supposed to be implemented in the near future by sPlan's vendor, Abacom [8].

QelektroTech is a promising open-source project which supports cross references (but no automatic numbering/labeling!), but lacks official support of a company. It does not support the insertion of images in the version v0.2. Despite intensive research, QelektroTech was only discovered when more than 70% of the circuit diagram was already drawn in sPlan, including new library elements. A big plus for this tool is the support for Windows and Linux desktops and that it is open-source and license free.

Still, sPlan seems to be the best choice in this case as well as for the future, regarding the learning period, complexity and feature set.

4.2 sPlan library for BECKHOFF components

When starting to document, all new modules had to be created. This task was the most time-consuming. Furthermore, a definition how the BECKHOFF modules should look like was required. Right now there is a nice set of macros available for the BECKHOFF products, that were used in the project. In the end, the publication of these modules either through the institute or through SourceForge is planned.

To achieve consistent macros and templates, the following guidelines for creating templates were used:

This chapter covers the software tools that were used to create BECKHOFF terminals and other components in sPlan. The result is a new library of BECKHOFF modules, which can be extended freely by others when needed. The concept was to have a photo representation of the components at the start of the wiring diagram, which act as "parents" for the in-detail drawings.

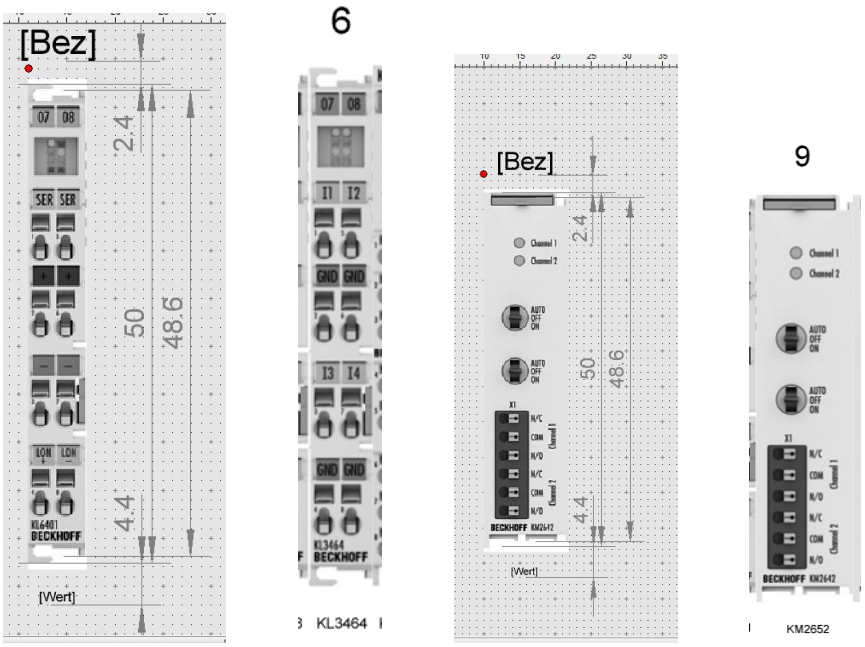
The "[Bez]" string ("Bez" stands for "Bezeichner", identifier in German) holds the terminal's position in the terminal block. It is formatted with Arial, 12 points. The numbering is created automatically depending on the order of adding the components to the diagram. The "[Wert]" string ("Wert" stands for value in German) holds the terminal's type, like KL3208. It is formatted with Arial, 12 points.

Table 4.1 displays the most important properties of the modules that need to be set when adding new components to the library.

Property	**Parent**	**Child**
Font	Arial	Arial
Font size "Bez"	12	12
Font size "Wert"	8	8
Auto numbering "Bez"	yes	no
"Bez" value visible	yes	yes
"Bez" value	empty	<PARENT_ID>
"Wert" value visible	yes	no
"Wert" value	modules name	empty

Table 4.1: Properties for parent and child modules

Figures 4.2a and 4.2b show how the connection between the photo representation and the detail drawing was created. First, the photo representation is inserted on the overview page, then the in-detail view on the corresponding page.



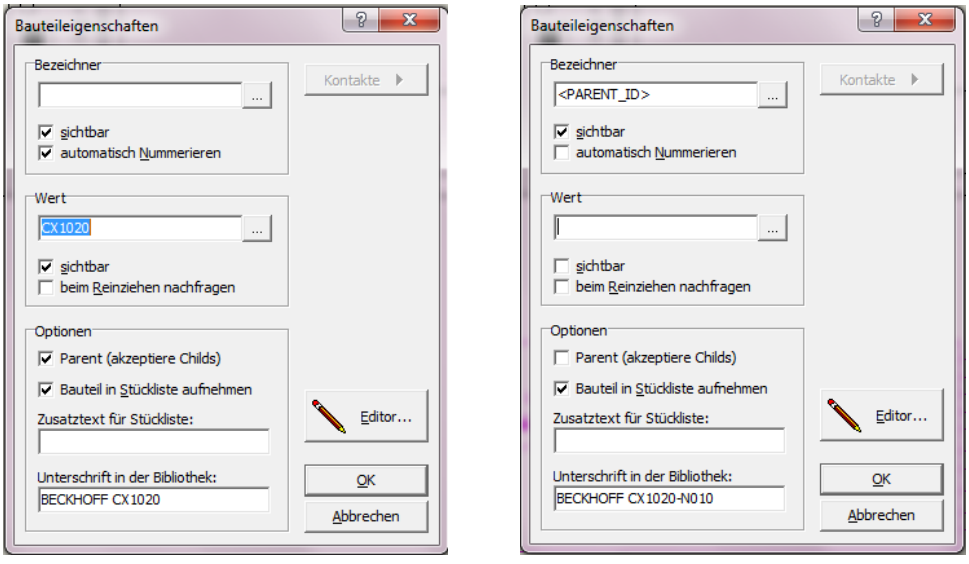
(a) BECKHOFF 12mm terminals with dimensions for future extentions of the library

(b) A 12mm terminal in use with real values for Bez and Wert strings

(c) BECKHOFF 24mm terminals with dimensions for future extentions of the library

(d) A 24mm terminal in use with real values for Bez and Wert strings

Figure 4.1: Template values for creating new components



(a) The terminal's photo representation properties

(b) The terminal's in-detail representation properties

Figure 4.2: The terminal's photo and in-detail settings

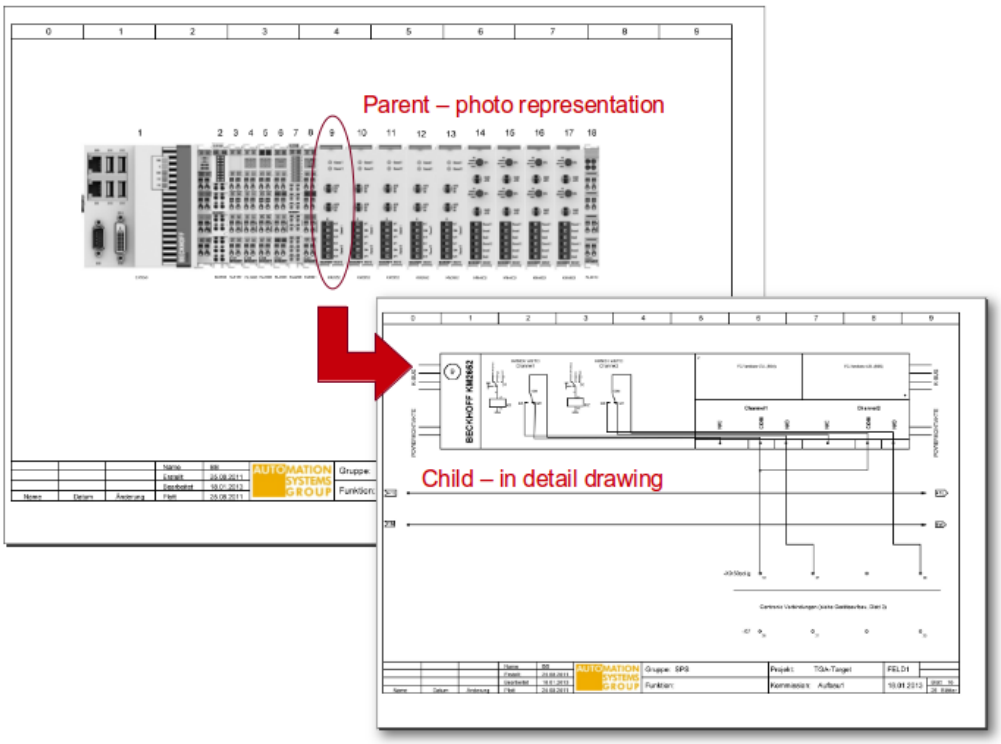


Figure 4.3: The relation between the photo and in-detail terminal's representation

4.3 Building the railmount cases for Centronics connectors

The signal integration using Centronics connectors and cables was a source of discussion at the beginning of the project. It was decided that the best solution is to build solid railmount cases instead of the plastic cases used in the past (see Figure 4.4).

Railmount cases have the advantage that (as their name says) they can be mounted on a standard DIN-rail. With small time consumption they can be equipped with PCB terminal blocks with screw connections. Six boxes had to be built, a 50- and a 36-pole box for the field signals, two 24-pole boxes for the PT1000 temperature sensors and another two 24-pole boxes for putting the NTC20k-sensors onto the same standard as the other signals. We decided to use Axxatronic products [11] as they turned out to be highly customizable yet offer good quality. All components used for a box are illustrated in Figure 4.5.

The first step was to adopt the right size of the printed circuit boards (PCBs). The PCB size depends whether a 50-, 36- or 24-pole box was to be created. The exact dimensions can be read in Appendix 6.6. The cutting was done with a trimmer to get the best results. The conductive copper on the bottom of the PCBs needs to be interrupted (Figure 4.6), so that the signals connecting at one end don't mix up with the signals from the other end. The disconnection was done with the help of a rasp and a trimmer as well.

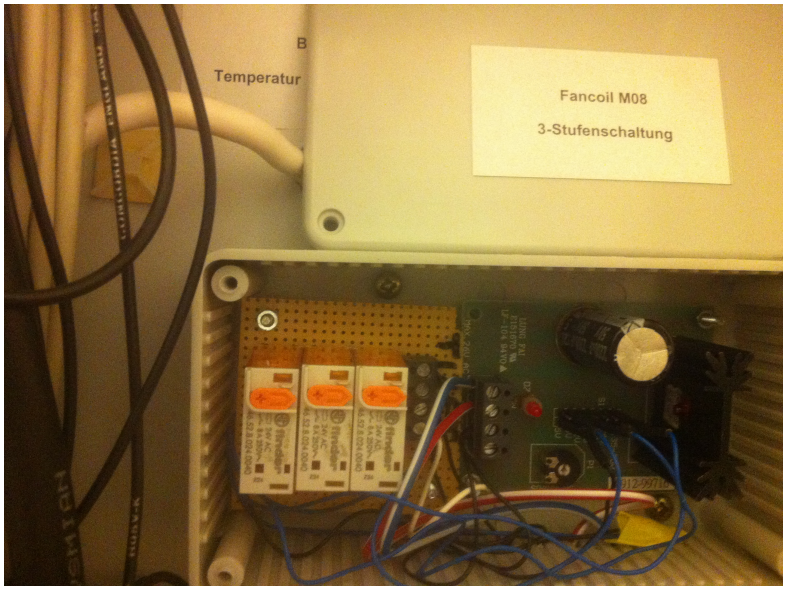


Figure 4.4: Plastic cases used for connecting signals in the past

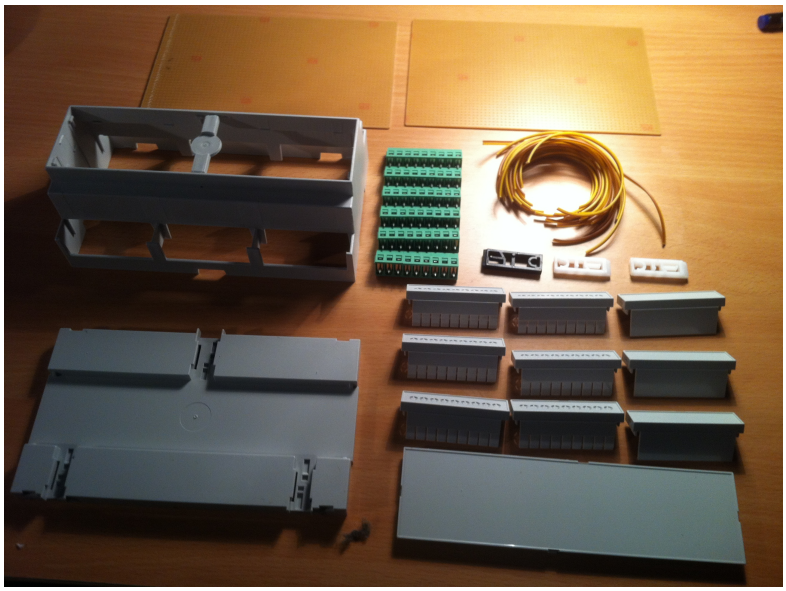


Figure 4.5: All components required for a 50-pole Axxatronic box

The second step involved the fitting of the Centronics connectors into the top plate of the railmount boxes. This was done with the help of a vernier caliper, so that an exact opening of the connector's shape could be cut into the top plate.

The third step was to cut the cables that carry the signals from the PCBs to the Centronics connectors to the desired length (see Figure 4.7).

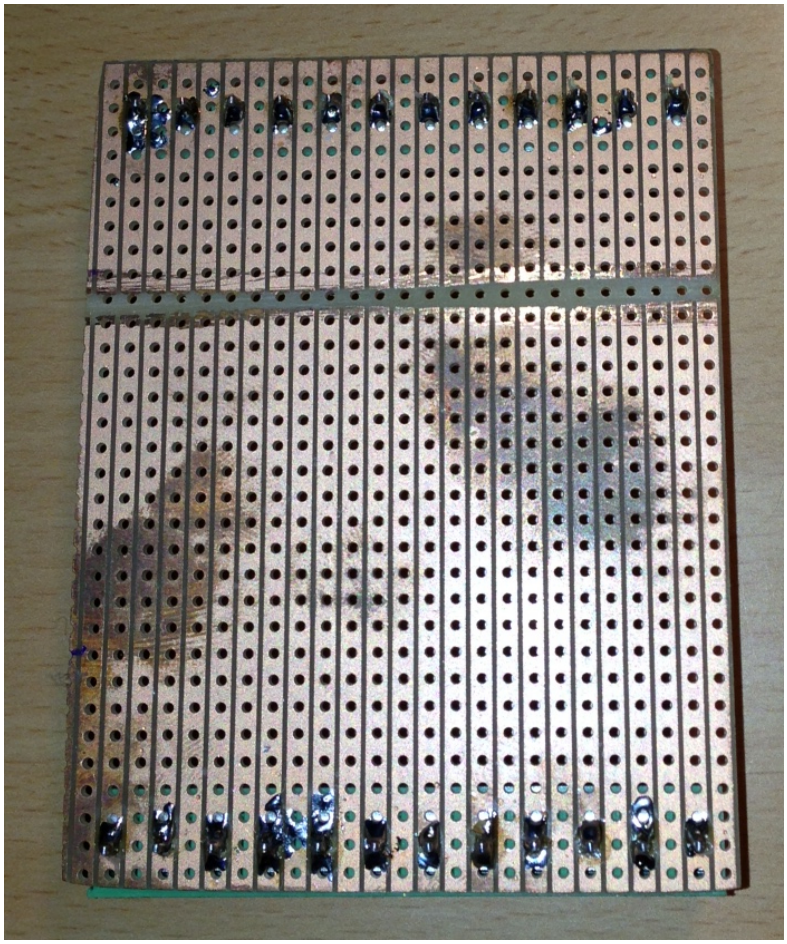


Figure 4.6: Disconnecting the wires on the back of a PCB

When finished, both ends of these cables were stripped and slightly soldered to hold the laces together. When all cables were prepared they were soldered to the Centronics connectors one by one. This step was one of the most difficult exercises, since precise work is required to prevent already connected wires to come loose again (see Figure 4.9).

The fourth step was to solder the terminal blocks to the PCB.

Figure 4.7: Cables with the right length and soldered ends

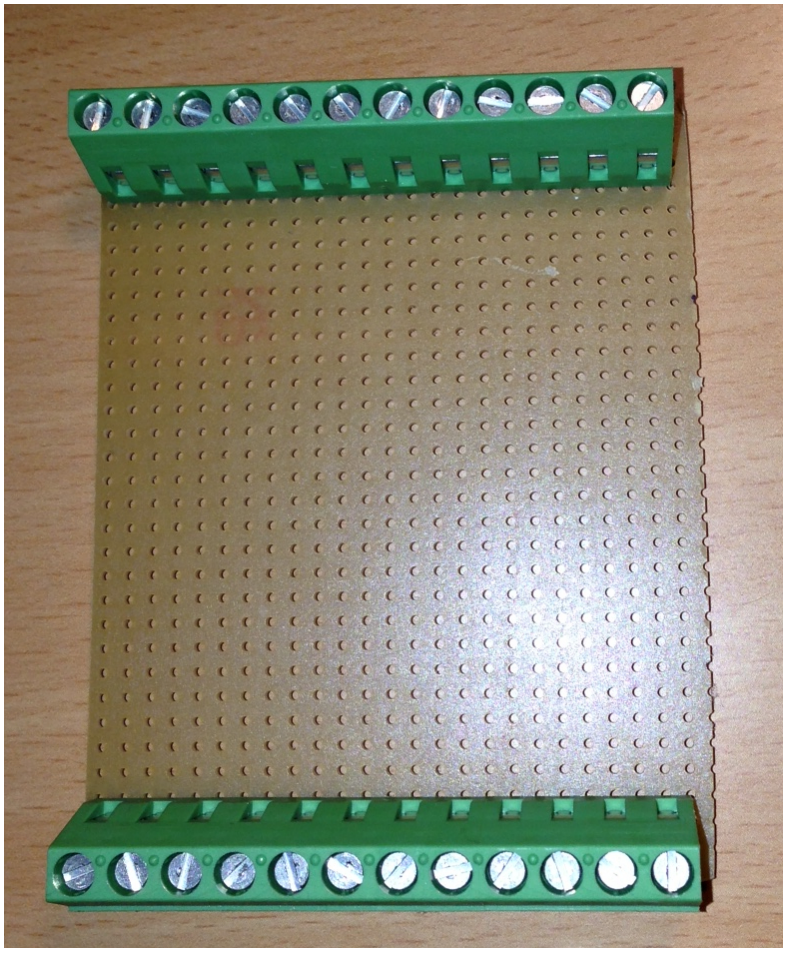


Figure 4.8: Terminal blocks soldered to the PCB

The fifth step involved to connect the other ends of the cables to the PCBs, one cable every second lane. Also, the PCB terminal blocks with screw connections had to be soldered on the PCBs. At first the holes had to be widened slightly, so that the blocks‘ feet could pass through the hole. Thereafter they were soldered on the back of the PCB (see Figure 4.9).

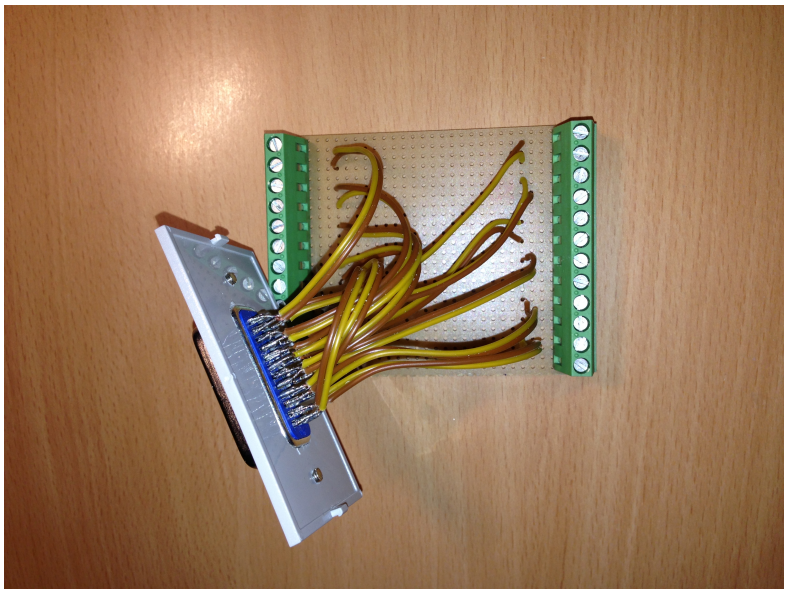


Figure 4.9: Finished PCB before being put into the box

When finished, the last step demanded to install the PCB in the Axxatronic box, fix it with two screws and insert the top plate into the box.

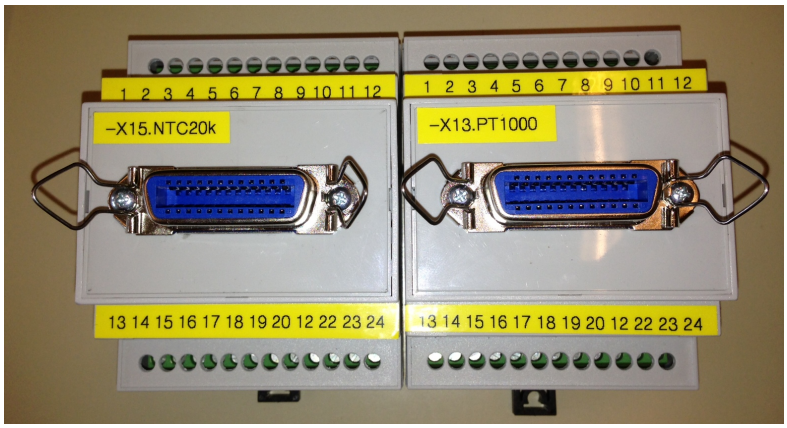


Figure 4.10: Two finished boxes for temperature signals

The last remaining exercise was to build a cable carrying 24 signals with a Centronics male connector on both ends. Soldering the connectors was a demanding job and attention was to

pay to not make any already connected wire come loose again, just like when the Centronics connectors were soldered into the Axxatronic boxes.

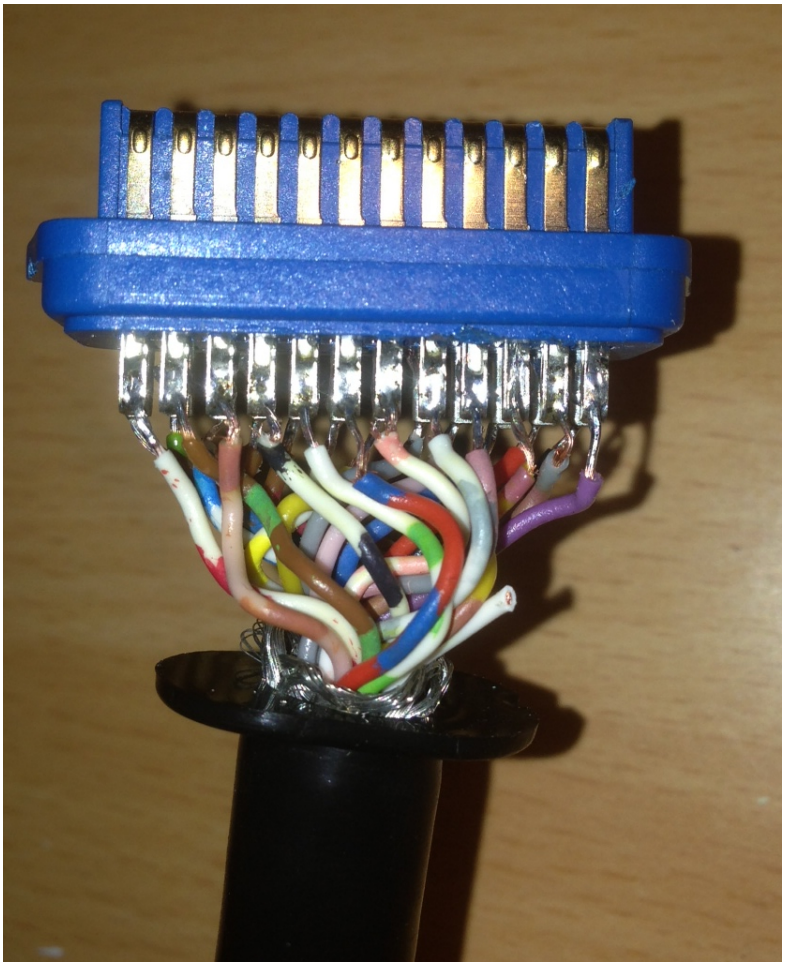


Figure 4.11: A cable with a Centronics connector

Material used for building the Centronics boxes

Product	Article Nr.	Source
Hutschienengehäuse CNMB-4-KIT	531443	Conrad Elektronik
Hutschienengehäuse CNMB-6-KIT	531445	Conrad Elektronik
Hutschienengehäuse CNMB-9-KIT	531447	Conrad Elektronik
Steckereinsatz 24polig	740276	Conrad Elektronik
Buchseneinsatz 36polig	740306	Conrad Elektronik
Buchseneinsatz 50polig	740322	Conrad Elektronik
Printklemmenblock MKDS 1,5/12-5,08	743516	Conrad Elektronik
Datenleitung Unitronic LIYCY 25X0.14	608890	Conrad Elektronik
PCB board	530249	Conrad Elektronik
PCB board	530249	Conrad Elektronik
Hutschienen-Netzteil PULS MiniLine ML30.241 24V/DC 1.3A 30W	519017	Conrad Elektronik

Table 4.2: Material list of the used components

Wiring the components

After the ground plate was equipped with a DIN rail on the front and on the back, the wire ways had to be installed on the back of the plate. Those wire ways carry the cables to the right connection of the railmount boxes. After the BECKHOFF components were mounted on the rail, a few holes were drilled to allow the cables to go through to the back side, into the wire ways (see Figure 4.12).

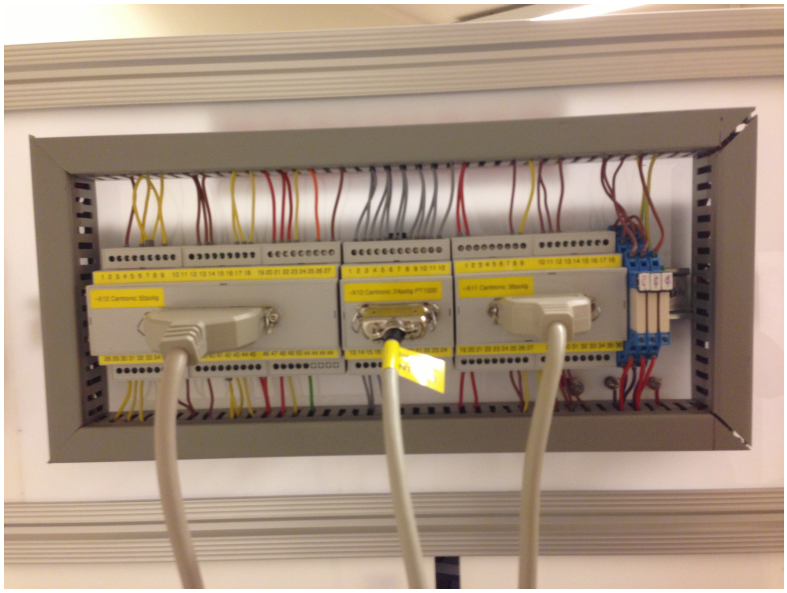


Figure 4.12: Wire ways on the back of the plate

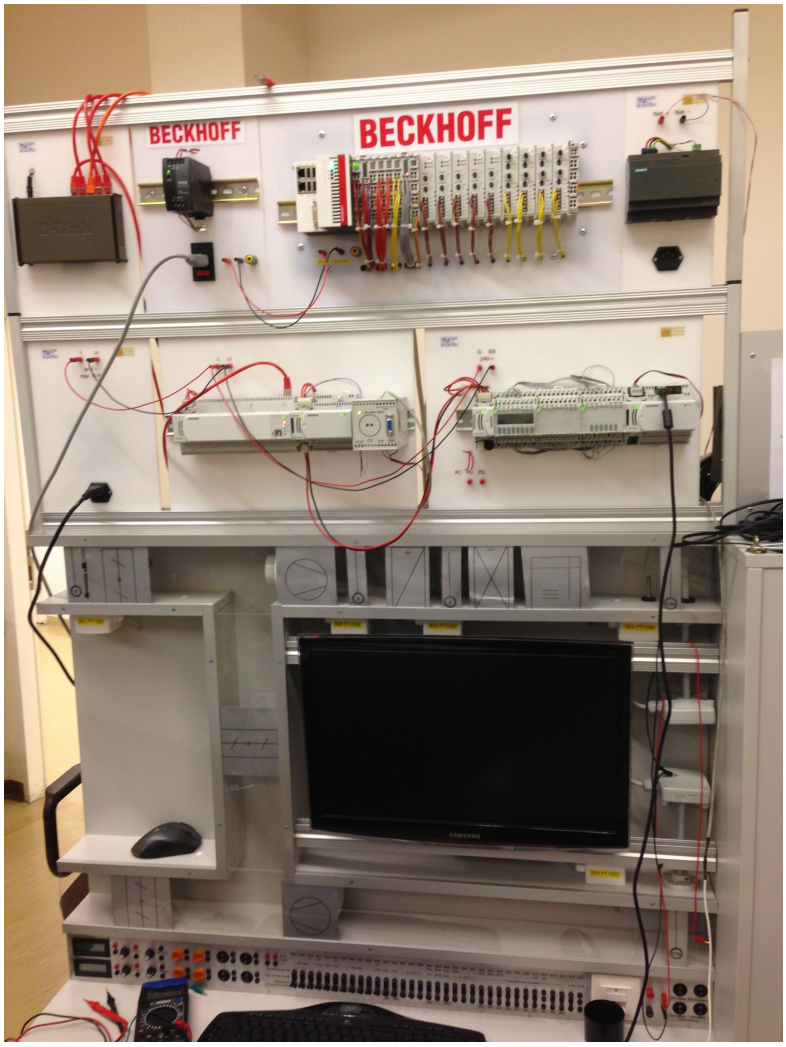


Figure 4.13: The final installation of all connector boxes and the BECKHOFF PLC

4.4 Brief programming introduction

Short introduction to TwinCAT programming

Currently, TwinCAT exists in two versions: TwinCAT 2.11 and TwinCAT 3. TwinCAT 2.11 is the version used throughout this project. TwinCAT 3 is a new implementation, in which the whole development environment was moved to Microsoft Visual Studio. This shift has lots of benefits – there is only one tool needed for configuring the hardware, writing the PLC application and creating a visualization either with the HMI/web visualization distributed with TwinCAT or with any of the programming languages available in Visual Studio. It also offers the possibility to program the hardware in real-time with C/C++ or transfer MATLAB/Simulink models into

PLC code with debugging support as well.

TwinCAT 2.11 will be used because when the project started TwinCAT 3 hadn't been available yet. In a follow up project the code could be re-used in TwinCAT 3 and a model based implementation in MATLAB/Simulink could be realized as well.

After installing TwinCAT 2.11, the programmer has to open the TwinCAT System Manager. By right clicking on the TwinCAT symbol next to the system clock and choosing "System Manager" the Manager starts with the last opened project.

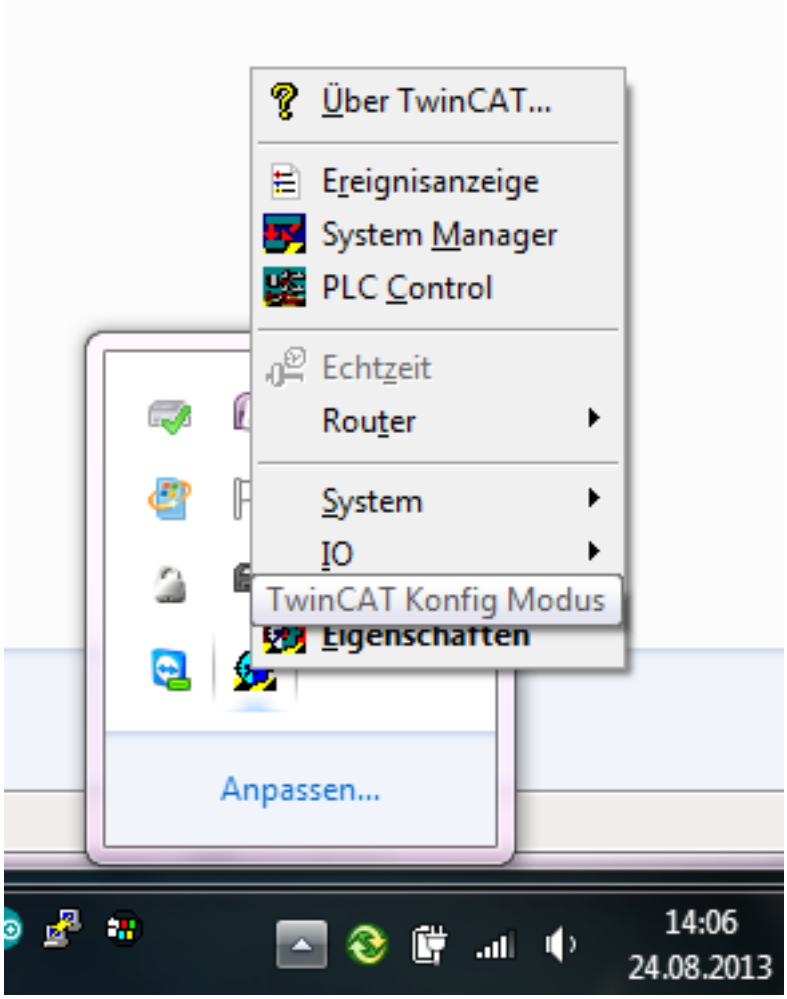


Figure 4.14: Opening TwinCAT over its symbol right next to the system clock

Starting the System Manager for the first time, it will open an empty project. The System Manager is a tool for configuring the hardware of the project.

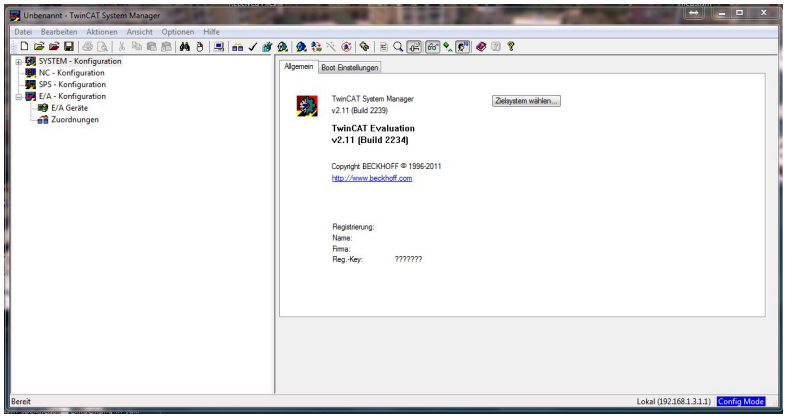


Figure 4.15: TwinCAT System Manager with an empty project

First, the network has to be scanned for existing hardware components or the components have to be created manually. If the hardware is up and running an ADS-route to the hardware has to be created. As mentioned earlier, ADS is a protocol developed by BECKHOFF for communicating with their components. ADS-commands can be any type that communicate with the Soft-PLC and in some cases with the hardware. All ADS-commands are sent through the ADS-router, see [12]. That is the reason behind creating an ADS-route as the first step in a project. Also, only devices that have routes to each other, are allowed to communicate with each other. For creating a route, a username and a password is required. These ADS-routes also act as a security mechanism. The System Manager communicates with the hardware over ADS-commands as well.

As mentioned earlier, a route to the device is required. For creating the route, select "Choose target system" from the "Actions" menu or select the symbol from the menubar.

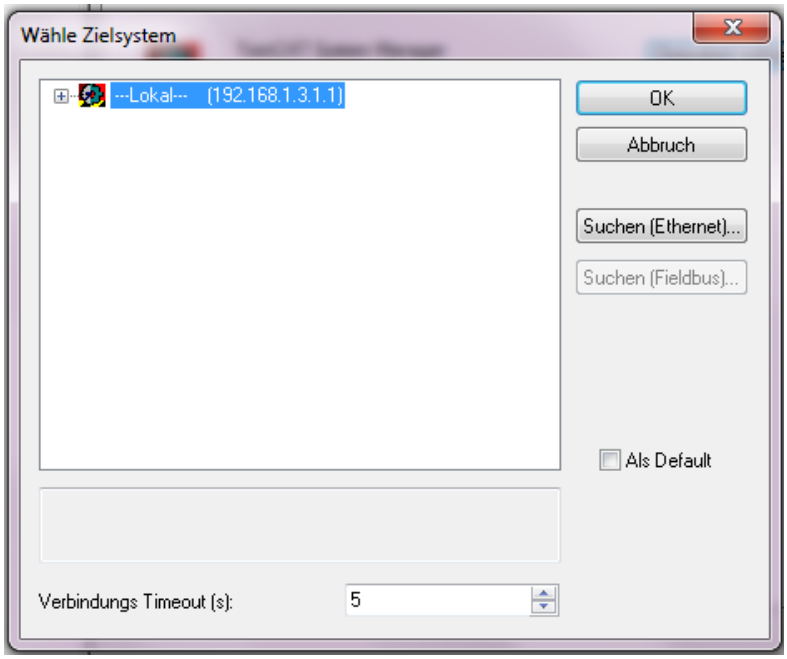


Figure 4.16: Searching for a target system

A new window appears where the button "Search (Ethernet)" (see Figure 4.16) needs to be selected. A new window pops up where selecting the button "Broadcast search" (see Figure 4.17) should be the next step. The broadcast search should deliver a list of ADS-capable devices that were found on the network (see Figure 4.18).

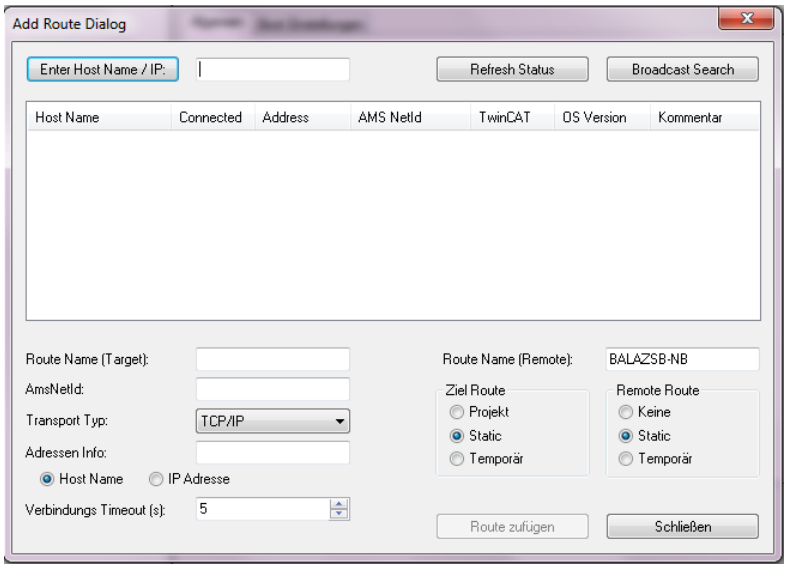


Figure 4.17: Broadcast search the network to find PLCs and add routes to them

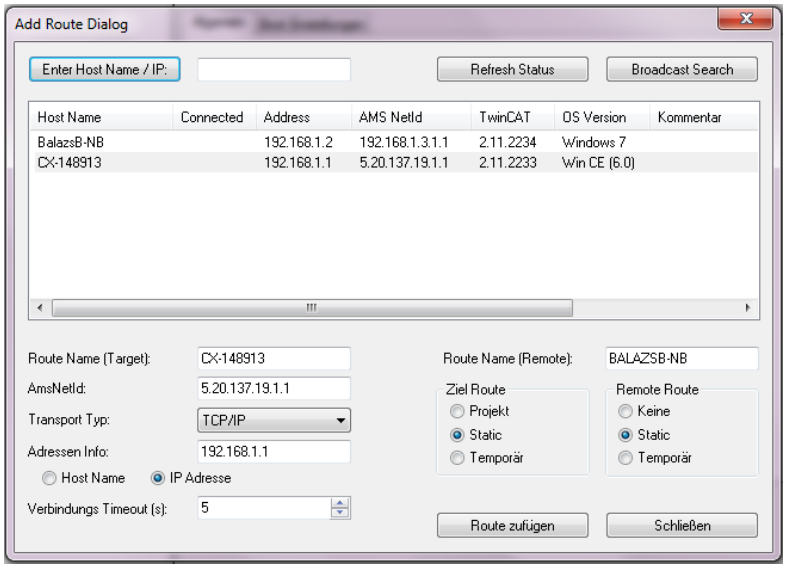


Figure 4.18: The broadcast search found targets on the network

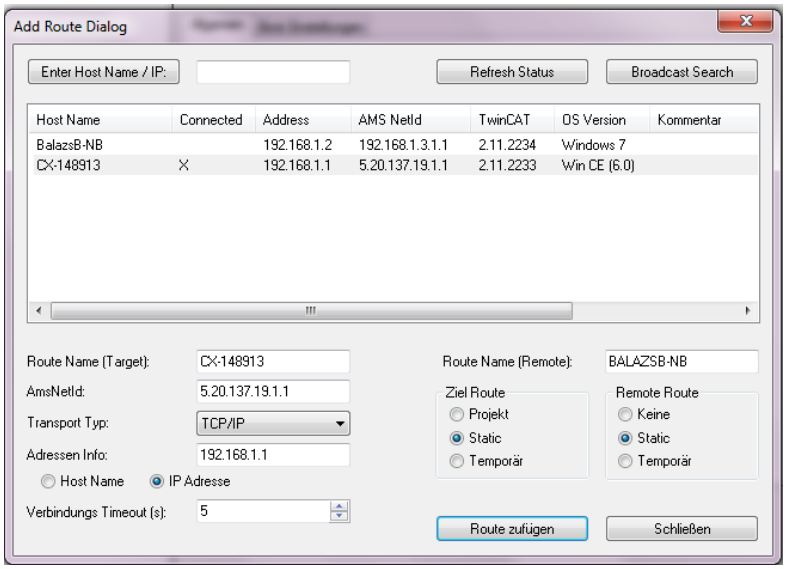


Figure 4.19: A route was added to the CX-148913 target

Marking the desired device and saying "Add route" generates an X-mark in the "connected" column right next to the device (see Figure 4.19). After that, the search window can be closed and in the window from Figure 4.16 the desired device's runtime task should be selected.

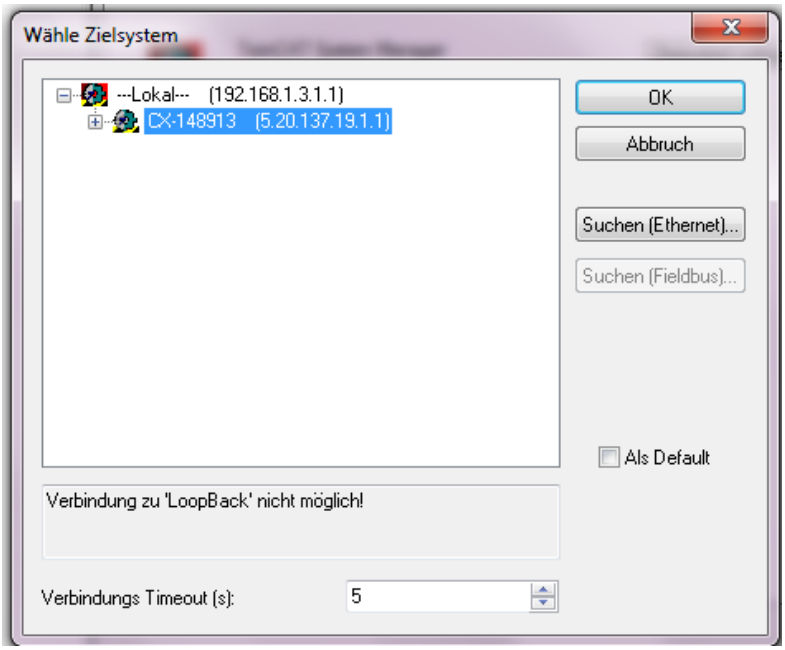


Figure 4.20: Choosing the newly found target

When the target system switch was successful, the target's name should appear in red at the right bottom (see Figure 4.21).

Figure 4.21: When successfully logged in, the target's NetID changes to red

At this point, the hardware can be scanned and inserted into the project. At first, the device has to be in config mode. By clicking on the button for config mode the system switches to that mode and allows the user to apply changes to the hardware configuration.

Figure 4.22: Symbol for switching to config mode

By right clicking on the device tree and choosing "Scan..." the device will be scanned for local hardware and other bus interfaces.

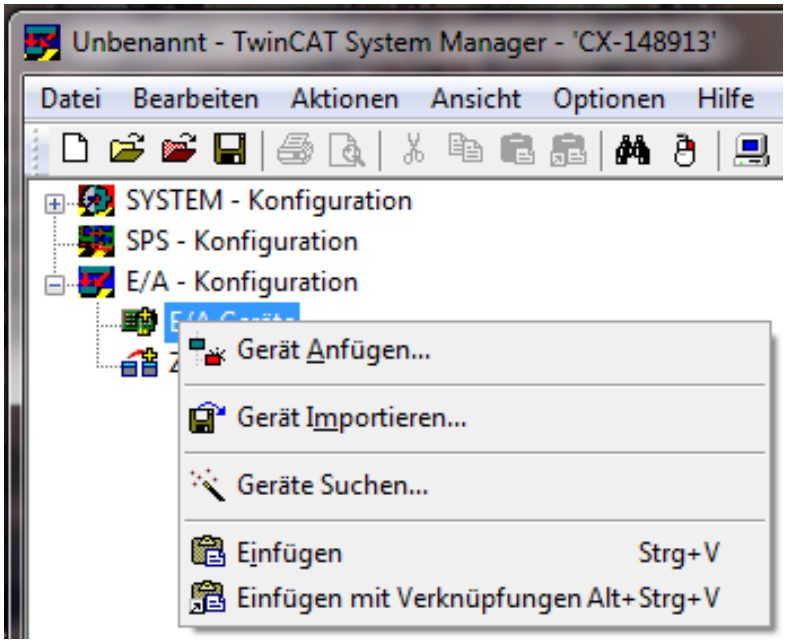


Figure 4.23: Right-click on the device tree for scanning the hardware

When the configuration is ready, it has to be activated on the device. This can be done by clicking on the activation button. The system asks after successful activation if the system should be set into Free Run mode. This mode is useful when the system engineer wants to check the cabling but has no PLC program ready yet. Free Run allows to check every input by monitoring the input value in real-time and by manually altering the outputs' value.

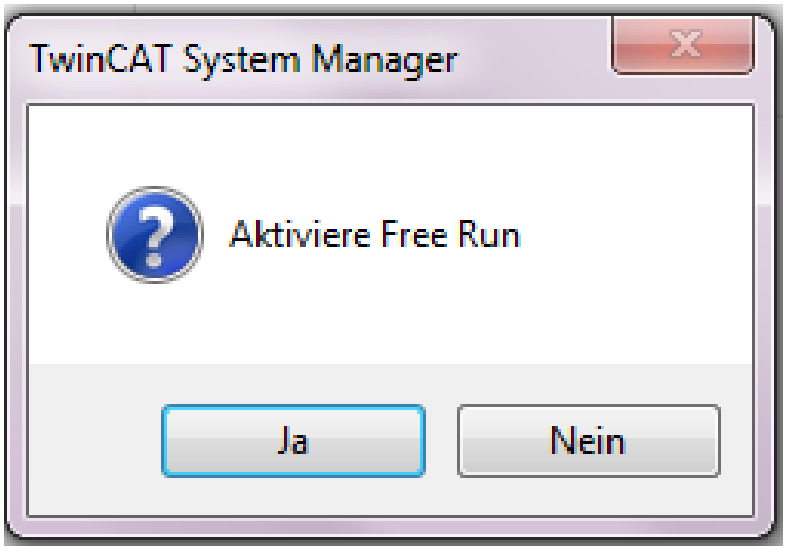


Figure 4.24: Activating Free Run allows to test IOs without having a PLC program

Figure 4.25: When Free Run is activated, the symbol in the taskbar switches from red to blue periodically

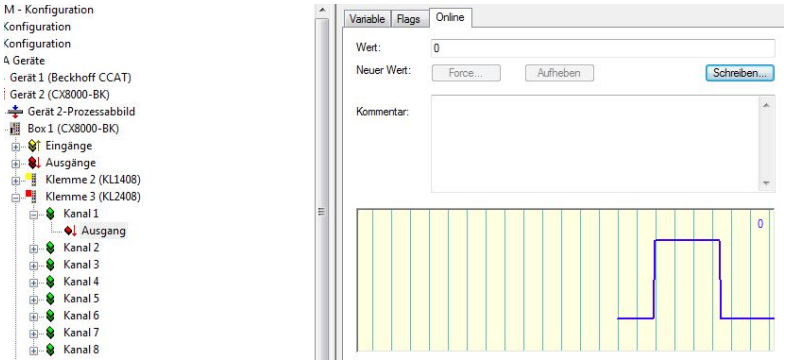


Figure 4.26: In Free Run the engineer can test IOs without a PLC program

The PLC program has to be written in "PLC Control". When starting for the first time it creates a new project. On startup the editor asks which target system will be used (this can be changed later on). The target CPU on the TGA-Target is an Atom 1.1GHz CPU (x86), so the right choice is "PC or CX (x86)".

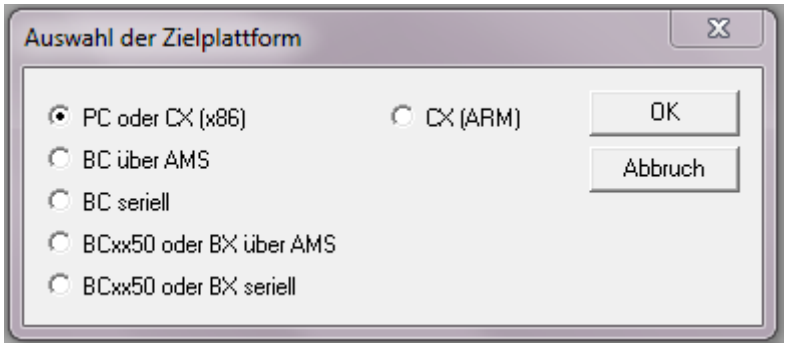


Figure 4.27: The right CPU architecture has to be chosen for each PLC program

The next dialog asks which kind of module the user wants to create and which programming language the user prefers. The IEC61131 (see [30]) offers two graphical and 2 textual standardized languages:

- Ladder diagram (LD), graphical

- Function block diagram (FBD), graphical
- Structured text (ST), textual
- Instruction list (IL), textual

Sequential function chart (SFC) is an additional language, which provides elements to organize programs for sequential and parallel control processing.

4.5 PLC program for HVAC control

The PLC program was implemented in a way that it should be kept in balance between complexity and understandability. For that reason, only two PID controllers were implemented in the project. The controllers were taken from an open source project called OSCAT [7]. The OSCAT PLC libraries implement HVAC function blocks that can be used freely in projects.

The OSCAT building library in version 1.00 [24] and the OSCAT basic library in version 3.33 [23] were used.

The main idea behind the HVAC controller was to set up a PID-controller (Function block called CTRL_PID) that takes care of the temperature regulation. The controller can either heat or cool, the operating mode depends on the value and the sign of the difference between setpoint and current value (DIFF output of CTRL_PID). When the difference is negative, the cooler will be started. Otherwise the heater will be turned on. To avoid swinging from one operating mode to another, a so called deadband is introduced which will allow the current value to drift slightly away from the setpoint value in any direction. This is referenced to as a sequential controller [25].

The PID-controller's output is a value between -100% (cooling) and 100% (heating). The output's absolute value has to be scaled to the 0-10V hardware output values that control either the heating or cooling circuit pumps and air supply and exhaust ventilators. The 0-10V values scale like 0 is 0 and 10V are a signed integer value of 32767. The PID-controller's output sign is used to determine the operating mode (cooling/heating).

Because the cooling and heating mode have different controller characteristics, the PID is filled with different values for KP, Tn and Tv when there is a changeover in the operating mode. Refer to Figure 4.35 for the controllers schematics and the tuning possibilities.

The second PID controller takes care about the humidity value in the target system. Because humidity in the air influences the dew point at which water condenses, a dew point calculation is introduced into the program. This calculation will not allow to lower the temperature setpoint under the dew point, so that condense water and damages therefore can be avoided in the system.

The whole program code can be found in Appendix 6.7.

4.6 Human-machine-interface, visualization

In every control system it is a need for the operator to check and adjust the control system's parameters. This is done with the help of a SCADA-system (supervisory control and data aquisition) in large plants - in smaller ones this task is realized with the help of smaller visualization

tools/HMIs (human-machine-interface). SCADA systems often have more tasks to take care of than simply visualizing the plant's current state: they have to

- log values and user inputs every x seconds/event based to a database
- provide reporting tools for management, finance and technicians
- in case of alarms an alarm reporting and alarm management tool has to take care of the alarms
- provide different access levels for technicians
- store documentation on different parts of the plant, like wiring diagrams, datasheets, etc.

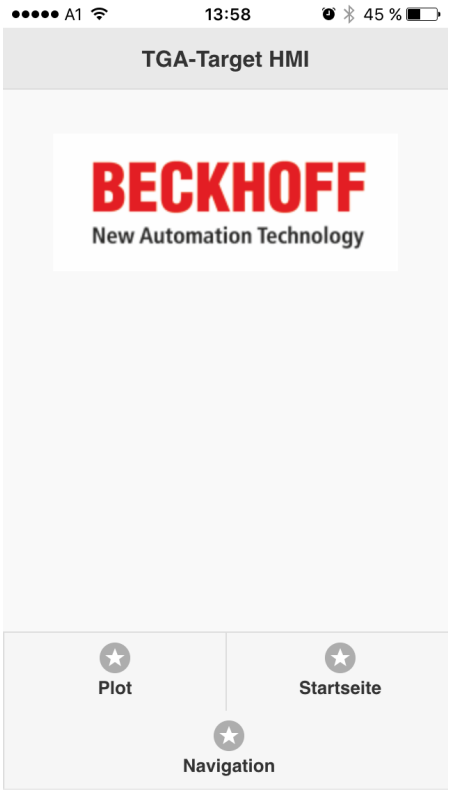
In the case of the target, a web-HMI was chosen for obvious reasons:

- there should be no need/requirement for an extra program that has to be installed
- no external device like a monitor/display should be necessary to use it
- it should be accessible in a web browser
- smartphone support would be a nice-to-have feature

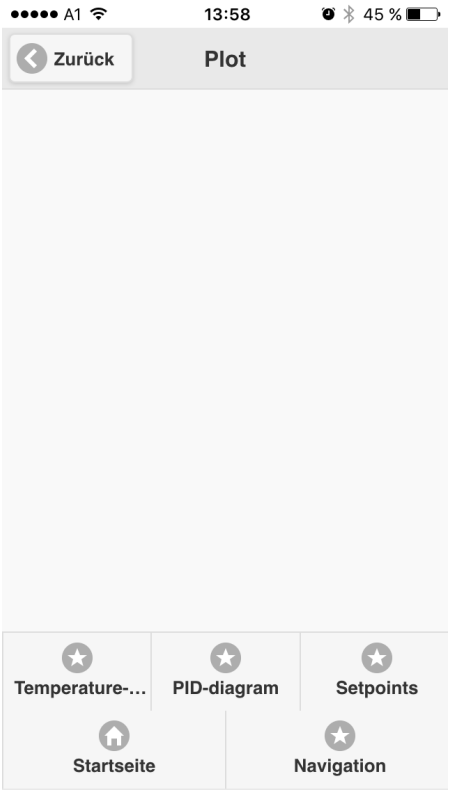
So an existing demo code from BECKHOFF Austria was taken to demonstrate the openness of the BECKHOFF Automation System / ADS protocol. The demo code relies on the jQuery mobile framework [22], which offers components for a GUI like buttons, sliders, input fields, etc. With this framework's help it was possible to create a plot for the setpoint and the exhaust temperatures and also for the PID output. The desired temperature for summer/winter or heating/cooling can also be set from the HMI.

Another benefit of PC-based automation is the integration of different services into one CPU. In this case, the HMI was served by the Windows built in web server, IIS, so no extra hardware was needed for this task.

The Figures 4.28 to 4.32 show the jQuery mobile application in demo mode.

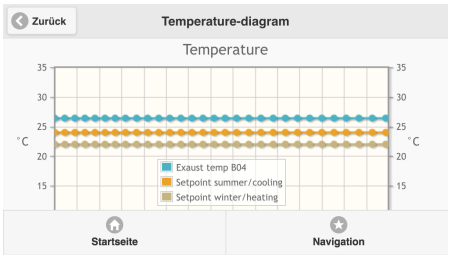


(a) JQM startpage on an iPhone 5s

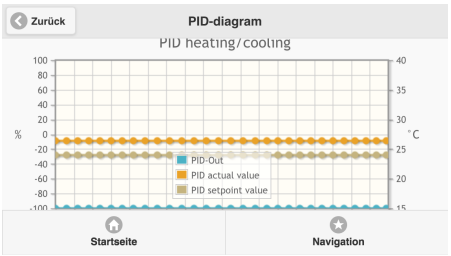


(b) JQM submenus

Figure 4.28: jQuery Mobile HMTL5 HMI on an iPhone 5S



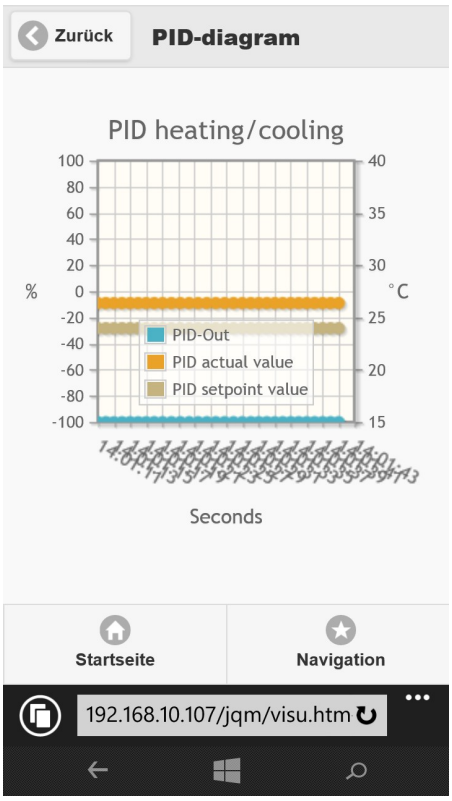
(a) JQM plot of the setpoint for summer, winter and the actual temperature



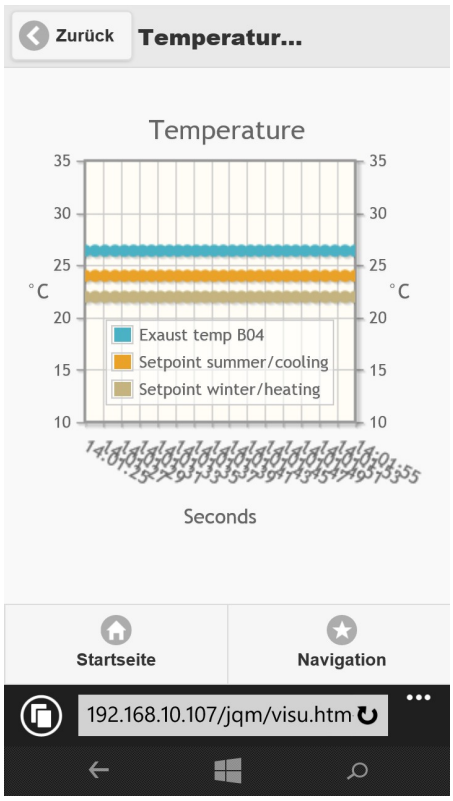
(b) JQM plot of the PID controller with PID output, actual temperature and setpoint

Figure 4.29: jQuery Mobile HMTL5 HMI plots on an iPhone 5S (landscape orientation)

The jQuery mobile framework works in every HTML5-capable browser, so the same application can be used on a Windows Phone 8.1 as well:



(a) JQM temperature plot on a WP 8.1



(b) JQM PID plot on a WP 8.1

Figure 4.30: jQuery Mobile HMTL5 HMI on a WP 8.1 (portrait orientation)

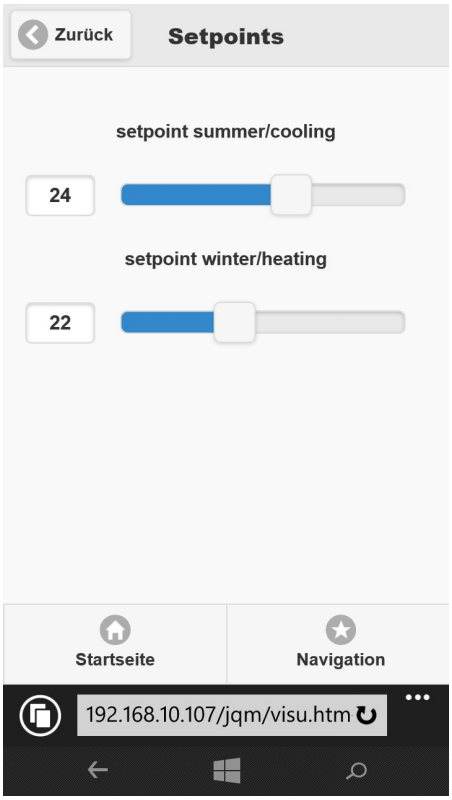
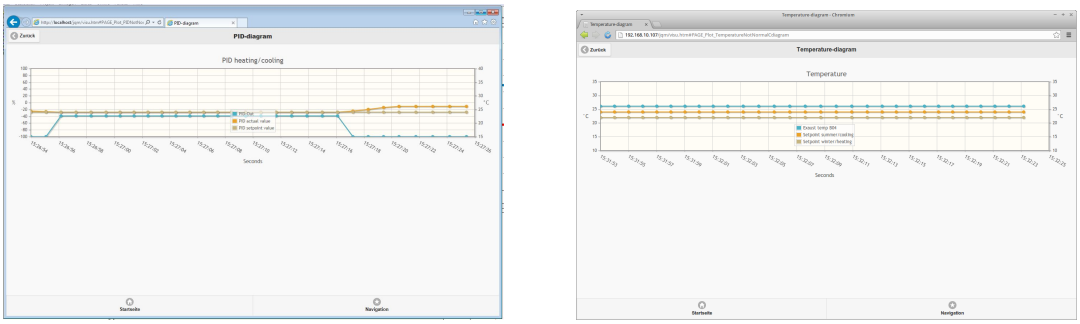


Figure 4.31: jQuery Mobile HTML5 HMI on a WP 8.1, setpoint sliders

For comparison, Figure 4.32 shows the same application on Microsoft Windows 7 in Internet Explorer and on Ubuntu Linux 13.10 in Google Chrome



(a) JQM on Windows 7/Internet Explorer

(b) JQM on Ubuntu Linux/Chrome

Figure 4.32: jQuery Mobile HMTL5 HMI on desktop systems

TwinCAT-HMI

TwinCAT offers a feature called HMI that can be run in full-screen mode or just as a visualization in the TwinCAT editor. For testing purposes it was useful to set up a simple HMI which can be seen in the following Figures.

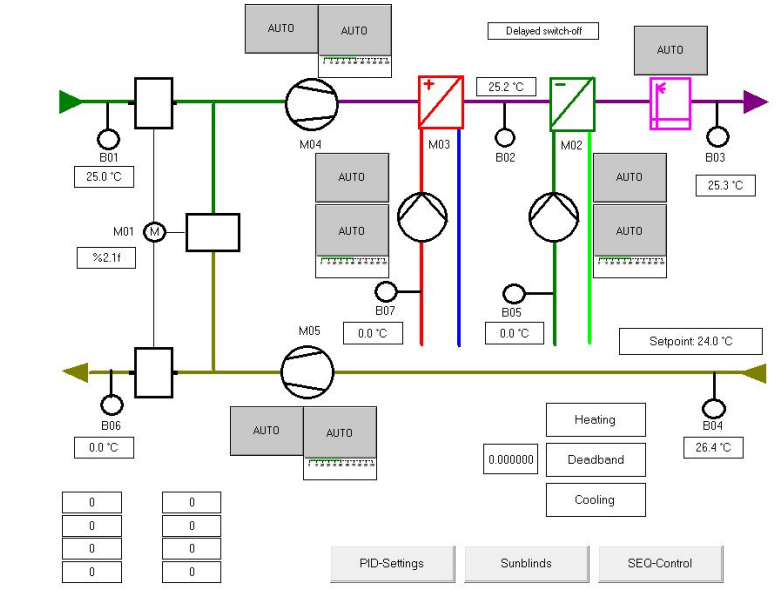


Figure 4.33: The target's schematics in the TwinCAT-HMI

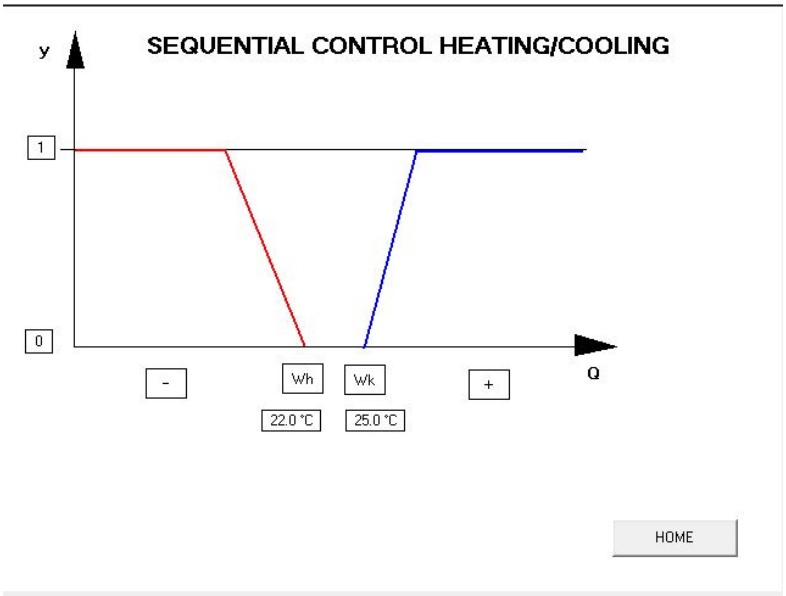


Figure 4.34: The page for the sequential control

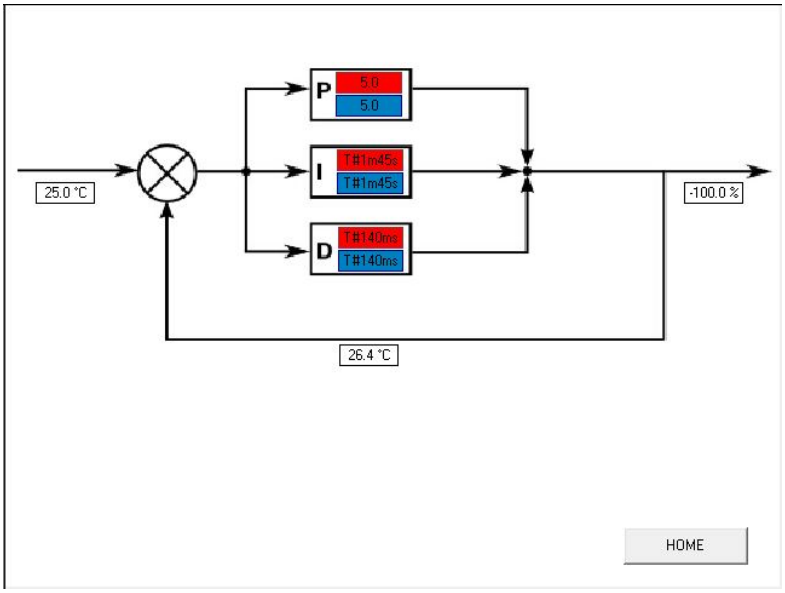


Figure 4.35: The page for tuning the PID controller

4.7 Diagram of the PLC program for HVAC control

Figure 4.36 shows a diagram in which the controller's behavior can be analyzed. To better understand the diagram the following circumstances have to be kept in mind:

- the environment's temperature was approx. $27.5\,^{\circ}\mathrm{C}$, the diagram was recorded in the summer
- the heater and the cooler only had limited power for heating/cooling and even those were differing from each other
- there is only one sequential PID controller implemented that is working in changeover mode, so it has an output range from -100% to +100%. The negative output is responsible for cooling, the positive for heating.
- The red line is representing the boiler's on/off signal, the blue one is responsible for the cooler's switch on/off
- The pumps and fans are controlled by the absolute value of the PID controller's output, so they are run in speed controlled mode.
- There is a small optimizer strategy on the PID controller's output so that the system doesn't get caught in a constant switching from cooling to heating. The strategy says that once the heater or cooler has started, they have to remain switched on for the next few minutes (the parameters can be adjusted, of course). This allows that the relays are not constantly being switched and guarantee for a longer lifespan. Also, the PID controller's

output change is only then submitted to the pumps, when the change is over a certain amount. That helps to smoothen the pumps' run behavior.

- The pink line represents the setpoint and the black one the exhaust temperature. There are three setpoint changes, at first a heating phase with a setpoint change of 0.8K, then a cooling phase with a negative setpoint change of 0.6K and later a second one with 0.8K.
- The green line is the PID controller's output value which is applied to the pumps and fans.

To remember the target's schematics, refer to Figure 4.33

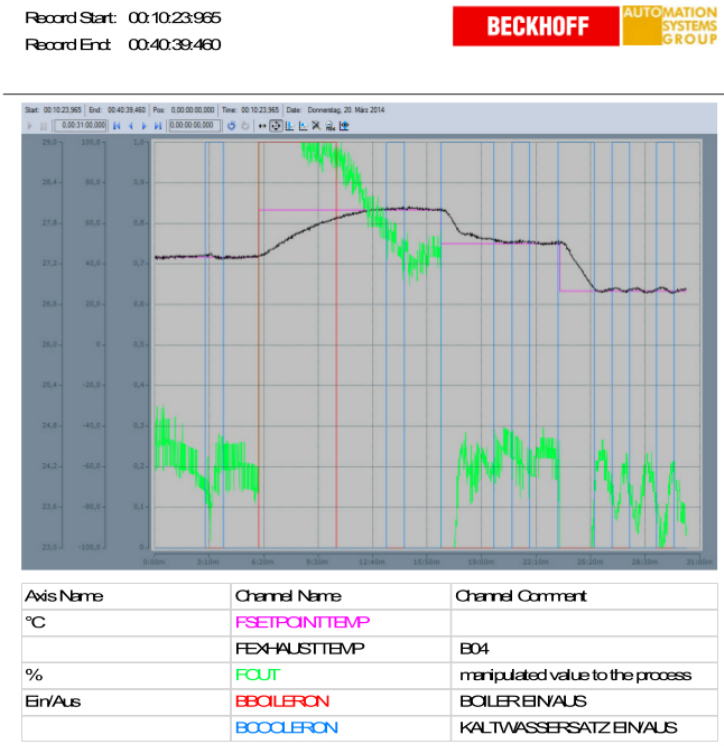


Figure 4.36: PID controller's behavior

CHAPTER 5

Summary and future work

5.1 Programming

Creating a PLC program for the ventilation system is the common way for realizing such a project. There are also model based approaches, which can also be realized with the BECKHOFF IO system. The model can be built either in Matlab/Simulink or LabVIEW. TwinCAT 3 offers the possibilities to build model based controls. Future bachelor theses could deal with these aspects of controlling the ventilation system.

5.2 Wiring

The Centronics connections work in the desired way but they are not industrial quality. A high quality improvement would be to use industrial heavy duty connectors such as products made by i.e. Harting or Phoenix Contact [20]. These type of connectors have the advantage that they can carry all the wires needed in this project and implement a solid hardware connection between male and female connectors by hardware locking.

Figure 5.1: Heavy duty connectors with hardware lock

It would be wise to rebuild the whole control cabinet after a detailed planning period. Also, the custom PWM modules could be replaced by either a BECKHOFF PLC, which would be transparent to the other DDCs and PLCs, as it would transfer the 0-10V signals for the pumps and fans in phase cutting signals for the real hardware.

5.3 Manufacturing

Manufacturing the DIN rail mount boxes by hand could be automated by taking part in the Fab Lab in Vienna [21]

All the cutting jobs could be done precisely by a laser cutter or CNC - of course the time costs for learning to use the machines have to stay in relation with the precision win for the modules.

The PCBs could be designed with a CAD tool like EAGLE and be manufactured professionally either by a company or graved by a CNC application as well.

5.4 Sensors

The target system is already very well equipped with sensors. For future tests and model developments adding a CO_2-sensor and an air quality sensor would be very useful.

5.5 Future ideas

Further development could be done on the engineering side of building automation projects. Right now, a projects life cycle looks as follows: An engineering company plans the HVAC system and the room automation of a building. Thereafter, the engineering company creates a ten-

der according to the standardized bill of qualities for building services (LB HT [4] , OENORM A2063). In this tender all components of the newly planned system have to be listed in the exact quantities and the appropriate technical details. This method is error prone, because different software tools are used to draw the HVAC schematics (some kind of CAD tools) and to create the tender text or calculate the valve/pump dimensions. When the tender is completed, it is published under certain circumstances to companies who want to bid for realizing the project. After that, the tender is calculated and submitted by companies who would like to win the project. Later, a winner is determined and the winner has to go through all the steps that the engineering company already did: check every part of the HVAC system, create a wiring diagram, import the IOs to the automation software and create a control software.

This process could be realized much easier and less error prone when the engineering process would be done in an object-oriented way: a software that allows the creation of the schematics and to add the information each object depends on. To demonstrate how this would work, let us consider a pump: this pump has a graphical representation in the HVAC schematic. It has other properties that are relevant to an HVAC plant as well:

- dimension for discharge head (Förderhöhe) in m
- discharge (Förderstrom) in m^3/h
- nominal voltage in V ([1] p. 36)

On the electric side the pump needs components in the control cabinet to be built according to OENORM A2063. These components are:

- a miniature circuit breaker ([3] p. 30)
- some kind of case, e.g. a control cabinet ([3] p. 9)
- a power supply connection at least in the dimension of the pump ([3] p. 12)
- the miniature circuit breaker also requires a residual current operated circuit breaker (FI-Schutzschalter), because the pump's housing is made of steel ([3] p. 25)

The pump is going to be controlled depending on the measurement data and HVAC functions, so it needs an automation device as well ([2] p. 9)

- AutoGer Zentraleinheit 32 Eing/Ausg.
- The automation device needs two digital inputs to read the failure and operational states of the pump ([2] p. 10)
- The automation device needs one digital output to set the start signal of the pump ([2] p. 10)
- The automation device needs one analog output to set the rotation level of the pump, if the pump is a modern, digital controlled pump. In most cases this is a 0-10V signal ([2] p. 10)

Therefore an object "pump" has lots of properties that have to be considered during the engineering phase. In Table 5.1 there is a short and incomplete list of these properties and positions according to OENORM A2063.

OENORM A2063 position	Position text	pcs.
52601A	Heizungs-UWP elektr.gereg.1,5m/2,5m3/h	1
880107A	Standverteiler B600	1
880201A	Einspeisung NH-Gr.000 100A	1
880347A	FI-Schalter AC 2pol.ÜL25A In40A 0,03A	1
880401A	Motorabgang 230V LS 1,5kW	1
850101A	AutoGer Zentraleinheit 32 Eing/Ausg	1
850104A	AutoGer digitaler Eingang	2
850104E	AutoGer digitaler Ausgang	1
850104K	AutoGer analoger Ausgsang	1

Table 5.1: OENORM A2063 positions for a single pump

Of course, a pump is not the only object in an HVAC system. There are temperature sensors, valves and other equipment that have to be depicted in the project.

When this process is not automated it can be error prone, especially when changes are made because of re-engineering. Therefore, with a new engineering tool that adds these positions automatically when a pump is created or changed, the engineering process would be faster and the quality would be higher. Going a few steps further would mean that the PLC project e.g. for BECKHOFF products could be created automatically and the according function blocks could be added to the project by the planning tool as well. It would also create the PLC software and hardware connections, such that the PLC programmer has only to care about the functional details. Under which circumstances should the pump stop or how the controlling process should look like, e.g., which temperature input is the sensor value a PID controlled pump should consider and which heating diagram's setpoint values are the desired values to follow.

Also, the circuit diagram could be initialized by this tool, ePlan and other professional CAD tools can read macros and other file formats to create a skeleton with the right components for a project.

Fortunately, there is research done in this field. The approach is called "Building information modeling" [29] or short "BIM", which models every aspect of a building into the very last detail. The standard (in Austria ÖNORM A 6240-1 and ÖNORM A 6240-2 [28]) hasn't been fully completed yet and there are country-specific versions to it all over the world. The conference "Engineering Days 2015" prooved [27] that the industry is reacting positively to these developments, as companies manufacturing machines for prefabricated concrete elements are already using data from BIM databases. The data is used to insert electrical/lightning outlets, electrical cableways, ventilation ducts, etc. into the prefabricated concrete elements by robots. Hopefully, automated code generation for HVAC controllers based on BIM databases will be done in the near future.

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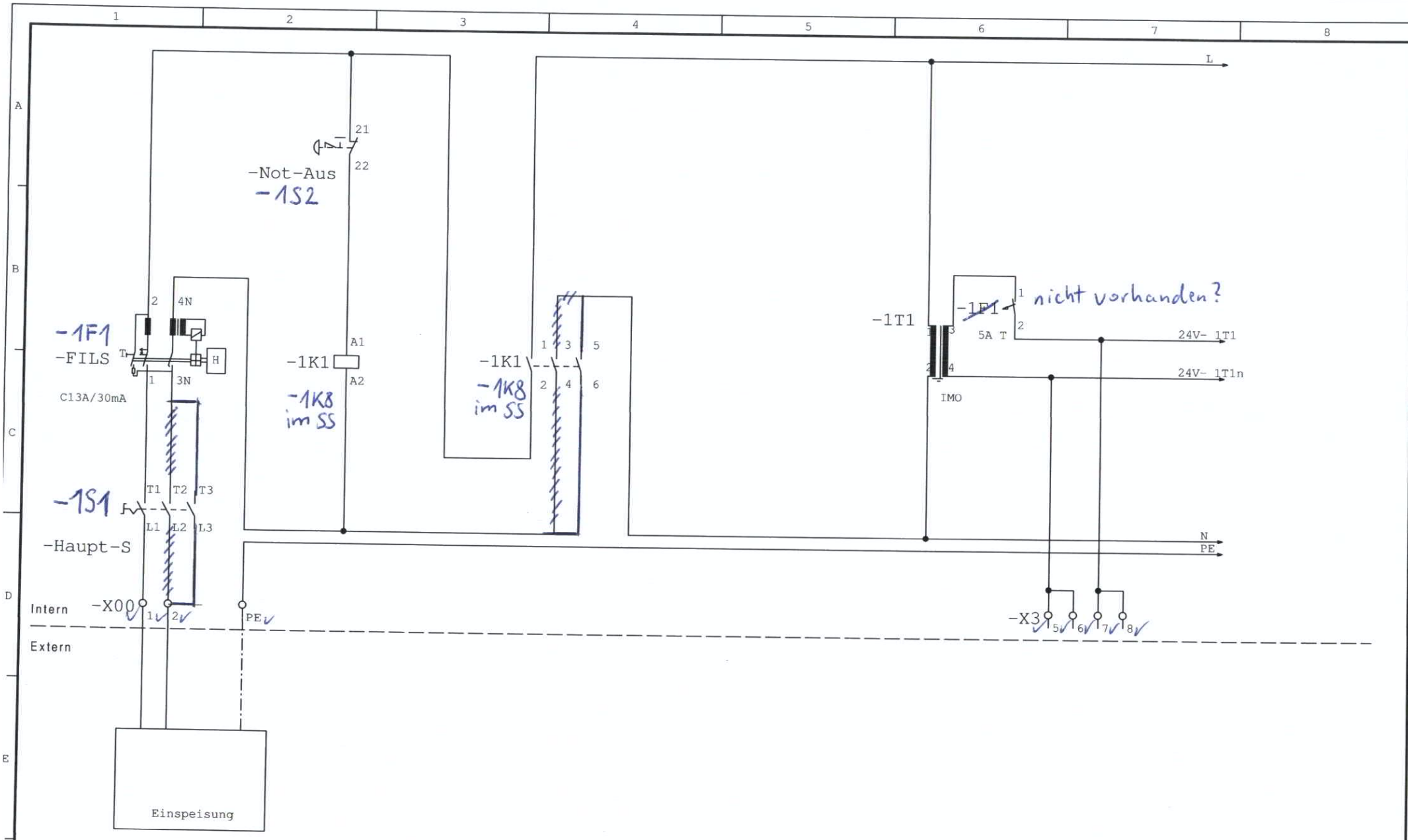
CHAPTER 6

Appendix

6.1 Updated circuit diagram of the high voltage switching cabinet



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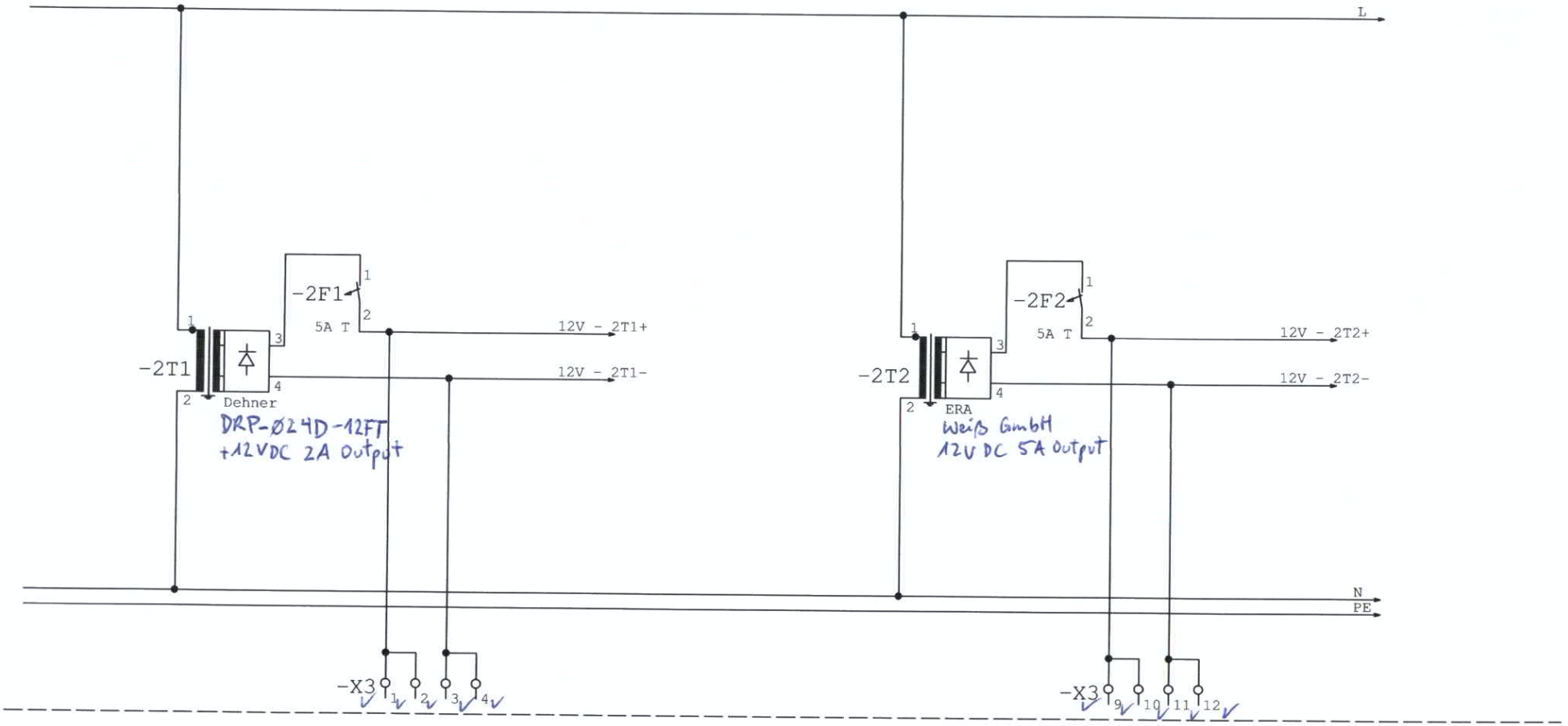

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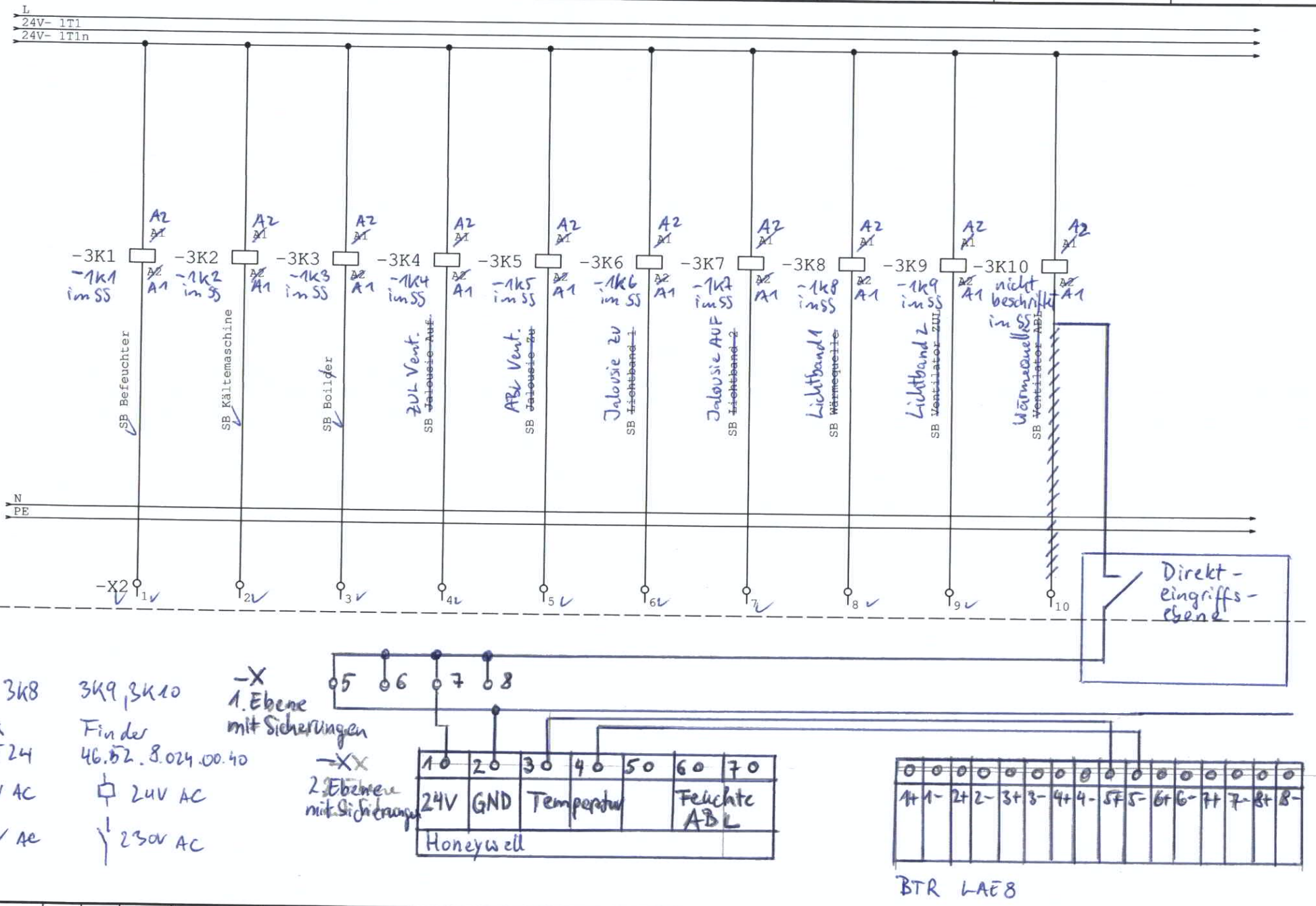

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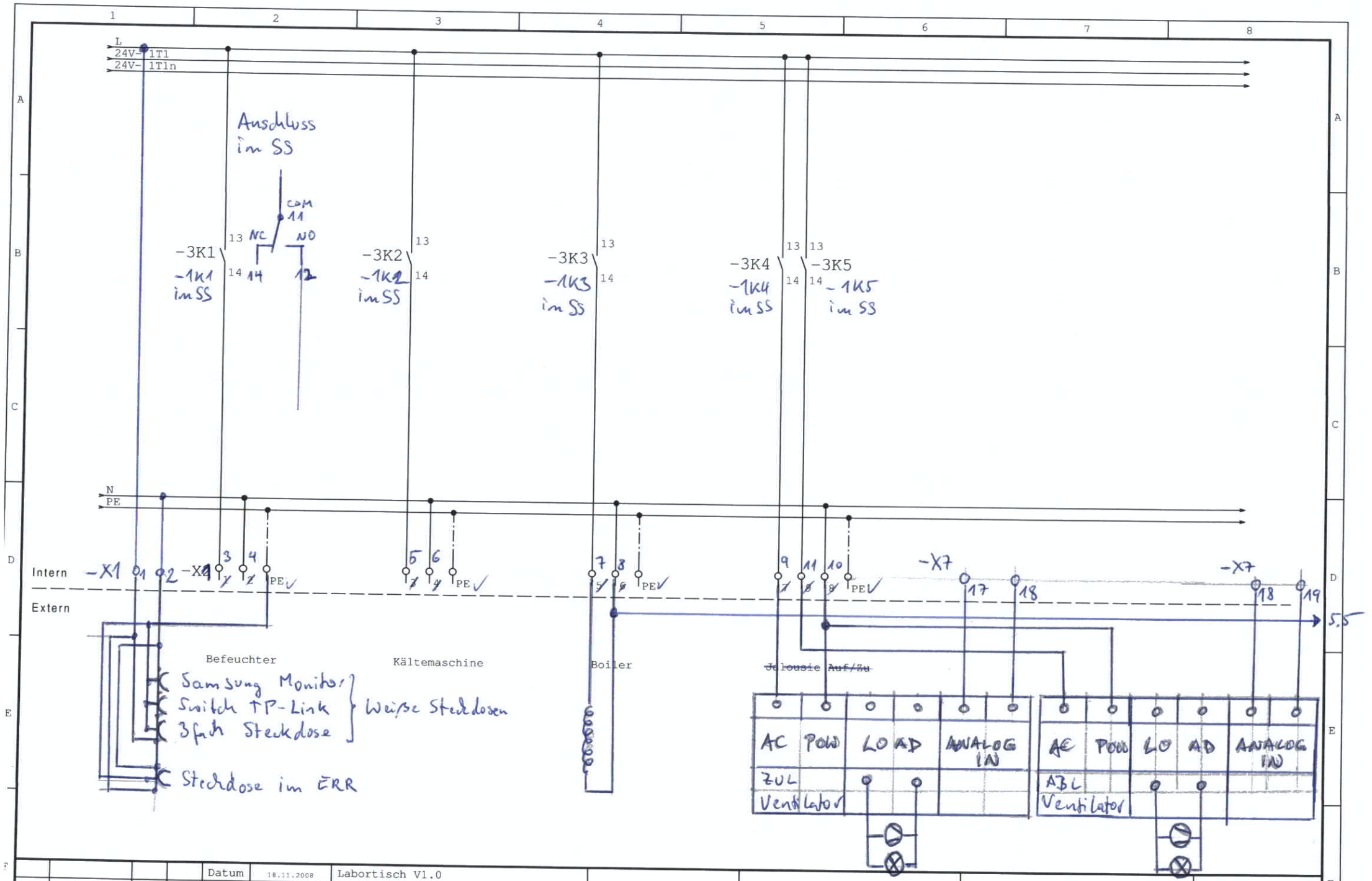

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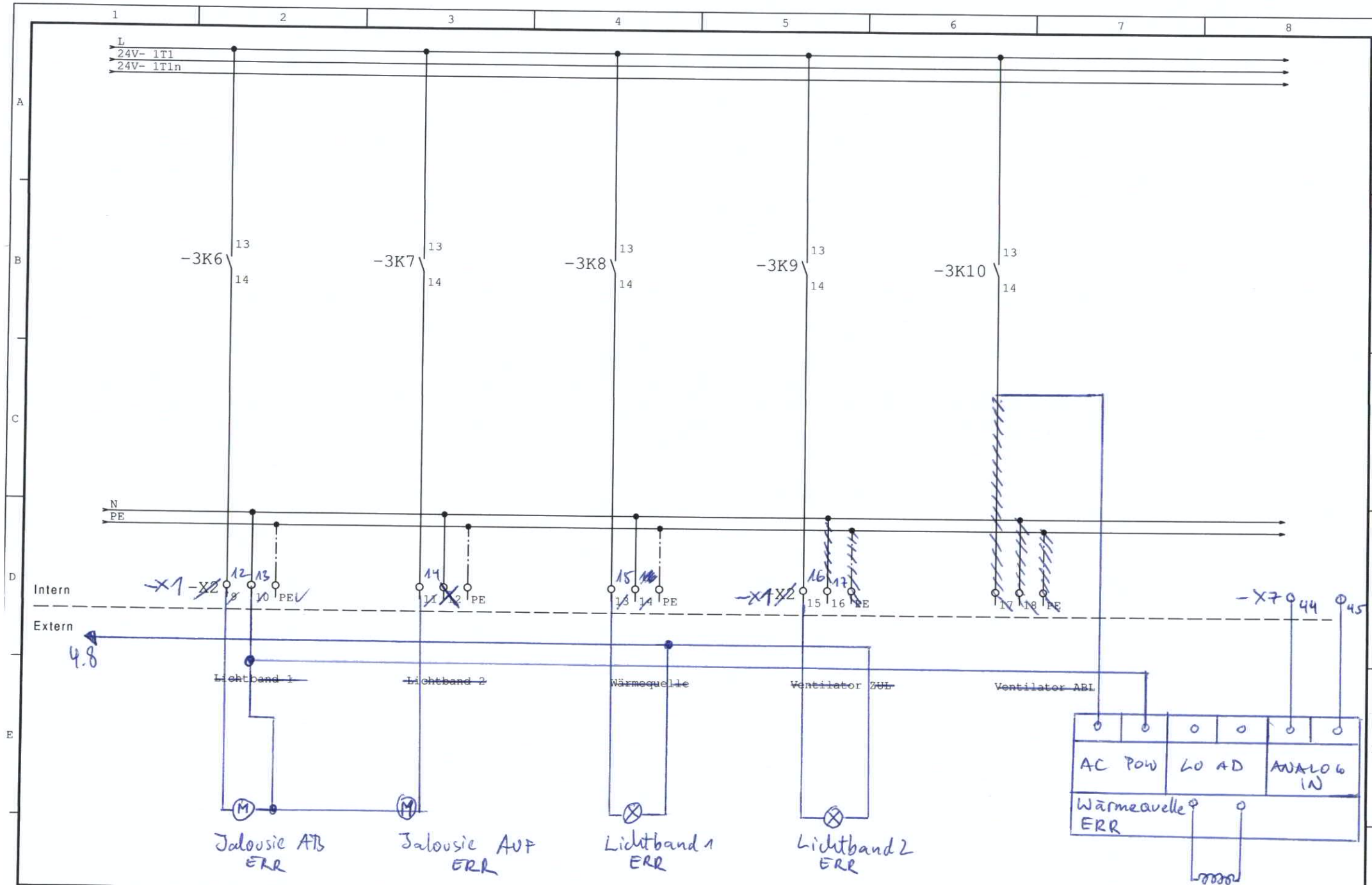

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6.2 Circuit diagram of the BECKHOFF components

0	1	2	3	4	5	6	7	8	9

Schaltschrankausführung:

ABMESSUNGEN
- Breite =
- Höhe =
- Tiefe =

SCHUTZART
- IP20

FARBE
- Tür
- Rahmen

Elektrische Kenndaten:

Betriebsspannung	: 230V AC/50Hz/PE
Anschlusswert Netz	: xxW
Steuerspannung	: 230V AC/50Hz - 24V
Signalspannung	:
Schutzmassnahme	: bauseits

Änderungen:

Klemmleiste:

X0
X1
X2
X3
X4
X5
X6
X7
X8
X9

Verdrahtungsfarben:

HAUPTSTROMKREIS

Phasen	schwarz
Neutralleiter	blau

STEUERLEITUNGEN	BIS 60V	ÜBER 60V
Wechselspannung		braun / blau
Gleichspannung	rot/violett	
Signalisierung		
Fühlerleitungen		
DDC		
Fremdspannung		

Bemerkungen:

Freigabevermerk:

TECHNISCHE UNIVERSITÄT WIEN
Vienna University of Technology

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			Bearbeitet	18.01.2013
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18.01.2013

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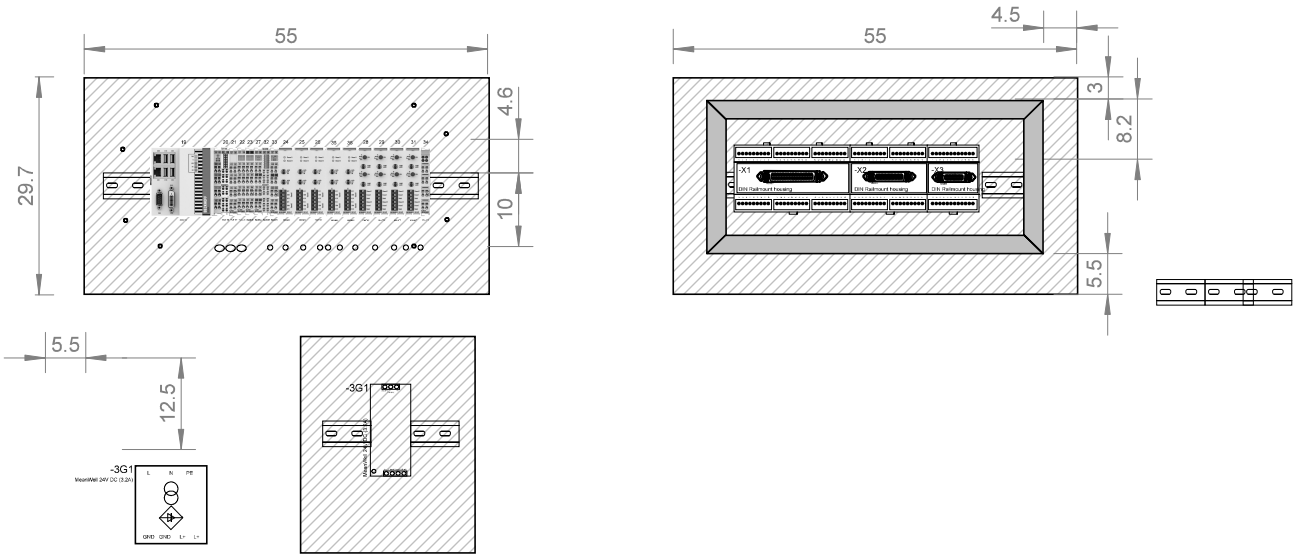

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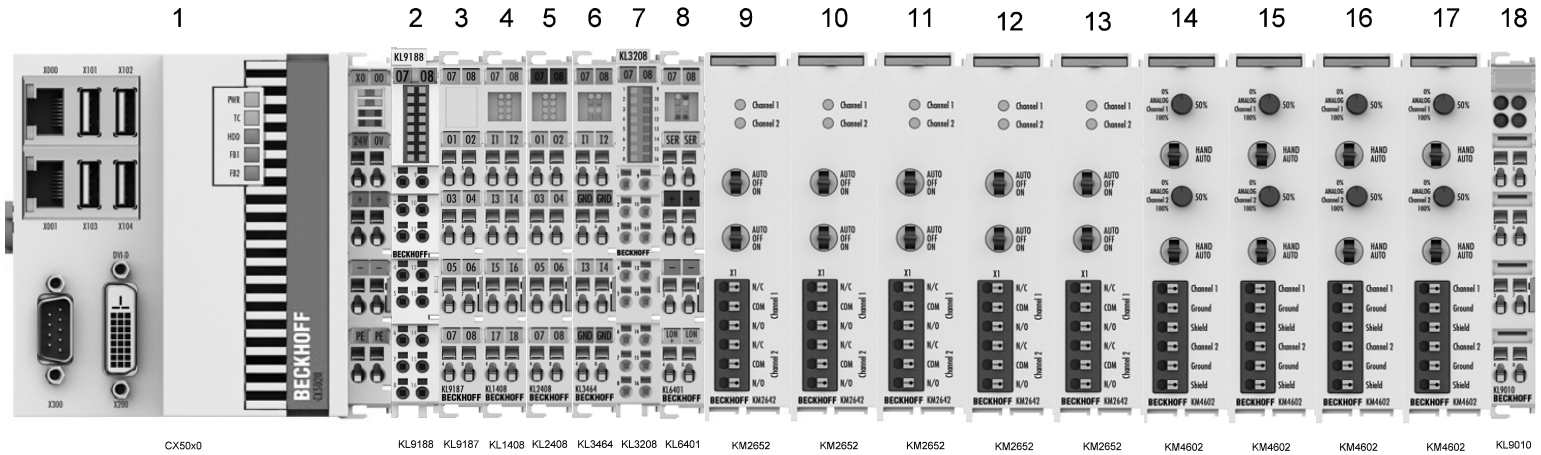

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Anspeisung von Dynacide-Schrank

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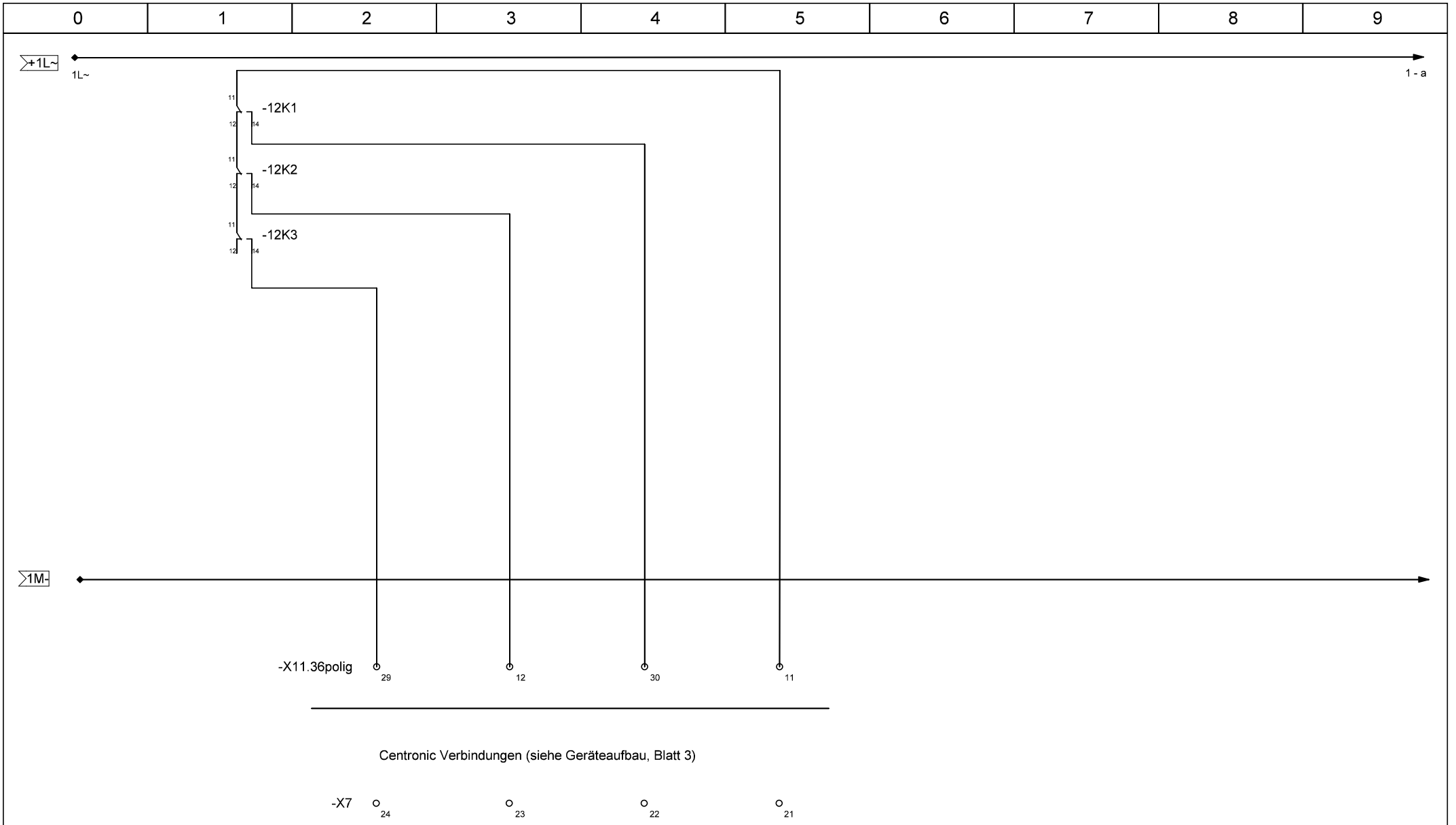

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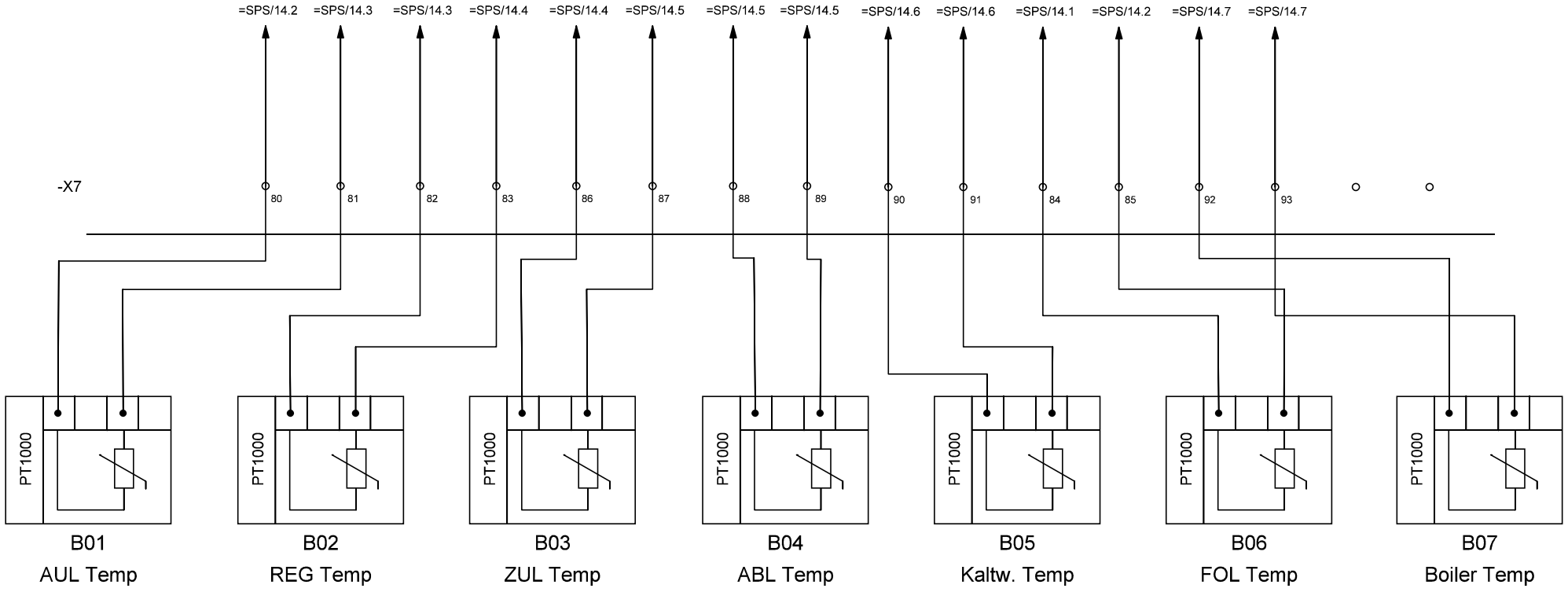

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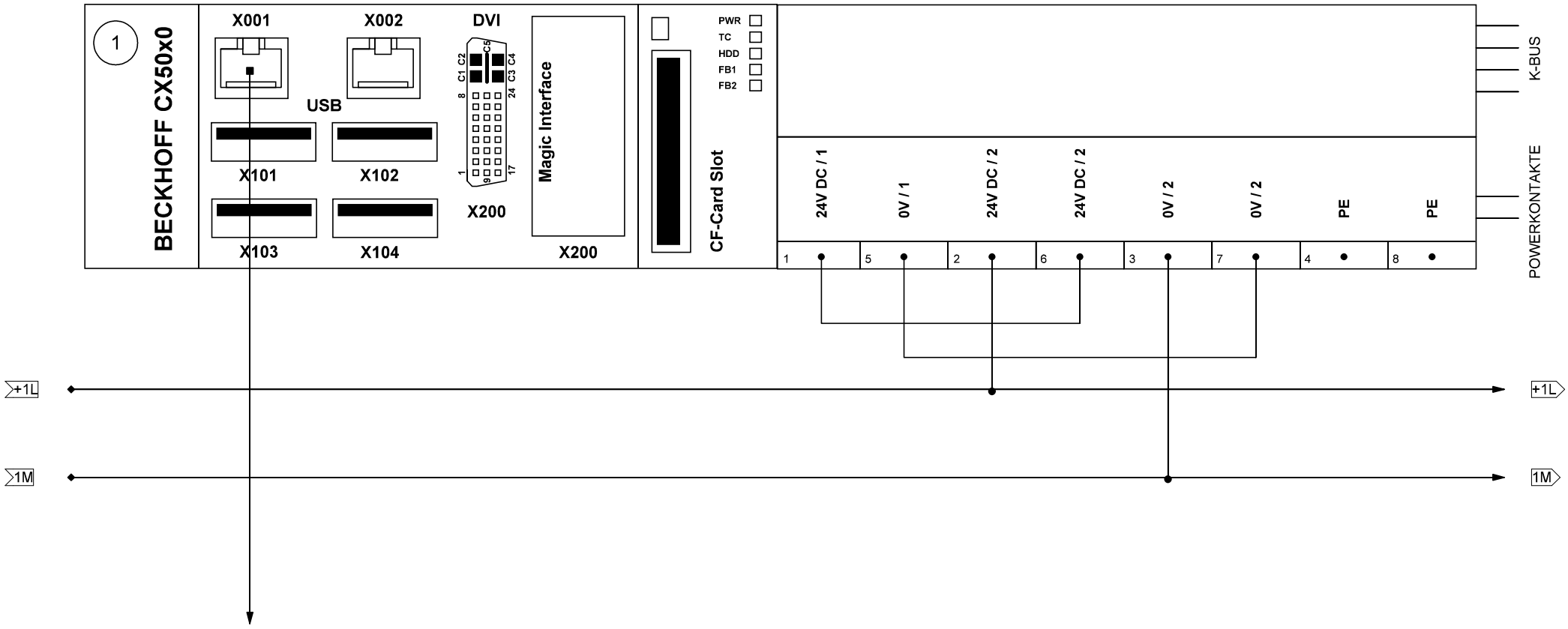

Switch / Netzwerk

IP-Adresse:

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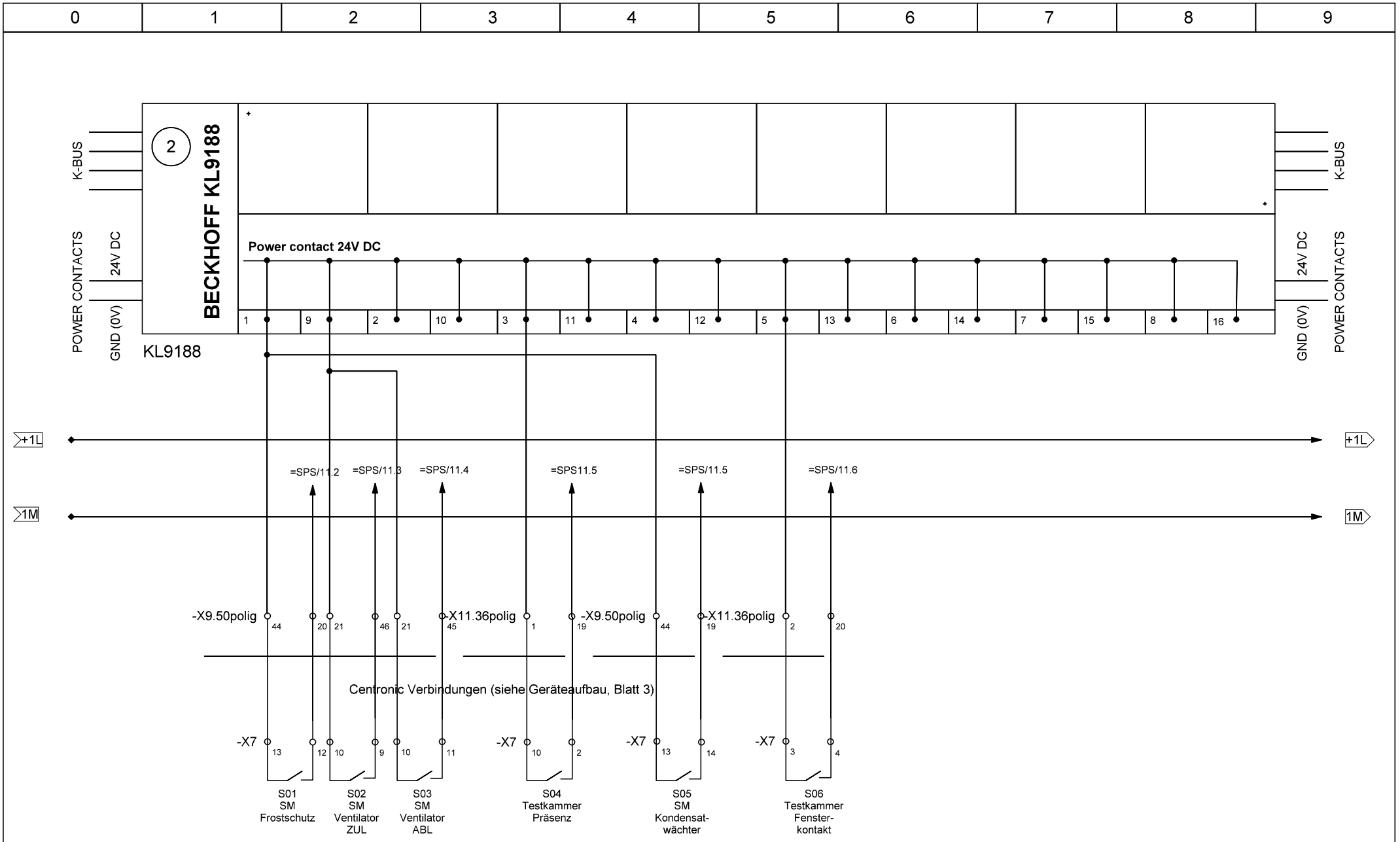

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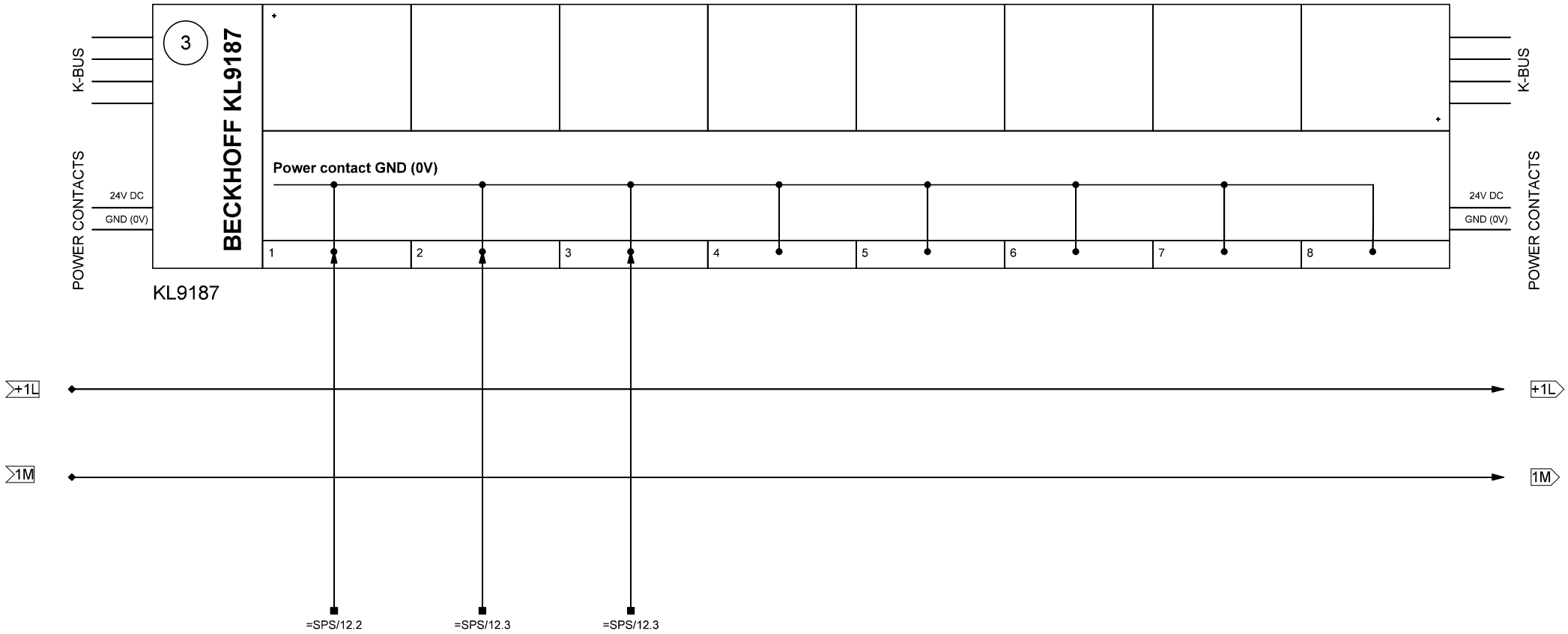

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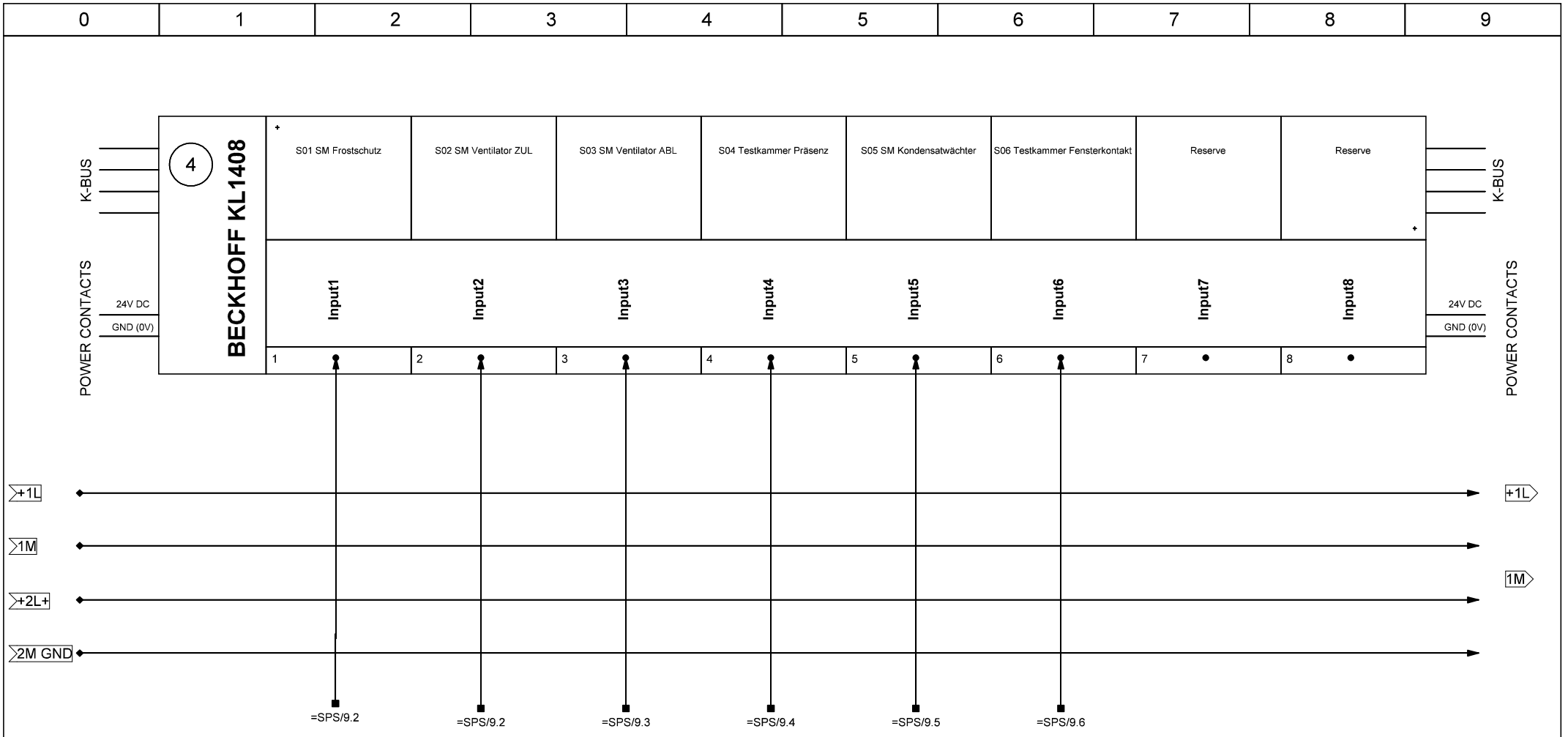

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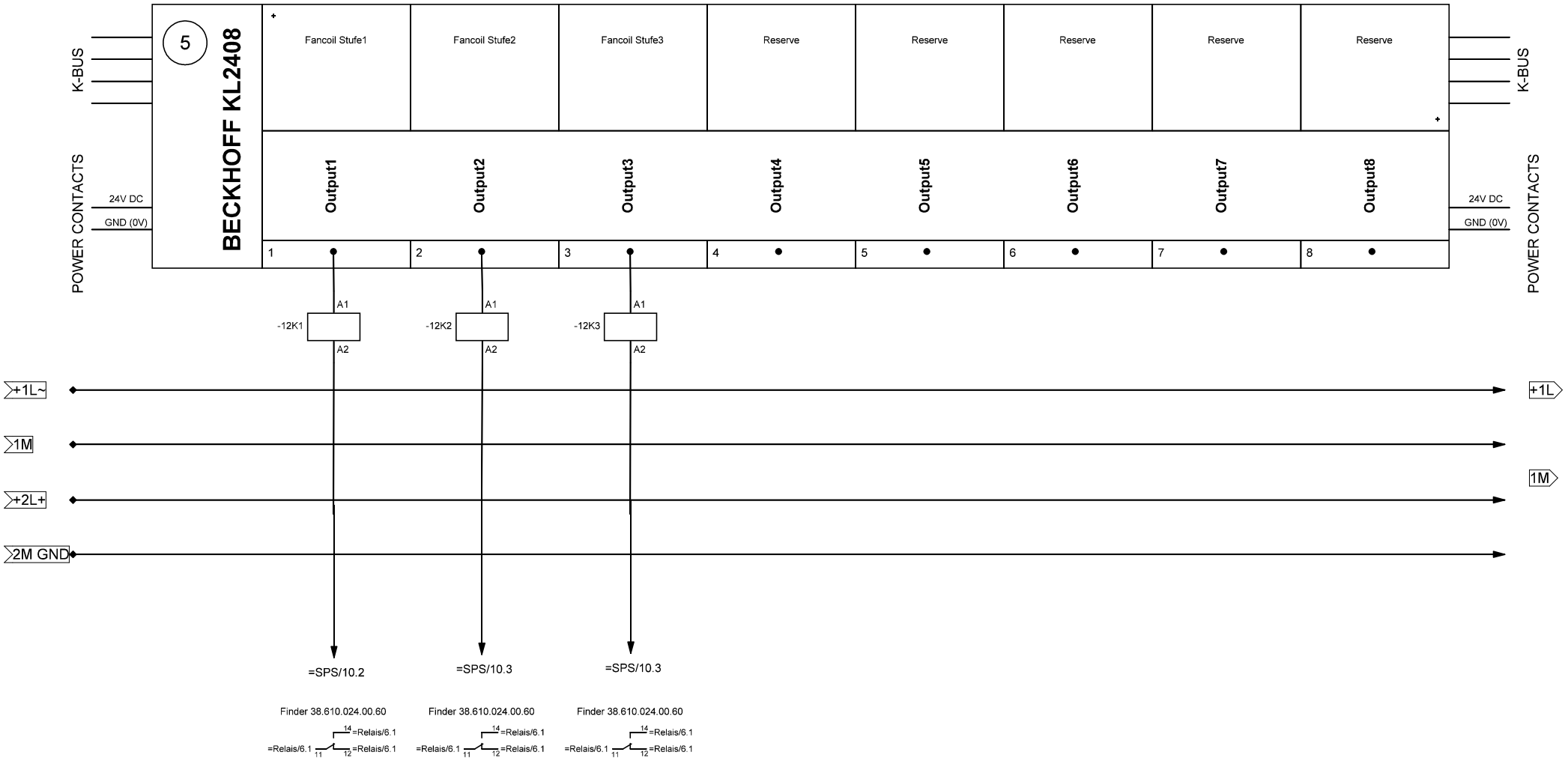

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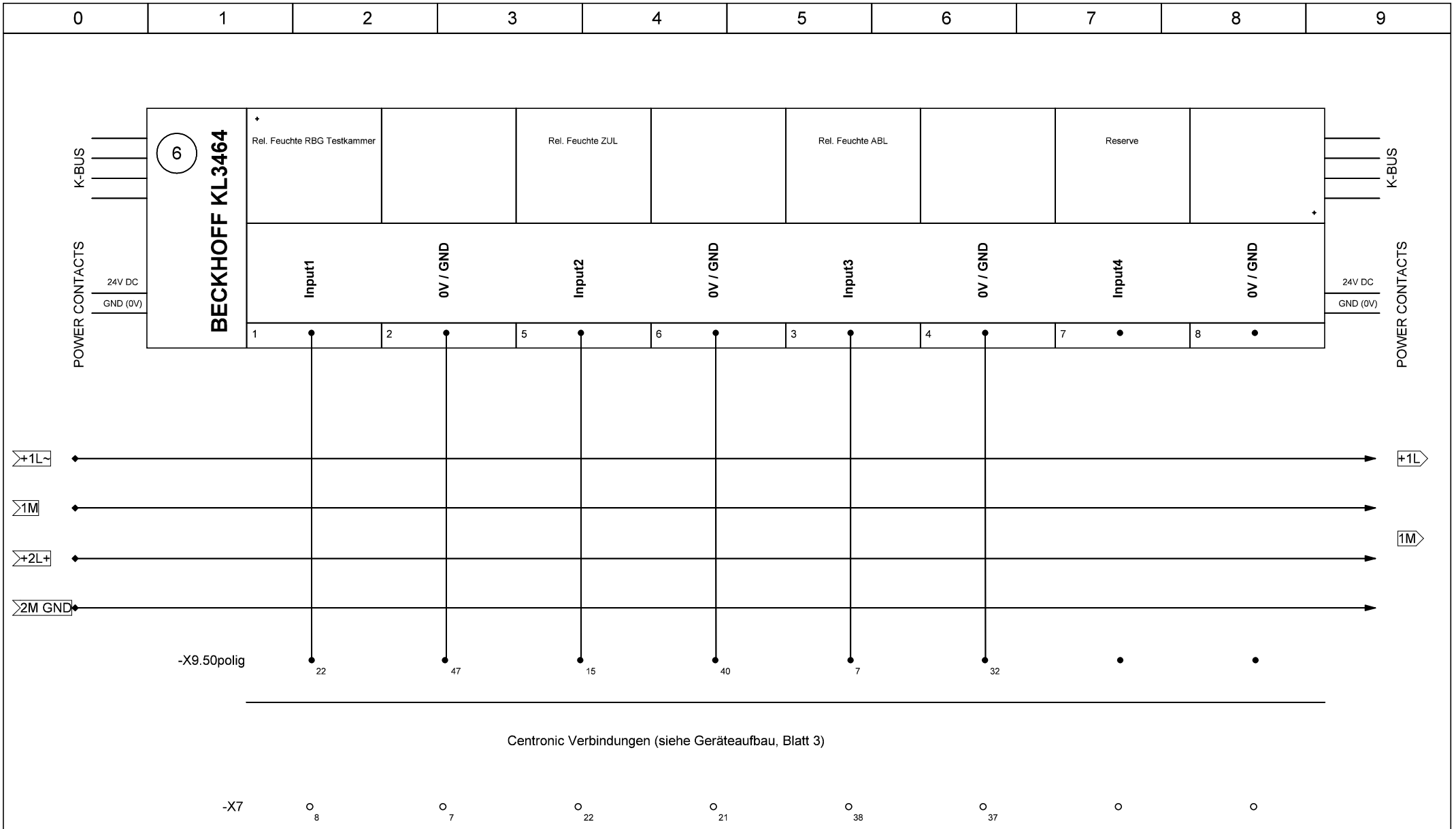

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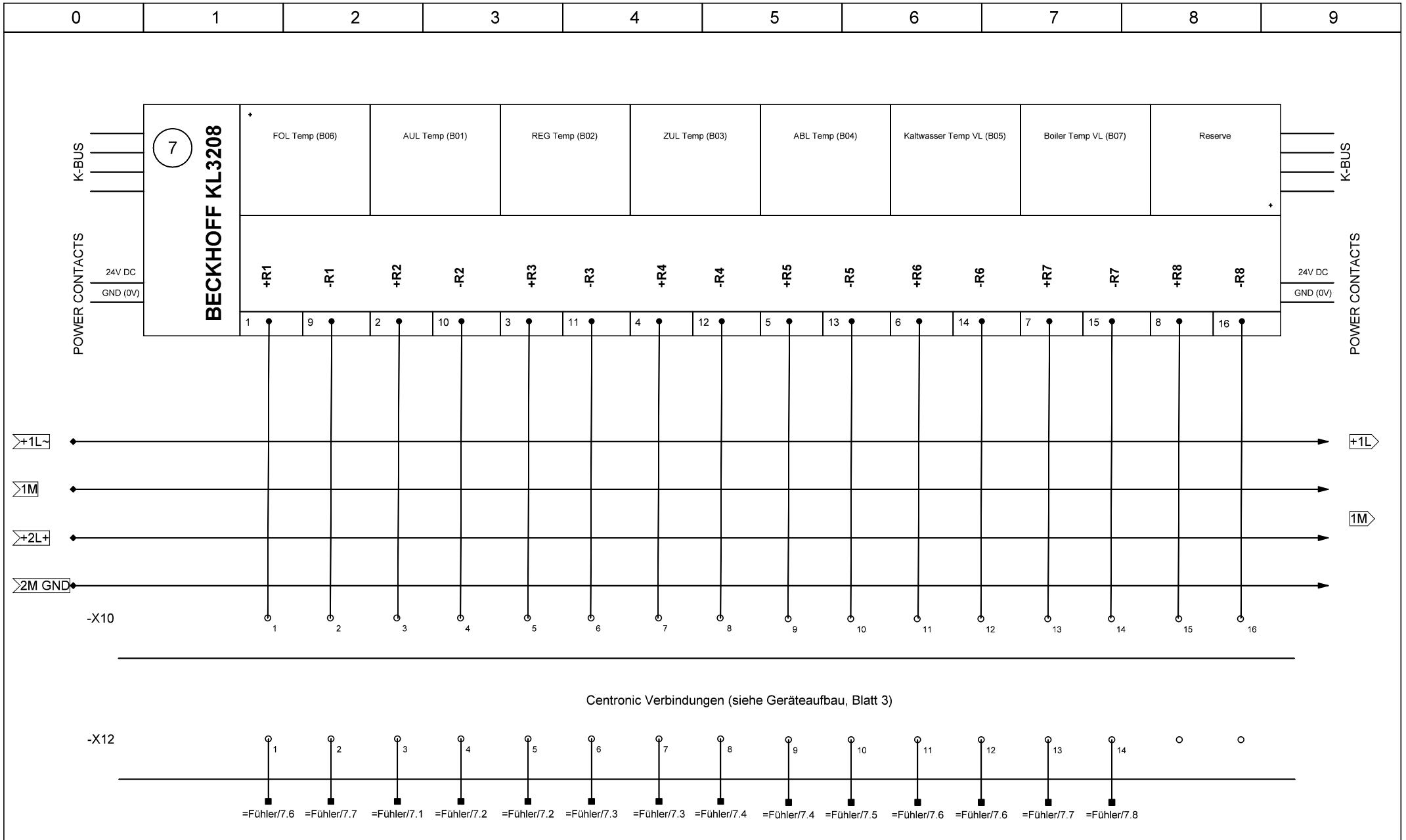

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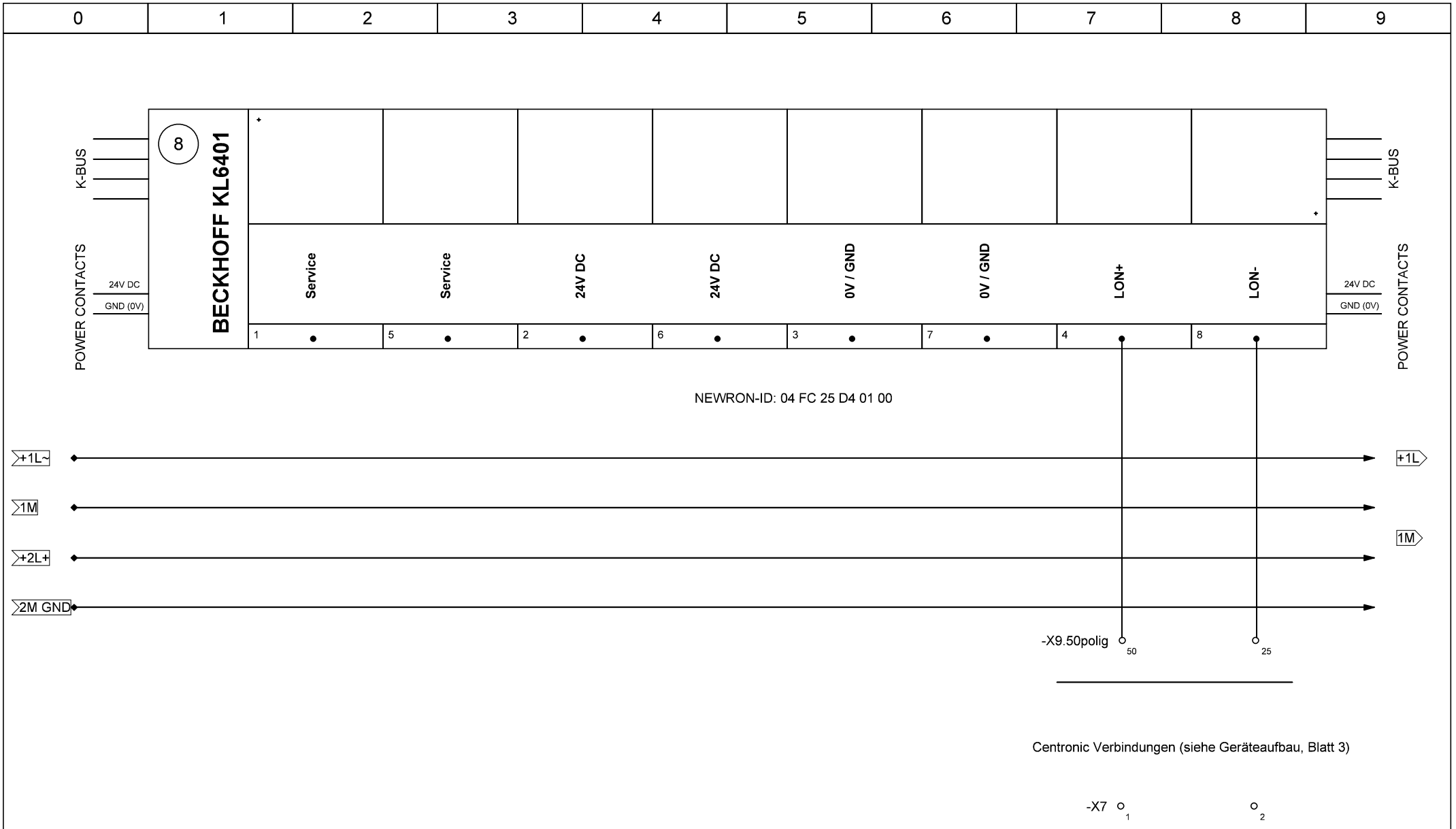

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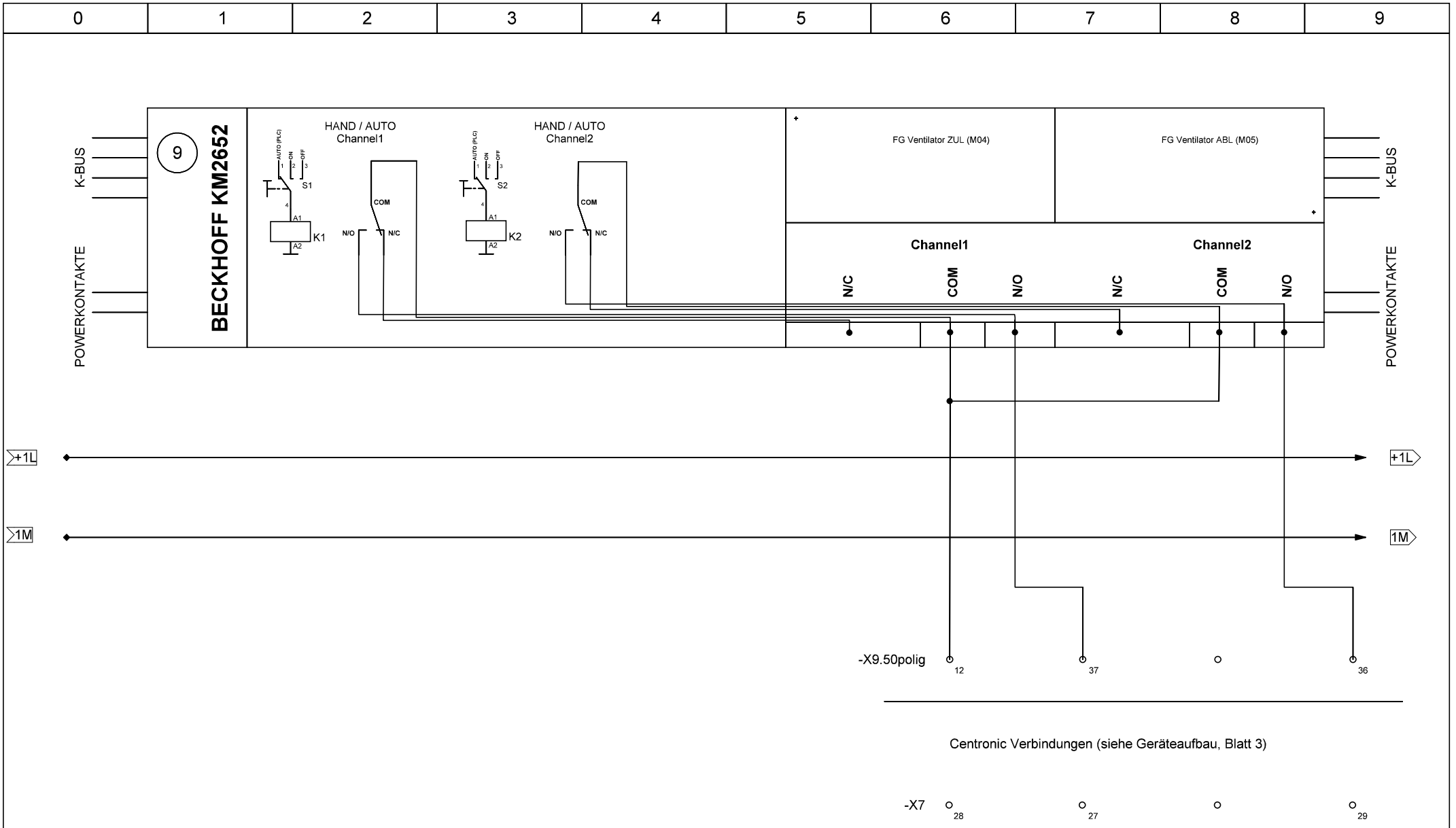

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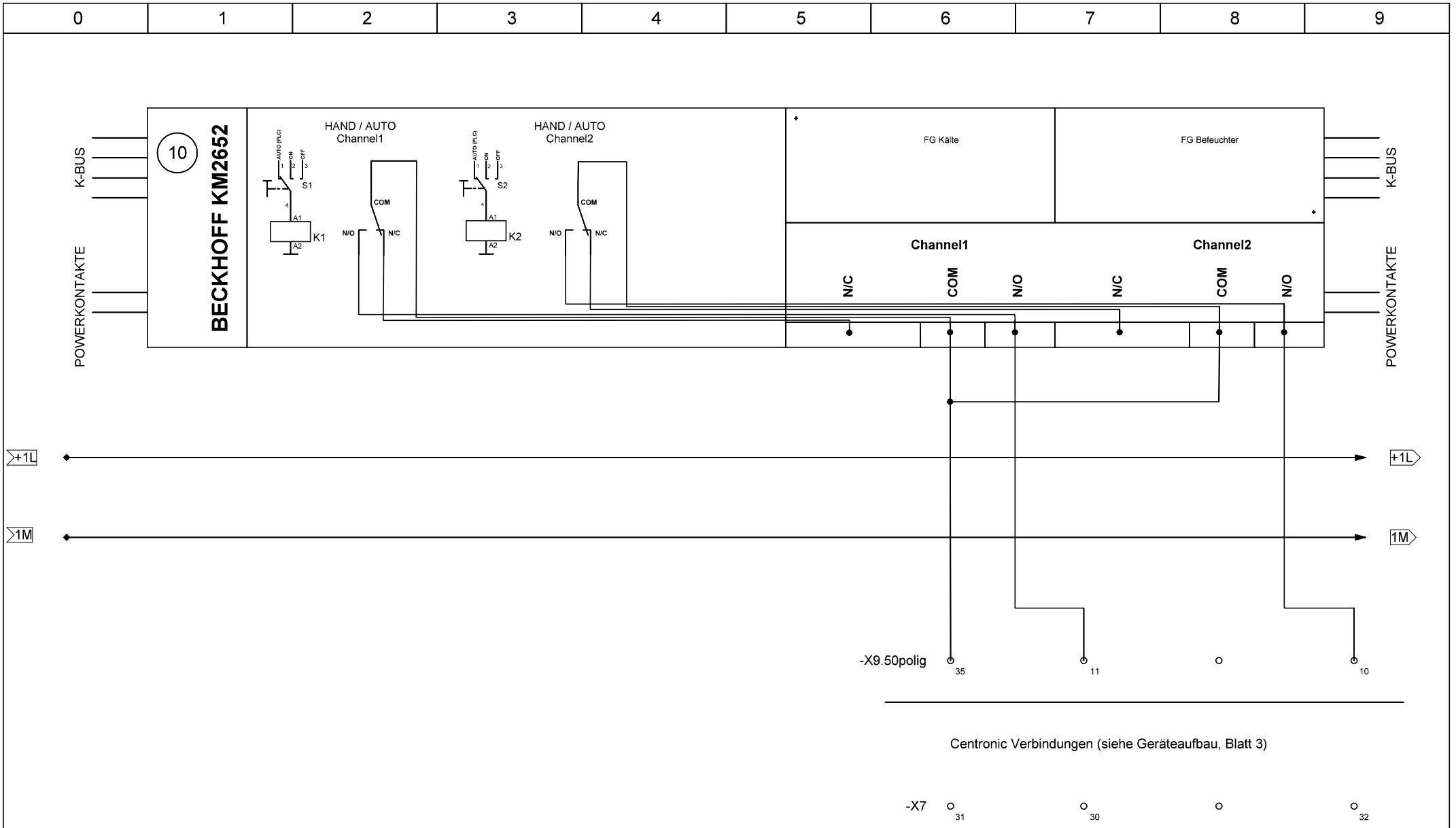

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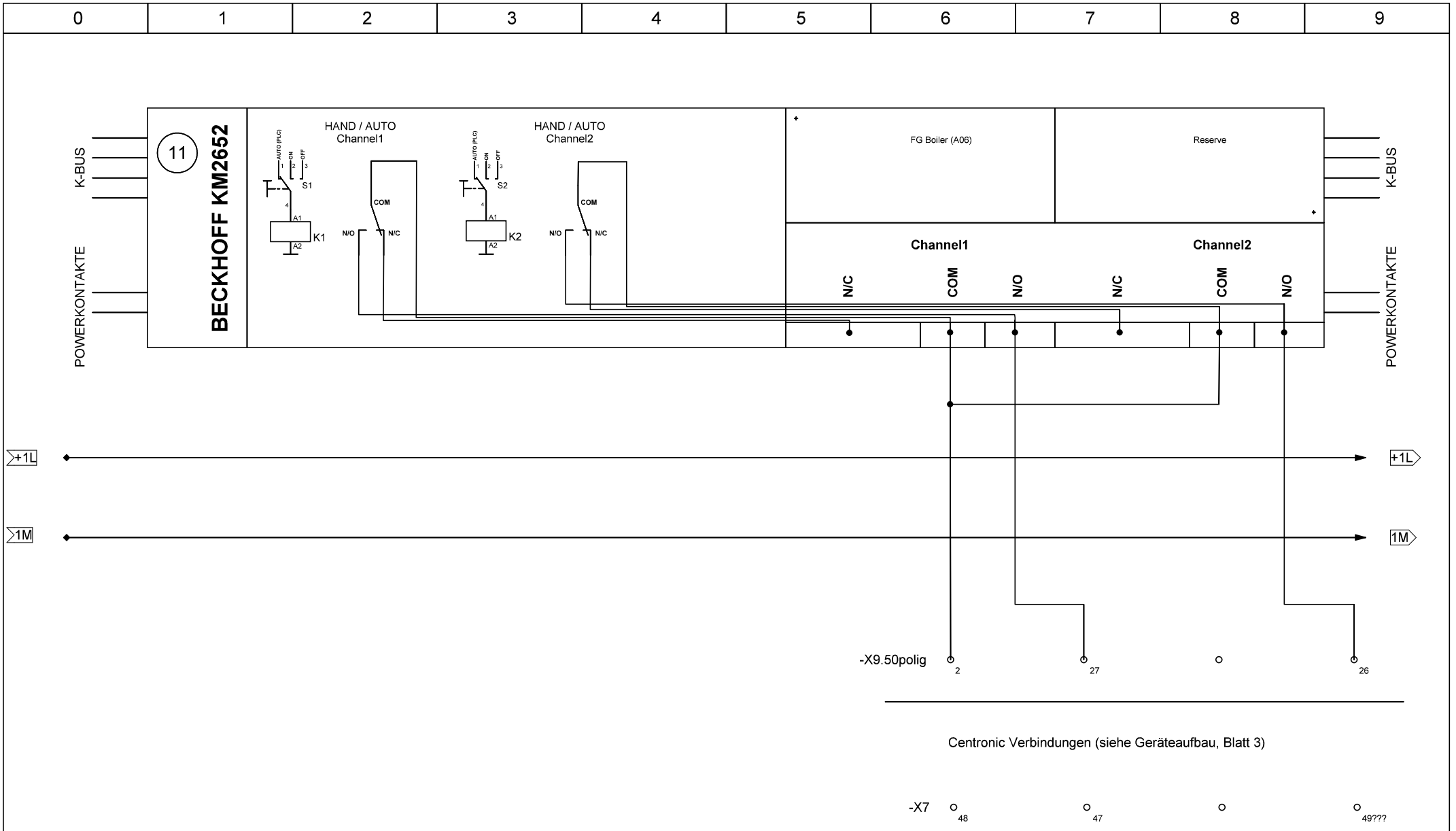

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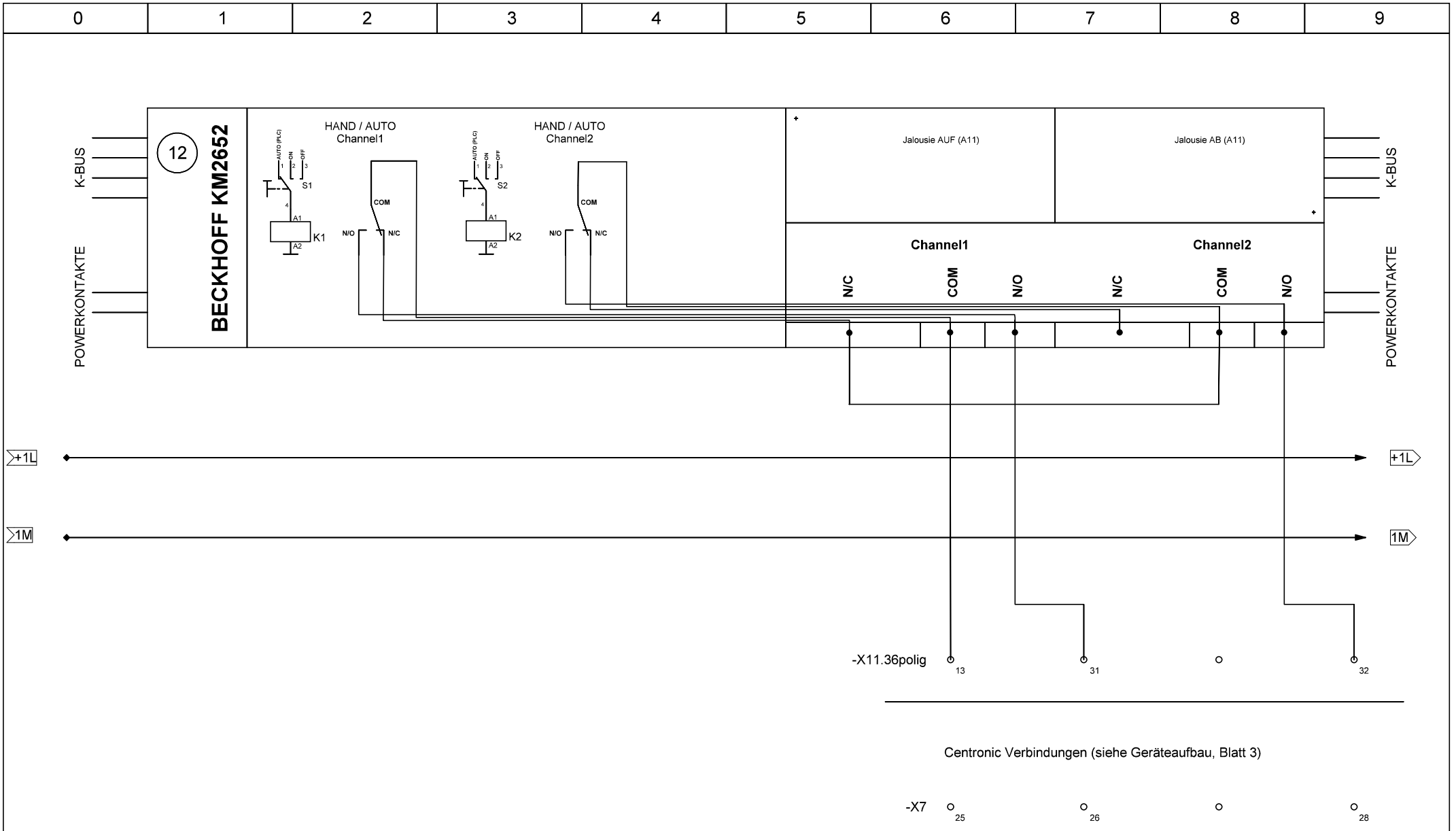

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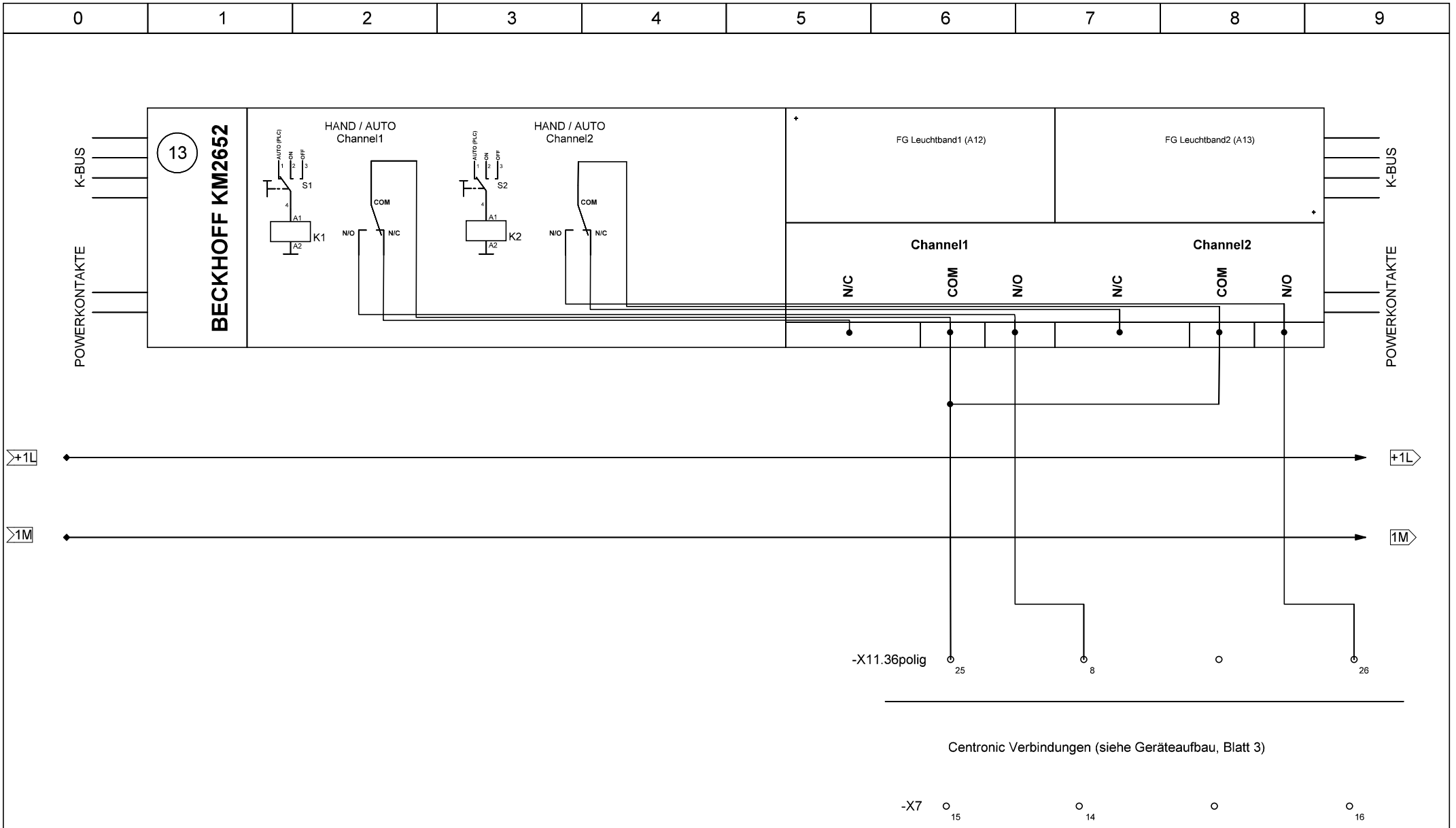

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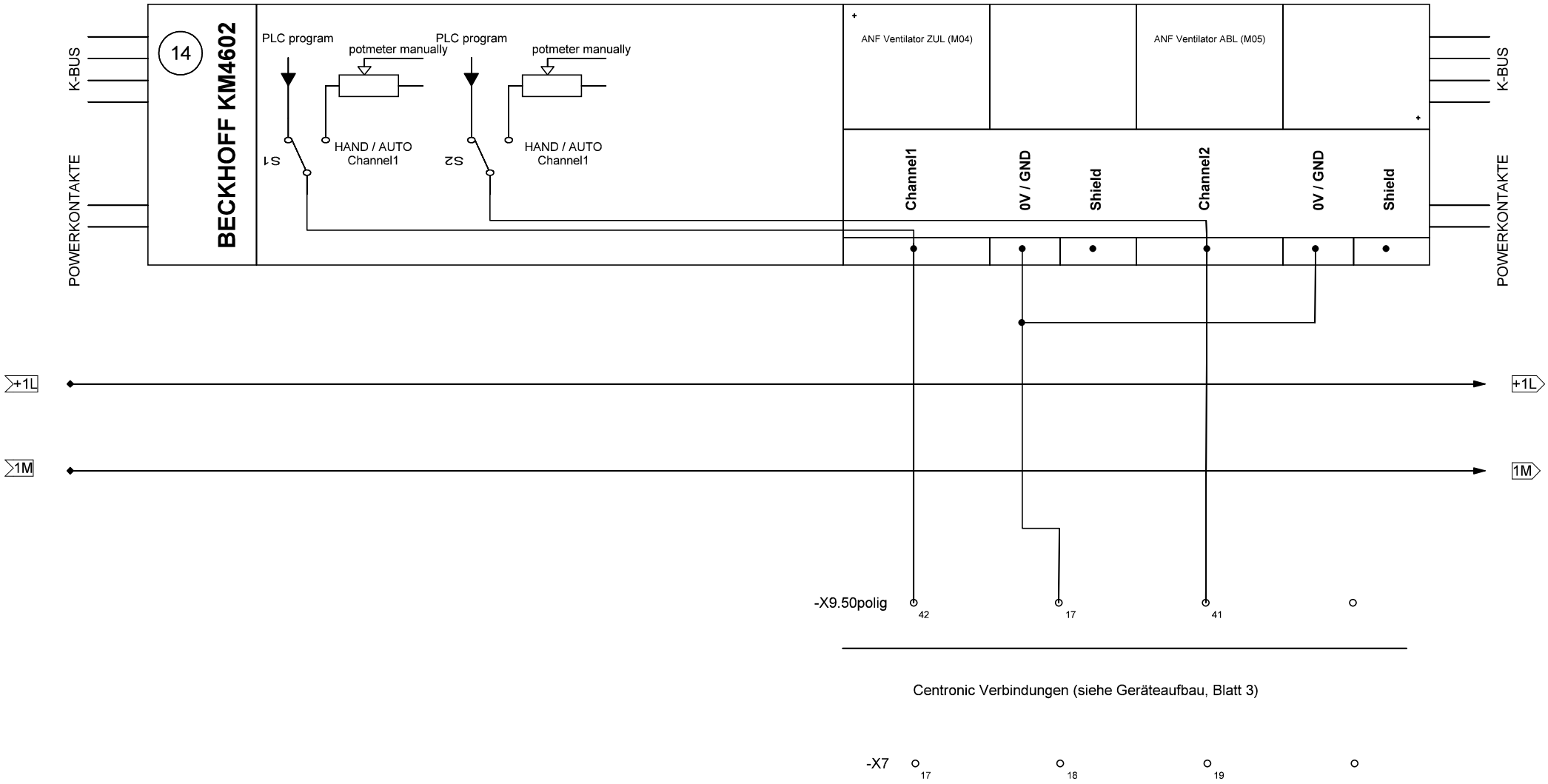

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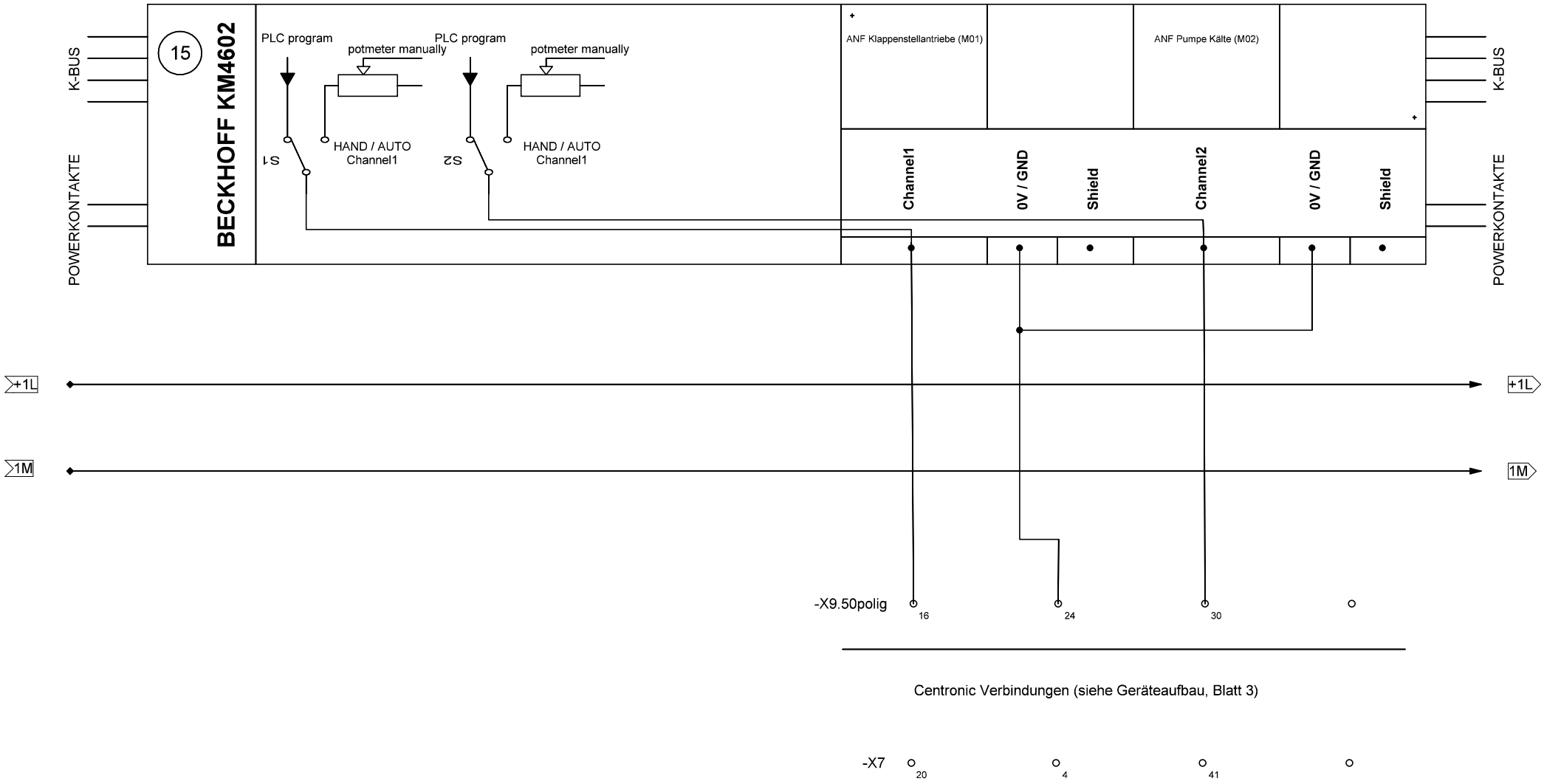

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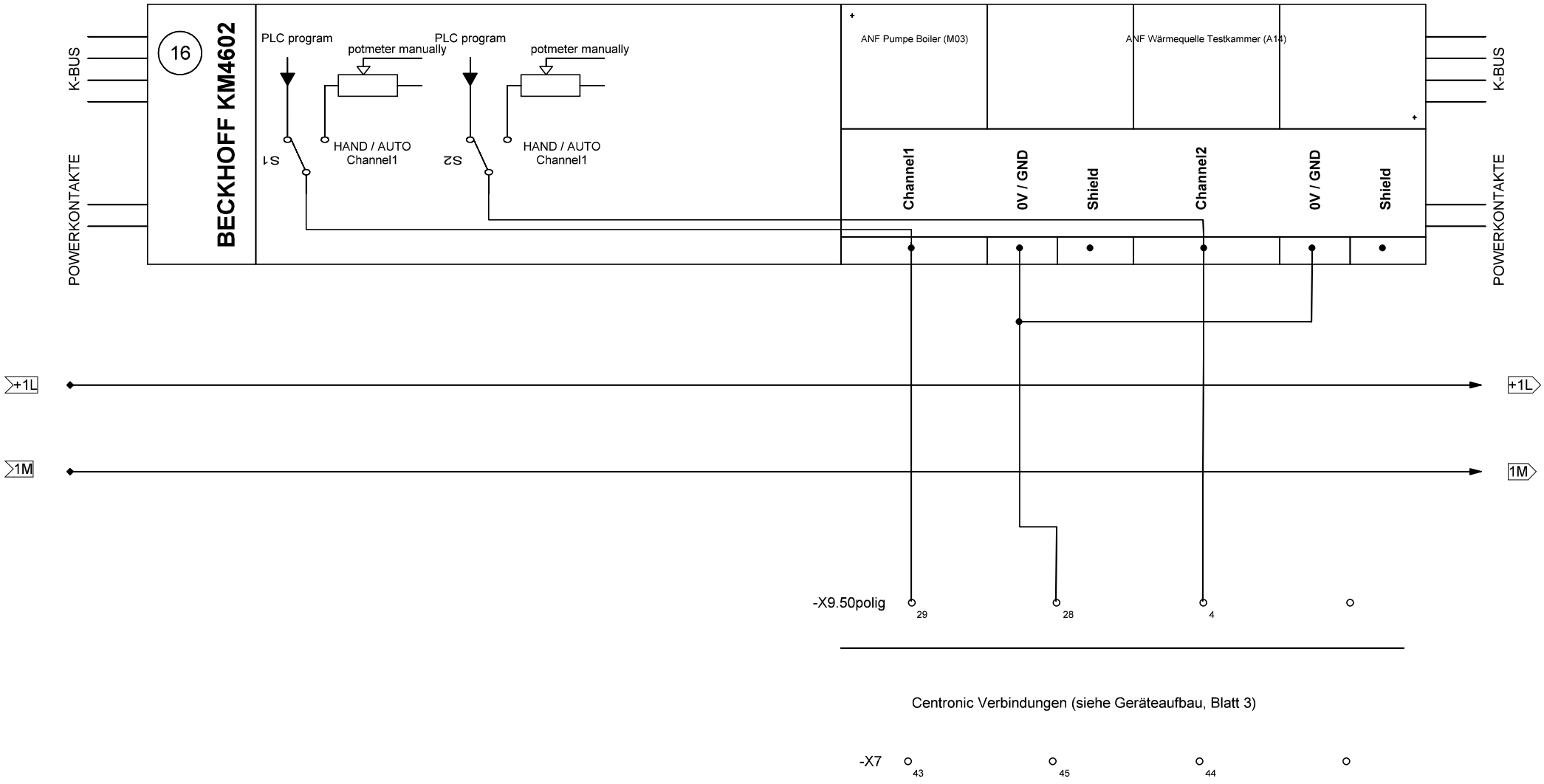

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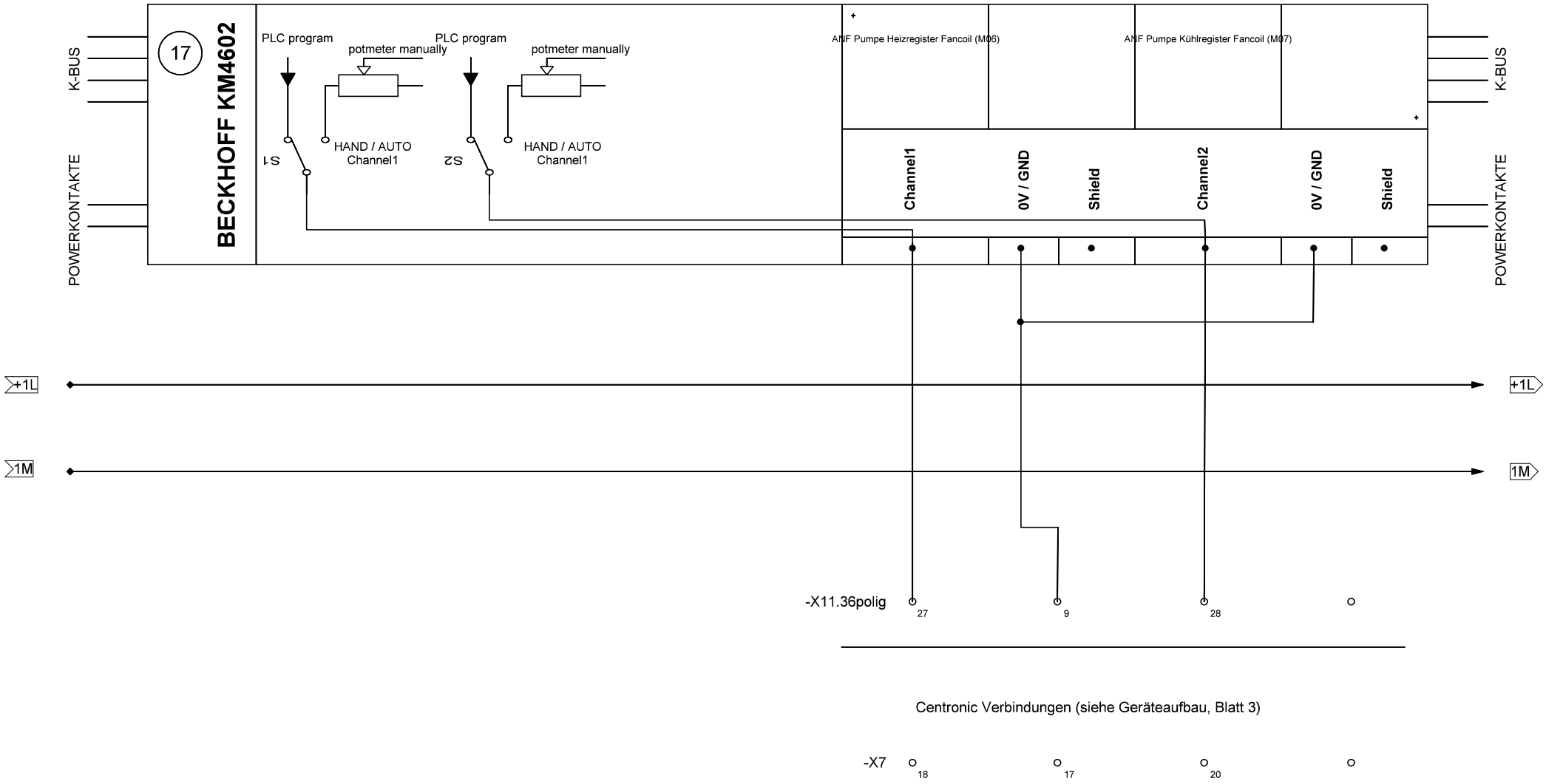

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Name	Datum	Änderung	Plott	25.08.2011					26 Blätter

0	1	2	3	4	5	6	7	8	9

Stückliste

Vom: 16.09.2011 um 01:01:30 Uhr
Datei: C:\Users\balazsb.BECKHOFF\Documents\Uni\TGA _ Target\TGA-Target.spl7
Blatt: "1: Deckblatt"
Blatt: "2: Inhaltsverzeichnis"
Blatt: "3: Allgemein"
Blatt: "4: Anspeisung"
Blatt: "5: Reserve"
Blatt: "6: SPS"
Blatt: "7: SPS"
Blatt: "8: SPS"
Blatt: "9: SPS"
Blatt: "10: SPS"
Blatt: "11: SPS"
Blatt: "12: SPS"
Blatt: "13: SPS"
Blatt: "14: SPS"
Blatt: "15: SPS"
Blatt: "16: SPS"
Blatt: "17: SPS"
Blatt: "18: SPS"
Blatt: "19: SPS"
Blatt: "20: Stückliste"

1 = 1 x CX1020-N010
2 = 1 x CX1020-N030
3 = 1 x CX1020
4 = 1 x CX1100-0002
5 = 1 x KL1408
8 = 1 x KM1644
9 = 1 x KL3464
10 = 1 x KL4404
11 = 1 x KM4602
12 = 1 x KL3208
13 = 1 x KL6401
6,7 = 2 x KL2408

			Name	BB	AUTOMATION SYSTEMS GROUP	Gruppe: Stückliste	Projekt: TGA-Target	FELD1	
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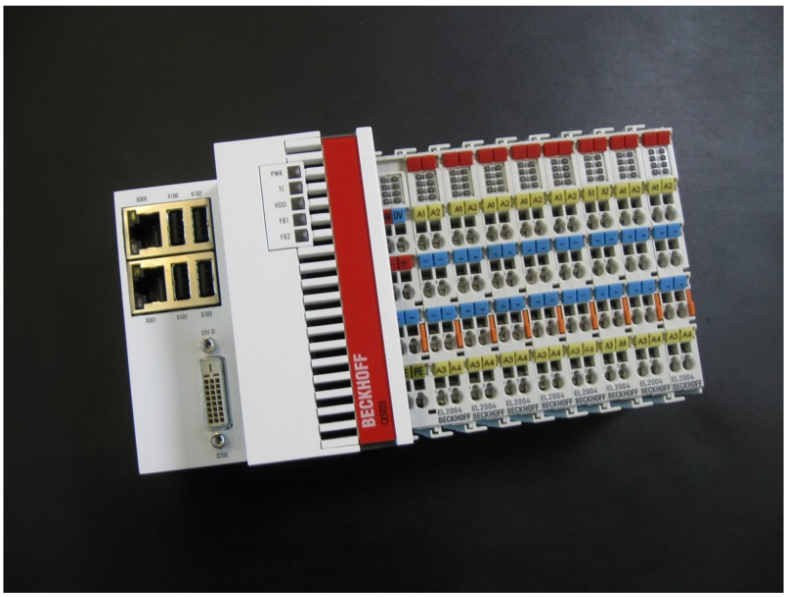
6.3 BECKHOFF components data sheets

CX5010-0111 CPU

BECKHOFF Automation



Hardware documentation

for CX5010 / CX5020 Embedded PC

CX5010-xxxx

CX5020-xxxx

version: 1.4

date: 2013-01-15

BECKHOFF Automation: Foreword

Notes on the documentation

This description is only intended for the use of trained specialists in control and automation engineering who are familiar with the applicable national standards.
It is essential that the following notes and explanations are followed when installing and commissioning these components.

The responsible staff must ensure that the application or use of the products described satisfy all the requirements for safety, including all the relevant laws, regulations, guidelines and standards.

Disclaimer

The documentation has been prepared with care. The products described are, however, constantly under development.
For that reason the documentation is not in every case checked for consistency with performance data, standards or other characteristics.
In the event that it contains technical or editorial errors, we retain the right to make alterations at any time and without warning.
No claims for the modification of products that have already been supplied may be made on the basis of the data, diagrams and descriptions in this documentation.

Trademarks

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Other designations used in this publication may be trademarks whose use by third parties for their own purposes could violate the rights of the owners.

Patent Pending

The EtherCAT Technology is covered, including but not limited to the following patent applications and patents:
EP1590927, EP1789857, DE102004044764, DE102007017835
with corresponding applications or registrations in various other countries.

The TwinCAT Technology is covered, including but not limited to the following patent applications and patents:
EP0851348, US6167425 with corresponding applications or registrations in various other countries.

Copyright

BECKHOFF Automation: Foreword

Safety instructions

Safety rules

Consider the following safety instructions and descriptions!
Product specific safety instructions are to be found on the following pages or in the areas mounting, wiring, commissioning etc.

Disclaimer

All the components are supplied in particular hardware and software configurations appropriate for the application. Modifications to hardware or software configurations other than those described in the documentation are not permitted, and nullify the liability of Beckhoff Automation GmbH.

Personnel qualification

This description is only intended for the use of trained specialists in control, automation and drive engineering who are familiar with the applicable national standards.

Description of symbols

The following symbols with a adjoining safety advise or notice are used in this documentation. You have to read the safety advices carefully and adhere them strictly!


DANGER

Acute risk of injury!

If you **do not** adhere the safety advise adjoining this symbol, there is immediate danger to life and health of individuals!


WARNING

Risk of injury!

If you **do not** adhere the safety advise adjoining this symbol, there is danger to life and health of individuals!


CAUTION

Hazard to individuals!

If you **do not** adhere the safety advise adjoining this symbol, there is obvious hazard to individuals!

Attention

Hazard to devices and environment

If you **do not** adhere the notice adjoining this symbol, there is obvious hazard to materials and environment.


Note

Note or pointer

This symbol indicates information that contributes to better understanding.

BECKHOFF CX50x0: Foreword

Documentation Issue Status

Version	Changes
1.4	Notes on passive terminals and power supply added
1.3	Requirements for power supply added
1.2	Changes on temperature range and K-bus diagnosis
1.1	Changes on system interface N031 and DVI resolution
1.0	first release
0.1	prelimenary version

BECKHOFF CX50x0: Product overview

Intended use

The CX5010 / CX5020 device series is a modular control system designed for top-hat rail installation. The system is scalable, so that the required modules can be assembled and installed in the control cabinet or terminal box as required.

Only switch the PC off after closing the software

Before the Embedded PC is switched off, the software currently running on it should be stopped properly in order to avoid data loss on the hard disk. Please read the section on "Switching off".

Switch off all system components and uncouple the Industrial PC from the system if the PC is not used for control purposes, e.g. during a function test. To disconnect first pull the first terminal behind the power supply unit (optional), then pull the connectors of the fieldbus connections.
System components that have been switched off must be secured against being switched on again.

The Embedded PC's power supply unit must be supplied with 24 V_{DC}.

Damage to the environment or devices

Caution

Do not exchange any parts when under power! Replacing control components while the system is live may lead to short circuits or overvoltages, which in turn may damage the controller and connected peripherals (terminals, monitors, input devices etc.).

When components are being fitted or removed, the supply voltage must be switched off.

Software knowledge

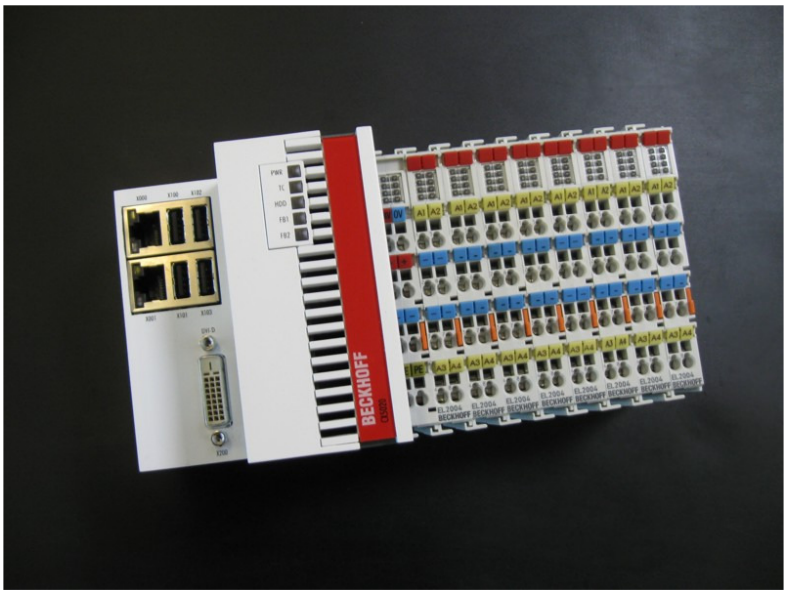
Caution

System malfunctions

Requires software knowledge! Each user must be familiar with all the functions of the software installed on the PC to which he has access.

BECKHOFF CX50x0: Product overview

System Overview



The system

The CX5000 series devices are DIN rail-mountable, fanless Embedded PCs with direct connection for Beckhoff Bus Terminals or EtherCAT terminals. In contrast to the other CX device families, the CX5000 series has a fixed, non-expandable number of system interfaces. The housing design for this series is optimised for robustness and compactness. No modular expandability for the left-hand side is provided. Although EtherCAT integration offers a wide range of expansion capability. Further master/slave fieldbus connections (PROFIBUS, CANopen, DeviceNet) or communication interfaces (RS232, RS422/RS485) and all other signal types accessible via EtherCAT can be directly connected as EtherCAT Terminals. Two independent Gigabit Ethernet ports and four USB 2.0 interfaces are available. A Beckhoff control panel or a commercially available DVI monitor can be connected to the DVI D interface. A serial port (RS232/RS422/RS485) or a fieldbus connection with master or slave function can be added as an optional interface as required. An interchangeable Compact Flash card located behind a flap that is accessible from outside is used as boot and storage medium. The built-in capacitive 1-second UPS ensures secure backup of persistent application data on the Compact Flash card. The date and time are buffered via a replaceable battery. The operating system can be Windows CE or Windows Embedded Standard. The TwinCAT automation software transforms a CX5000 system into a powerful PLC and motion control system that can be operated with or without visualisation.

EtherCAT as a fast I/O system

Like all Embedded PCs from the CX series (except CX100x), the CX5000 was developed for optimum interaction with EtherCAT. One of the two independent Ethernet interfaces of the CPU module (X001) is intended for EtherCAT mode. The primary EtherCAT connection is generally established via terminals. Both can also be configured as a ring in order to achieve line redundancy.

Interestingly, EtherCAT offers several options for connecting conventional fieldbus systems to the CX50x0:
As EtherCAT device in terminal form, for example the PROFIBUS master as EtherCAT Terminal EL6731. In practice, this means that the PROFIBUS master can be positioned exactly where it is required within a machine. It no longer has to be implemented as a plug-in card in the IPC or a master controller in the control cabinet.

PLC, Motion Control, interpolation and visualisation

As a DIN rail IPC and in conjunction with the TwinCAT software from Beckhoff, the CX50x0 offers the same functionality as large Industrial PCs. In terms of PLC, up to four virtual IEC 61131 CPUs can be programmed with up to four tasks each, with a minimum cycle time of 50 µs. All IEC 61131-3 languages can be used.

Moreover, all TwinCAT functionalities are available for Motion Control applications:
In theory, up to 256 axes can be controlled. In addition to simple point-to-point movements, more complex multi-axis functions such as “electronic gearbox”, “cam plates” and “flying saw” can be implemented.

In addition to real-time execution of control tasks, the TwinCAT real-time kernel ensures that enough time remains for the user interface (HMI), to communicate with the real-time components via software interfaces such as ADS or OPC.

For CX50x0 the familiar basic principle applies: it is a programming tool for all controllers.
The complete programming of PLC, Motion Control and visualisation is transferable to all PC controls from Beckhoff, which is reassuring in cases where it becomes apparent during a project that more processing power is required after all. In this case a system with higher performance can be used.

Fieldbus interfaces

The fieldbus interfaces are currently available as master and slave versions for the following fieldbuses:

Optional interfaces:

The optional interfaces can be used to connect single-channel fieldbus interfaces. Operation is limited to **one** interface at a time. If several fieldbus interfaces are required, they can be added as E-bus terminals (EL67xx). The following fieldbus interfaces are available:

- CX50x0-N030 = RS232, D-Sub connector
- CX50x0-N031 = RS422/RS485, D-Sub socket
- CX50x0-M310 = PROFIBUS master, D-Sub socket, 9-pin
- CX50x0-B310 = PROFIBUS slave, D-Sub socket, 9-pin
- CX50x0-M510 = CANopen master, D-Sub connector, 9-pin
- CX50x0-B510 = CANopen slave, D-Sub connector, 9-pin
- CX50x0-M930 = PROFINET RT, controller, Ethernet (2 x RJ-45 switch)
- CX50x0-B930 = PROFINET RT, device, Ethernet (2 x RJ-45 switch)
- CX50x0-B951 = Ethernet/IP slave, Ethernet (2 x RJ-45 switch)
- CX50x0-B100 = EtherCAT slave, EtherCAT IN and OUT (2 x RJ 45)

The software

In combination with the TwinCAT automation software, the CX50x0 Industrial PC becomes a powerful IEC 61131-3 PLC with up to four user tasks. Additionally, Motion Control tasks can also be executed. Depending on the required cycle time, several servo axes can be controlled. Even special functions such as flying saw, electronic gearbox and cam plate can be realised.

The CX50x0 system is programmed in the same way as other bus controllers:

Remote programming via Ethernet

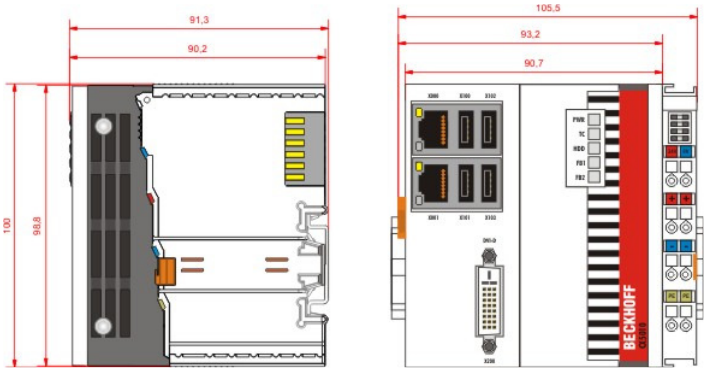
This option is used if the basic unit is equipped with “Windows CE.NET”. In this case, the system is programmed via a laptop or a desktop PC, which is connected to the CX via Ethernet (network or crossover cable). The programs are developed on the laptop with a standard TwinCAT software licence and then loaded into the target device.

Visualisation

The Beckhoff OPC server is available for interfacing with SCADA packets, if the two operating system variants “Windows CE.NET” or “Windows XP Embedded” are used. In other words, the CX50x0 also offers straightforward visualisation and simultaneous control in real-time on a single system.

BECKHOFF CX5010: Product overview

CX5010 Technical data



The basic configuration of the CX5010 includes a 64 MB Compact Flash card. The basic configuration includes two Ethernet RJ-45 interfaces, four USB-2.0 interfaces and a DVI-D interface.

Technical data	CX5010
Processor	Intel® Atom™ Z510 processor, 1.1 GHz clock frequency
Internal Flash memory	64 MB Compact Flash card
Internal main memory	512 MB RAM (interior, not expandable)
Interfaces	2 x RJ 45, 10/100/1000 Mbit/s, DVI-D, 4 x USB 2.0
Diagnostics LED	1 x power, 1 x TC status, 1 x flash access, 2 x bus status
Clock	Internal clock with battery backup for time and date (battery replaceable)
Operating system	Microsoft Windows CE or Microsoft Windows Embedded Standard
Control software	TwinCAT PLC runtime or TwinCAT NC PTP runtime
Power supply	24 V DC (-15 %/+20 %)
Power supply	I/O terminals 2 A
Max. power loss	12 W (including system interfaces)
Dielectric strength	500 Veff (supply/internal electronics)
Dimensions (H x W x D)	100 mm x 106 mm x 92 mm
Weight	approx. 575 g
Operating/storage temperature	-25 °C ... +60 °C/-40 °C ... +85 °C
Relative humidity	95 % no condensation
Vibration/shock resistant	conforms to EN 60068-2-6/EN 60068-2-27/ 29

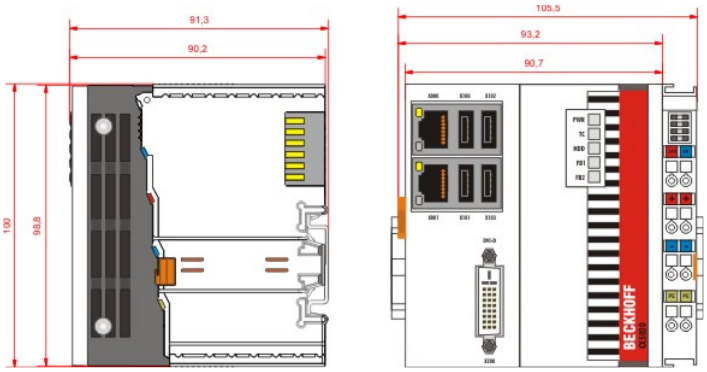
EMC immunity/emission	conforms to EN 61000-6-2 / EN 61000-6-4
Protection class	IP 20

Technical data

Further Information: www.beckhoff.de/CX5010

BECKHOFF CX5010: Product overview

CX5020 - Technical data



The basic configuration of the CX5010 includes a 64 MB Compact Flash card. The basic configuration includes two Ethernet RJ-45 interfaces, four USB-2.0 interfaces and a DVI-D interface.

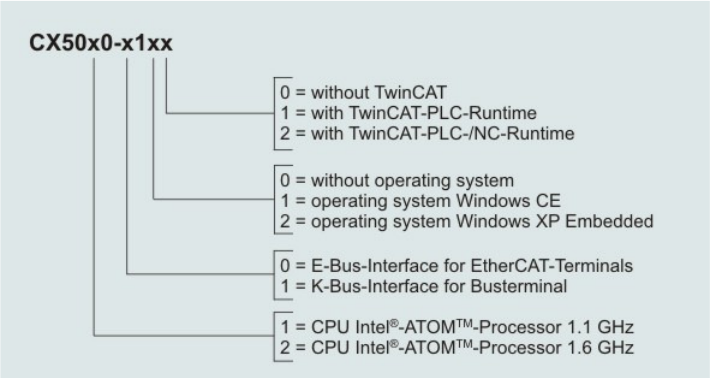
Technical data	CX5010
Processor	Intel® Atom™ Z530 processor, 1.6 GHz clock frequency
Internal Flash memory	64 MB Compact Flash card
Internal main memory	512 MB RAM (interior, not expandable)
Interfaces	2 x RJ 45, 10/100/1000 Mbit/s, DVI-D, 4 x USB 2.0
Diagnostics LED	1 x power, 1 x TC status, 1 x flash access, 2 x bus status
Clock	Internal clock with battery backup for time and date (battery replaceable)
Operating system	Microsoft Windows CE or Microsoft Windows Embedded Standard
Control software	TwinCAT PLC runtime or TwinCAT NC PTP runtime
Power supply	24 V DC (-15 %/+20 %)
Power supply	I/O terminals 2 A
Max. power loss	12.5 W (including system interfaces)
Dielectric strength	500 Veff (supply/internal electronics)
Dimensions (H x W x D)	100 mm x 106 mm x 92 mm
Weight	approx. 575 g
Operating/storage temperature	-25 °C ... +60 °C / -40 °C ... +85 °C
Relative humidity	95 % no condensation
Vibration/shock resistant	conforms to EN 60068-2-6/EN 60068-2-27/ 29
EMC immunity/emission	conforms to EN 61000-6-2 / EN 61000-6-4
Protection class	IP 20

Further Information: www.beckhoff.de/CX5020

BECKHOFF CX50x0: Product overview

Types

The CPU module can be equipped with different hardware and software options: "Windows CE" or "Windows Embedded Standard" are available as operating system. The TwinCAT automation software transforms a CX50x0 system into powerful PLC and Motion Control system that can be operated with or without visualisation. Further system interfaces (pre-installed in the factory) or fieldbus connections can be added to the basic CPU module.



The CX 50x0 modules are available in the following types:

Module	K-BUS	E-BUS	Clock frequency of the CPU	without Operating system	Windows CE	Windows Embedded Standard	without TwinCAT	TwinCAT PLC Runtime	TwinCAT NC PTP Runtime
CX5010-0100		X	1.1 GHz	X	-	-	X	-	-
CX5010-0110		X	1.1 GHz	-	X	-	X	-	-
CX5010-0111		X	1.1 GHz	-	X	-	-	X	-
CX5010-0112		X	1.1 GHz	-	X	-	-	-	X
CX5010-0120		X	1.1 GHz	-	-	X	X	-	-
CX5010-0121		X	1.1 GHz	-	-	X	-	X	-
CX5010-0122		X	1.1 GHz	-	-	X	X	-	X
CX5010-1100	X	-	1.1 GHz	X	-	-	X	-	-
CX5010-1110	X	-	1.1 GHz	-	X	-	X	-	-
CX5010-1111	X	-	1.1 GHz	-	X	-	-	X	-
CX5010-1112	X	-	1.1 GHz	-	X	-	-	-	X
CX5010-1120	X	-	1.1 GHz	-	-	X	X	-	-
CX5010-1121	X	-	1.1 GHz	-	-	X	-	X	-
CX5010-1122	X	-	1.1 GHz	-	-	X	X	-	X
CX5020-0100		X	1.6 GHz	X	-	-	X	-	-
CX5020-0110		X	1.6 GHz	-	X	-	X	-	-
CX5020-0111		X	1.6 GHz	-	X	-	-	X	-
CX5020-0112		X	1.6 GHz	-	X	-	-	-	X
CX5020-0120		X	1.6 GHz	-	-	X	X	-	-
CX5020-0121		X	1.6 GHz	-	-	X	-	X	-
CX5020-0122		X	1.6 GHz	-	-	X	X	-	X
CX5020-1100	X	-	1.6 GHz	X	-	-	X	-	-
CX5020-1110	X	-	1.6 GHz	-	X	-	X	-	-
CX5020-1111	X	-	1.6 GHz	-	X	-	-	X	-
CX5020-1112	X	-	1.6 GHz	-	X	-	-	-	X
CX5020-1120	X	-	1.6 GHz	-	-	X	X	-	-
CX5020-1121	X	-	1.6 GHz	-	-	X	-	X	-
CX5020-1122	X	-	1.6 GHz	-	-	X	X	-	X

CX50x0 systems with Windows Embedded Standard require a Compact Flash card with a minimum capacity of 2 GB.

Notice

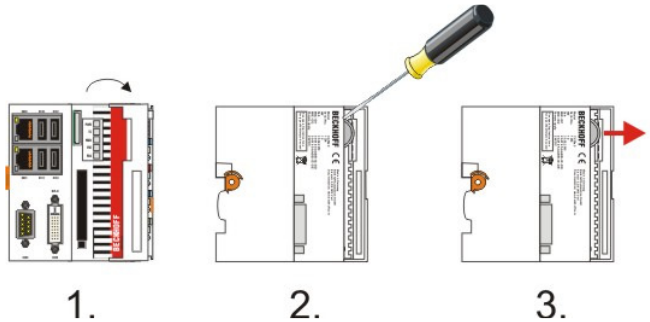
Software Images

A list of the different software images can be found in the CX1000 Software Documentation.

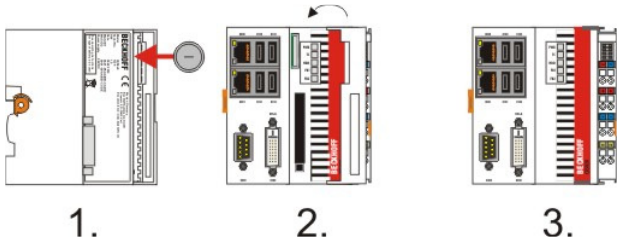
BECKHOFF CX50x0: Product overview

Battery compartment

The battery compartment is located under the front cover of the CX50x0. The opening in which the battery bracket is mounted can be seen when the front cover is opened. Use a screwdriver to carefully lift the battery out of the bracket.



To insert a new battery push it into the battery compartment. Ensure correct polarity. Then close the front cover. The battery change is then complete.



The battery is a CR2032 type from Panasonic.

The correct specifications are:

Battery type	Electrical properties (at 20 °C)		Standard charge	Dimensions		
	nominal voltage	nominal capacity	continuous load	Diameter	Height	Weight
CR2032	3.0 V	225 mAh	0.20 mA	20.0 mm	3.20 mm	3.1 g

Caution

An incorrectly inserted battery may explode!
Only use the same battery type (CR2032) from Sanyo or Panasonic.

It is essential that positive and negative terminals of the battery are inserted correctly (negative pole on the left)

Never open the battery or throw it into a fire.

The battery cannot be recharged.

Notice

Battery maintenance

The battery must be replaced every 5 years.

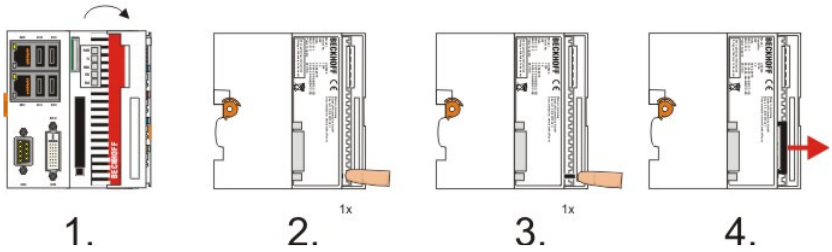
Spare batteries can be ordered from Beckhoff Service.

BECKHOFF CX50x0: Product overview

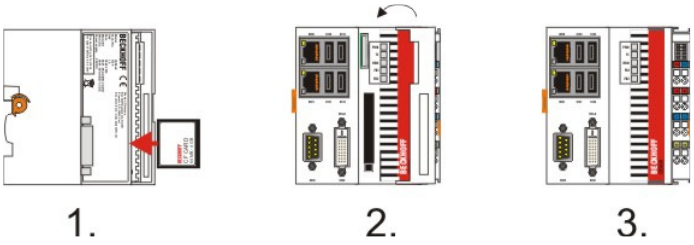
CF slot

A Compact Flash slot is located at the front, which enables the storage medium to be replaced. In the basic module this should only be done in **switched-off state**, otherwise the system may crash. The Compact Flash card can be removed from the module for maintenance. In this way it is also possible to expand the system (only operating system and program memory). Compact Flash cards (CF cards) are available as accessories in various sizes.

The following images illustrate the handling of the CF cards. Open the front cover. Then eject mechanism and the CF card slot are then visible. The eject mechanism is based on the push-push principle: If the head of the mechanical system is retracted, pushing it makes it move out of the housing. Pushing the head again will lock it back in the housing. At the same time the card moves approx. 4 mm out of the housing, so that it can be pulled out. If the card is pushed in (FIGURE 3), the eject mechanism will re-engage. The card is positioned correctly, if it is located approx. 1 mm lower than the front of the housing.



When the card is pushed back the eject mechanism locks again. The card is positioned correctly, if it is located approx. 1 mm lower than the front of the housing.



Type of CF slot

The Compact Flash slot is a memory interface, not an I/O type CF slot.

Notice

BECKHOFF CX50x0: Product overview

CF card

The Compact-Flash card (CF card) is a non-volatile memory.

Data to be retained in the event of a power failure should be saved on the CF card. The CF card operates like a hard disk.

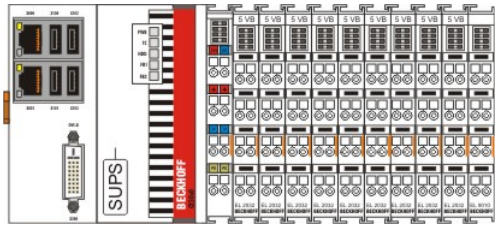
Notice

Using CF cards
We strongly recommend that **only** CF cards supplied by Beckhoff Automation GmbH should be used.
These are industrial CF cards with a higher number of write/read cycles and an extended temperature range (+85 °C).

Proper operation can **only** be **guaranteed** with CF cards from Beckhoff Automation GmbH!

BECKHOFF CX50x0: S-UPS (Second - Unbreakable Power Supply)

S-UPS: capacitive seconds UPS



The CX50x0 family features a built-in capacitive one-second UPS. It ensures a safe storage of the persistent application data on the Compact Flash card.

Up to 1 MB of data can be saved. The UPS can be switched on and off via the BIOS:

Phoenix – AwardBIOS CMOS Setup Utility

PC Health Status

SUSV	[Enabled]	Item Help
SUSV holds USB	[Enabled]	
SUSV Status	100% Cap. / Charging	
On Die Digital Temp.	47°C	
Temp. Board	56°C	
Temp DDR	57°C	
CPU Core	1.07V	
SCH Core	1.04V	
	...	

SUSV

Option for deactivating the one-second UPS.

SUSV holds USB

If system buffering based on SUSV is active, this option can be used to switch the power supply for the USB port on or off. This is important for data back-up on a USB storage medium, for example.

SUSV Status

This value indicates the status of the one-second UPS.

n% Cap. (n={0..100}) indicates the capacity of the UPS.

State (charging / discharging) describes the state of the one-second UPS.

Integration into a PLC

TwinCAT offers special function blocks for integrating the S-UPS into a PLC program. These are described below. From TwinCAT 2.11R2 Build 2016 the required library is integrated in the installation. For older versions the library TcSUPS.lib has to be copied into the TwinCAT library directory.

TwinCAT PLC Library: SUPS

Overview

The library **TcSUPS.Lib** contains functions and function blocks which are needed in order to use the Seconds UPS. See sample project Sample_S_UPS.pro.

Function Blocks

Name	Description
FB_S_UPS	Function block to use the Seconds UPS from the PLC.
FB_NT_QuickShutdown	Internal function block for the QuickShutdown, used by the FB_S_UPS.

Functions

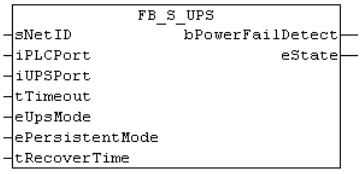
Name	Description
F_GetVersionTcSUPS	The function returns library version info.

Requirements

Component	Version
TwinCAT on the development PC, on the target system	TwinCAT 2.11 Build 2016 or higher (R2)

TwinCAT PLC Library: SUPS

FUNCTION_BLOCK FB_S_UPS



The function block FB_S_Ups can be used on PCs with Seconds UPS, to communicate from the PLC with the UPS. The FB_S_Ups can be used to save persistent data and to QuickShutdown the PC in case of a power failure. The INPUTs of the FB_S_UPS should be used with the default values.

Attention

Data loss

The Seconds UPS is only capable of holding the voltage for a few seconds. This is just enough time to save the persistent data. The used persistent saving mode must be "SPDM_2PASS", even though if this could causes realtime problems. The router memory must be big enough in order to save the persistent data!

Mode eSUPS_WrPersistData_Shutdown (default setting): The persistenten data are written and a QuickShutdown is automatically performed.

Mode eSUPS_WrPersistData_NoShutdown: Only the persistenten data are written, a QuickShutdown will not be performed.

Mode eSUPS_ImmediateShutdown: a QuickShutdown is immediatelly performed.

Mode eSUPS_CheckPowerStatus: only the powerfailure will be detected, no action is performed. In case of the powerfailure the FB waits until the tRecoverTime (10s) has expired before it goes back to the PowerOK state.

The UPS will switch off the main board after the capacitors have been discharged, independent of the mode and therefore independent of the writing of the persistent data and of the QuickShutdown, even if the power supply is restored.

The capacity of the UPS is to small to hold the system alive during longer power outages. The saving of the persistent data has to be done to the Compact Flash, since a hard disk cannot be operated if the UPS supplies the voltage. After the saving of the persistent data a QuickShutdown will be executed.

Attention

Attention if files are modified:

If other applications or the PLC are keeping files open or write to files during a power failure, then these files can get corrupted, since the QuickShutdown immediately reboots the PC.

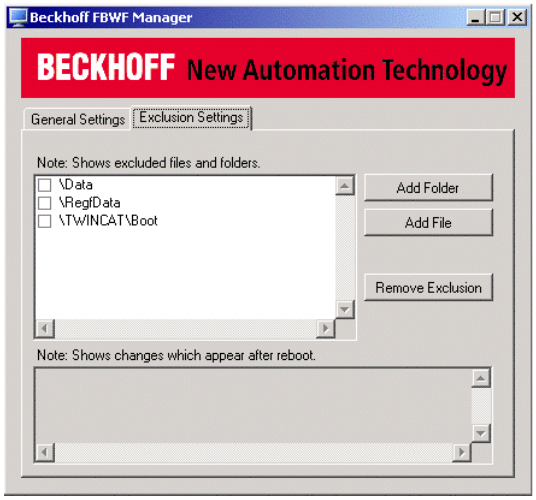
Attention

Attention if using Windows XP embedded:

The EWF (Enhanced Write Filter) or the FBWF (File Based Write Filter) has to be activated in order to ensure the validity of the Windows XP embedded files on systems with a Seconds UPS.

In case of the EWF the TwinCAT\Boot folder needs to be located on a not protected partition (see in the registry: HKEY_LOCAL_MACHINE\SOFTWARE\Beckhoff\TwinCAT\System\BootPrjPath).

In case of the FBWF the TwinCAT\Boot folder needs to be excluded from the protection (see Beckhoff FBWF Manager, Exclusion Settings).



FUNCTION_BLOCK FB_S_UPS

VAR_INPUT

```
VAR_INPUT
        sNetID          : T_AmsNetId := '';             (* '' = local netid *)
        iPLCPort        : UINT := AMSPORT_R0_PLC_RTS1;  (* PLC Runtime System for writing persistent data *)
        iUPSPort        : UINT := 16#4A8;               (* Port for reading Power State of UPS, dafault 16#4A8 *)
        tTimeout        : TIME := DEFAULT_ADS_TIMEOUT;  (* ADS Timeout *)
        eUpsMode        : E_S_UPS_Mode := eSUPS_WrPersistData_Shutdown; (* UPS mode (w/wo writing persistent data, w/wo shutdown) *)
        ePersistentMode : E_PersistentMode := SPDM_2PASS; (* mode for writing persistent data *)
        tRecoverTime    : TIME := T#10s;                (* ON time to recover from short power failure in mode eSUPS_WrPersistData_No
END_VAR
```

sNetID : AmsNetID of the PC.

iPLCPort : Port number of the PLC runtime system (AMSPORT_R0_PLC_RTS1 = 801, AMSPORT_R0_PLC_RTS2 = 811, AMSPORT_R0_PLC_RTS3 = 821, AMSPORT_R0_PLC_RTS4 = 831).

iUPSPort : Port number for reading the UPS-State (default value is 16#4A8).

tTimeout : Timeout for the execution of the QuickShutdown.

eUpsMode : eUpsMode defines, if persistent data need to be written and if a QuickShutdown needs to be executed.
The default value is eSUPS_WrPersistData_Shutdown, means with writing of the persistent data and then a QuickShutdown. See E_S_UPS_Mode.

ePersistentMode : Mode for the writing of the persistent data. Default value is SPDM_2PASS.

tRecoverTime : Time which will be waited after a power failure (in case of UPS modes without shutdown) to go back to the status PowerOK.
The tRecoverTime needs to be a little bit bigger than the maximum holding time of the UPS, since the UPS will shut off even if the power supply is restored.

VAR_OUTPUT

```
VAR_OUTPUT
        bPowerFailDetect: BOOL;             (* TRUE while powerfailure is detected *)
        eState          : E_S_UPS_State;    (* current ups state *)
END_VAR
```

bPowerFailDetect : TRUE if a power failure is detected; FALSE if the power supply is sufficiant.

eState : internal state of the function block, for the values see E_S_UPS_State.

VAR_GLOBAL

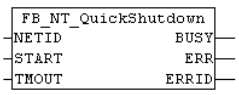
```
VAR_GLOBAL
        eGlobalSUpsState : E_S_UPS_State;     (* current ups state *)
END_VAR
```

eGlobalUpsState : internal state of the function block as a global copy of **eState**, for the values see E_S_UPS_State.

Development environment	Target plattform	Hardware	PLC Libraries to include
TwinCAT v2.11.0 Build 2016 or higher (R2)	PC (i386)	Second-UPS	TcSUPS.Lib

TwinCAT PLC Library: SUPS

FUNCTION_BLOCK FB_NT_QuickShutdown



The function block FB_NT_QuickShutdown is used to immediately reboot the PC without stopping TwinCAT or the operating system Windows.

Attention:
The function block FB_NT_QuickShutdown is used internally from FB_S_UPS and is not intended to be used elsewhere!

FUNCTION_BLOCK FB_NT_QuickShutdown

VAR_INPUT

```
VAR_INPUT
        NETID :T_AmsNetId;
        START :BOOL;
        TMOUT :TIME := DEFAULT_ADS_TIMEOUT;
END_VAR
```

NETID : AmsNetID of the PC.

START : rising edge leads to an immediate reboot of the PC.

TMOUT : Timeout time.

VAR_OUTPUT

```
VAR_OUTPUT
        BUSY  :BOOL;
        ERR   :BOOL;
        ERRID :UDINT;
END_VAR
```

BUSY : The QuickShutdown is being executed.

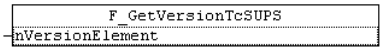
ERR : Is TRUE, if an error occurs.

ERRID : Delivers the error number in case that **ERR** is TRUE.

Development environment	Target plattform	Hardware	PLC Libraries to include
TwinCAT v2.11.0 Build 2016 or higher (R2)	PC (i386)	Second-UPS	TcSUPS.Lib

TwinCAT PLC Library: SUPS

FUNCTION F_GetVersionTcSUPS



The function returns library version info.

FUNCTION F_GetVersionTcSUPS : UINT

```
VAR_INPUT
        nVersionElement : INT;
END_VAR
```

nVersionElement : Version element:

- 1 : major number;
- 2 : minor number;
- 3 : revision number;

Development environment	Target plattform	Hardware	PLC Libraries to include
TwinCAT v2.11.0 Build 2016 or higher (R2)	PC (i386)	Second-UPS	TcSUPS.Lib

TwinCAT PLC Library: SUPS

TYPE E_S_UPS_Mode

```
eSUPS_WrPersistData_Shutdown: Writing of persistent data and then a QuickShutdown

eSUPS_WrPersistData_NoShutdown: Only writing of the persistent data (no QuickShutdown)

eSUPS_ImmediateShutdown: Only QuickShutdown (no writing of persistent data)

eSUPS_CheckPowerStatus: Only check status (neither writing of persistent data nor a QuickShutdown)
```

Development environment	Target plattform	Hardware	PLC Libraries to include
TwinCAT v2.11.0 Build 2016 or higher (R2)	PC (i386)	Second-UPS	TcSUPS.Lib

TwinCAT PLC Library: SUPS

TYPE E_S_UPS_State

```
eSUPS_PowerOK:
        in all modes: Power supply is OK

eSUPS_PowerFailure:
        in all modes: Power supply is faulty (only shown for one PLC cycle)

eSUPS_WritePersistentData:
        in Mode eSUPS_WrPersistData_Shutdown: Writing of persistent data is active
        in Mode eSUPS_WrPersistData_NoShutdown: Writing of persistent data is active

eSUPS_QuickShutdown:
        in Mode eSUPS_WrPersistData_Shutdown: QuickShutdown is active
        in Mode eSUPS_ImmediateShutdown: QuickShutdown is active

eSUPS_WaitForRecover:
        in Mode eSUPS_WrPersistData_NoShutdown: Wait for the reestablishment of the power supply
        in Mode eSUPS_CheckPowerStatus: Wait for the reestablishment of the power supply

eSUPS_WaitForPowerOFF:
        in Mode eSUPS_WrPersistData_Shutdown: Wait for switching off of the PC by the UPS
        in Mode eSUPS_ImmediateShutdown: Wait for switching off of the PC by the UPS
```

Development environment	Target plattform	Hardware	PLC Libraries to include
TwinCAT v2.11.0 Build 2016 or higher (R2)	PC (i386)	Second-UPS	TcSUPS.Lib

BECKHOFF CX50x0: Installation and wiring

Unpacking, installation and transport

The specified storage conditions must be adhered to (see "Technical data").

Dimensions and weight of the individual modules:

Dimensions (H x W x D): 100 x 102 x 92 mm

Weight: 575 g (basic module)

Unpacking

Proceed as follows to unpack the unit:

1. Remove packaging.
2. Do not discard the original packaging. Keep it for transporting the device in the future.
3. Check the delivery for completeness by comparing it with your order.
4. Please keep the associated paperwork. It contains important information for handling the unit.
5. Check the contents for visible shipping damage.
6. If you notice any shipping damage or inconsistencies between the contents and your order, you should notify Beckhoff Service.

Caution

Danger of damage to the unit!
During transport in cold conditions, or if the unit is subjected to extreme temperature swings, condensation on and inside the unit must be avoided.

Prior to operation, the unit must be allowed to slowly adjust to room temperature. Should condensation occur, a delay time of approximately 12 hours must be allowed before the unit is switched on.

Installation

The devices are designed for installation in control cabinets.

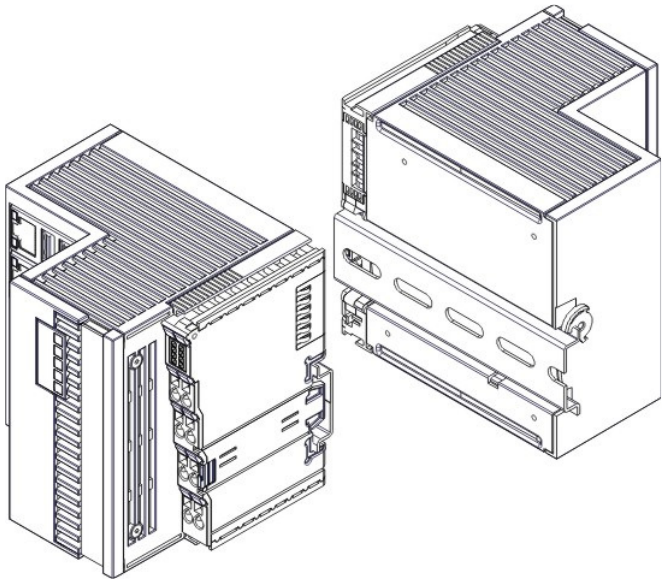
Shipping and relocation

Despite the robust design of the unit, the components are sensitive to strong vibrations and impacts. During transport, your computer should therefore be protected from excessive mechanical stress. Therefore, please use the original packaging.

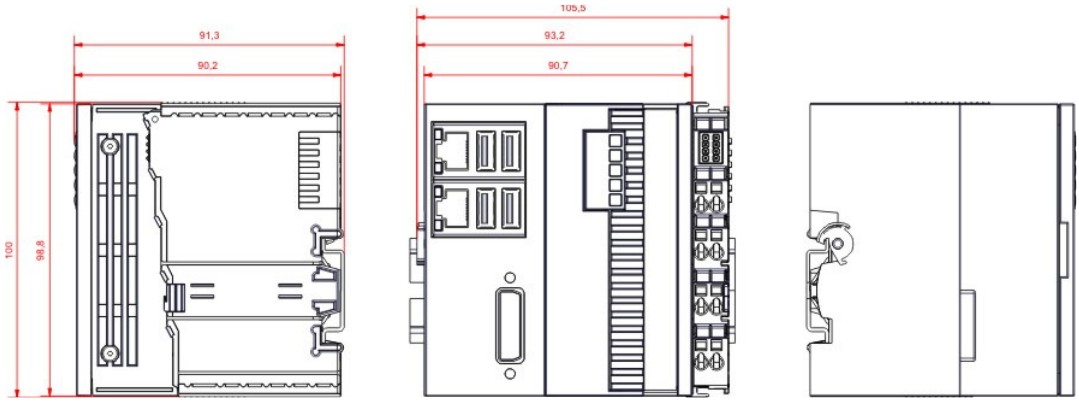
BECKHOFF CX50x0: Installation and wiring

Dimensions

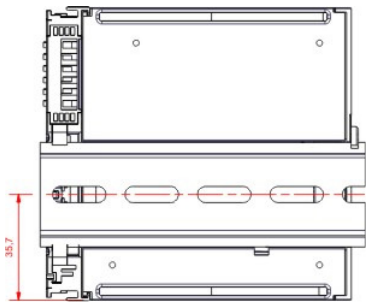
The following drawings show the dimensions of the CX50x0 devices.



Dimensions



Rear view

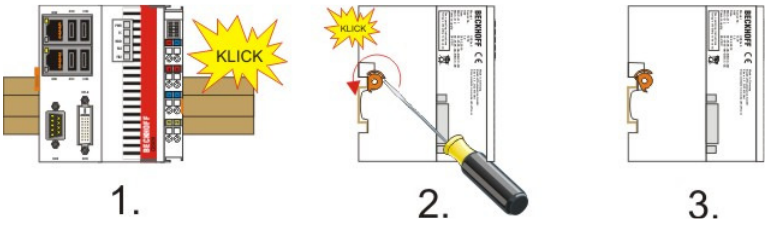


BECKHOFF CX50x0: Installation and wiring

Installation on the mounting rail

Snapping onto the mounting rail

The CX50x0 can simply be snapped onto the mounting rail. To this end position the block on the mounting rail and push it slightly until it engages on the right-hand side. The is indicated by a distinct click. Use a screwdriver to push up the lock on the left-hand side, thereby turning it and causing it to engage audibly.



Caution

Avoid damage!

Do not force the module or apply excessive pressure!

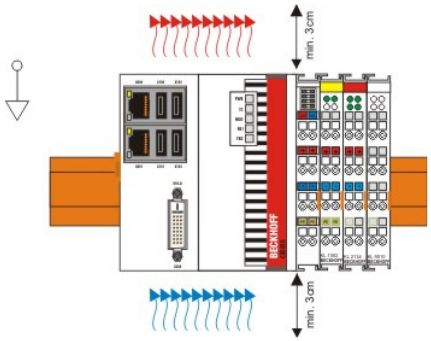
Installation position

Caution

Comply with the permitted installation position **and minimum distances!**
The maximum ambient temperature for CPU modules mounted on a top-hat rail is 55 °C. The orientation in which the device is fitted must be selected in such a way that cooling air can flow vertically through the ventilation holes. The images show the permitted and two incorrect installation positions.

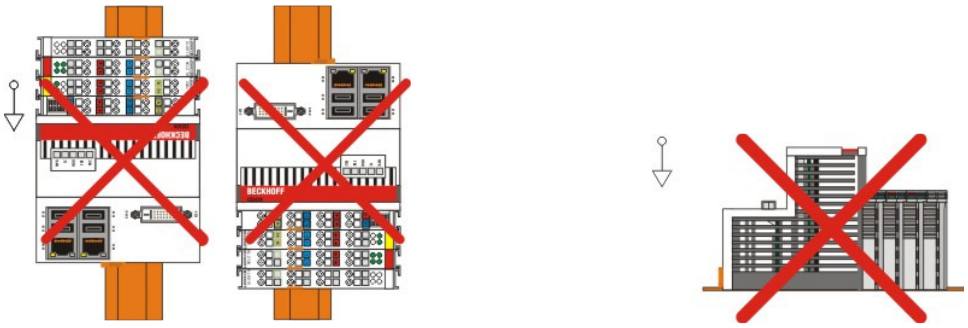
Mounting must provide a clearance of 30 mm both above and below a CX50x0 device combination to ensure adequate ventilation of the base CPU module and the power supply unit.

The high performance and the compact design of the CX50x0 systems may result in increased heat generation. The heat is dissipated via a passive ventilation system. This system requires the unit to be mounted correctly. Ventilation openings are located at the top and bottom of the housing. The system therefore has to be installed horizontally. This ensures optimum air flow.



Incorrect installation positions

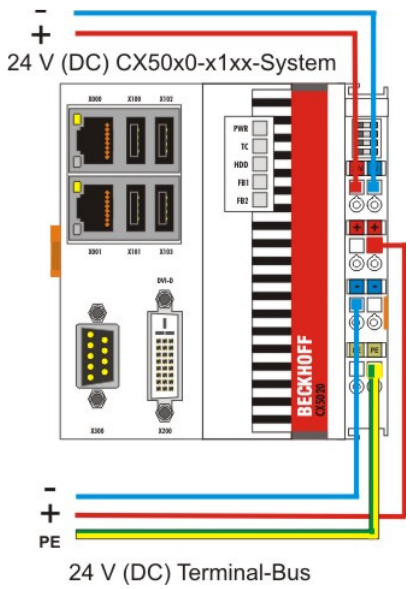
The CX50x0 system must not be operated vertically on the top-hat rail. A vertical position would lead to insufficient CPU ventilation, since the ventilation openings are located on the top and bottom of the housing. Installation of the system on its side would also lead to inadequate ventilation.



BECKHOFF CX50x0: Product overview

Power supply

This power supply unit is equipped with an I/O interface, which permits connection of the Beckhoff Bus Terminals. The power is supplied via the upper spring-loaded terminals labeled “24V” and “0V”.
The supply voltage supplies the CX system ant the terminal Bus and Bus Terminal with a voltage of 24 V DC (-15 %/+20 %). The dielectric strength of the power supply unit is 500 V_{rms}. Since the Terminal Bus (K- and E-bus) only transfers data, a separate power supply is required for the Bus Terminals. This is provided by means of the power contacts, which are not connected to the power supply.



Requirements for the 24V power supply

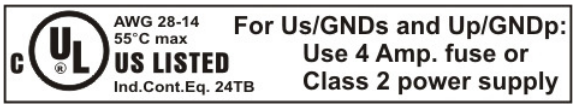
The power supply must be capable to supply 4A to guarantee proper function of CPU module and terminals.

LED

If the power supply unit is connected correctly and the power supply is switched on, the two upper LEDs in the terminal prism are green. The left LED (Us) indicates the CPU supply. The right LED (Up) indicates the terminal supply. The other LEDs indicate the Terminal Bus status. A detailed description of the LEDs can be found in section "LED troubleshooting".

UL requirements

Danger	
	For the compliance of the UL requirements the CX-Controllers should only be supplied • by a 24 V_{DC} supply voltage, supplied by an isolating source and protected by means of a fuse (in accordance with UL248), rated maximum 4 Amp. • by a 24 V_{DC} power source, that has to satisfy *NEC class 2*. A *NEC class 2* power supply shall not be connected in series or parallel with another (class 2) power source! This UL requirements are valid for all supply voltages of the CX-Controllers!
	To meet the UL requirements, the CX-Controllers must not be connected to unlimited power sources!



PE power contacts

Caution

Power contact "PE"

The "PE" power contact must not be used for other potentials.

BECKHOFF CX50x0: Product overview

Mounting of passive terminals to the power supply of CX50x0


Note

Hint for mounting passive terminals
EtherCAT Bus Terminals (ELxxxx / ESxxxx), which do not take an active part in data transfer within the bus terminal block are so called Passive Terminals.
The Passive Terminals have no current consumption out of the E-Bus
To ensure an optimal data transfer, you must not directly connect the passive terminal directly to the power supply!

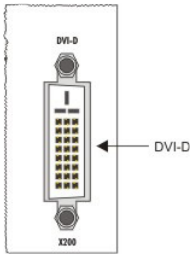
Sample for configurations with passive terminals (grey colored):

The following picture shows an invalid configuration:

This piczure shows the valid configuration:

BECKHOFF CX50x0: Product overview

DVI-D connection



DVI-D connection (X200)

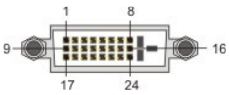
The DVI-D interface transfers digital display data and is suitable for connecting a digital display. The maximum length of the DVI cable is determined by screen resolution and quality of the DVI cable. Without the use of special electronics, a DVI cable length of 5m should not be exceeded. Beckhoff offers various displays with integrated DVI extension electronics, enabling DVI cable length up to 50m.

Notice

DVI-D interface

The DVI interface does **not** use VGA signals, so that the connection of CRT VGA monitors to the CX1000 system using a DVI to VGA adapter is **not** possible.

DVI-D socket



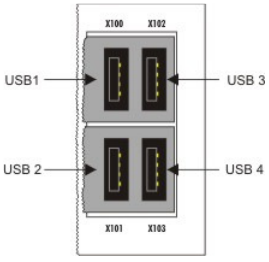
Pin	Assignment	Pin	Assignment	Pin	Assignment
1	TMDS Data 2-	9	TMDS Data 1-	17	TMDS Data 0-
2	TMDS Data 2+	10	TMDS Data 1+	18	TMDS Data 0+
3	TMDS Data 2/4 Shield	11	TMDS Data 1/3 Shield	19	TMDS Data 0/5 Shield
4	not connected	12	not connected	20	not connected
5	not connected	13	not connected	21	not connected
6	DDC Clock	14	+ 5V Power	22	TMDS Clock Shield
7	DDC Data	15	Ground (+5V, Analog H/V Sync)	23	TMDS Clock +
8	Analog Vertical Sync	16	Hot Plug Detect	24	TMDA Clock -

Resolution at the monitor

Resolution in pixels	Distance of the interface from the monitor
1920 x 1200	5 m
1600 x 1200	5 m
1280 x 1024	5 m
1024 x 768	5 m
800 x 600	5 m
640 x 480	5 m

BECKHOFF CX50x0: Product overview

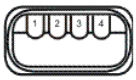
USB connections



USB interface (X100 / X101 / X102 / X103):

The CX50x0 has 4 independent USB interfaces, for connecting keyboards, mice, touchscreens and other input or data storage devices. Keep an eye on the power

consumption of the individual devices. Each port is limited to 500 mA.

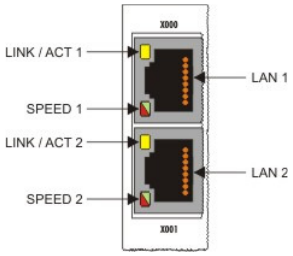


The USB socket is a type A socket. The USB interface complies with the USB 2.0 specification.

Pin	Assignment	Typical assignment
1	VBUS	Red
2	D-	White
3	D+	Green
4	GND	Black
Shell	Shield	Drain Wire

BECKHOFF CX50x0: Product overview

LAN connections



LAN interface (X000/ X001)

The CX50x0 systems have two independent LAN interfaces. Both ports are able to operate at speeds of 10 / 100 / 1000 Mbit. The LEDs on the left-hand sides of the RJ45 sockets indicate the status of the LAN connection. The upper LED indicates whether the port is connected to a network. If this is the case the LED is yellow. The LED flashes if data traffic takes place on the port. The lower LED indicates the connection speed. The LED is green if the speed is 10 or 100 Mbit. In 1000 Mbit mode (Gigabit) the LED is red.

Configuration of the RJ45 interface, port 1 (X000)

PIN	Signal	Description
1	TD +	Transmit +
2	TD -	Transmit -
3	RD +	Receive +
4	connected	not used
5		
6	RD -	Receive -
7	connected	not used
8		

Configuration of the RJ45 interface, port 2 (X001)

PIN	Signal	Description
1	TD +	Transmit +
2	TD -	Transmit -
3	RD +	Receive +
4	connected	not used
5		
6	RD -	Receive -
7	connected	not used
8		

Notice

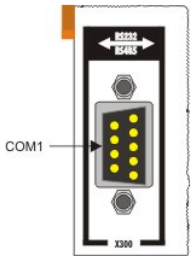
Independence of the ports
Both ports are independent of each other. In contrast to the CX1020 and CX9000 systems, **no** switch is integrated. For a line topology an additional switch is required. The independent ports can be configured in different ways:

- The upper port (1) is configured as Gigabit IT port,
- The lower port (2) is configured for EtherCAT communication

in the delivery state.

BECKHOFF CX50x0: Product overview

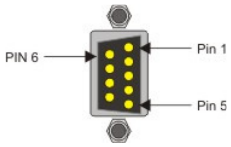
RS232 connections (CX50x0-N030)



The CX50x0-N030 system interface provides an RS232 interface, COM1 (X300). It is implemented on a 9-pole Sub-D pin strip. If more than one interface is required the system can be extended via the Terminal Bus (K- or E-bus) or Bus Terminals (KL/EL6001) which provide serial interfaces. The pin assignment is shown at the bottom of the page.

The maximum baud rate on both channels is 115 kbit. The interface parameters are set via the operating system or from the PLC program.

RS232 COM interface (connector)

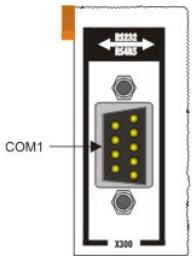


Pin assignment of the COM interface

PIN	Signal	Type	Description
1	DCD	Signal in	Data Carrier Detected
2	RxD	Signal in	Receive Data
3	TxD	Signal out	Transmit Data
4	DTR	Signal out	Data Terminal Ready
5	GND	Ground	Ground
6	DSR	Signal in	Dataset Ready
7	RTS	Signal out	Request to Send
8	CTS	Signal in	Clear to Send
9	RI	Signal in	Ring Indicator

BECKHOFF CX50x0: Product overview

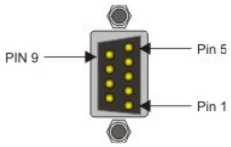
RS422/RS485 connections (CX50x0-N031)



The CX50x0-N030 system interface provides an RS422 or RS 485 interface, COM1 (X300). It is implemented on a 9-pole Sub-D socket strip. If more than one interface is required the system can be extended via the Terminal Bus (K- or E-bus) or Bus Terminals (KL/EL6021) which provide serial interfaces. The pin assignment is shown at the bottom of the page.

The maximum baud rate on both channels is 115 kbit. The interface parameters are set via the operating system or from the PLC program.

COM interface (socket)



Pin assignment of the COM interface

PIN	Signal	Typ	Beschreibung
2	TxD+	Data-Out +	Transmit 422
3	RxD+	Data-In +	Receive 422
5	GND	Ground	Ground
6	VCC	VCC	+5V
7	TxD-	Data-Out -	Transmit 422
8	RxD-	Data-In -	Receive 422

For RS 485 pins 2 and 3 (data +) must be connected, and pins 7 and 8 (data -).

Parameter setting of the interface

The interface is parameterized as follows:

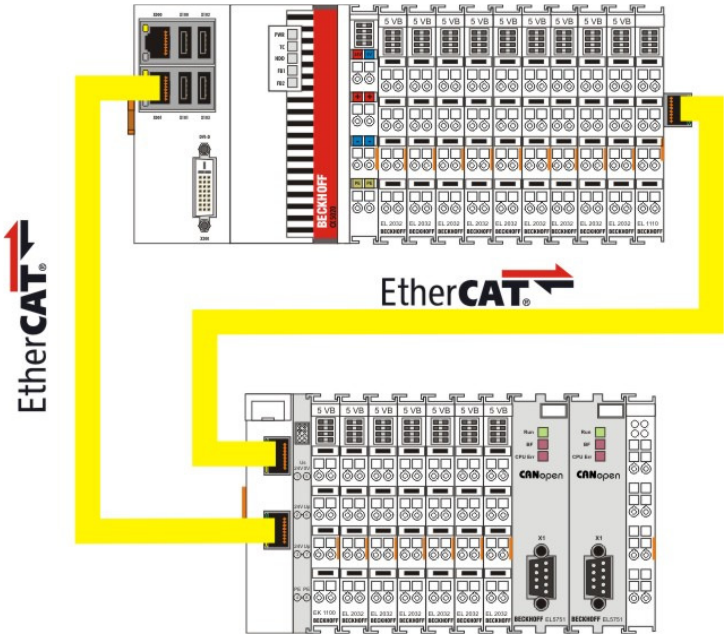
RS485 without Echo, End-Point (Termination) default setting

Function	State
Echo on	off
Echo off	on
Auto send on	on
Always send on	off
Auto receive on	on
Always receive on	off
Term on	on
Term on	on

Note	Change of parameters
i	If there are other parameters needed, please contact your local service department.

BECKHOFF CX50x0: EtherCAT cable redundancy

EtherCAT cable redundancy



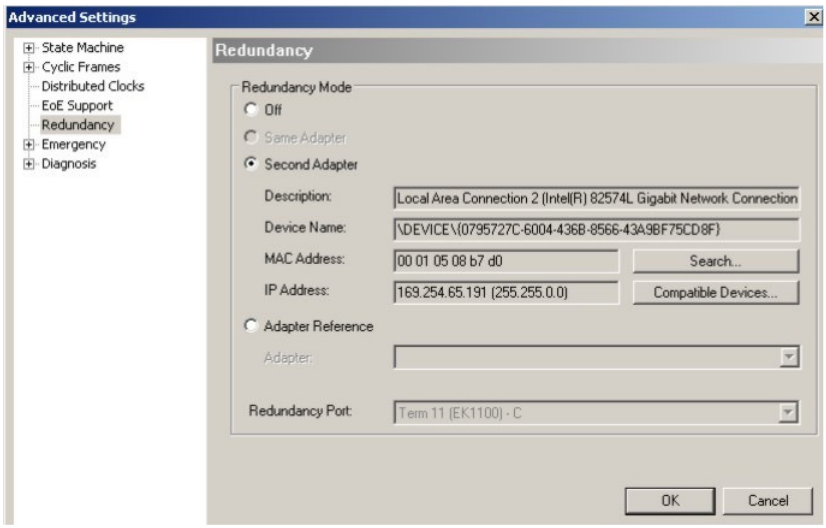
EtherCAT cable redundancy can be realised in the CX50x0 systems through the two independent Ethernet ports. Minimum requirements:

1. EtherCAT redundancy supplement
2. EK1110 (bus extension)
3. EK1100 (Bus Coupler)

The supplement product on the Beckhoff website at

http://download.beckhoff.com/download/Software/TwinCAT/TwinCAT2/Supplement/TwinCAT_EtherCAT_Redundancy/Install/TcEcRedundancy.exe

can be downloaded. The required licence key can be ordered from our sales division. The required couplers are ordered together with the other hardware. These components can then be used to configure the controller. The upper figure shows a minimum configuration example for cable redundancy. Once the hardware has been wired and commissioned, the supplement must be installed on the device, for example via a USB stick or the IT network. During the installation the system asks for the licence key. The cable redundancy can be set up in the System Manager. The first step involves reading the terminal configuration. Then select "Advanced Settings" under the "EtherCAT" tab in the EtherCAT device properties. The second adapter can be set under the "Redundancy" menu. Use the "Search" button to open the selection menu. Select "Local Area Connection 2 (Intel(R).....)" for the lower network connection (X001). Click "OK" to complete the configuration.



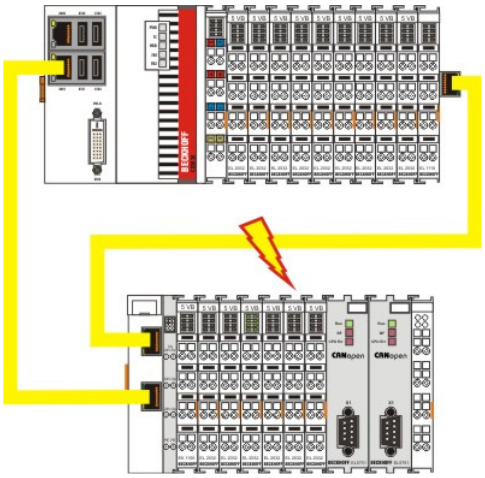
Notice

The supplement only supports CABLE REDUNDANCY
This supplement only supports cable redundancy, which means that only the cable sections can be regarded as fail-safe, i.e. connections between the couplers.
Failures of individual terminals are not covered.

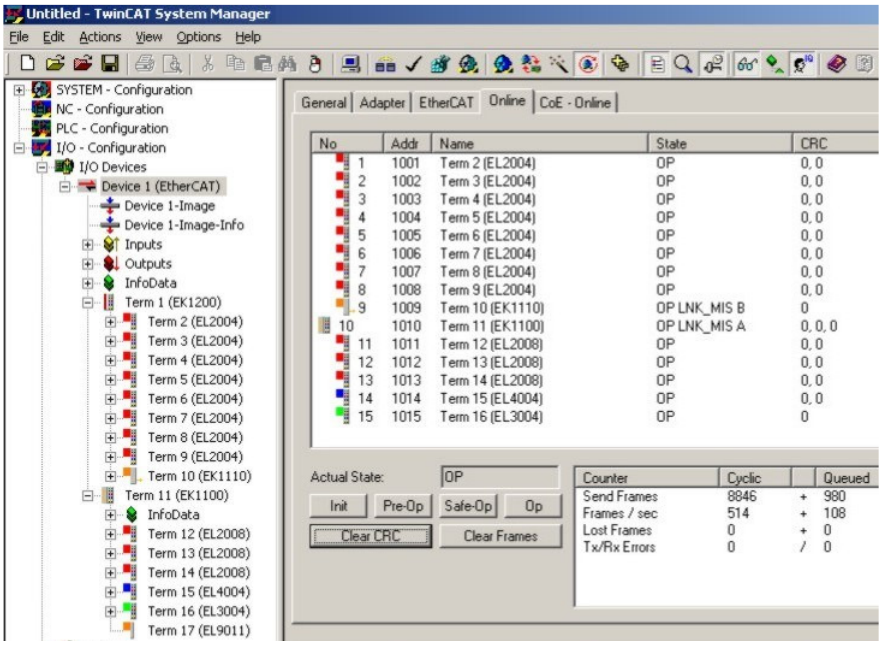
Further details can be found in the Beckhoff Information System under EtherCAT cable redundancy.

Cases of failure

The two possible failures are described in the example below.

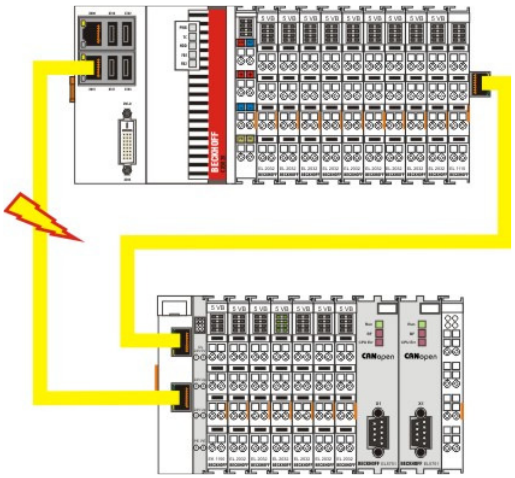


In this example the supply line for coupler EK1100 is faulty. The EK1100 terminals continue to run despite the cable failure. The System Manager indicates the failure as follows:

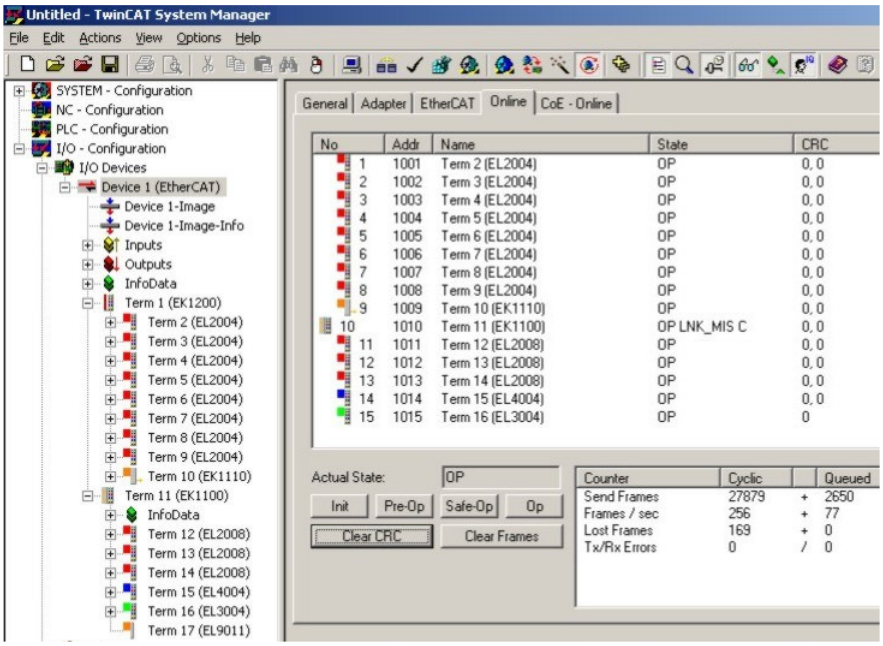


The interruption is indicated by "LNK_MIS B" and "LNK_MIS A".

The next example shows a failure of the "return line":



In this case the second cable is faulty. The terminals at the coupler continue to run without malfunction. The System Manager indicates the behavior as follows:



The interruption is indicated by "LNK_MIS C" at coupler EK1100.

The EtherCAT ring is expandable. The number of devices in the ring is controlled by licenses: up to 250, up to 1000, more than 1000. A master is only able to bridge one failure. In the event of two failures the ring components will continue to run up to the breaking points.

BECKHOFF CX50x0: Commissioning

Switching on and off

Switching on

The power supply for the basic CPU module comes from the power supply unit. The basic CPU module starts automatically when the power supply unit is connected to the mains.

Switching on for the first time

When you switch on the PC for the first time, the pre-installed operating system (optional) will be started.

Switching off

The Embedded PC switches off when the power supply unit is switched off. The control software typically running on Embedded PCs should be shut down or stopped correctly. A user who may not close software may also not switch the Embedded PC off, since data can be lost from the hard disk by switching off while software is running.

Once the software has been stopped, the operating system can be shut down. Only then should the power supply be interrupted.

BECKHOFF CX50x0: BIOS Setup

Note on using the setup

Caution

Changes in the BIOS settings may only be implemented by appropriately trained staff.
The CX50x0 systems are delivered by Beckhoff Automation GmbH in a preconfigured state and are therefore operational!

The BIOS settings should only be executed by **appropriately trained** staff.

Under **Windows CE** the BIOS should not be changed at all, since the operating system is adapted to the hardware configuration. Any change in the addresses or interrupts would lead to unstable system behaviour or even crashing.

Within the individual setup pages, F6 can be used for loading fail-safe defaults, and F7 for optimised default values for the individual setup entries. These default values are applied irrespective of whether the board was previously booted successfully with a particular setup setting. The situation is different if the defaults are called from the TOP menu. Once a setup setting that subsequently led to successful booting was saved, both menu items will load these values as default for the setup pages. See also "Load Fail-Safe Defaults" and "Load Optimized Defaults".

Top menu

```
                    Phoenix - AwardBIOS CMOS Setup Utility

▶ Standard CMOS Features                  ▶ Frequency/Voltage Control
▶ Advanced BIOS Features                  Load Fail-Save Defaults
▶ Advanced Chipset Features               Load Optimized Defaults
▶ Integrated Peripherals                  Set Password
▶ Power Management Setup                  Save & Exit Setup
▶ PnP/PCI Configuration                   Exit Without Saving
▶ PC Health Status

ESC: Quit                                          ↑ ↓ → ← Select Item

F10: Save & Exit Setup


                        "Brief description of the function selected above"
```

A „▶“ sign in front of the menu item indicates that a submenu is available. An "x" before a menu item indicates that there is a setting option that has to be activated via a setting at a higher level.

Load Fail-Save Defaults

This option is used for absolute security settings. It is not suitable for continuous operation, but can be useful if the PC malfunctions.

Load Optimized Defaults

This option is used for setting optimum values as recommended by the manufacturer.

Set Password

Here you can enter a setup password for preventing unauthorised invoking of the BIOS.

Save & Exit Setup

This option is used to save the settings and exit setup. Input: Y (Please note: enter Z with German keyboard).

Exit Without Saving

Quit setup without saving the settings. Setting: Y (Please note: enter Z with German keyboard).

BECKHOFF CX50x0: BIOS Setup

Standard CMOS Features

This menu is used for setting date, time, hard disks, graphics mode and start-up behaviour. At the same time, information about the memory configuration determined by the system is provided. The memory configuration information cannot be changed. The setting options for date, time, graphics mode and startup behaviour are described below. A new menu opens for setting the hard disk data.

Phoenix – AwardBIOS CMOS Setup Utility

Standard CMOS Features

		Item Help
Date (mm:dd:yy)	Wed, Jun 30 2010	
Time (hh:mm:ss)	11 : 11 : 00	
u8; IDE Channel 0 Master	[None]	
u8; IDE Channel 0 Slave	[None]	
Halt On	[All, But Keyboard]	
Base Memory	639K	
Extended Memory	514,048K	
Total Memory	515,072K	

↑ ↓ → ← :Move Enter:Select +/-/PU/PD:Value F10:Save ESC:Exit F1:Help

F5: Previous Values F6: Fail-Safe Defaults F7: Optimized Defaults

Date (mm:dd:yy)

Options:

- mm … month
- dd … day
- yy … year

Time (hh:mm:ss)

Options:

- hh … hours
- mm … minutes
- ss … seconds

Halt On

This parameter can be used for stopping the boot process in the event of errors. Errors may be ignored. This menu item is used to configure the settings.

Options:

- All Errors (stop for all types of error)
- No Errors (ignore all errors and continue system start-up)
- All , But Keyboard (missing keyboard is ignored)

Base Memory

This option is used for displaying the conventional memory (0 KB to 640 KB) in order to indicate whether it was detected by the POST.

Extended Memory

Available memory from the first MB to the maximum memory capacity.

Total Memory

This is the total of base memory, extended memory and other memory.

BECKHOFF CX50x0: BIOS Setup

IDE Primary Master

This menu is used to set the data for the hard disk connected as master to the first IDE bus. The hard disk data (size, number of cylinders, heads, sectors, pre-compensation and home position of the heads when the disk is switched off) are displayed automatically for the connected hard disk.

IDE HDD Auto-Detection

Automatic detection of the hard disk is initiated by pressing the <Enter> key. After a few seconds the physical data of the connected hard disk should be displayed in the lower section of the menu.

IDE Channel 0 Master

This parameter is used for configuring the IDE bus. The following options are available:

- None (no hard disk connected to this bus connection)
- Auto (auto-detection during each boot process)
- Manual (the hard disk is addressed with the set parameters)

Access Mode

This option can be used to select the operating system for the hard disk. Setting options: CHS, LBA, LARGE, or Auto. Auto is the recommended setting. Normal (standard) mode supports hard disks with a capacity of up to 528 MB. This mode uses positions for data access that are specified via cylinders (CYLS), heads, and sectors. The older LBA (Logical Block Addressing) mode can support hard disks with a capacity of up to 8.4 GB. This mode uses a different method for calculating the position disk data to be accessed. It translates cylinders, heads and sectors into a logical address for the data location. Large hard disks support this mode. The BIOS supports the INT 13h extension function that enables the LBA mode to manage hard disk drives with a capacity of more than 8.4 GB. If the number of cylinders (CYLs) on the hard disk exceeds 1024 and DOS cannot support it, or if your operating system does not support LBA mode, LARGE mode should be selected. The following options are available for setting the hard disk access mode:

- CHS
- LBA
- LARGE
- Auto

The following parameters are automatically determined and displayed.

Capacity

Storage capacity of the hard disk. This value is calculated from the individual hard disk parameters.

Cylinder

Define or set the number of cylinders. Depending on the BIOS version and the manufacturer it varies between 1,024 and 16,384 cylinders.

Head

Define or set the number of heads. The number is between 1 and 16 heads.

Precomp

Write pre-compensation, required for older hard disks. This parameter specifies the cylinder from which a difference in the information density is to be expected.

Landing Zone

This parameter defines the so-called landing zone or park cylinder. This is the resting position for the hard disk head when the hard disk motor is switched off.

Sector

Define or set the number of sectors per track. Up to 63 sectors are supported, for Phoenix up to 64.

BECKHOFF CX50x0: BIOS Setup

IDE Primary Slave

This menu is used to set the data for the hard disk connected as master to the first IDE bus. The hard disk data (size, number of cylinders, heads, sectors, pre-compensation and home position of the heads when the disk is switched off) are displayed automatically for the connected hard disk.

Phoenix – AwardBIOS CMOS Setup Utility

IDE Primary Slave

IDE HDD Auto-Detection	[Press Enter]	Item Help
IDE Channel 0 Slave	[Auto]	
Access Mode	[Auto]	
Capacity	0 MB	
Cylinder		
Head	0	
Precomp	0	
Landing Zone	0	
Sector	0	

↑ ↓ → ← :Move Enter:Select +/-/PU/PD:Value F10:Save ESC:Exit F1:Help

F5: Previous Values F6: Fail-Safe Defaults F7: Optimized Defaults

IDE HDD Auto-Detection:

Automatic detection of the hard disk is initiated by pressing the <Enter> key. After a few seconds the physical data of the connected hard disk should be displayed in the lower section of the menu.

IDE Primary Master:

This parameter is used for configuring the IDE bus. The following options are available:

- None (no hard disk connected to this bus connection)
- Auto (auto-detection during each boot process)
- Manual (the hard disk is addressed with the set parameters)

Access Mode:

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- CHS
- LBA
- LARGE
- Auto

The following parameters are automatically determined and displayed.

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Define or set the number of cylinders. Depending on the BIOS version and the manufacturer it varies between 1,024 and 16,384 cylinders.

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Sector

Define or set the number of sectors per track. Up to 63 sectors are supported, for Phoenix up to 64.

BECKHOFF CX50x0: BIOS Setup

Advanced BIOS Features

This menu is used to set the data for the hard disk connected as master to the first IDE bus. The hard disk data (size, number of cylinders, heads, sectors, pre-compensation and home position of the heads when the disk is switched off) are displayed automatically for the connected hard disk.

Phoenix – AwardBIOS CMOS Setup Utility

Advanced BIOS Features

u8; CPU Feature	[Press Enter]	Item Help
u8; Hard Disk Boot Priority	[Press Enter]	
CPU L1 & L2 Cache	[Enabled]	
Hyper Threading Technology	Enabled	
Quick Power On Self Test	[Enabled]	
First Boot Device	[Harddisk]	
Second Boot Device	[LS120]	
Second Boot Device	[LS120]	
Boot Other Device	[Enabled]	
Boot Up NumLock Status	[On]	
Gate A20 Option	[Fast]	
Typematic Rate Setting	[Disabled]	
Typematic Rate (Chars/Sec)	6	
Typmatic Delay (Msec)	250	
Security Option	[Setup]	
APIC Mode	Enabled	
MPS Version Control For OS	[1.4]	
OS Select For DRAM > 64 MB	[Non-OS2]	
HDD S.M.A.R.T. Capability	[Enabled]	
Full Screen Logo	[Disabled]	

↑ ↓ → ← :Move Enter:Select +/-/PU/PD:Value F10:Save ESC:Exit F1:Help

F5: Previous Values F6: Fail-Safe Defaults F7: Optimized Defaults

CPU Feature

This menu item can be used for setting the CPU behaviour for thermal profiles.

Virus Warning

On start-up the boot sectors are checked for changes since the last start. Setting options: Enabled (a virus warning may appear until it is acknowledged with Confirm or switched off (Disabled)), Confirm (a required boot sector modification, e.g. after reinstallation of an operating system, is confirmed), Disabled (boot sectors are not verified).

CPU L1 & L2 Cache

The cache memory is an additional memory that is substantially faster than the conventional DRAM (system memory). If the CPU requests data, the system transfers theses data from the main DRAM to the cache memory for faster access by the CPU. Setting options: Enable (standard) - cache activated, Disabled - cache deactivated.

Quick Power On Self Test

If this option is enabled the computer will start significantly faster. Booting will be up to 50 seconds faster with 64 MB RAM or more. However, not all POST tests are carried out.

First Boot Device

Here you can specify which drive should boot first. First set the drive to be used as boot drive. Options:

- LS120 (LS-Drive)
- Hard Disk
- CDROM (CD drive)
- ZIP100 (Zip-Drive)
- USB-FDD (USB-Floppy)
- USB-ZIP (USB Zip-Drive)
- USB-CDROM (USB CDROM)
- Legacy LAN (network)
- WIN CE
- Disabled (deactivated)

Second Boot Device

This setting is used for booting, if the first boot device is not available. First set the drive to be used as boot drive. Options:

- S120 (LS-Drive)
- Hard Disk
- CDROM (CD drive)
- ZIP100 (Zip-Drive)
- USB-FDD (USB-Floppy)
- USB-ZIP (USB Zip-Drive)
- USB-CDROM (USB CDROM)
- Legacy LAN (network)
- WIN CE
- Disabled (deactivated)

Second Boot Device

This setting is used for booting, if the first and second boot device are not available. First set the drive to be used as boot drive. Options:

- S120 (LS-Drive)
- Hard Disk
- CDROM (CD drive)
- ZIP100 (Zip-Drive)
- USB-FDD (USB-Floppy)
- USB-ZIP (USB Zip-Drive)
- USB-CDROM (USB CDROM)
- Legacy LAN (network)
- WIN CE
- Disabled (deactivated)

Boot Other Device

This option offers two choices: Enabled or Disabled. The standard setting is Enabled. The Enabled setting enables the BIOS to try all three types, i.e. "First Boot Device", "Second Boot Device" or "Third Boot Device".

Boot Up NumLock Status

State of the numeric keypad. With On it is activated, with Off not.

Gate A20 Option

Defines how the memory above 1MB is accessed. This should be set to Fast, in order to activate access through the chipset. With the Normal setting it is accessed via the keyboard controller. This option may speed up older computers. The first 64 K Block above 1 MB can be accessed in standard mode via address line A20. DOS will anchor itself there, if DOS=High is inserted in Config.sys.

Typematic Rate Setting

This parameter is used to specify whether the options Keyboard Typematic Speed, Delay Before Keys Repeat, Typematic Rate or Typematic Delay are available. If Disabled, the values are set to 6 characters per second, with a keyboard delay of 250 ms. The settings can also be specified via the operating system.

Typematic Rate (Chars/Sec)

Specifies the repetition rate of the keyboard when a key is pressed. The options are 6, 8, 10, 12, 15, 20, 24 or 30 characters/second.

Typmatic Delay (Msec)

This value determines when the key function is activated after a key is pressed. The options are 250, 500, 750 or 1000 milliseconds.

Security Option

This parameter specifies the option for which a password applies. If the SYSTEM option is selected, a password has to be entered during PC start-up. If the SETUP option is selected, a password is only required for accessing the BIOS.

APIC Mode

This parameter switches the APIC Controller (Advanced Programmable Interrupt Controller) on or off. According to the PC2001 regulations, the system may run in APIC mode. APIC mode offers extended IRQ resources (depending on the board). Settings: Enabled or Disabled

MPS Version Control For OS

This option specifies what MPS version (Multi-Processor Specification) is used by this board. Setting options: 1.1 or 1.4 For older operating systems 1.1 should be used, otherwise leave as 1.4.

OS Select For DRAM > 64 MB

For OS/2 systems with more than 64 MB RAM, option OS/2 should be used.

HDD S.M.A.R.T. Capability

S.M.A.R.T. (Self Monitoring Analysis and Reporting Technology) is implemented in modern hard disks. Among other things, in conjunction with suitable software this technology can be used to detect hard disk read or speed problems at an early stage. If the option is activated, the system will issue a warning regarding an impending crash, for example. The results can be analysed with Norton-Utilities from version 3.0, for example.

Full Screen Logo

This option can be used to specify that the start logo should fill the whole screen during booting, thereby hiding the start data. Setting options: Enabled, Disabled

BECKHOFF CX50x0: BIOS Setup

CPU Features

This menu is used for setting the CPU behaviour with thermal profiles.

```
                    Phoenix - AwardBIOS CMOS Setup Utility

                                CPU Feature

┌──────────────────────────────────────────────────────────────────────┬──────────┐
│ Thermal Management                 Disabled                          │ Item     │
│                                                                      │ Help     │
│ Limit CPUID MaxVal                 [Disabled]                        ├──────────┤
│ C1E Function                       [Disabled]                        │          │
│ CPU C State Capability             [Disabled]                        │          │
│ Execute Disable Bit                [Enabled]                         │          │
│ Virtualization Technology          [Enabled]                         │          │
│                                                                      │          │
│                                                                      │          │
└──────────────────────────────────────────────────────────────────────┴──────────┘
   ↑ ↓ → ← :Move Enter:Select +/-/PU/PD:Value F10:Save ESC:Exit F1:Help
   F5: Previous Values F6: Fail-Safe Defaults F7: Optimized Defaults
```

Thermal Management

The processor used has a thermal monitor. In order to maintain real-time it is switched off.

Limit CPUID MaxVal

This option supports Prescott CPUs in older operating systems. Enabled: Activate this option if an older operating system is used. Disabled: Deactivate the CPUID limit if Windows XP is used.

C1E Function

This option is only available for certain processors with C1E (Enhanced Halt State) function.

CPU C State Capability

This option can be used to set the lowest C-state of the CPU. Usually DISABLED should be selected.

DISABLED:	function off
C2 (STOP Grant):	CPU clock is stopped, API functions run with normal speed
C4 (Deeper Sleep):	CPU voltage is reduced.
C6 (Deep Power Down):	CPU voltage is reduced to 0 V.

Execute Disable Bit

This option represents a safety function that can help you to protect your CPU and your operating system from malicious software that may execute a code and harm the BIOS. This option is available only if the CPU supports this function. Setting options: Enabled, Disabled.

Virtualization Technology

This option activates or deactivates the additional hardware capabilities of virtualization technology. Intel Virtualization Technology (code names Vanderpool or Vanderpool Technology) describes the implementation of a Secure Virtual Machine by Intel. AMD Virtualization or AMD-V (also known under the code name "Pacifica") is a technology for virtualization of a computer and refers to AMD's implementation of a Secure Virtual Machine in conjunction with an IOMMU. Setting options: Enabled, Disabled.

BECKHOFF CX50x0: BIOS Setup

Advanced Chipset Features

This menu is used for memory functions settings. Such settings should be implemented cautiously since they can affect the stability of the whole system.

Phoenix – AwardBIOS CMOS Setup Utility

Advanced Chipset Features

DRAM Timing Selectable	[by SPD]	Item Help
System BIOS Cachable	[Enabled]	
Video BIOS Cachable	[Disabled]	
** On-Chip VGA Setting **		
On-Chip Video Memory Size	[128 MB]	
On-Chip Frame Buffer Size	[8 MB]	
Current Configuration	DVO	
Boot Type	DVI	

↑ ↓ → ← :Move Enter:Select +/-/PU/PD:Value F10:Save ESC:Exit F1:Help

F5: Previous Values F6: Fail-Safe Defaults F7: Optimized Defaults

DRAM Timing Selectable

This submenu can be used for setting the optimum timing for options, depending on the memory modules used. By default the options are configured via 'By SPD', by reading the content of the SPD (Serial Presence Detect) unit. During this process critical parameter information relating to memory type, size, speed, voltage interface and module banks are stored in the EEPROM.

System BIOS Cachable

If the function is active the cache memory makes use of the available BIOS-ROM, thereby enhancing the performance, although this applies mainly to DOS and Win3.x. Under Windows 95/98 this option is less relevant.

Video BIOS Cachable

If this option is enabled, the cache memory can take the VIDEO BIOS of the graphics card at the address C0000h to C7FFFh into account. Please note that caching involves risks, if the cache contains the code and a program wants to write into the BIOS area. If this option is enabled, the option Video BIOS Shadow should also be activated. Under DOS the speed benefits is around 40%. Under Win.x and DOS this option should be enabled, otherwise it should be disabled.

On-Chip Video Memory Size

This option can be used to set the size of the video memory. (128 MB, 256 MB)

On-Chip Frame Buffer Size

This option can be used to adapt the frame buffer. Various setting options are available. The individual options can be used to try and enhance the performance. Make sure the system stability is not affected and proceed step-by-step (1 MB, 4 MB, 8 MB)

Current Configuration

The current graphics configuration is shown here. In this device it is set to DVO.

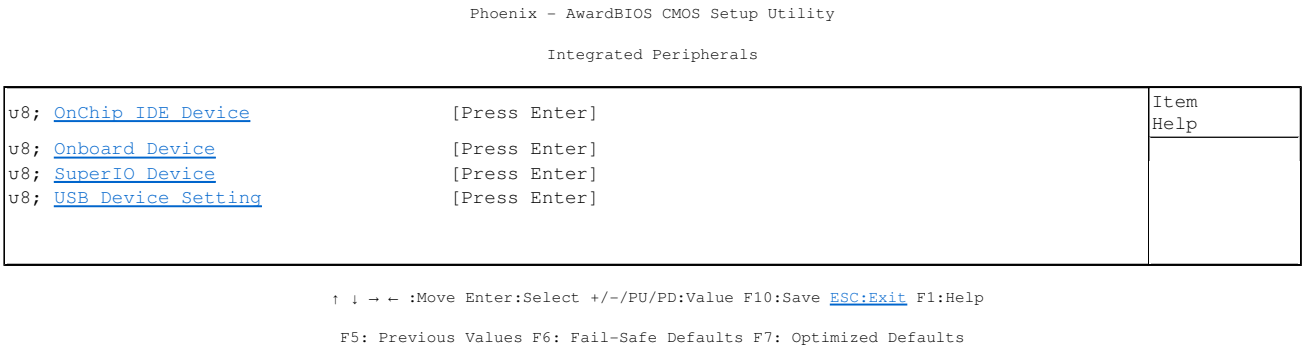
Boot Type

This setting indicates the output source for the boot process. Since the CX50x0 devices support graphic outputs only via DVI-I, this setting is always set to DVI.

BECKHOFF CX50x0: BIOS Setup

Integrated Peripherals

This option can be used for audio, multimedia and LAN interface settings.



OnChip IDE Device

Here you can set the onboard IDE controller settings.

Onboard Device

This menu can be used for audio, multimedia and LAN interface settings.

SuperIO Device

Here you can set the settings for the serial interfaces (port 1 and port 2).

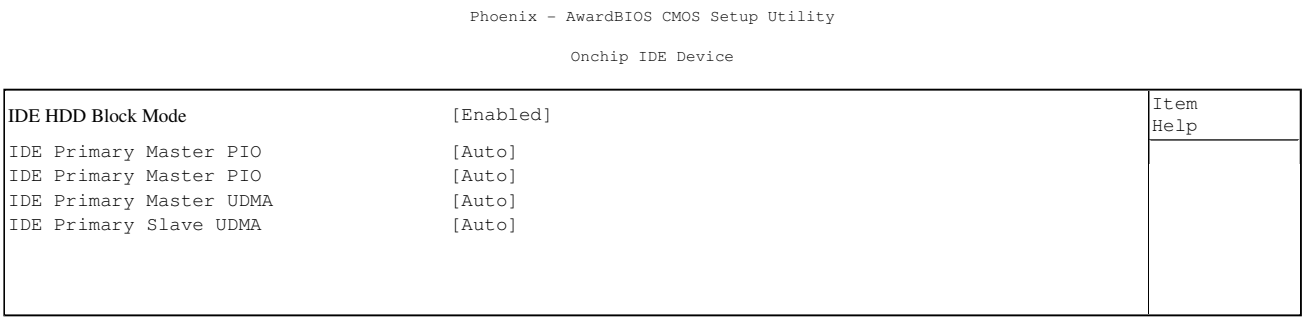
USB Device Setting

This option can be used for USB interface settings.

BECKHOFF CX50x0: BIOS Setup

Onchip IDE Device

This menu is used for setting the IDE interfaces.



IDE HDD Block Mode

This option is used to activate block mode for IDE hard disks. If your drive supports this mode and this option is activated, the system will read the number of blocks per request from the configuration sector of the hard disk. The recommended setting is Enabled, although it should be noted that this is not suitable for older hard disks.

IDE Primary Master PIO

PIO refers to the concept of programmed input and output. Instead of the BIOS issuing an instruction sequence for initiating a data transfer from or to the hard disk, PIO enables the BIOS to notify the controller what task should be executed. The task is then fully handled by the controller and the CPU. Your system supports five PIO modes, 0 (standard) to 4, with the main difference relating to timing. If "Auto" (automatic) is selected, the BIOS will assess your drive and automatically specify the optimum PIO mode. Auto**:** The BIOS automatically sets the system value depending on the timing of your hard disk drive. Mode 0-4: You can select a mode suitable mode that matches the timing your hard drive.

IDE Primary Master PIO

PIO refers to the concept of programmed input and output. Instead of the BIOS issuing an instruction sequence for initiating a data transfer from or to the hard disk, PIO enables the BIOS to notify the controller what task should be executed. The task is then fully handled by the controller and the CPU. Your system supports five PIO modes, 0 (standard) to 4, with the main difference relating to timing. If "Auto" (automatic) is selected, the BIOS will assess your drive and automatically specify the optimum PIO mode. Auto**:** The BIOS automatically sets the system value depending on the timing of your hard disk drive. Mode 0-4: You can select a mode suitable mode that matches the timing your hard drive.

IDEPrimary Master UDMA

This option is used to configure the Ultra-DMA/33 mode of your hard disk. Setting options: Auto, Enabled, Disabled. The option should be set to Enabled.

IDE Primary Slave UDMA

This option is used to configure the Ultra-DMA/33 mode of your hard disk. Setting options: Auto, Enabled, Disabled. The option should be set to Enabled.

BECKHOFF CX50x0: BIOS Setup

Onboard Device

This menu is used for configuring the audio, multimedia and LAN interfaces.

Phoenix - AwardBIOS CMOS Setup Utility

Onboard Device

		Item Help
Intel HD Audio Controller	[Disabled]	
USB Client Routing	[Disabled]	
SDIO/MMC Controller	[Disabled]	
Onboard Lan Controller	Enabled	
Console Redirect	[Disabled]	
x Serial Port Mode	115200,8,n,1	
x After Boot	Enabled	
x Flow Control Signals	Ignore	

↑ ↓ → ← :Move Enter:Select +/-/PU/PD:Value F10:Save ESC:Exit F1:Help

F5: Previous Values F6: Fail-Safe Defaults F7: Optimized Defaults

Intel HD Audio Controller

Option for activating the internal audio controller. The function is disabled since currently no associated extension is implemented.

USB Client Routing

Option for configuring the second USB port with USB client functionality.

SDIO/MMC Controller

Option for activating/deactivating the SDIO / MMC controller. In general the CX50x0 units are not equipped with the required hardware. The function is therefore disabled.

Onboard Lan Controller

The two Gigabit LAN ports are always enabled.

Console Redirect

Option for redirecting the boot process output to the serial interface. If the function is enabled the communication parameters in the locked menus can be set.

Serial Port Mode

Option for setting the baud rate, number of bits, parity and stop bit.

After Boot

The console can remain active after the boot process. This function is only supported by a small number of operating systems.

Flow Control Signals

Option for activating or deactivating hardware flow control.

BECKHOFF CX50x0: BIOS Setup

SuperIO Device

This menu is used for configuring the USB and audio interfaces.

Phoenix – AwardBIOS CMOS Setup Utility

SuperIO Device

Onboard Serial Port 1	[3F8/IRQ4]	Item Help
Onboard Serial Port 2	[2F8/IRQ3]	
UART Mode Select	[Normal]	
RxD, TxD Active	Hi, Lo	
IR Transmission Delay	Enabled	
UR2 Duplex Mode	Half	
Use IR Pins	IR-Rx2Tx2	

↑ ↓ → ← :Move Enter:Select +/-/PU/PD:Value F10:Save ESC:Exit F1:Help

F5: Previous Values F6: Fail-Safe Defaults F7: Optimized Defaults

Onboard Serial Port1

Configuration of the serial interface settings: IRQ4 (used for the first serial port), Disabled (no interrupt is used). Setting options: Auto, 3F8/IRQ4, 2F8/IRQ4, 3E8/IRQ4 or 2E8/IRQ4 .

Onboard Serial Port 2

Configuration of the serial interface settings: IRQ3 (used for the second serial port), Disabled (no interrupt is used). Setting options: Auto, 3F8/IRQ3, 2F8/IRQ3, 3E8/IRQ3 or 2E8/IRQ3.

UART Mode Select

Mode for the serial interface driver. Setting options:

- Normal for RS-232 serial interface
- ASKIR for amplitude keyed shift interface for IR devices
- IrDA for IrDA interface

RxD, TxD Active

Settings cannot be changed in standard mode. This option is used for setting IR transmission/reception to High or Low.

IR Transmission Delay

If this option is activated, transmission is delayed. Setting options: Enabled, Disabled.

UR2 Duplex Mode

This option is used for configuring infrared devices. Setting options: Full or Half. Please refer to the IR device manual regarding the duplex mode setting.

Use IR Pins

This option is identical to the TxD, RxD Active option. The required information can be found in the documentation for your IR device.

BECKHOFF CX50x0: BIOS Setup

USB Device Settings

This menu is used for configuring the USB and audio interfaces.

Phoenix – AwardBIOS CMOS Setup Utility

Onboard Device

USB 1.0 Controller	[Enabled]	Item Help
USB 2.0 Controller	[Enabled]	
USB Operation Mode	[High Speed]	
USB Keyboard Function	[Enabled]	
USB Storage Function	[Enabled]	
*** USB Mass Storage Device Boor Settings ***		
BeckhoffAutomation 2000	[Auto mode]	

↑ ↓ → ← :Move Enter:Select +/-/PU/PD:Value F10:Save ESC:Exit F1:Help

F5: Previous Values F6: Fail-Safe Defaults F7: Optimized Defaults

USB 1.0 Controller

The board contains a USB 1.0 chipset with support for USB 1.0. The option can be switched on or off here.

USB 2.0 Controller

The board contains a USB 2.0 chipset with support for USB 2.0. The option can be switched on or off here.

USB Operation Mode

Option for setting the data transfer rate of the USB port:

High Speed: Each device is connected based on the device-specific speed.

Full / Low Speed: All devices are connected with 1.5 MB/s or 12 MB/s.

USB Keyboard Function

The USB keyboard driver (if available) of the BIOS can be activated/deactivated here. This enables the USB keyboard to be operated during and after system startup, if your operating system does not have a USB driver.

USB Storage Function

Option for activating or deactivating USB mass storage support.

BeckhoffAutomation 2000

This function is intended only for internal purposes!

BECKHOFF CX50x0: BIOS Setup

Power Management Setup

This menu is used for power management settings.

Phoenix – AwardBIOS CMOS Setup Utility

Power Management Setup

Power-Supply Type	[AT]	Item Help
APCI Function	Enabled	
ACPI Suspend Type	[S1(POS)]	
Soft-Off by PWR-BTTN	[Instant-Off]	
u8; HPET Feature	[Press Enter]	
u8; Intel DTS Feature	[Press Enter]	

↑ ↓ → ← :Move Enter:Select +/-/PU/PD:Value F10:Save ESC:Exit F1:Help

F5: Previous Values F6: Fail-Safe Defaults F7: Optimized Defaults

Power-Supply Type

Option for setting the power supply unit mode. In AT mode the power supply unit remains switched on when the system is shut down. In ATX mode the internal power supply unit of the controller switches off. For a restart the power supply must be interrupted briefly.

APCI function

APCI is always active.

ACPI Suspend Type

The ACPI option (Advanced Configuration and Power Interface) is an extended PnP and power management function.

S1(POS): Switches the PC to sleep mode. Only a few functions are switched off and are available again at a keystroke

S3(STR): Option for writing the current state of the operating system to the RAM. In this case only the RAM is supplied with power.

Soft-Off by PWR-BTTN

This function is not used, since no power button is installed.

BECKHOFF CX50x0: BIOS Setup

HPET power management

This menu is used for HPET settings.

Phoenix – AwardBIOS CMOS Setup Utility

HPET Feature

HPET Support	[Enable]	Item Help
HPET Mode	[32-bit mode]	

↑ ↓ → ← :Move Enter:Select +/-/PU/PD:Value F10:Save ESC:Exit F1:Help

F5: Previous Values F6: Fail-Safe Defaults F7: Optimized Defaults

HPET Support

Activates or deactivates HPET support . It is a kind of timer within the PC that is able to trigger an interrupt with very high precision, thereby enabling other programs to better synchronise various applications. If multimedia applications are used this option should be enabled. Setting options: Enabled, Disabled.

HPET Mode

Two operating modes are available: 32-bit mode and 64-bit mode.

BECKHOFF CX50x0: BIOS Setup

DTS Powermanagement

Menu for setting the digital thermo sensors.

Phoenix – AwardBIOS CMOS Setup Utility

DTS Feature

Intel DTS function	[Enable]	Item Help
DTS Active temperature	[55°C]	
Passive Cooling Trip Point	[95°C]	
Passive TC1 Value	[2]	
Passive TC2 Value	[2]	
Passive TSP Value	[2]	
Critical Trip Point	[POR]	

↑ ↓ → ← :Move Enter:Select +/-/PU/PD:Value F10:Save ESC:Exit F1:Help

F5: Previous Values F6: Fail-Safe Defaults F7: Optimized Defaults

Intel DTS function

System monitoring is switched on or off by the thermal sensors. For operation in controller mode the DTS function is switched off in order to avoid problems with real-time functionality.

DTS Active temperature

At this temperature the system switches on the fan.

Passive Cooling Trip Point

At this temperature the CPU is slowed down in order to cool it.

Passive TC1 Value

This value specifies the performance reduction for TC1.

The formula is: ΔPerformance [%]= _TC1 * (Tn - Tn-1) + _TC2 * (Tn. - Tt)

Passive TC2 Value

This value specifies the performance reduction for TC2.

The formula is: ΔPerformance [%]= _TC1 * (Tn - Tn-1) + _TC2 * (Tn. - Tt)

Passive TSP Value

This option is used to specified how often the system should analyse the temperature sensors. Values are entered in 10th of a second.

Critical Trip Point

At this temperature the CPU is switched off in order to prevent damage.

BECKHOFF CX50x0: BIOS Setup

PnP/PCI Configurations

This menu is used for configuring the PCI bus and Plug and Play Management.

Phoenix – AwardBIOS CMOS Setup Utility

PnP/PCI Configurations

Init Display First	[PCI Slot]	Item Help
Reset Configuration Data	[Enabled]	
Resources Controlled By	[Manual]	
u8; IRQ Resources	[Press Enter]	
PCI/VGA Palette Snoop	[Disabled]	

↑ ↓ → ← :Move Enter:Select +/-/PU/PD:Value F10:Save ESC:Exit F1:Help

F5: Previous Values F6: Fail-Safe Defaults F7: Optimized Defaults

Init Display First

This option can be used to specify which graphics card should be initialised first: either PCI slot, onboard or PCIEx.

Reset Configuration Data

If activated, the option ensures that the BIOS deletes the information relating to built-in components and their resources and reconfigures them (all settings are reset). Setting options: Enabled, Disabled.

Resources Controlled By

Specifies whether the PnP settings should be assigned via setup or automatically. Auto should be used, if there are no problems with IRQ or DMA assignments. The default is auto.

IRQ Resources

If these resources are set manually, each system interrupt should be assigned a type, depending on the type of device using the interrupt.

PCI/VGA Palette Snoop

Used by multimedia video cards. This function should be switched on (Enabled), depending on the card. It is switched off by default.

BECKHOFF CX50x0: BIOS Setup

IRQ Resources

This menu is used for disabling interrupts for free allocation to PCI slots.

Phoenix – AwardBIOS CMOS Setup Utility

IRQ Resources

IRQ-3 assigned to	[PCI Device]	Item Help
IRQ-4 assigned to	[PCI Device]	
IRQ-5 assigned to	[PCI Device]	
IRQ-7 assigned to	[PCI Device]	
IRQ-9 assigned to	[PCI Device]	
IRQ-10 assigned to	[PCI Device]	
IRQ-11 assigned to	[PCI Device]	
IRQ-12 assigned to	[PCI Device]	

↑ ↓ → ← :Move Enter:Select +/-/PU/PD:Value F10:Save ESC:Exit F1:Help

F5: Previous Values F6: Fail-Safe Defaults F7: Optimized Defaults

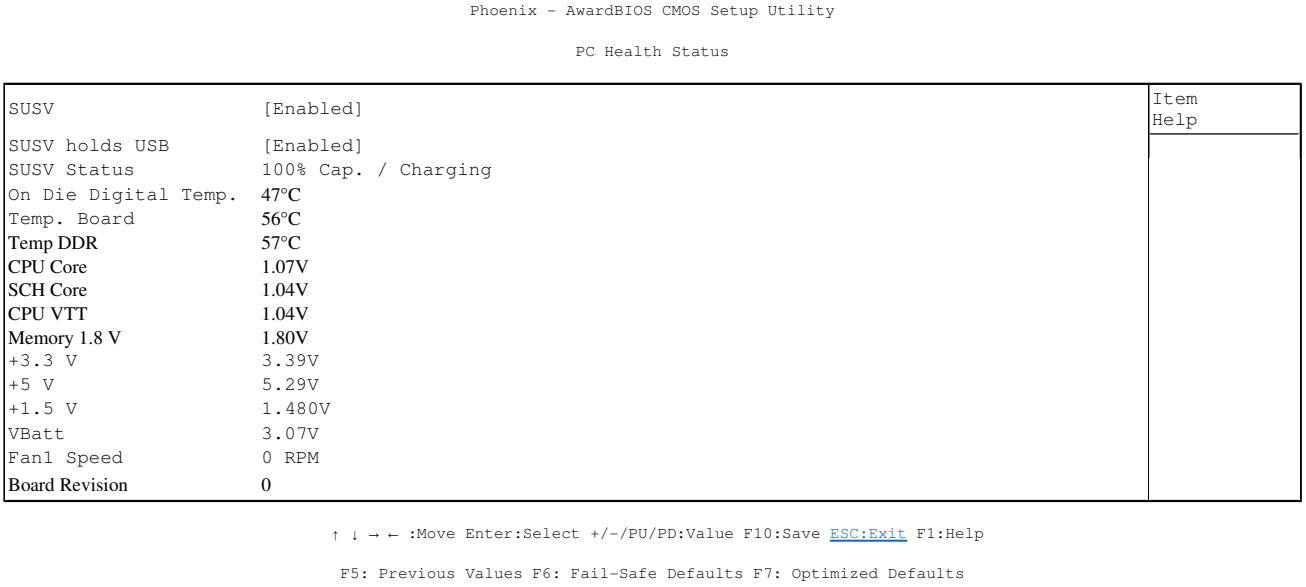
IRQ-n assigned to (n = {3,4,5,7,9,10,11,12,14,15})

This parameter is used for disabling (reserving) an interrupt for free allocation. If the setting [PCI Device] is used, the interrupt is allocated dynamically.

BECKHOFF CX50x0: BIOS Setup

PC Health Status

This menu is used for displaying the settings for CPU and motherboard temperatures, power supply, and fan speed.



SUSV

Option for deactivating the one-second UPS.

SUSV holds USB

If system buffering based on SUSV is active, this option can be used to switch the power supply for the USB port on or off. This is important for data back-up on a USB storage medium, for example.

SUSV Status

This value indicates the status of the one-second UPS.

n% Cap. (n={0..100}) indicates the capacity of the UPS.

State (charging / discharging) describes the state of the one-second UPS.

On Die Digital Temp.

Temperature inside the CPU.

Temp. Board

Board temperature.

Temp. DDR

Memory temperature.

CPU Core

CPU core voltage.

SCH Core

CPU VTT voltage.

CPU VTT

CPU VTT voltage.

Memory 1.8 V

Memory power supply (1.8 V).

+3.3 V

Supply voltage, 3.3 V.

+5 V

Supply voltage, 5 V.

+1.5 V

Supply voltage, 1.5 V.

VBatt

Battery voltage.

Fan1 Speed

0 RPM, since no fan is connected.

Board Revision

Hardware version of the CPU board.

BECKHOFF CX50x0: BIOS Setup

Frequency/Voltage Control

This menu can be used to implement the CLK setting for the PCI bus. Moreover, the tolerances for the power supply can be specified.

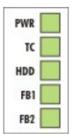
```
Phoenix - AwardBIOS CMOS Setup Utility
Frequency/Voltage Control

XDP-Clock                              [Disabled]                    Item Help

↑ ↓ → ← :Move Enter:Select +/-/PU/PD:Value F10:Save ESC:Exit F1:Help
F5: Previous Values F6: Fail-Safe Defaults F7: Optimized Defaults
```

XDP-Clock

This setting is for internal purposes and may not be modified.

BECKHOFF CX50x0: Error handling and diagnostics

LEDs on the basic CPU module

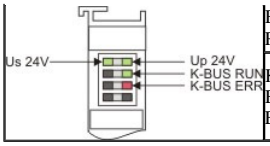
Display	LED	Meaning
	PWR	Power supply The Power LED comes on when the device is connected to a live power supply unit (green).
	TC	TwinCAT status LED TwinCAT is in Run mode (green) TwinCAT is in Stop mode (red) TwinCAT is in Config mode (blue)
	HDD	Read/Write Compact Flash (red) Indicates access to the CF card.
	FB1	Status LED1 for fieldbus (function is written at the fieldbus interface)
	FB2	Status LED2 for fieldbus (function is written at the fieldbus interface)

BECKHOFF CX50x0: Error handling and diagnostics

LEDs of the K-bus-power supply unit (CX50x0-1xxx)

After switching on, the power supply immediately checks the connected Bus Terminal configuration. Error-free start-up is signalled by the red "I/O ERR" LED being extinguished. If the "I/O ERR" LED blinks, an error in the area of the terminals is indicated. The error code can be determined from the frequency and number of blinks. This permits rapid rectification of the error.

Display	LED	Meaning
	Us 24 V	Power supply for the CPU module The LED lights green if the power supply is correct.
	Up 24V	Power supply for terminal bus. The LED lights green if the power supply is correct.
	K-	K-Bus diagnostics

	BUS RUN	The green LED lights up in order to indicate fault-free operation. "Fault-free" means that the communication with the fieldbus system is also running.
	K-BUS ERR	K-Bus diagnostics The red LED flashes to indicate an error. The red LED blinks with two different frequencies.

The I/O error LED blink code

fast blinking	**Start of the error code**
first slow sequence	Error code
second slow sequence	Error code argument

LEDs for K-Bus diagnosis

Error code	Error code argument	Description	Remedy
Persistent, continuous flashing		EMC problems	• Check power supply for overvoltage or undervoltage peaks • Implement EMC measures • If a K-Bus error is present, it can be localised by a restart of the power supply (by switching it off and then on again)
1 pulse	0	EEPROM checksum error	Revert to the manufacturer’s setting
	1	Code buffer overflow	Insert fewer Bus Terminals. Too many entries in the table for the programmed configuration
	2	Unknown data type	Software update required for the power supply
2 pulses	0	Programmed configuration has an incorrect table entry	Check programmed configuration for correctness
	n (n > 0)	Table comparison (Bus Terminal n)	Incorrect table entry
3 pulses	0	K-Bus command error	• No Bus Terminal inserted • One of the Bus Terminals is defective; halve the number of Bus Terminals attached and check whether the error is still present with the remaining Bus Terminals. Repeat until the defective Bus Terminal is located.
4 pulses	0	K-Bus data error, break behind the power supply	Check whether the n+1 Bus Terminal is correctly connected; replace if necessary.
	n	Break behind Bus Terminal n	Check whether the Bus End Terminal 9010 is connected.
5 pulses	n	K-Bus error in register communication with Bus Terminal n	Exchange the nth bus terminal.
7 pulses	0	Process data length of the configuration (programmed) does not match the terminal process data length (termnals)	Check the terminal configuration and the terminals.
9 pulses	0	Checksum error in Flash program	Revert to the manufacturer’s setting
	n (n>0)	Bus Terminal n is not consistent with the configuration that existed when the boot project was created	Revert to the manufacturer's setting which will clear the boot project.
14 pulses	n	nth Bus Terminal has the wrong format	Start the power supply again, and if the error occurs again then exchange the Bus Terminal.
15 pulses	n	Number of Bus Terminals is no longer correct	Start the power supply up again.
16 pulses	n	Length of the K-Bus data is no longer correct	Start the power supply up again.

Error code argument

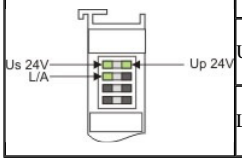
The number of pulses indicates the position of the last Bus Terminal before the fault. Passive Bus Terminals, such as a power feed terminal, are not included in the count.

In the case of some errors, rectification does not cause the power supply to leave the blink sequence. The power supply can only be restarted by switching its supply voltage off and on again.

BECKHOFF CX50x0: Error handling and diagnostics

LEDs of the E-bus-power supply unit (CX50x0-0xxx)

After switching on, the power supply immediately checks the connected Bus Terminal configuration. Error-free start-up is signalled by the red "I/O ERR” LED being extinguished. If the ”I/O ERR" LED blinks, an error in the area of the terminals is indicated. The error code can be determined from the frequency and number of blinks. This permits rapid rectification of the error.

Display	LED		Meaning
	Us 24 V		Power supply for the CPU module The LED lights green if the power supply is correct.
	Up 24V		Power supply for terminal bus. The LED lights green if the power supply is correct.
	L/A	off	E-bus not connected
		on	E-bus connected / no data traffic
		flashing	E-bus connected / data traffic on the E-bus.

BECKHOFF CX50x0: Appendix

Faults

Please also refer to the Safety instructions section.

Possible faults and their correction

Fault	Cause	Procedures
no function after the Embedded PC has been switched on	no power supply for the Embedded PC other causes	1. Check fuse 2. Measure voltage at connection, check plug wiring Call Beckhoff support
Embedded PC does not boot fully	Hard disk damaged (e.g. due to switching off while software is running), incorrect setup, other causes	Check setup Call Beckhoff support
Computer boots, software starts, but control does not operate correctly	Cause of the fault is either in the software or in parts of the plant outside the Embedded PC	Call the manufacturer of the machine or the software.
CF card access error	Faulty CF card, faulty CF slot	Use a different CF card to check the CF slot Call Beckhoff support
Embedded PC only works partially or temporarily	Defective components in the Embedded PC	Call Beckhoff support

Please make a note of the following information **before** contacting Beckhoff service or support:

1. Precise device ID: CXxxxx-xxxx
2. Serial number
3. Hardware version
4. Any interfaces (N030, N031, B110, ...)
5. TwinCAT version used
6. Any components / software used

The quickest response will come from support / service in your country. Therefore please contact your regional contact. For details please refer to our website at www.beckhoff.com or ask your distribution partner.

BECKHOFF CX50x0: Decommissioning

Disassembly and disposal

A CX50x0 hardware configuration is dismantled in 2 stages:

1. Switching off and disconnecting the power supply

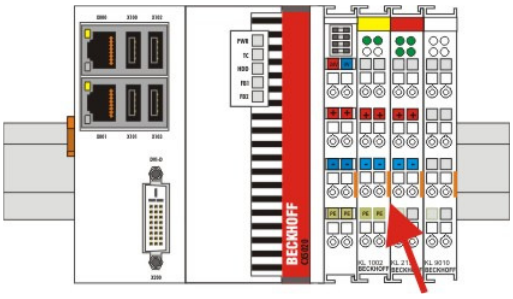
Before a CX50x0 system can be dismantled, the system should be switched off, and the power supply should be disconnected.

2. Removing from the top-hat rail:

Before the individual modules are disconnected, the whole CX50x0 hardware block should be removed from the top-hat rail. Proceed as follows:

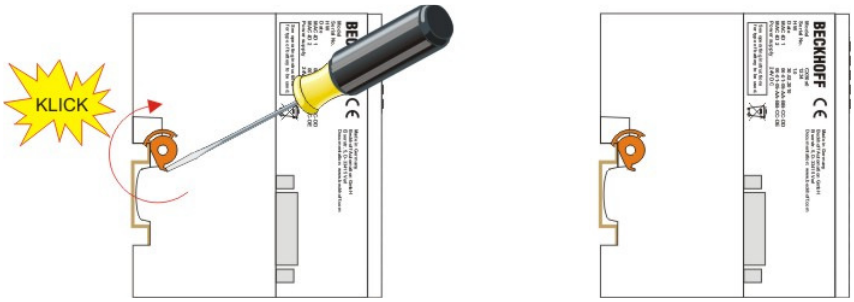
2.1. Release and remove the first Terminal next to the power supply unit on the top-hat rail.

First remove any wiring from power supply unit and then from the first terminal on the top-hat rail next to the power supply unit. If the wiring is to be reused for another system, it is advisable to make a note of the connections. Then pull the orange terminal release (see arrow) to release the terminal and pull it out.

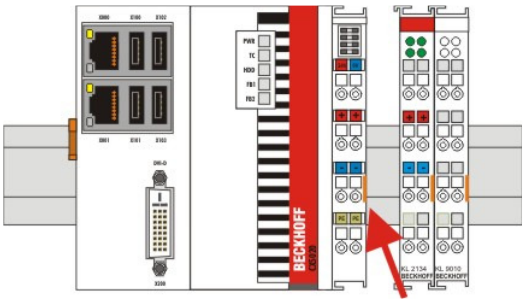


2.2. Releasing the CX50x0 systems

To release the CX50x0 block, release the orange DIN rail bracket on the left-hand side of the device. Push back the lower hook. An audible click indicates that the device is released.



After pulling the terminal release of the power supply unit, the block can be removed **carefully** from the top-hat rail.



Caution

Do not us force to open the device!

Opening the module housing by force would destroy it. The devices may only be opened by Beckhoff service personnel.

Disposal

The device must be fully dismantled in order to dispose of it.

Electronic parts must be disposed of in accordance with national electronics scrap regulations.

BECKHOFF CX System: Appendix

Accessories

Compact flash cards

instead of the64 MB compact flash card

order number	Description
CX1900-0023	1 GByte compact flash card type I instead of 64 MB compact flash card
CX1900-0025	2 GByte compact flash card type I instead of 64 MB compact flash card
CX1900-0027	4 GByte compact flash card type I instead of 64 MB compact flash card
CX1900-0029	8 GByte compact flash card type I instead of 64 MB compact flash card
CX1900-0031	16 GByte compact flash card type I instead of 64 MB compact flash card

spare compact flash cards

order number	Description
CX1900-0022	64 MByte compact flash card type I instead of 64 MB compact flash card
CX1900-0024	1 GByte compact flash card type I instead of 64 MB compact flash card
CX1900-0026	2 GByte compact flash card type I instead of 64 MB compact flash card
CX1900-0028	4 GByte compact flash card type I instead of 64 MB compact flash card
CX1900-0030	8 GByte compact flash card type I instead of 64 MB compact flash card
CX1900-0032	16 GByte compact flash card type I instead of 64 MB compact flash card

Formatting options

order number	Description
CX1900-0010	Formatting a compact flash card (bootable) FAT16
CX1900-0012	Formatting a compact flash card (bootable) NTFS

Memory extensions DDR RAM

order number	Description
CX1900-0201	512 MB DDR RAM for CX1020/CX1030 instead of 265 MB

CX1900-0202	1 GB DDR RAM for CX1020/CX1030 instead of 265 MB

Connectors and Adaptors

order number	Description
CX1900-0101	DVI-to-VGA passive Adaptor for connecting a standard desktop VGA monitor to the CX1000 system – singles out the VGA signals of the DVI-I interface of the CX1000-N001 module – 29-pin male DVI-A connector (bottom) to 15-pin female connector (top) – weight approx. 40 g – dimensions (W x H x D) 40 x 42 x 15 mm

Labeling Tags

order number	Description
CX1900-0200	Universal plastic labels for the CX1000 system (package contains 1000 labels) – snaps into the premoulded spots on the CX1000 components – labeling can be done with a X-Y plotter – dimension of the single label 15 x 5 mm – material: white colored plastic – Murrplastik type KMR 5/15, order number 86401014

Spare battery for CX-Systems

order number	Description
CX1900-0102	Battery for the CX-Systems - original product description: Panasonic type CR2032 3V/225mAh

Spare fan cartridge for CX1030

order number	Description
CX1900-0103	Spare fan cartridge for CX1030 – cartridge consisting of chassis and 40 mm fan – simple exchange in the field due to wireless installation – weight approx. 30 g – dimensions (W x H x D) 57 x 14 x 60 mm

Certifications

All products of the Embedded PC family are CE, UL and GOST-R certified. Since the product family is continuously developed further, we are unable to provide a full listing here. The current list of certified products can be found on the Embedded PC certificates web page or at www.beckhoff.com under Embedded PC.

Support and Service

Beckhoff and their partners around the world offer comprehensive support and service, making available fast and competent assistance with all questions related to Beckhoff products and system solutions.

Beckhoff's branch offices and representatives

Please contact your Beckhoff branch office or representative for local support and service on Beckhoff products!

The addresses of Beckhoff's branch offices and representatives round the world can be found on her internet pages:
http://www.beckhoff.com

You will also find further documentation for Beckhoff components there.

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Beckhoff Support

Support offers you comprehensive technical assistance, helping you not only with the application of individual Beckhoff products, but also with other, wide-ranging services:

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- design, programming and commissioning of complex automation systems
- and extensive training program for Beckhoff system components

Hotline: +49(0)5246/963-157

Fax: +49(0)5246/963-9157
e-mail: support@beckhoff.com

Beckhoff Service

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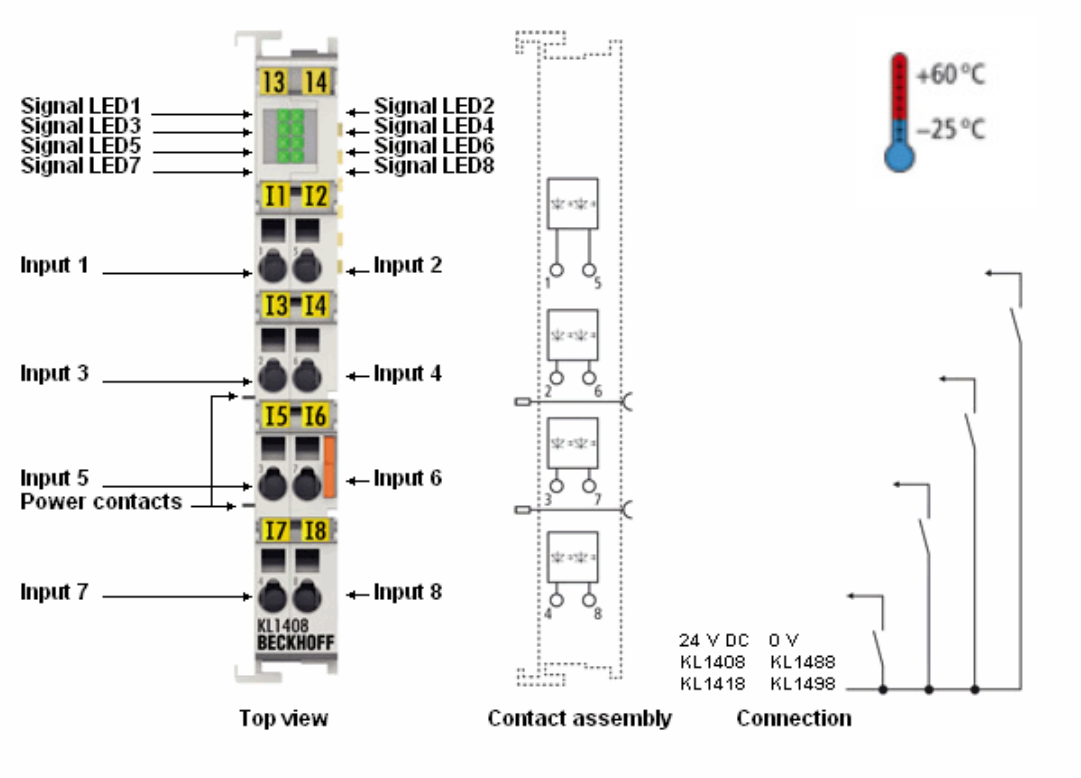
- repair service
- spare parts service
- hotline service

Hotline: +49(0)5246/963-460
Fax: +49(0)5246/963-479
e-mail: service@beckhoff.com

KL1408 8 channel digital input terminal



Eight-channel, digital input terminals, 24 V_{DC}

The digital input terminals KL1408 and KL1418 (positive switching) and KL1488 and KL1498 (negative switching) acquire the binary control signals from the process level and transmit them, in an electrically isolated form, to the higher-level automation unit. The Bus Terminals each contain eight channels, whose signal states are displayed by LEDs. They are particularly suitable for space-saving use in control cabinets. By using the single-conductor connection technique a multi-channel sensor can be connected in the smallest space with a minimum amount of wiring. The power contacts are looped through. For the KL1408 and KL1418 Bus Terminals, the reference ground for all inputs is the 0 V power contact. For the KL1488 and KL1498 Bus Terminals, the reference point for all inputs is the 24 V power contact. These versions have input filters with different speeds.

Technical data	KL1408/KS1408	KL1418/KS1418	KL1488/KS1488	KL1498/KS1498
Number of inputs / rated voltage	8 / 24 V_{DC} (-15% / +20%)			
Signal voltage “0”	-3 V … +5 V (IEC 61131-2, type 1/3)		18 V ... 30 V	
Signal voltage “1”	15 V … 30 V (IEC 61131-2, type 3)		0 V ... 7 V	
Signal current “0”	0 … 1.5 mA	0 … 1.5 mA	-	-
Signal current “1”	2.0 … 2.5 mA	2.0 … 2.5 mA	typ. 3 mA	typ. 3 mA
Input filter	3 ms	0.2 ms	3 ms	0.2 ms
Current consumption from K-bus	typ. 5 mA			
Electrical isolation	500 V (K-Bus/field potential)			
Bit width in process image	8 input bits			
Configuration	no address-or configuration settings required			
Dimensions (W x H x D)	15mm x 100mm x 70mm (connected width: 12mm)			
Weight	approx. 55 g			
Permissible ambient temperature range	-25°C ... +60°C in operation 0°C ... +55°C (according to cULus for Canada and USA) 0°C ... +55°C (according to ATEX, see special conditions)		-0°C... +55 °C in operation	
	-40°C... +85 °C during storage		-25°C... +85 °C during storage	
Relative humidity	5% ... 95%, no condensation			
Vibration / shock resistance	conforms to EN 60068-2-6 / EN 60068-2-27			

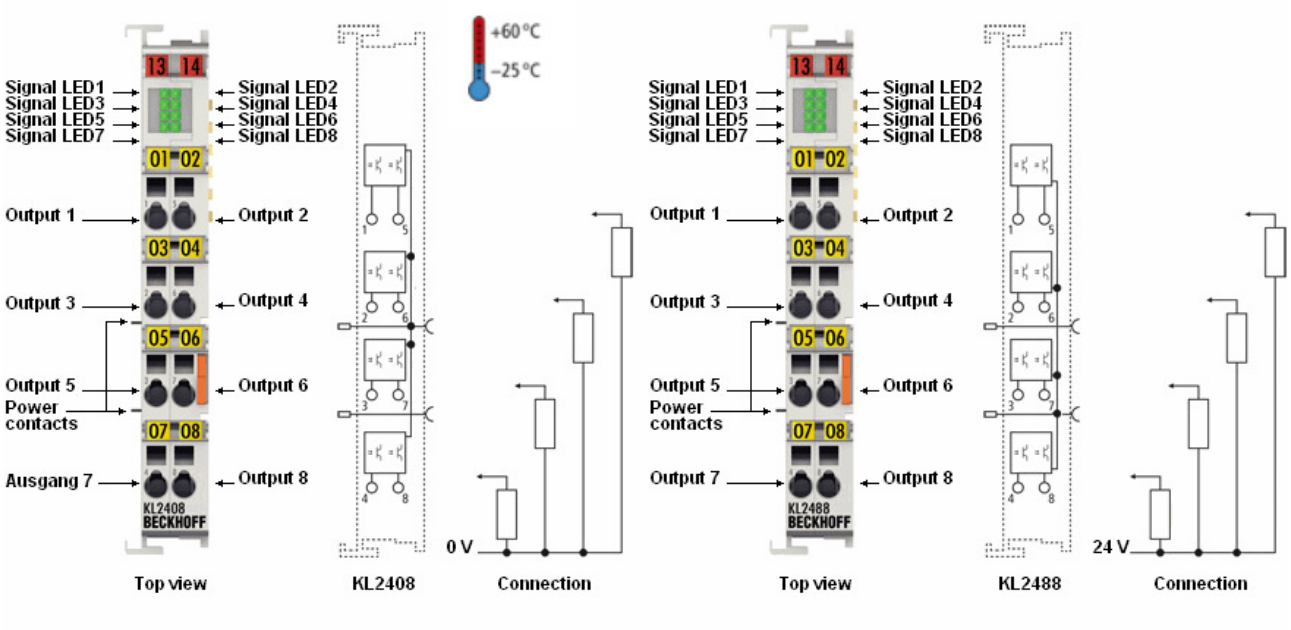
Technical data	KL1408/KS1408	KL1418/KS1418	KL1488/KS1488	KL1498/KS1498
EMC resistance/emission	conforms to EN 61000-6-2 / EN 61000-6-4			
Mounting position / protection class	any / IP20			
Approvals	CE, cULus, ATEX, GL		CE, cULus, ATEX	
Pluggable wiring	at all KSxxxx series terminals			

ATEX - Special conditions

WARNING	**Observe the special conditions for the intended use of Beckhoff fieldbus components in potentially explosive areas (directive 94/9/EU)!** • The certified components are to be installed in a suitable housing that guarantees a protection class of at least IP54 in accordance with EN 60529! The environmental conditions during use are thereby to be taken into account! • If the temperatures during rated operation are higher than 70°C at the feed-in points of cables, lines or pipes, or higher than 80°C at the wire branching points, then cables must be selected whose temperature data correspond to the actual measured temperature values! • Observe the permissible ambient temperature range of 0 - 55°C for the use of Beckhoff fieldbus components in potentially explosive areas! • Measures must be taken to protect against the rated operating voltage being exceeded by more than 40% due to short-term interference voltages! • The individual terminals may only be unplugged or removed from the Bus Terminal system if the supply voltage has been switched off or if a non-explosive atmosphere is ensured! • The connections of the certified components may only be connected or disconnected if the supply voltage has been switched off or if a non-explosive atmosphere is ensured! • The fuses of the KL92xx power feed terminals may only be exchanged if the supply voltage has been switched off or if a non-explosive atmosphere is ensured! • Address selectors and ID switches may only be adjusted if the supply voltage has been switched off or if a non-explosive atmosphere is ensured!

Note	**Operation of the Bus Terminal System in potentially explosive areas (ATEX)!** Pay also attention to the continuative documentation *Notes about operation of the Bus Terminal System in potentially explosive areas (ATEX)* that is available in the download area of the Beckhoff homepage http://www.beckhoff.com!

KL2408 8 channel digital output terminal



Eight-channel, digital output terminal, 24 V_{DC}

The KL2408 (positive switching) and KL2488 (negative switching) digital output terminals connect the binary control signals from the automation unit on to the actuators at the process level with electrical isolation. The KL2408/KL2488 variants are protected against reverse polarity connection. They handle load currents with outputs that are protected against overload and short circuit. The Bus Terminals contain eight channels which indicate their signal state by means of light emitting diodes. They are particularly suitable for space-saving use in control cabinets. The connection technology is particularly suitable for single-ended inputs. All components have to use the same reference point as the KL2408 or KL2488. The power contacts are looped through. In the KL2408 terminal, the outputs are supplied by the 24 V power contact. In the KL2488 terminal, they are supplied via the 0 V power contact.

Technical data	KL2408 / KS2408	KL2488 / KS2488
Connection technology	1 wire	
Number of outputs	8 (positive switching)	8 (negative switching)
Rated voltage	24 V_{DC} (-15% / +20%)	
Load type	ohmic, inductive, lamp load	
Output current max. (per channel)	0.5 A (short-circuit-proof)	
Short circuit current	< 2 A	< 7 A
Breaking energy	< 150 mJ/channel	< 100 mJ/channel
Reverse voltage protection	yes	
Electrical isolation	500 V (K-Bus/field potential)	
Current consumption K-bus	typ. 18 mA	
Current consumption power contacts	typ. 60 mA +load	
Bit width in process image	8 output bits	
Configuration	no address-or configuration settings required	
Dimensions (W x H x D)	15mm x 100mm x 70mm (connected width: 12mm)	
Weight	approx. 70 g	
Permissible ambient temperature range	-25 °C ... +60 °C in operation 0 °C ... +55 °C (according to cULus for Canada and USA) 0 °C ... +55 °C (according to ATEX, see special conditions)	-0 °C... +55 °C in operation
	-40 °C... +85 °C during storage	-25 °C... +85 °C during storage
Relative humidity	5% ... 95%, no condensation	
Vibration / shock resistance	conforms to EN 60068-2-6 / EN 60068-2-27	

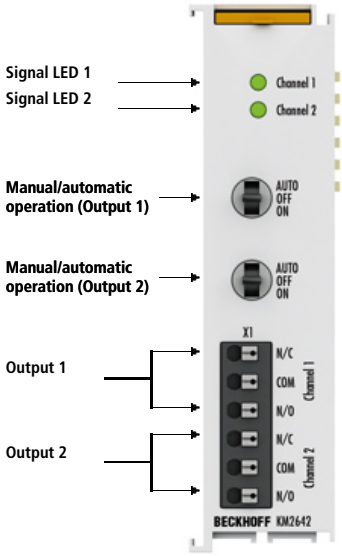
Technical data	KL2408 / KS2408	KL2488 / KS2488
EMC resistance/emission	conforms to EN 61000-6-2 / EN 61000-6-4	
Protection class/installation position	variable / IP20	
Pluggable wiring	at all KSxxxx series terminals	
Approvals	CE, cULus, ATEX, GL	CE, ATEX

ATEX - Special conditions

WARNING	**Observe the special conditions for the intended use of Beckhoff fieldbus components in potentially explosive areas (directive 94/9/EU)!** • The certified components are to be installed in a suitable housing that guarantees a protection class of at least IP54 in accordance with EN 60529! The environmental conditions during use are thereby to be taken into account! • If the temperatures during rated operation are higher than 70°C at the feed-in points of cables, lines or pipes, or higher than 80°C at the wire branching points, then cables must be selected whose temperature data correspond to the actual measured temperature values! • Observe the permissible ambient temperature range of 0 - 55°C for the use of Beckhoff fieldbus components in potentially explosive areas! • Measures must be taken to protect against the rated operating voltage being exceeded by more than 40% due to short-term interference voltages! • The individual terminals may only be unplugged or removed from the Bus Terminal system if the supply voltage has been switched off or if a non-explosive atmosphere is ensured! • The connections of the certified components may only be connected or disconnected if the supply voltage has been switched off or if a non-explosive atmosphere is ensured! • The fuses of the KL92xx power feed terminals may only be exchanged if the supply voltage has been switched off or if a non-explosive atmosphere is ensured! • Address selectors and ID switches may only be adjusted if the supply voltage has been switched off or if a non-explosive atmosphere is ensured!

Note	**Operation of the Bus Terminal System in potentially explosive areas (ATEX)!** Pay also attention to the continuative documentation *Notes about operation of the Bus Terminal System in potentially explosive areas (ATEX)* that is available in the download area of the Beckhoff homepage http://www.beckhoff.com!

KM2652 2 channel digital output w. manual override terminal



Top view

KM2642, KM2652 | 2-channel relay module 230 V AC, 6 A, manual/automatic operation

The digital KM2642 and KM2652 output terminals have two independent relay change-over contacts, which can be used for switching mains current consumers. For each channel a switch enables selection between automatic, manual on, manual off. In automatic mode the logical state of an output bit switches the relay. For manual mode a 24 V supply is required for the Bus Coupler. The output state – for KM2652 also the setting of the switch – can be read by the controller.

Technical data	KM2642	KM2652
Number of outputs	2 x change-over	
Nominal voltage	230 V AC (max. switching voltage 250 V AC)	
Switching capacity max.	1.5 kVA	
Switching voltage max.	250 V AC	
Load type	ohmic, inductive, lamp load	
Max. output current	6 A	
Switching current	6 A AC/4 A DC at 30 V DC	
Minimum permitted load	100 mA (12 V DC)	
Lamp test, electronic ballast	max. 10 A starting current	
Current consumption power contacts	– (no power contacts)	
Current consumpt. K-bus	typ. 130 mA	
Contact material	$AgSnO_2$	
Bit width in the process image	2 inputs (relay ON/OFF), 2 outputs	4 inputs (status hand, auto, relay ON/OFF), 2 outputs
Operating cycles	10^6	
Operating cycles mech. (min.)	1×10^6	
Operating cycles electr. (min.)	1×10^5 (3 A/250 V AC)	
Configuration	no address or configuration setting	
Special features	manual/automatic operation	manual/automatic operation, switch setting readable
Weight	approx. 110 g	
Operating/storage temperature	0…+55 °C/-25…+85 °C	
Relative humidity	95 %, no condensation	
Vibration/shock resistance	conforms to EN 60068-2-6/EN 60068-2-27	
EMC immunity/emission	conforms to EN 61000-6-2/EN 61000-6-4	
Protect. class/installation pos.	IP 20/variable	
Approvals	CE	

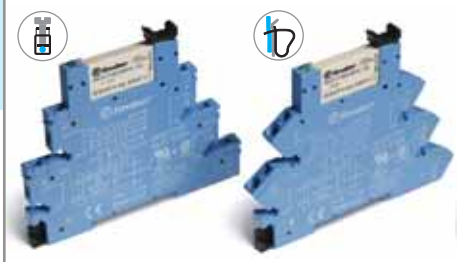
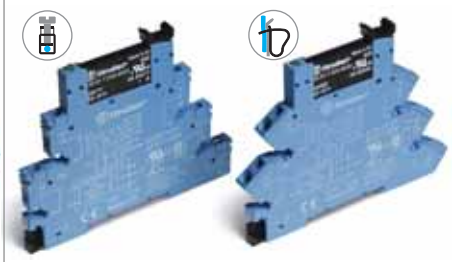
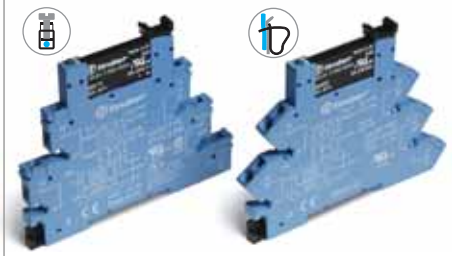
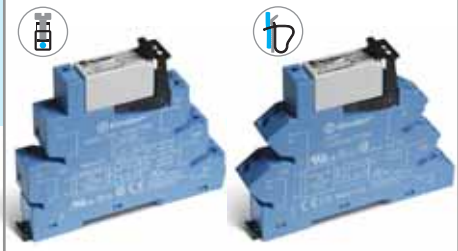
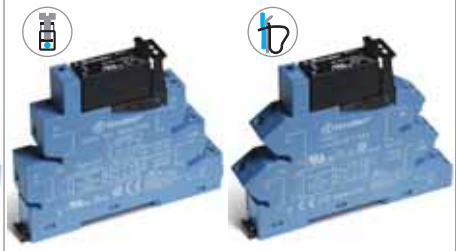
Further manual operating terminals	
KM1644	4-channel manual operation
KM2614	4-channel relay module 230 V AC, 16 A, potential-free change-over contact, with manual operation
KM4602	2-channel analog output terminal 0…10 V, manual/automatic operation

6.4 Finder components data sheets

Serie 38 - Koppel-Relais 0,1 - 2 - 3 - 5 - 6 - 8 - 16 A

Variantenvielfalt in der Serie 38*

- Kontakt- und Halbleiter-Ausgang
- Schraub- und Zugfederklemme
- Zeit-Relais in gleicher Bauform

	EMR Elektromechanische Relais	SSR Optokoppler
6,2 mm breit • **EMR - DC, AC oder AC/DC-Eingang** • **SSR - DC oder AC/DC-Eingang** • Schraub- oder Zugfederklemmen	**38.51/38.61**  • **1 Wechsler - 6 A 250VAC** 6 mm Luft- und 8 mm Kriechstrecke zwischen Eingang und Ausgang **Seite 1**	**38.81/38.91**  • Optokoppler mit Halbleiterausgang für **0,1A 48VDC, 2A 24VDC oder 2A 240VAC** • Leise und schnell schaltend • Kein Kontaktverschleiss **Seite 2**
6,2 mm breit • **Ausführung mit AC-Reststromunterdrückung bei langen Steuerleitungen** • **EMR - AC oder AC/DC-Eingang** • **SSR - AC oder AC/DC-Eingang** • Schraub- oder Zugfederklemmen	**38.51.3... - 38.61.3...**  • **1 Wechsler - 6 A 250VAC** 6 mm Luft- und 8 mm Kriechstrecke zwischen Eingang und Ausgang **Seite 1**	**38.81.3... - 38.91.3...**  • Optokoppler mit Halbleiterausgang für **0,1A 48VDC, 2A 24VDC oder 2A 240VAC** • Leise und schnell schaltend • Kein Kontaktverschleiss **Seite 2**
6,2 mm breit • **Zeit-Relais** • **4 Funktionen, 4 Zeitbereiche 0,1s ... 6h** • **EMR - AC/DC 12V- oder 24V-Eingang** • **SSR - AC/DC 24V-Eingang** • Schraubklemmen	**38.21**  • **1 Wechsler - 6 A 250VAC** 6 mm Luft- und 8 mm Kriechstrecke zwischen Eingang und Ausgang **Seite 3**	**38.21...9024-8240**  • Optokoppler mit Halbleiterausgang für **2A 24VDC, 2A 240VAC** • Leise und schnell schaltend • Kein Kontaktverschleiss **Seite 3**
14 mm breit • **1 Wechsler 16 A oder 2 Wechsler 8 A** • **EMR - DC oder AC/DC-Eingang** • **SSR - DC-Eingang** • Schraub- oder Zugfederklemmen	**38.01/38.52/38.11/38.62**  • **1 Wechsler - 16 A 250VAC** • **2 Wechsler - 8 A 250VAC** 6 mm Luft- und 8 mm Kriechstrecke zwischen Eingang und Ausgang **Seite 4**	**38.31/38.41**  • Optokoppler mit Halbleiterausgang für **5A 24VDC, 3A 240VAC** • Leise und schnell schaltend • Kein Kontaktverschleiss **Seite 5**

*Alle Koppel-Relais der Serie 38
Für Tragschiene DIN EN 60715 TH35

Koppel-Relais, mit EMR- oder SSR-Ausgang, 1 oder 2 Wechsler, 6,2 mm oder14 mm breit

- Innerhalb der Serie 38 gibt es Relais für AC, DC oder AC/DC Ansteuerung
- Ausführung für lange Steuerleitungen
- Ausführung mit Optokoppler
- Koppelrelais mit integrierter EMV-Spulenbeschaltung, LED, Halte- und Demontagehebel
- Verbrauchte Schaltrelais austauschbar
- Sichere Trennung nach EN50178 zwischen Spule und Kontaktsatz, 6 kV (1,2/50 µs)
- 6 mm Luft- und 8 mm Kriechstrecke
- Anschlüsse mit Schraub- oder Zugfederklemmen

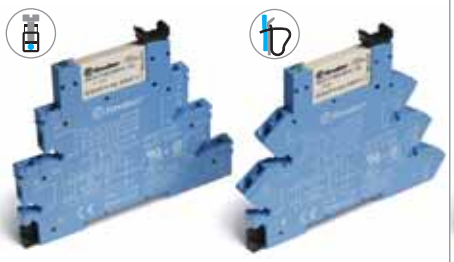
38.51 / 38.51.3
Schraubklemmen

38.61 / 38.61.3
Zugfederklemmen

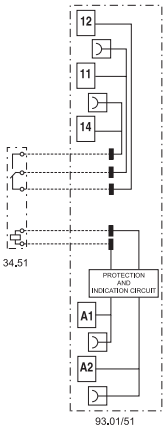
* Version für eine max. Umgebungstemperatur bis +70°C.

Abmessungen siehe Seite 12

38.51/61

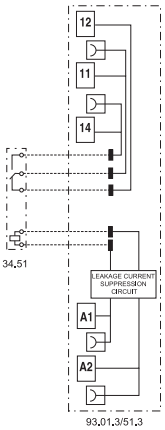


- 1 Wechsler 6 A
- Elektromechanische Relais
- Für Schraub- oder Zugfederklemmen



38.51.3 / 38.61.3

- 1 Wechsler 6 A
- AC-Reststromunterdrückung
- Elektromechanische Relais
- Für Schraub- oder Zugfederklemmen



Kontakte				
Anzahl der Kontakte		1 Wechsler	1 Wechsler	
Max. Dauerstrom/max. Einschaltstrom	A	6/10	6/10	
Nennspannung/max. Schaltspannung	V AC	250/400	250/400	
Max. Schaltleistung AC1	VA	1.500	1.500	
Max. Schaltleistung AC15 (230 V AC)	VA	300	300	
1-Phasenmotorlast, AC3 - Betrieb (230 V AC)	kW	0,185	0,185	
Max. Schaltstrom DC1: 30/110/220V	A	6/0,2/0,12	6/0,2/0,12	
Min. Schaltlast	mW (V/mA)	500 (12/10)	500 (12/10)	
Kontaktmaterial Standard		AgNi	AgNi	
Spule				
Lieferbare	V AC/DC	12 - 24 - 48 - 60 - (110...125) - (220...240)	(110...125)	—
Nennspannungen (U_N)	V AC	(230...240)*	—	(230...240)
	V DC	6 - 12 - 24 - 48 - 60 (polaritätsneutral)	—	—
Bemessungsleistung AC/DC	VA (50 Hz)/W	Siehe Seite 9	1/1	0,5/—
Arbeitsbereich	AC/DC	(0,8...1,1)U_N	(94...138)V	—
	AC	(184...264)V	—	(184...264)V
	DC	(0,8...1,2)U_N	—	
Haltespannung	AC/DC	0,6 U_N / 0,6 U_N	0,6 U_N / 0,6 U_N	
Rückfallspannung	AC/DC	0,1 U_N / 0,05 U_N	44 V	72 V
Allgemeine Daten				
Mech. Lebensdauer AC/DC	Schaltspiele	$10 \cdot 10^6$	$10 \cdot 10^6$	
Elektrische Lebensdauer AC1	Schaltspiele	$60 \cdot 10^3$	$60 \cdot 10^3$	
Ansprech-/Rückfallzeit	ms	5/6	5/6	
Spannungsfestigkeit Spule/Kontakte (1,2/50 µs)	kV	6 (8 mm)	6 (8 mm)	
Spannungsfestigkeit offene Kontakte	V AC	1.000	1.000	
Umgebungstemperatur ($U_N \leq$ 60 V/>60V)	°C	–40...+70/–40...+55	—/–40...+55	
Schutzart		IP 20	IP 20	
Zulassungen (Details auf Anfrage)		CE SB PG RINA cULus		

Serie 38 - Koppel-Relais 0,1 - 2 - 3 - 5 - 6 - 8 - 16 A

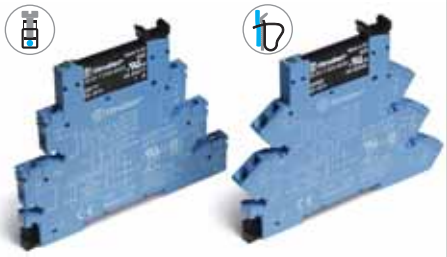
Koppel-Relais, SSR-Ausgang bis 2 A, 6,2 mm oder SSR bis 5 A, 14 mm breit, Typ 38.31/41

- Innerhalb der Serie 38 gibt es Relais für AC, DC oder AC/DC Ansteuerung
- Ausführung für lange Steuerleitungen
- Ausführung mit Optokoppler
- Koppelrelais mit integrierter EMV-Spulenbeschaltung, LED, Halte- und Demontagehebel
- Verbrauchte Schaltrelais austauschbar
- Sichere Trennung nach EN50178 zwischen Spule und Kontaktsatz, 6 kV (1,2/50 µs)
- 6 mm Luft- und 8 mm Kriechstrecke
- Anschlüsse mit Schraub- oder Zugfederklemmen

38.81 / 38.81.3
Schraubklemmen

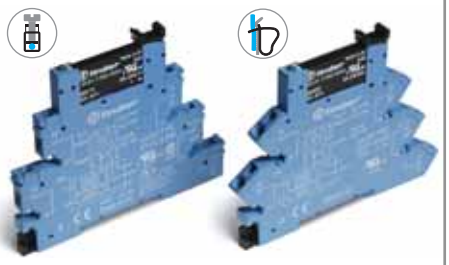
38.91 / 38.91.3
Zugfederklemmen

38.81/38.91

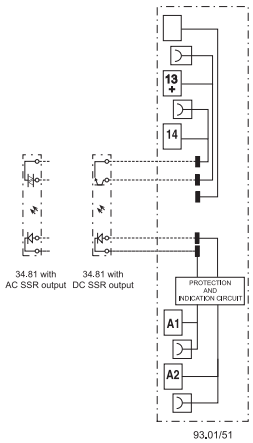


- Optokoppler, SSR
- Schraub- oder Zugfederklemmen

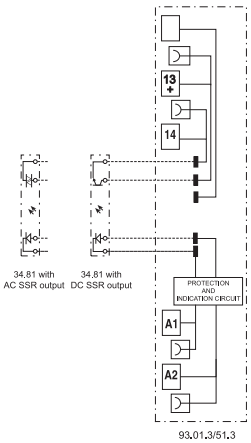
38.81.3/38.91.3



- Optokoppler, SSR
- AC-Reststromunterdrückung am Eingang
- Schraub- oder Zugfederklemmen



93.01/51



93.01.3/51.3

Abmessungen siehe Seite 12

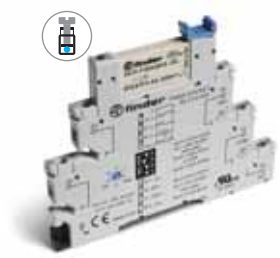
Ausgangskreis									
Anzahl der Kontakte		1 Schliesser (SSR)					1 Schliesser (SSR)		
Max. Dauerstrom/max. Einschaltstrom (10 ms)	A	2/20		0,1/0,5		2/40	2/20	0,1/0,5	2/40
Nennspannung/Max. Sperrspannung	V	24/33 DC		48/60 DC		240/275 AC	24/33 DC	48/60 DC	240/275 AC
Schaltlast-Spannungsbereich	V	(1,5…24)DC		(1,5…48)DC		(12…240)AC	(1,5…24)DC	(1,5…48)DC	(12…240)AC
Min. Schaltstrom	mA	1		0,05		22	1	0,05	22
Max. Reststrom bei 55 °C	mA	0,001		0,001		1,5	0,001	0,001	1,5
Max. Spannungsabfall bei 20 °C, Nennstrom	V	0,12		1		1,6	0,12	1	1,6
Eingangskreis									
Lieferbare Nennspannungen	V AC	—	—	—	—	—	—	230…240	
Lieferbare Nennspannungen	V DC	6	24	60	—	—	—	—	
Lieferbare Nennspannungen	V AC/DC	—	—	—	110...125	220...240	110…125	—	
Arbeitsbereich	V DC	5…7,2	16,8…30	35,6…72	88…138	184…264	(94…138)V AC/DC	(184…264)V AC	
Bemessungsleistung AC/DC	VA (50 Hz)/W	0,04	0,25	0,40	Siehe Seite 10		1 / 1	1,3 / —	
Steuerstrom	mA	7	10,5	6,5	5	4,5	8	5,6	
Rückfallspannung	V DC	2,4	10	20	45	90	44	72	
Eingangswiderstand	kΩ	0,18	2,3	9,2	25	51	17,4	42	
Allgemeine Daten									
Ansprech-/Rückfallzeit	ms	0,2/0,6		0,04/0,11		12/12	0,2/0,6	0,04/0,11	12/12
Spannungsfestigkeit Steuer-/Lastkreis	V AC	2.500					2.500		
Umgebungstemperatur	°C	–20…+55					–20…+55		
Schutzart		IP20					IP20		
Zulassungen (Details auf Anfrage)									

Schmales Zeit-Relais, 6,2 mm breit

- Innerhalb der Serie 38 gibt es Relais für AC, DC oder AC/DC Ansteuerung
- Ausführung für lange Steuerleitungen
- Ausführung mit Optokoppler
- Koppelrelais mit integrierter EMV-Spulenbeschaltung, LED, Halte- und Demontagehebel
- Verbrauchte Schaltrelais austauschbar
- Sichere Trennung nach EN50178 zwischen Spule und Kontaktsatz, 6 kV (1,2/50 µs)
- 6 mm Luft- und 8 mm Kriechstrecke
- Anschlüsse mit Schraub- oder Zugfederklemmen

38.21
Schraubklemmen

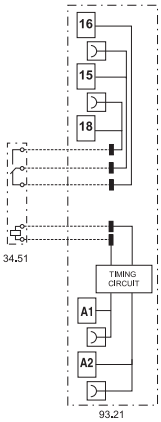
38.21



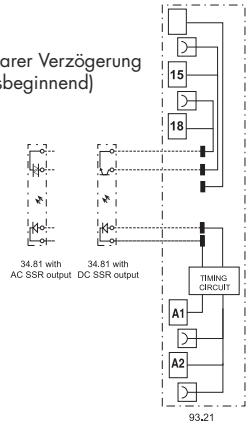
- 1 Wechsler, 6 A, Kontaktausgang
- 12 oder 24 V AC/DC Eingangsspannung
- 4 Zeitbereiche 0,1s ... 6h
- Schraubklemmen

38.21...9024-8240

- 1 Schliesser, 2 A DC oder AC, Halbleiter
- 24V AC/DC Eingangsspannung
- 4 Zeitbereiche 0,1s ... 6h
- Schraubklemmen



AI: Ansprechverzögerung
DI: Einschaltwischer
GI: Impulsgeber (0,5s) nach einstellbarer Verzögerung
SW: Symmetrischer Blinkgeber (impulsbeginnend)



Abmessungen siehe Seite 12

Kontakte				
Anzahl der Kontakte		1 Wechsler	–	
Max. Dauerstrom/max. Einschaltstrom	A	6/10	–	
Nennspannung/max. Schaltspannung	V AC	250/400	–	
Max. Schaltleistung AC1	VA	1.500	–	
Max. Schaltstrom DC1: 30/110/220V	A	6/0,2/0,12	–	
Min. Schaltlast	mW (V/mA)	500 (12/10)	–	
Kontaktmaterial Standard		AgNi	–	
Ausgangskreis			**DC Ausgang (...9024)**	**AC Ausgang (...8240)**
Anzahl der Kontakte		–	1 Schliesser (SSR)	1 Schliesser (SSR)
Max. Dauerstrom/max. Einschaltstrom	A	–	2/20	2/40
Nennspannung/Max. Sperrspannung	V	–	(24/33)DC	(240/275)AC
Schaltlast-Spannungsbereich	V	–	(1,5...24)DC	(12...240)AC
Min. Schaltstrom	mA	–	1	22
Max. Reststrom bei 55 °C	mA	–	0,001	1,5
Max. Spannungsabfall bei 20 °C, Nennstrom	V	–	0,12	1,6
Versorgung				
Lieferbare Nennspannungen (U_N) V AC (50/60Hz)/DC		12 - 24	24	
Bemessungsleistung	VA/W	0,5	0,5	
Arbeitsbereich	AC	(0,8...1,1)U_N	(0,8...1,1)U_N	
	DC	(0,8...1,1)U_N	(0,8...1,1)U_N	
Allgemeine Daten				
Zeitbereich		(0,1...3)s, (3...60)s, (1...20)min, (0,3...6)h		
Wiederholpräzision	%	± 1		
Wiederbereitschaftsdauer	ms	≤ 50		
Einstellgenauigkeit (vom Endwert)	%	5%		
Umgebungstemperatur	°C	–40...+70	–20...+55	
Schutzart		IP 20		
Zulassungen (Details auf Anfrage)		CE EAC cULus		

Koppelrelais, 1 oder 2 Wechsler, 14 mm breit oder 1 Wechsler Typ 38.51/61, 6,2 mm breit

- Innerhalb der Serie 38 gibt es Relais für AC, DC oder AC/DC Ansteuerung
- Ausführung für lange Steuerleitungen
- Ausführung mit Optokoppler
- Koppelrelais mit integrierter EMV-Spulenbeschaltung, LED, Halte- und Demontagehebel
- Verbrauchte Schaltrelais austauschbar
- Sicher Trennung nach EN50178 zwischen Spule und Kontaktsatz, 6 kV (1,2/50 µs)
- 6 mm Luft- und 8 mm Kriechstrecke
- Anschlüsse mit Schraub- oder Zugfederklemmen

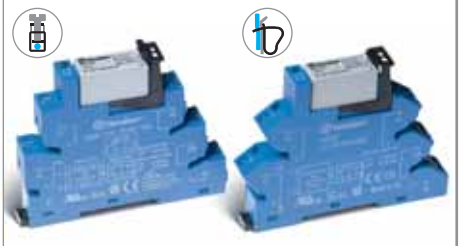
38.01/52
Schraubklemmen

38.11/62
Zugfederklemmen

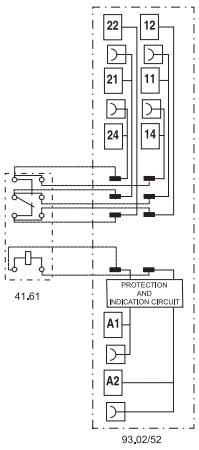
38.01/38.11

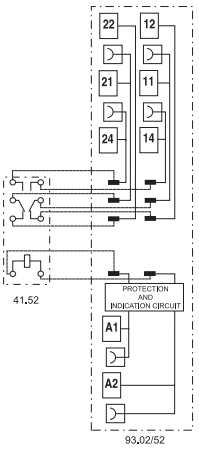
- 1 Wechsler 16 A
- Schraub- oder Zugfederklemmen
- Elektromechanische Relais

38.52/38.62



- 2 Wechsler 8 A
- Schraub- oder Zugfederklemmen
- Elektromechanische Relais





* Bei einem Dauerstrom >10 A sind die Anschlüsse 11-21, 14-24, 12-22 zu brücken

Abmessungen siehe Seite 12

Kontakte			
Anzahl der Kontakte		1 Wechsler	2 Wechsler
Max. Dauerstrom/max. Einschaltstrom	A	16*/30	8/15
Nennspannung/max. Schaltspannung	V AC	250/400	250/400
Max. Schaltleistung AC1	VA	4.000	2.000
Max. Schaltleistung AC15 (230 V AC)	VA	750	400
1-Phasenmotorlast, AC3 - Betrieb (230 V AC)	kW	0,5	0,3
Max. Schaltstrom DC1: 30/110/220V	A	16/0,3/0,12	8/0,3/0,12
Min. Schaltlast	mW (V/mA)	300 (5/5)	300 (5/5)
Kontaktmaterial Standard		AgNi	AgNi
Spule			
Lieferbare	V AC/DC	24 - 60 - (110...125) - (220...240)	24 - 60 - (110...125) - (220...240)
Nennspannungen (U_N)	V AC	230...240	230...240
	V DC	12 - 24 - 60	12 - 24 - 60
Bemessungsleistung AC/DC	VA (50 Hz)/W	(0,5...0,9) / 0,5 Siehe Seite 9	(0,5...0,9) / 0,5 Siehe Seite 9
Arbeitsbereich	AC/DC	0,8...1,1	0,8...1,1
	DC	(0,8...1,2)U_N	(0,8...1,2)U_N
Haltespannung	AC/DC	0,6 / 0,6 U_N	0,6 / 0,6 U_N
Rückfallspannung	AC/DC	0,1 / 0,05 U_N	0,1 / 0,05 U_N
Allgemeine Daten			
Mech. Lebensdauer AC/DC	Schaltspiele	$30 \cdot 10^6$	$30 \cdot 10^6$
Elektrische Lebensdauer AC1	Schaltspiele	$70 \cdot 10^3$	$80 \cdot 10^3$
Ansprech-/Rückfallzeit	ms	8 / 10	8 / 10
Spannungsfestigkeit Spule/Kontakte (1,2/50 µs)	kV	6 (8 mm)	6 (8 mm)
Spannungsfestigkeit offene Kontakte	V AC	1.000	1.000
Umgebungstemperatur ($U_N \leq$ 60 V/>60V)	°C	–40...+70 / –40...+55	–40...+70 / –40...+55
Relaisschutzart		IP 20	IP 20
Zulassungen (Details auf Anfrage)		CE cULus RINA cULus	

Koppel-Relais, SSR-Ausgang bis 5 A, 14 mm oder SSR bis 2 A, 6,2 mm breit, Typ 38.81/91

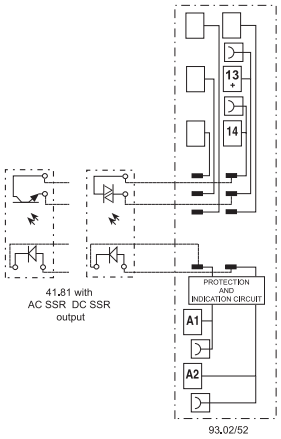
- Innerhalb der Serie 38 gibt es Relais für AC, DC oder AC/DC Ansteuerung
- Ausführung für lange Steuerleitungen
- Ausführung mit Optokoppler
- Koppelrelais mit integrierter EMV-Spulenbeschaltung, LED, Halte- und Demontagehebel
- Verbrauchte Schaltrelais austauschbar
- Sichere Trennung nach EN50178 zwischen Spule und Kontaktsatz, 6 kV (1,2/50 µs)
- 6 mm Luft- und 8 mm Kriechstrecke
- Anschlüsse mit Schraub- oder Zugfederklemmen

38.31
Schraubklemmen

38.41
Zugfederklemmen

38.31/38.41

- DC-Ausgang bis 5 A oder AC-Ausgang bis 3 A
- Optokoppler, SSR - DC-Eingang
- Schraub- oder Zugfederklemmen



Abmessungen siehe Seite 12

Ausgangskreis				
Anzahl der Kontakte		1 Schliesser (SSR)		1 Schliesser (SSR)
Max. Dauerstrom/max. Einschaltstrom (10 ms)	A	5/40		3/40
Nennspannung/Max. Sperrspannung	V	(24/35)DC		(240/275)AC
Schaltlast-Spannungsbereich	V	(1,5…24)DC		(12…240)AC
Min. Schaltstrom	mA	1		50
Max. Reststrom bei 55 °C	mA	0,01		1
Max. Spannungsabfall bei 20 °C, Nennstrom	V	0,3		1,1
Eingangskreis				
Lieferbare	V AC/DC	—	—	24
Nennspannungen (U_N)	V DC	12	24	—
Arbeitsbereich	V DC	9,6...18	16,8...30	16,8...30
Bemessungsleistung DC	W	0,2	0,3	0,3
Steuerstrom	mA	9	12	16,5
Rückfallspannung	V DC	5	5	9
Allgemeine Daten				
Ansprech-/Rückfallzeit	ms	0,05/0,25		12/12
Spannungsfestigkeit Steuer-/Lastkreis	V AC	2.500		
Umgebungstemperatur	°C	–20...+55		
Schutzart		IP20		
Zulassungen (Details auf Anfrage)		CE SP PG RINA cULus		

Bestellbezeichnung - Elektromechanische Relais

Beispiel: Serie 38, Koppelrelais, elektromechanisch mit Schraubanschluss, 6,2 mm breit, 1 Wechsler, Spulenspannung 12 V DC sensitiv.

									A	B	C	D		
3	8	.	5	1	.	7	.	0	1	2	.	0	0	5	0

Serie

Typ
0 = Elektromechanisches Koppel-Relais 16 A, mit Schraubanschluss
1 = Elektromechanisches Koppel-Relais 16 A, mit Zugfederklemme
2 = Zeit-Relais*, EMR mit Schraubanschluss
5 = Elektromechanisches Koppel-Relais 6 oder 8 A mit Schraubanschluss
6 = Elektromechanisches Koppel-Relais 6 oder 8 A mit Zugfederklemme

Anzahl der Kontakte
1 = 1 Kontakt, 6 A, 6,2 mm breit oder 16 A, 14 mm breit
2 = 2 Kontakte, 8 A, 14 mm breit

Spulenerregung
0 = AC (50/60 Hz)/ DC
3 = Für AC-Reststromunterdrückung** nur für (110...125)V AC/DC - (230...240)V AC
7 = DC sensitiv, nur für (6, 12, 24, 48, 60)V
8 = AC (50/60 Hz)

Spulennennspannung
Siehe Spulentabelle

D: Ausführung
0 = Standard

C: Option
5 = Standard DC
6 = Standard AC oder AC/DC

B: Kontaktart
0 = Wechsler

A: Kontaktmaterial
0 = AgNi Standard
4 = $AgSnO_2$
5 = AgNi + Au (5 µm)

* Zeitrelais-Funktionen
AI: Ansprechverzögerung
DI: Einschaltwischer
GI: Impulsgeber (0,5s) nach einstellbarer Verzögerung
SW: Symmetrischer Blinkgeber (impulsbeginnend)

** Zur Reststromunterdrückung bei Ansteuerung mit (115 oder 230) VAC durch Halbleiterausgänge, SPS, lange Steuerleitungen, Thyristoren und induktive Näherungsschalter, um zu erreichen, dass die Relais abfallen.

Die Ausführung kann nur innerhalb einer Zeile gewählt werden.

Typ	Spule	A	B	C	D
38.01/11	7	0 - 4	0	5	0
38.01/11	0 - 8	0 - 4	0	6	0
38.51/61	7	0 - 4 - 5	0	5	0
38.51/61	0 - 3 - 8	0 - 4 - 5	0	6	0
38.52/62	7	0 - 5	0	5	0
38.52/62	0 - 8	0 - 5	0	6	0
38.21	0	0	0	6	0

Bestellbezeichnung - Koppel-Relais mit Halbleiter

Beispiel: Serie 38, Koppelrelais als Optokoppler (SSR) mit Schraubklemme, 6,2 mm breit, Eingangsnennspannung 24 V DC geglättet, Ausgang 2 A - 24 V DC

3 8 . 8 1 . 7 . 0 2 4 . 9 0 2 4

Serie

Typ
21 = Zeit-Relais*, SSR, 6,2mm breit, Schraubklemmen
31 = SSR, 14mm breit, Schraubklemmen
41 = SSR, 14mm breit, Zugfederklemmen
81 = SSR, 6,2mm breit, Schraubklemmen
91 = SSR, 6,2mm breit, Zugfederklemmen

Eingangskreis
0 = AC/DC
3 = Für Koppel-SSR mit AC-Reststromunterdrückung** nur für (110...125)VAC/DC oder (230...240)VAC
7 = DC, nur für Koppel-SSR (6, 24, 60)V

Betriebsspannung
Siehe Eingangs-Spezifikation

Ausgangskreis
9024 = 2 A - 24 V DC (bei Typ 38.21, 38.81 und 38.91)
9024 = 5 A - 24 V DC (bei Typ 38.31 und 38.41)
7048 = 0,1 A - 48 V DC (bei Typ 38.81 und 38.91)
8240 = 2 A - 240 V AC (bei Typ 38.21, 38.81 und 38.91)
8240 = 3 A - 240 V AC (bei Typ 38.31 und 38.41)

* Zeitrelais-Funktionen
AI: Ansprechverzögerung
DI: Einschaltwischer
GI: Impulsgeber (0,5s) nach einstellbarer Verzögerung
SW: Symmetrischer Blinkgeber (impulsbeginnend)

** Zur Reststromunterdrückung bei Ansteuerung mit (115 oder 230) VAC durch Halbleiterausgänge, SPS, lange Steuerleitungen, Thyristoren und induktive Näherungsschalter, um zu erreichen, dass die Relais abfallen.

Die Ausführung kann nur innerhalb einer Zeile gewählt werden.

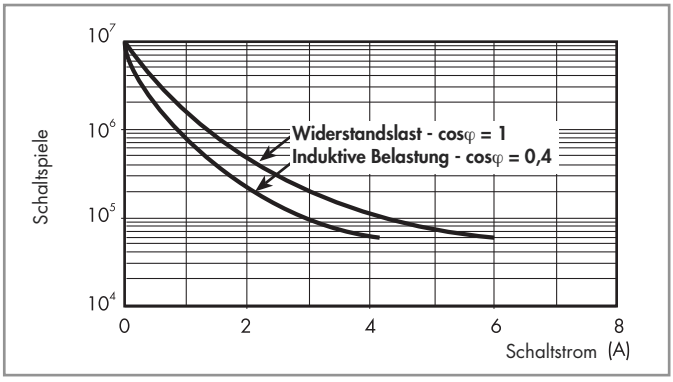
Typ	Eingangskreis	Ausgangskreis
38.81/91	7	9024 - 7048 - 8240
38.81/91	0 - 3	9024 - 7048 - 8240
38.31/41	0 - 7	9024 - 8240
38.21	0	9024 - 8240

Allgemeine Angaben - Elektromechanisches Relais, 1 und 2 Wechsler

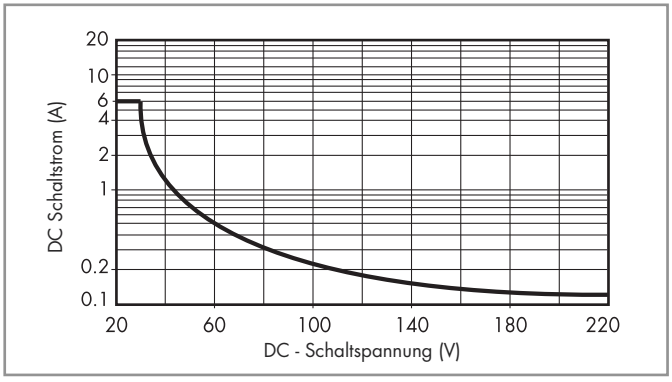
Isolationseigenschaften nach EN 61810-1, VDE 0435 T 210						
Bemessungsisolationsspannung		V	250		400	
Bemessungs - Stossspannung		kV	4		4	
Verschmutzungsgrad			3		2	
Überspannungskategorie			III		III	
Spannungfestigkeit Spule/Kontakt (1,2/50 µs)		kV	6 (8 mm)			
Spannungfestigkeit zwischen benachbarten Kontakten		V AC	1.000			
EMV - Störfestigkeit des Ansteuerungskreises (Spule)						
Burst (5...50) ns, 5 kHz, an A1 - A2			EN 61000-4-4		Klasse 4 (4 kV)	
Surge (1,2/50 µs) an A1 - A2 (differential mode)			EN 61000-4-5		Klasse 3 (2 kV)	
Weitere Daten			**1 Wechsler 6 A**		**1 Wechsler 16 A - 2 Wechsler 8 A**	
Prellzeit beim Schliessen des Schliessers/Öffners		ms	1/6		2/5	
Vibrationsfestigkeit (10...55)Hz: Schliesser/Öffner		g	10/5		15/2	
Wärmeabgabe an die Umgebung	ohne Kontakstrom	W	0,2 (12 V) - 0,9 (240 V)		0,5 (24 V) - 0,9 (240 V)	
	bei Dauerstrom	W	0,5 (12 V) - 1,5 (240 V)		1,3 (24 V) - 1,7 (240 V)	
Anschlüsse			**38.21/38.51(Schraubklemme)**		**38.61 (Zugfederklemme)**	
Abisolierungslänge		mm	10		10	
⏀ Drehmoment		Nm	0,5		—	
Max. Anschlussquerschnitt			eindrähtig	mehrdrätig	eindrähtig	mehrdrätig
		mm^2	1x2,5/2x1,5	1x2,5/2x1,5	1x2,5	1x2,5
		AWG	1x14/2x16	1x14/2x16	1x14	1x14
			38.01/38.52 (Schraubklemme)		**38.11/38.62 (Zugfederklemme)**	
Abisolierungslänge		mm	10		10	
⏀ Drehmoment		Nm	0,5		—	
Max. Anschlussquerschnitt			eindrähtig	mehrdrätig	eindrähtig	mehrdrätig
		mm^2	1x2,5/2x1,5	1x2,5/2x1,5	1x2,5	1x2,5
		AWG	1x14/2x16	1x14/2x16	1x14	1x14

Kontaktdaten - Elektromechanisches Relais, 1 und 2 Wechsler

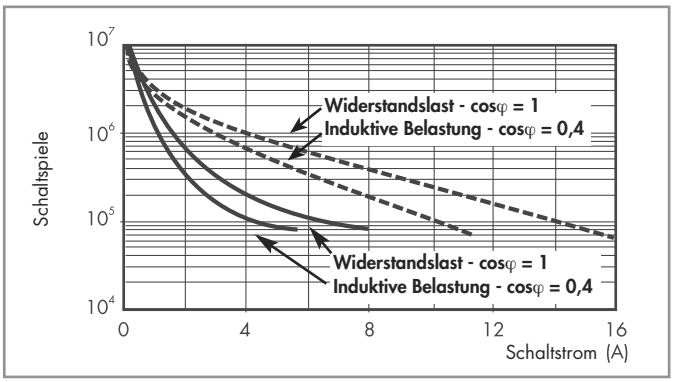
F 38 - Elektrische Lebensdauer bei AC, 1 Wechsler 6 A



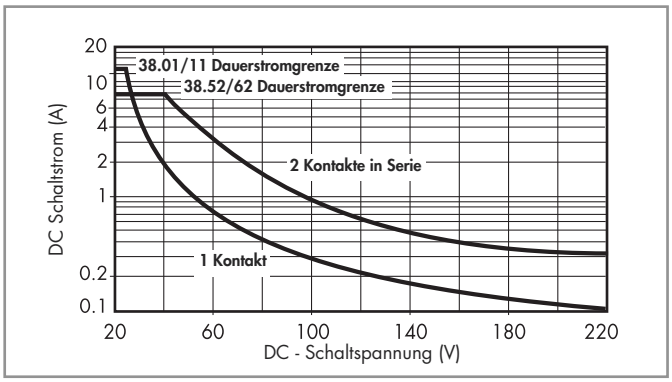
H 38 - Gleichstromschaltvermögen bei DC1 - Belastung, 1 Wechsler 6 A



F 38 - Elektrische Lebensdauer bei AC,
1 Wechsler 16 A und 2 Wechsler 8 A



H 38 - Gleichstromschaltvermögen bei DC1 - Belastung,
1 Wechsler 16 A und 2 Wechsler 8 A



——— : 2 Wechsler 8 A
--------- : 1 Wechsler 16 A

- Bei ohmscher Last (DC1) und einem Schnittpunkt von Strom und Spannung unterhalb der Kurve kann von einer elektrischen Lebensdauer bei dem Relais mit einem Wechsler von ≥ 60.000 und bei dem Relais mit 2 Wechslern von ≥ 80.000 Schaltspielen ausgegangen werden.
- Bei einer induktiven Last (DC13) ist eine Freilaufdiode parallel zur Last zu schalten. Anmerkung: Die Rückfallzeit der Last verlängert sich.

Spulendaten - Elektromechanisches Relais

DC Ausführung (sensitiv), 1 Wechsler 6 A

Nenn-spannung U_N	Spulen-code	Arbeitsbereich U_{min}	Arbeitsbereich U_{max}	Bemessungs-strom I	Bemessungs-leistung P
V		V	V	mA	W
6	**7**.006	4,8	7,2	35	0,2
12	**7**.012	9,6	14,4	15,2	0,2
24	**7**.024	19,2	28,8	10,4	0,3
48	**7**.048	38,4	57,6	6,3	0,3
60	**7**.060	48	72	7	0,4

AC/DC Ausführung, 1 Wechsler 6 A

Nenn-spannung U_N	Spulen-code	Arbeitsbereich U_{min}	Arbeitsbereich U_{max}	Bemessungs-strom I	Bemessungs-leistung P
V		V	V	mA	VA/W
12	**0**.012	9,6	13,2	16	0,2/0,2
24	**0**.024	19,2	26,4	12	0,3/0,2
48	**0**.048	38,4	52,8	6,9	0,3/0,3
60	**0**.060	48	66	7	0,5/0,5
110...125	**0**.125	88	138	5(*)	0,6/0,6(*)
220...240	**0**.240	176	264	4(*)	1/0,9(*)

(*) Bemessungsstrom und Bemessungsleistung bei U_N = 125 und 240 V.

AC Ausführung, 1 Wechsler 6 A, für eine max. Umgebungstemperatur bis +70°C

Nenn-spannung U_N	Spulen-code	Arbeitsbereich U_{min}	Arbeitsbereich U_{max}	Bemessungs-strom I	Bemessungs-leistung P
V		V	V	mA	VA/W
(230...240) AC	**8**.240	184	264	3	0,7/0,3

AC Ausführung für Reststromunterdrückung**, 1 Wechsler 6 A

Nenn-spannung U_N	Spulen-code	Arbeitsbereich U_{min}	Arbeitsbereich U_{max}	Bemessungs-strom I	Bemessungs-leistung P
V		V	V	mA	VA/W
(110...125) AC/DC	**3**.125	94	138	8(*)	1/1(*)
(230...240) AC	**3**.240	184	264	7(*)	1,7/0,5(*)

(*) Bemessungsstrom und Bemessungsleistung bei U_N = 125 und 240 V.

** Zur Reststromunterdrückung bei Ansteuerung mit (115 oder 230) VAC durch Halbleiterausgänge, SPS, lange Steuerleitungen, Thyristoren und induktive Näherungsschalter, um zu erreichen, dass die Relais abfallen.

DC Ausführung, 1 Wechsler 16 A und 2 Wechsler 8 A

Nenn-spannung U_N	Spulen-code	Arbeitsbereich U_{min}	Arbeitsbereich U_{max}	Bemessungs-strom I	Bemessungs-leistung P
V		V	V	mA	W
12	**7**.012	9,6	14,4	41	0,5
24	**7**.024	19,2	28,8	19,5	0,5
60	**7**.060	48	72	8	0,5

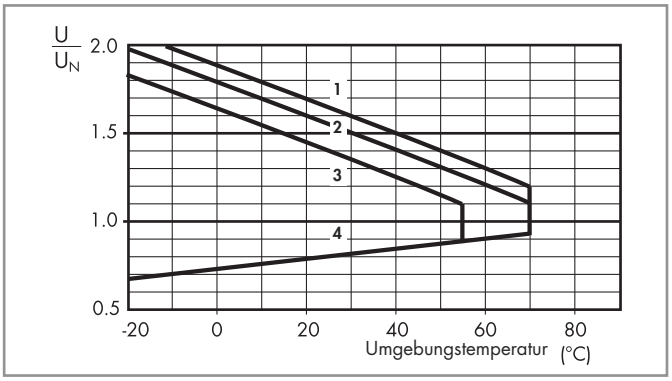
AC/DC Ausführung, 1 Wechsler 16 A und 2 Wechsler 8 A

Nenn-spannung U_N	Spulen-code	Arbeitsbereich U_{min}	Arbeitsbereich U_{max}	Bemessungs-strom I	Bemessungs-leistung P
V		V	V	mA	VA/W
24	**0**.024	19,2	26,4	20	0,5/0,5
60	**0**.060	48	66	7,1	0,5/0,5
110...125	**0**.125	88	138	4,6	0,6/0,6
220...240	**0**.240	184	264	3,8	0,9/0,9

AC Ausführung, 1 Wechsler 16 A und 2 Wechsler 8 A

Nenn-spannung U_N	Spulen-code	Arbeitsbereich U_{min}	Arbeitsbereich U_{max}	Bemessungs-strom I	Bemessungs-leistung P
V		V	V	mA	VA/W
230...240	**8**.230	184	264	5,3	1,2/0,6

R 38 - DC-Spulen-Betriebsspannungsbereich, 1 und 2 Wechsler



1 - Max. zulässige Spulenspannung bei Nennspannungen (DC-Ausführung)
2 - Max. zulässige Spulenspannung bei Nennspannungen (≤ 60 V AC/DC-Ausführung)
3 - Max. zulässige Spulenspannung bei Nennspannungen (> 60 V AC/DC-Ausführung)
4 - Ansprechspannung bei Spulentemperatur gleich Umgebungstemperatur

Allgemeine Angaben - Optokoppler, SSR

Weitere Daten			**38.81/38.91**		**38.31/38.41**	
Wärmeabgabe an die Umgebung	ohne Kontaktstrom	W	0,25 (24 V DC)		0,5	
	bei Dauerstrom	W	0,4		2,2 (DC Ausgang) / 3 (AC Ausgang)	
Anschlüsse			**38.81**		**38.91**	
Abisolierungslänge		mm	10		10	
⊖ Drehmoment		Nm	0,5		–	
Max. Anschlussquerschnitt			eindrähtig	mehrdrähtig	eindrähtig	mehrdrähtig
		mm^2	1x2,5 / 2x1,5	1x2,5 / 2x1,5	1x2,5	1x2,5
		AWG	1x14 / 2x16	1x14 / 2x16	1x14	1x14
			38.31		**38.41**	
Abisolierungslänge		mm	10		10	
⊖ Drehmoment		Nm	0,5		–	
Max. Anschlussquerschnitt			eindrähtig	mehrdrähtig	eindrähtig	mehrdrähtig
		mm^2	1x2,5 / 2x1,5	1x2,5 / 2x1,5	1x2,5	1x2,5
		AWG	1x14 / 2x16	1x14 / 2x16	1x14	1x14

Eingangs-Spezifikation - Optokoppler, SSR

DC Eingang-Ausführung, 6,2 mm breit

Nenn-spannung U_N	Eingangs-code	Arbeitsbereich U_{min}	Arbeitsbereich U_{max}	Rückfall-spannung U	Bemessungs-strom I	Bemessungs-leistung P
V		V	V	V	mA	W
6	**7**.006	5	7,2	2,4	7	0,2
24	**7**.024	16,8	30	10	10,5	0,3
60	**7**.060	35,6	72	20	6,5	0,4

AC/DC Eingangs-Ausführung, 6,2 mm breit

Nenn-spannung U_N	Eingangs-code	Arbeitsbereich U_{min}	Arbeitsbereich U_{max}	Rückfall-spannung U	Bemessungs-strom I	Bemessungs-leistung P
V		V	V	V	mA	VA/W
110...125	**0**.125	88	138	22	5,5*	0,7/0,7
220...240	**0**.240	184	264	44	3,5*	1/0,9

(*) Bemessungsstrom und Bemessungsleistung bei U_N = 125 und 240 V.

Ausführung für Reststromunterdrückung,** 6,2 mm breit

Nenn-spannung U_N	Eingangs-code	Arbeitsbereich U_{min}	Arbeitsbereich U_{max}	Rückfall-spannung U	Bemessungs-strom I	Bemessungs-leistung P
V		V	V		mA	VA/W
110...125 AC/DC	**3**.125	94	138	44	8(*)	1/1(*)
230...240 AC	**3**.240	184	264	72	6,5(*)	1,6/0,6(*)

(*) Bemessungsstrom und Bemessungsleistung bei U_N = 125 und 240 V.

** Zur Reststromunterdrückung bei Ansteuerung mit (115 oder 230) VAC durch Halbleiterausgänge, SPS, lange Steuerleitungen, Thyristoren und induktive Näherungsschalter, um zu erreichen, dass die Relais abfallen.

DC Eingang-Ausführung, 14 mm breit

Nenn-spannung U_N	Eingangs-code	Arbeitsbereich U_{min}	Arbeitsbereich U_{max}	Rückfall-spannung U	Bemessungs-strom I	Bemessungs-leistung P
V		V	V	V	mA	W
12	**7**.012	9,6	18	5	9	0,2
24	**7**.024	16,8	30	5	12	0,3

AC/DC Eingang-Ausführung, 14 mm breit

Nenn-spannung U_N	Eingangs-code	Arbeitsbereich U_{min}	Arbeitsbereich U_{max}	Rückfall-spannung U	Bemessungs-strom I	Bemessungs-leistung P
V		V	V	V	mA	W
24	**0**.024	16.8	30	9	16,5	0,3

Allgemeine Angaben - Zeit-Relais

EMV - Störfestigkeit				
Art der Prüfung			**Vorschrift**	**Prüfschärfe**
ESD - Entladung	über die Anschlüsse		EN 61000-4-2	4 kV
	durch die Luft		EN 61000-4-2	8 kV
Elektromagnetisches HF-Feld (80 ÷ 1.000 MHz)			EN 61000-4-3	10 V/m
Burst (5-50 ns, 5 kHz) an A1 - A2			EN 61000-4-4	4 kV
Surges (1,2/50 µs) an A1 - A2	gemeinsam (common mode)		EN 61000-4-5	4 kV
	gegeneinander (differential mode)		EN 61000-4-5	4 kV
Leitungsgeführtes elektromagnetisches HF-Signal (0,15 ÷ 80 MHz) an A1 - A2			EN 61000-4-6	10 V
EMV - Emission, elektromagnetische Felder			EN 55022	Klasse B
Weitere Daten			**EMR**	**SSR**
Wärmeabgabe	an die Umgebung ohne Kontaktstrom	W	0,1	0,1
	bei Dauerstrom	W	0,6	0,5
Anschlüsse			**38.21 (Schraubklemme)**	
Abisolierungslänge		mm	10	
Drehmoment		Nm	0,5	
Max. Anschlussquerschnitt			eindrähtig	mehrdrähtig
		mm^2	1x2,5 / 2x1,5	1x2,5 / 2x1,5
		AWG	1x14 / 2x16	1x14 / 2x16

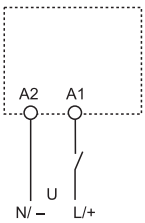
Zeitbereiche

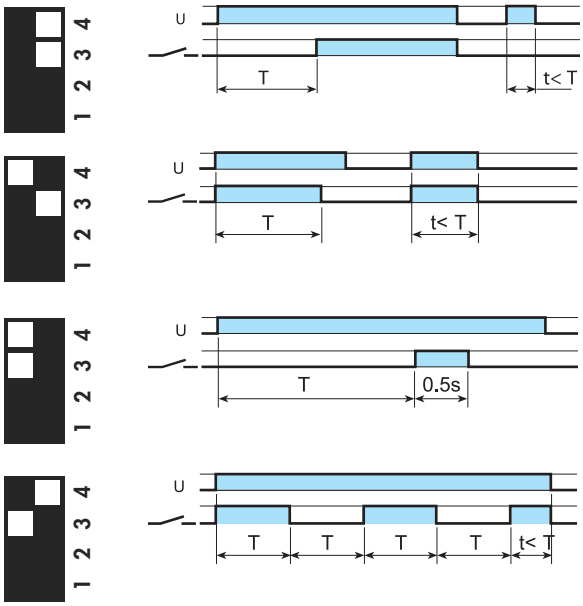
(0,1...3)s (3...60)s (1...20)min (0,3...6)h

Funktion

LED-Anzeige	Betriebsspannung	Ausgangs-Relais/SSR
	liegt nicht an	in Ruhestellung
	liegt an	in Ruhestellung, Zeit läuft
	liegt an	in Arbeitsstellung

Anschlussbild **Funktionsdiagramm** **U** = Betriebsspannung = Schaltzustand des Schliessers





(AI) Ansprechverzögerung
Der Start erfolgt durch Anlegen der Betriebsspannung (U). Nach Ablauf der einstellbaren Verzögerungszeit schaltet das Relais in die Arbeitsstellung.

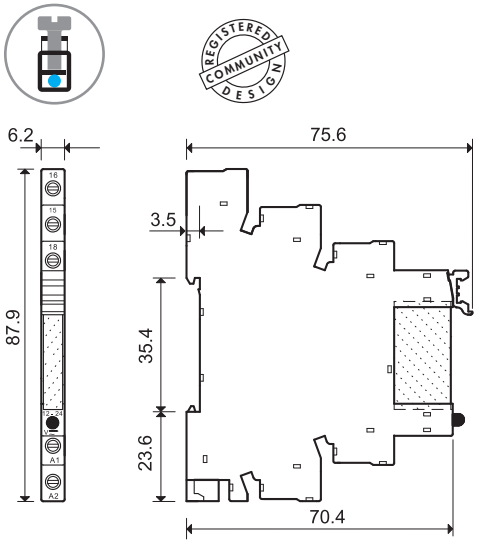
(DI) Einschaltwischer
Der Start erfolgt durch Anlegen der Betriebsspannung (U) das Relais schaltet sofort in die Arbeitsstellung. Nach Ablauf der einstellbaren Wischzeit schaltet das Relais in die Ruhestellung.

(GI) Impulsgeber (0,5s) nach einstellbarer Verzögerung
Bei Anlegen der Betriebsspannung (U) an A1-A2 und Ablauf der einstellbaren Verzögerungszeit schaltet das Relais für 0,5 s in die Arbeitsstellung.

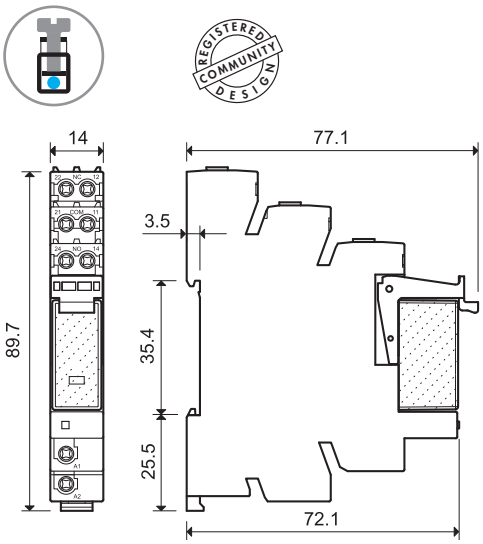
(SW) Symmetrischer Blinkgeber (impulsbeginnend)
Beim Anlegen der Betriebsspannung (U) schaltet das Relais in die Arbeitsstellung. Nach Ablauf der Impulszeit schaltet das Relais in die Ruhestellung, um danach wieder in die Arbeitsstellung zu gehen (Impulszeit = Pausenzeit).

Abmessungen / Position der Anschlüsse

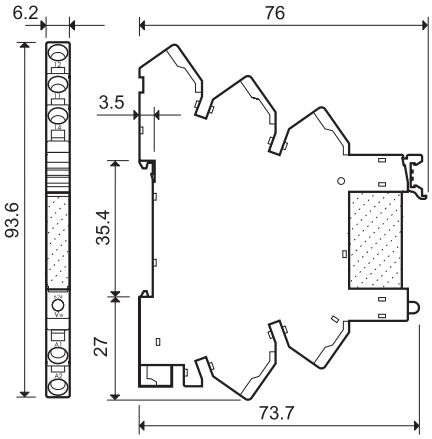
38.21*
38.51 / 38.51.3
38.81* / 38.81.3*
Schraubklemmen



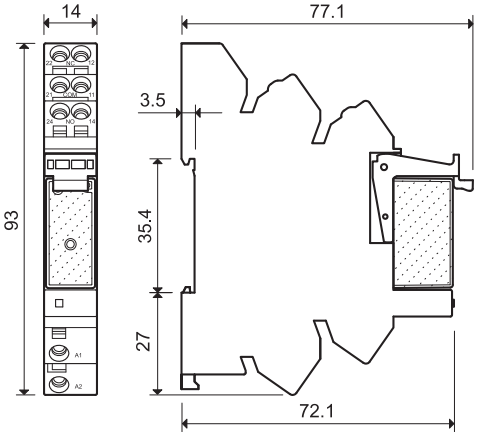
38.01***
38.31**
38.52
Schraubklemmen



38.61 / 38.61.3
38.91* / 38.91.3*
Zugfederklemmen

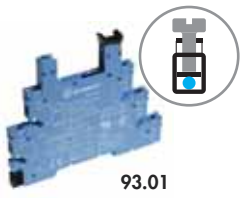


38.11**-*
38.41**
38.62
Zugfederklemmen

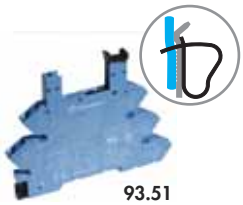


* Bei den 6,2 mm breiten Koppel-Relais mit SSR-Ausgang sind die Anschlüsse 11-14 zu benutzen, der Anschluss 12 ist nicht belegt.
** Bei den 14 mm breiten Koppel-Relais mit SSR-Ausgang sind die Anschlüsse 11-14 zu benutzen, die Anschlüsse 12, 21, 22 und 24 sind nicht belegt.
*** Bei einem Dauerstrom > 10 A sind die Anschlüsse 11-21, 14-24, 12-22 zu brücken.

Komponenten - elektromechanische Koppel-Relais



93.01



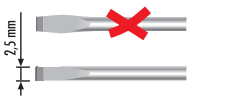
93.51

93.02

93.52

Zulassungen
(Details auf Anfrage):

Zulassung für die Kombination aus Fassung und Relais bei einigen Ausführungen



Koppel-Relais mit Schraubklemme - 1 Wechsler 6 A

Code	Betriebsspannung	Relais-Typ	Fassungs-Typ *
38.51.0.012.0060	12 V AC/DC	34.51.7.012.0010	93.01.0.024
38.51.0.024.0060	24 V AC/DC	34.51.7.024.0010	93.01.0.024
38.51.0.048.0060	48 V AC/DC	34.51.7.048.0010	93.01.0.060
38.51.0.060.0060	60 V AC/DC	34.51.7.060.0010	93.01.0.060
38.51.0.125.0060	(110...125)V AC/DC	34.51.7.060.0010	93.01.0.125
38.51.0.240.0060	(220...240)V AC/DC	34.51.7.060.0010	93.01.0.240
38.51.3.125.0060	(110...125)V AC/DC	34.51.7.060.0010	93.01.3.125
38.51.3.240.0060	(230...240)V AC	34.51.7.060.0010	93.01.3.240
38.51.7.006.0050	6 V DC	34.51.7.005.0010	93.01.7.024
38.51.7.012.0050	12 V DC	34.51.7.012.0010	93.01.7.024
38.51.7.024.0050	24 V DC	34.51.7.024.0010	93.01.7.024
38.51.7.048.0050	48 V DC	34.51.7.048.0010	93.01.7.060
38.51.7.060.0050	60 V DC	34.51.7.060.0010	93.01.7.060
38.51.8.240.0060	(230...240)V AC	34.51.7.060.0010	93.01.8.240

Koppel-Relais mit Zugfederklemme - 1 Wechsler 6 A

Code	Betriebsspannung	Relais-Typ	Fassungs-Typ *
38.61.0.012.0060	12 V AC/DC	34.51.7.012.0010	93.51.0.024
38.61.0.024.0060	24 V AC/DC	34.51.7.024.0010	93.51.0.024
38.61.0.125.0060	(110...125)V AC/DC	34.51.7.060.0010	93.51.0.125
38.61.0.240.0060	(220...240)V AC/DC	34.51.7.060.0010	93.51.0.240
38.61.3.125.0060	(110...125)V AC/DC	34.51.7.060.0010	93.51.3.125
38.61.3.240.0060	(230...240)V AC	34.51.7.060.0010	93.51.3.240
38.61.7.012.0050	12 V DC	34.51.7.012.0010	93.51.7.024
38.61.7.024.0050	24 V DC	34.51.7.024.0010	93.51.7.024
38.61.8.240.0060	(230...240)V AC	34.51.7.060.0010	93.51.8.240

Koppel-Relais mit Schraubklemme - 1 Wechsler 16 A

Code	Betriebsspannung	Relais-Typ	Fassungs-Typ *
38.01.7.012.0050	12 V DC	41.61.9.012.0010	93.02.7.024
38.01.7.024.0050	24 V DC	41.61.9.024.0010	93.02.7.024
38.01.7.060.0050	60 V DC	41.61.9.060.0010	93.02.7.060
38.01.0.024.0060	24 V AC/DC	41.61.9.024.0010	93.02.0.024
38.01.0.060.0060	60 V AC/DC	41.61.9.060.0010	93.02.0.060
38.01.0.125.0060	125 V AC/DC	41.61.9.110.0010	93.02.0.125
38.01.0.240.0060	240 V AC/DC	41.61.9.110.0010	93.02.0.240
38.01.8.230.0060	230 V AC	41.61.9.110.0010	93.02.8.230

Koppel-Relais mit Zugfederklemme - 1 Wechsler 16 A

Code	Betriebsspannung	Relais-Typ	Fassungs-Typ *
38.11.7.012.0050	12 V DC	41.61.9.012.0010	93.52.7.024
38.11.7.024.0050	24 V DC	41.61.9.024.0010	93.52.7.024
38.11.7.060.0050	60 V DC	41.61.9.060.0010	93.52.7.060
38.11.0.024.0060	24 V AC/DC	41.61.9.024.0010	93.52.0.024
38.11.0.060.0060	60 V AC/DC	41.61.9.060.0010	93.52.0.060
38.11.0.125.0060	125 V AC/DC	41.61.9.110.0010	93.52.0.125
38.11.0.240.0060	240 V AC/DC	41.61.9.110.0010	93.52.0.240
38.11.8.230.0060	230 V AC	41.61.9.110.0010	93.52.8.230

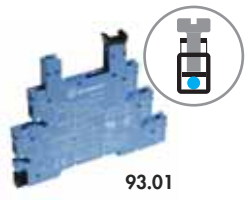
Koppel-Relais mit Schraubklemme - 2 Wechsler 8 A

Code	Betriebsspannung	Relais-Typ	Fassungs-Typ *
38.52.0.024.0060	24 V AC/DC	41.52.9.024.0010	93.02.0.024
38.52.0.060.0060	60 V AC/DC	41.52.9.060.0010	93.02.0.060
38.52.0.125.0060	(110...125)V AC/DC	41.52.9.110.0010	93.02.0.125
38.52.0.240.0060	(220...240)V AC/DC	41.52.9.110.0010	93.02.0.240
38.52.7.012.0050	12 V DC	41.52.9.012.0010	93.02.7.024
38.52.7.024.0050	24 V DC	41.52.9.024.0010	93.02.7.024
38.52.7.060.0050	60 V DC	41.52.9.060.0010	93.02.7.060
38.52.8.230.0060	(230...240)V AC	41.52.9.110.0010	93.02.8.230

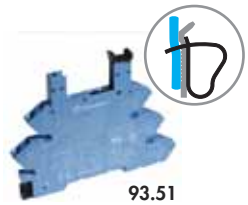
Koppel-Relais mit Zugfederklemme - 2 Wechsler 8 A

Code	Betriebsspannung	Relais-Typ	Fassungs-Typ *
38.62.0.024.0060	24 V AC/DC	41.52.9.024.0010	93.52.0.024
38.62.0.060.0060	60 V AC/DC	41.52.9.060.0010	93.52.0.060
38.62.0.125.0060	(110...125)V AC/DC	41.52.9.110.0010	93.52.0.125
38.62.0.240.0060	(220...240)V AC/DC	41.52.9.110.0010	93.52.0.240
38.62.7.012.0050	12 V DC	41.52.9.012.0010	93.52.7.024
38.62.7.024.0050	24 V DC	41.52.9.024.0010	93.52.7.024
38.62.7.060.0050	60 V DC	41.52.9.060.0010	93.52.7.060
38.62.8.230.0060	(230...240)V AC	41.52.9.110.0010	93.52.8.230

* Schwarze Fassungen sind auf Anfrage lieferbar. Die Bestellbezeichnung ist um ".0" zu ergänzen.



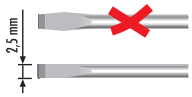
93.01



93.51

Zulassungen
(Details auf Anfrage):

Zulassung für die Kombination aus Fassung und Relais bei einigen Ausführungen



Komponenten - Opto-Koppler (SSR) - 6,2 mm breit

Koppel-Relais mit Schraubklemme			
Code	**Betriebsspannung**	**Relais-Typ**	**Fassungs-Typ***
38.81.7.006.xxxx	6 V DC	34.81.7.005.xxxx	93.01.7.024
38.81.7.024.xxxx	24 V DC	34.81.7.024.xxxx	93.01.7.024
38.81.7.060.xxxx	60 V DC	34.81.7.060.xxxx	93.01.7.060
38.81.0.125.xxxx	(110...125)V AC/DC	34.81.7.060.xxxx	93.01.0.125
38.81.0.240.xxxx	(220...240)V AC/DC	34.81.7.060.xxxx	93.01.0.240
38.81.3.125.xxxx	(110...125)V AC/DC	34.81.7.060.xxxx	93.01.3.125
38.81.3.240.xxxx	(230...240)V AC	34.81.7.060.xxxx	93.01.3.240
Koppel-Relais mit Zugfederklemme			
Code	**Betriebsspannung**	**Relais-Typ**	**Fassungs-Typ ***
38.91.7.006.xxxx	6 V DC	34.81.7.005.xxxx	93.51.7.024
38.91.7.024.xxxx	24 V DC	34.81.7.024.xxxx	93.51.7.024
38.91.7.060.xxxx	60 V DC	34.81.7.060.xxxx	93.51.7.060
38.91.0.125.xxxx	(110...125)V AC/DC	34.81.7.060.xxxx	93.51.0.125
38.91.0.240.xxxx	(220...240)V AC/DC	34.81.7.060.xxxx	93.51.0.240
38.91.3.125.xxxx	(110...125)V AC/DC	34.81.7.060.xxxx	93.51.3.125
38.91.3.240.xxxx	(230...240)V AC	34.81.7.060.xxxx	93.51.3.240

Beispiel: .xxxx
.9024 Ausgang: 2 A - 24 V DC
.7048 Ausgang: 0,1 A - 48 V DC
.8240 Ausgang: 2 A - 240 V AC, Nullpunktschalter

* Schwarze Fassungen sind auf Anfrage lieferbar. Die Bestellbezeichnung ist um ".0" zu ergänzen.

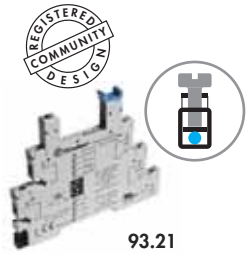
93.52

Zulassungen
(Details auf Anfrage):

Komponenten - Opto-Koppler (SSR) - 14 mm breit

Koppel-Relais mit Schraubklemme			
Code	**Betriebsspannung**	**Relais-Typ**	**Fassungs-Typ**
38.31.0.024.xxxx	24 V AC/DC	41.81.7.024.xxxx	93.02.0.024
38.31.7.012.xxxx	12 V DC	41.81.7.012.xxxx	93.02.7.024
38.31.7.024.xxxx	24 V DC	41.81.7.024.xxxx	93.02.7.024
Koppel-Relais mit Zugfederklemme			
Code	**Betriebsspannung**	**Relais-Typ**	**Fassungs-Typ**
38.41.0.024.xxxx	24 V AC/DC	41.81.7.024.xxxx	93.52.0.024
38.41.7.012.xxxx	12 V DC	41.81.7.012.xxxx	93.52.7.024
38.41.7.024.xxxx	24 V DC	41.81.7.024.xxxx	93.52.7.024

Beispiel: .xxxx
.9024 Ausgang: 5 A - 24 V DC
.8240 Ausgang: 3 A - 240 V AC, Nullpunktschalter



93.21

Zulassungen
(Details auf Anfrage):

Komponenten - Zeit-Relais (EMR / SSR) - 6,2 mm breit

Koppel-Relais mit Schraubklemme			
Code	**Betriebsspannung**	**Relais-Typ**	**Fassungs-Typ**
38.21.0.012.0060	12 V AC/DC	34.51.7.012.0010	93.21.0.024
38.21.0.024.0060	24 V AC/DC	34.51.7.024.0010	93.21.0.024
38.21.0.024.xxxx	24 V AC/DC	34.81.7.024.xxxx	93.21.0.024

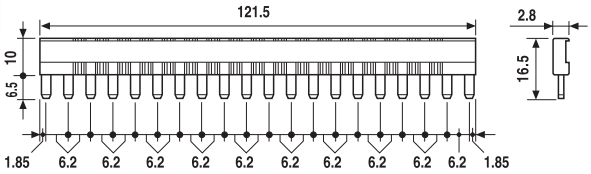
Beispiel: .xxxx
. 9024 Ausgang: 2 A - 24 V DC
. 8240 Ausgang: 2 A - 240 V AC, Nullpunktschalter

Zubehör

093.20

Zulassungen
(Details auf Anfrage):

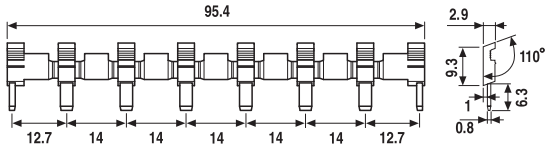
Kammbrücke zum Verbinden von bis zu drei Klemmen gleichen Potentials bei bis zu 20 Fassungen, Zeit- oder Koppel-Relais mit einer Baubreite von 6,2 mm	093.20 (blau)	093.20.0 (schwarz)	093.20.1 (rot)
Bemessungswerte	36 A - 250 V		



093.08

Zulassungen
(Details auf Anfrage):

Kammbrücke zum Verbinden von bis zu drei Klemmen gleichen Potentials bei bis zu 8 Fassungen oder Koppel-Relais mit einer Baubreite von 14 mm	093.08 (blau)	093.08.0 (schwarz)	093.08.1 (rot)
Bemessungswerte	10 A - 250 V		



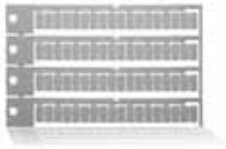
093.01

Isolierplatte, grau, bei Bedarf anzuordnen zwischen den Fassungen Typ 93.21, 93.01, 93.02, 93.51, 93.52	093.01

- Zur Trennung von Kammbrücken unterschiedlicher Potentiale
- Zur optischen Trennung von Gruppen
- Zur Isolation gegen metallische Tragschienen-Endhalter und andere Bauelemente

093.64

Bezeichnungsschild-Matte für Koppel-Relais 6,2 mm breit, zum Bedrucken mit Plotter, Kunststoff, 64 Schildern, (6x10) mm für Typ 38.21/51/61/81/91	093.64



060.72

Bezeichnungsschild-Matte für Koppel-Relais 14 mm breit, zum Bedrucken mit Plotter, Kunststoff, 72 Schildern, (6x12) mm für typ 38.01/11/31/41/52/62	060.72

6.5 Thermokon components data sheets

PR25.100.11NTC20k/PT1000 passive contact temperature sensor

AF25/AF50/PR25/VFG54

Anlegetemperaturfühler
Contact Temperature Sensor

thermokon Sensortechnik GmbH

DE - Datenblatt

Technische Änderungen vorbehalten
Stand 22.07.2008

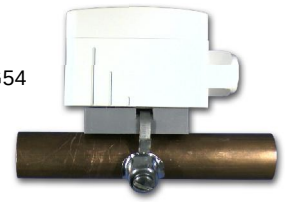
EN - Data Sheet

Subject to technical alteration
Issue date 2008/07/22

AF25/AF50

PR25

VFG54



Anwendung

Zur Temperaturmessung an Rohren und gewölbten Flächen.

Ausgelegt zur Aufschaltung an Regler- und Anzeigesysteme.

Anlegefühler VFG54 direkt mit Anschlussgehäuse und Klemme.

Typenübersicht

AF25	Sensor	passiv, mit Sensor nach Kundenwunsch*
	TRA	aktiv, 4...20mA
	TRV	aktiv, 0...10V
AF50	Sensor	passiv, mit Sensor nach Kundenwunsch*
	TRA	aktiv, 4...20mA
	TRV	aktiv, 0...10V
PR25	Sensor	passiv, mit Sensor nach Kundenwunsch*
	TRA	aktiv, 4...20mA
	TRV	aktiv, 0...10V
VFG54	Sensor	passiv, mit Sensor nach Kundenwunsch*
	TRA	aktiv, 4...20mA
	TRV	aktiv, 0...10V
	LON	aktiv, FTT

*z.B.: PT100/PT1000/NI1000/NI1000TK5000/LM235Z/NTC.../PTC... und andere Sensoren auf Anfrage.

Application

For measuring temperature on pipes and arched surfaces.

Designed for locking on to control and display systems.

Contact temperature sensor VFG54 includes connection housing and clamp.

Types Available

AF25	Sensor	passive, with sensor acc. to customer´s need*
	TRA	active, 4...20mA
	TRV	active, 0...10V
AF50	Sensor	passive, with sensor acc. to customer´s need*
	TRA	active, 4...20mA
	TRV	active, 0...10V
PR25	Sensor	passive, with sensor acc. to customer´s need*
	TRA	active, 4...20mA
	TRV	active, 0...10V
VFG54	Sensor	passive, with sensor acc. to customer´s need*
	TRA	active, 4...20mA
	TRV	active, 0...10V
	LON	active, FTT

*eg: PT100/PT1000/NI1000/NI1000TK5000/LM235Z/NTC.../PTC... and other sensors on request.

Normen und Standards

CE-Konformität:	2004/108/EG Elektromagnetische Verträglichkeit
Produktsicherheit:	2001/95/EG Produktsicherheit
EMV:	EN 60730-1: 2002
Produktsicherheit:	EN 60730-1: 2002

Norms and Standards

CE-Conformity:	2004/108/EG Electromagnetic compatibility
Product safety:	2001/95/EG Product safety
EMC:	EN 60730-1: 2002
Product safety:	EN 60730-1: 2002

Technische Daten

Allgemein:

Sensorleitung L:	1m/2m/4m/6m, andere Längen auf Anfrage, Kabelenden standardmäßig mit Aderend-Hülsen
Leiterquerschnitt:	AF25: 0,25mm² AF50: 0,50mm² bei PVC/HT 0,25mm² bei Silikon PR25: 0,25mm²
Einsatztemperatur:	PVC/HT: -35...100°C Silikon: -50...180°C
Fühlerhülse:	AF25: Messing, max. Einsatztemp. 150°C AF50: Messing, max. Einsatztemperatur 150°C PR25: Aluminium, max. Einsatztemperatur 180°C VFG54: Messing
Gehäuse:	VFG54: Polyamid, Farbe weiß
Schutzart:	IP65 gemäß EN60529

Typ Sensor:

Messelement:	Sensor nach Kundenwunsch,
Messbereich:	Abhängig v. verwendeten Sensor,
Genauigkeit:	Abhängig v. verwendeten Sensor und der Länge der Sensorleitung
Messstrom:	Typ. <1mA
Anschluss:	2polig (Zweileiter) 3polig (Dreileiter) 4polig (Vierleiter) VFG54: Schraubklemme max 1,5mm²
Kabeleinführung:	VFG54: Einfach M16 für Kabel mit max. D=8mm
Umgebungstemperatur Gehäuse:	-35...+90°C
Gewicht:	AF25: 30g; AF50: 50g; PR25: 35g; VFG54: 80g

Typ TRA:

Versorgungsspannung:	15-24V= (±10%)
Leistungsaufnahme:	max. 20mA/24V=
Messbereich:	am Messumformer einstellbar TRA1: -50°C...+50°C TRA2: -10°C...+120°C TRA3: 0°C...+50°C TRA4: 0°C...+160°C TRA5 0°C...+250°C TRA8 -15°C...+35°C
Ausgang:	4...20mA, max. Bürde 500 /24V
Genauigkeit@21°C:	Typ. ±1% v. Messbereich bei max. 2m Sensorleitung
Anschlussklemmen:	2polig (Zweileiter) Schraubklemme max 1,5mm²
Kabeleinführung:	Einfach M20 für Kabel mit max. D=8mm
Umgebungstemperatur Gehäuse:	-35...70°C
Transport:	-35...70°C / max. 85%rF, nicht kond..
Gewicht:	AF25: 120g; AF50: 140g; PR25: 125g; VFG54: 120g

Technical Data

General:

Sensor wire L:	1m/2m/4m/6m, other lengths on request Cable ends with conductor sleeves as standard
Conductor cross-section:	AF25: 0,25mm² AF50: 0,50mm² with PVC/HT AF50: 0,25mm² with Silicone PR25: 0,25mm²
Operating temperature:	PVC/HT: 100°C Silicone: 180°C
Sensor bushing:	AF25: Brass, max. operating temp. 150°C AF50: Brass, max. operating temp. 150°C PR25: Aluminium, max. Operating temp. 180°C VFG54: Brass
Enclosure:	VFG54: Polyamide, Colour white
Protection:	IP65 according to EN60529

Type Sensor:

Measuring elements:	Sensor according to customer's request,
Measuring range:	Depending on sensor used,
Accuracy :	Depending on sensor used and wire length
Measuring current:	Typ. <1mA
Connection:	2pole (two-wire) 3pole (three-wire) 4pole (four-wire) VFG54: Terminal screw max 1,5mm²
Cable entry:	VFG54: Single entry,M16 for cable max. D=8mm
Ambient temperature enclosure:	-35...+90°C
Weight:	AF25: 30g; AF50: 50g; PR25: 35g; VFG54: 80g

Type TRA:

Power supply:	15-24V= (±10%)
Power consumption:	max. 20mA/24V=
Measuring range:	adjustable at the transducer TRA1: -50°C...+50°C TRA2: -10°C...+120°C TRA3: 0°C...+50°C TRA4: 0°C...+160°C TRA5 0°C...+250°C TRA8 -15°C...+35°C
Output:	4...20mA, max load 500 /24V
Accurancy@21°C:	Typ. +/-1% of measuring range with cable of max. 2m
Clamps:	2pole (two-wire) Terminal screw max 1,5mm²
Cable entry:	Single entry,M20 for cable max. D=8mm
Ambient temperature enclosure:	-35...+70°C
Transport:	-35...70°C / max. 85%rH, no condensation
Weight:	AF25: 120g; AF50: 140g; PR25: 125g; VFG54: 120g VFG54:120g

Typ TRV:

Versorgungsspannung:	15-24V= (±10%) oder24V~ (±10%)
Leistungsaufnahme:	typ. 0,42W / 0,84VA
Messbereich:	am Messumformer einstellbar TRV1: -50°C...+50°C TRV2: -10°C...+120°C TRV3: 0°C...+50°C TRV4: 0°C...+160°C TRV5 0°C...+250°C TRV8 -15°C...+35°C
Ausgang:	0...10V, min. Belastung 5k
Genauigkeit@21°C:	Typ. ±1% v. Messbereich bei max. 2m Sensorleitung
Anschlussklemmen:	3polig (Dreileiter) Schraubklemme max 1,5mm²
Kabeleinführung:	Einfach, M20 für Leiter mit max. D=8mm
Umgebungstemperatur	
Gehäuse:	-35...70°C
Transport:	-35...70°C / max. 85%rF, nicht kond..
Gewicht:	AF25: 120g; AF50: 140g; PR25: 125g; VFG54: 120g

Typ LON:

Versorgungsspannung:	15-24V= (±10%) oder 24V~ (±10%)
Leistungsaufnahme:	typ. 0,5W / 1,7VA
Messbereich:	-45°C...+130°C
Ausgang:	LON FTT (free topology)
Genauigkeit@21°C:	Typ. ±0,5K
Klemmen:	4polig (Vierleiter) Schraubklemme max 1,5mm²
Kabeleinführung:	Einfach, M20 für Kabel mit max. D=8mm Doppelt, M20 für 2 Kabel mit max. D=7mm
Umgebungstemperatur	
Gehäuse:	-35...70°C
Transport:	-35...70°C / max. 85%rF, nicht kond..
Gewicht:	ca. 130g

Sicherheitshinweis

Achtung

Einbau und Montage elektrischer Geräte dürfen nur durch eine Elektrofachkraft erfolgen.
Die Module dürfen nicht in Verbindung mit Geräten benutzt werden, die direkt oder indirekt menschlichen, gesundheits- oder lebenssichernden Zwecken dienen oder durch deren Betrieb Gefahren für Menschen, Tiere oder Sachwerte entstehen können.

Montagehinweis

Die Montage erfolgt mittels Spannband. Zur besseren Wärmeübertragung zwischen Fühler und Messmedium, Wärmeleitpaste verwenden. Um Eindringen von Kondensat zu vermeiden, Fühler nach Möglichkeit auf der Rohroberseite montieren.

Elektrischer Anschluss

Die Geräte sind für den Betrieb an Schutzkleinspannung (SELV) ausgelegt. Beim elektrischen Anschluss der Geräte gelten die techn. Daten der Geräte. Speziell bei passiven Fühlern (z.B. Pt100 etc.) in Zweileiter-Ausführung ist der Leitungswiderstand der Zuleitung zu berücksichtigen. Gegebenenfalls muss dieser in der Folgeelektronik korrigiert werden. Infolge der Eigenerwärmung beeinflusst der Messstrom die Genauigkeit der Messung. Daher sollte dieser nicht größer 1mA liegen.
Bei Fühlern mit Messumformer sollte dieser in der Regel in der Messbereichsmitte betrieben werden, da an den Messbereichsendpunkten erhöhte Abweichungen auftreten können. Die Umgebungstemperatur der Messumformerelektronik sollte konstant gehalten werden.
Die Messumformer müssen bei einer konstanten Betriebsspannung (±0,2V) betrieben werden. Strom-/Spannungssitzen beim Ein-/Ausschalten der Versorgungsspannung müssen bauseits vermieden werden.
Die Messbereichsumstellung erfolgt durch Umstecken der Kurzschlußbrücken (sieheAnschlußplan).
Der Ausgangswert im neuen Messbereichliegt dann nach ca. 2s vor.

Zubehör optional

(Sb2“)	Spannband für 2“ Rohre und Spritze Wärmeleitpaste ca. 0,5cm³
(Sb900)	Spannband L=900mm und Spritze Wärmeleitpaste ca. 0,5cm³

Type TRV:

Power supply:	15-24V= (±10%) or24V~ (±10%)
Power consumption:	typ. 0,42W / 0,84VA
Measuring range:	adjustable at the transducer TRA1: -50°C...+50°C TRA2: -10°C...+120°C TRA3: 0°C...+50°C TRA4: 0°C...+160°C TRA5 0°C...+250°C TRA8 -15°C...+35°C
Output:	0...10V, min. load 5k
Accuracy@21°C:	Typ. +/-1% of measuring range with cable of max. 2m
Clamps:	3pole (three-wire) Terminal screw max 1,5mm²
Cable entry:	Single entry,M20 for cable max. D=8mm
Ambient temperature	
enclosure:	-35...+70°C
Transport:	-35...70°C / max. 85%rH, no condensation
Weight:	AF25: 120g; AF50: 140g; PR25: 125g;

Type LON:

Power supply:	15-24V= (±10%) or 24V~ (±10%)
Power consumption:	typ. 0,5W / 1,7VA
Measuring range:	-45...+130°C
Output:	LON FTT (free topology)
Accuracy@21°C:	Typ. ±0,5K
Clamps:	4pole (four-wire) Terminal screw max 1,5mm²
Cable entry:	Single entry, M20 for cable max. D=8mm Double entry, M20 for 2 cable max.
D=7mm	
Ambient temperature	
enclosure:	-35...70°C
Transport:	-35...70°C / max 85%rH, no condensation

Security Advice

Caution

The installation and assembly of electrical equipment may only be performed by a skilled electrician.
The modules must not be used in any relation with equipment that supports, directly or indirectly, human health or life or with applications that can result in danger for people, animals or real value.

Mounting Advice

Fixing by tightening strap. Use contact fluid for better heat transfer between sensor and measuring medium. To avoid permeation of condensate, mount sensor on top of the tube, if possible.

Electrical Connection

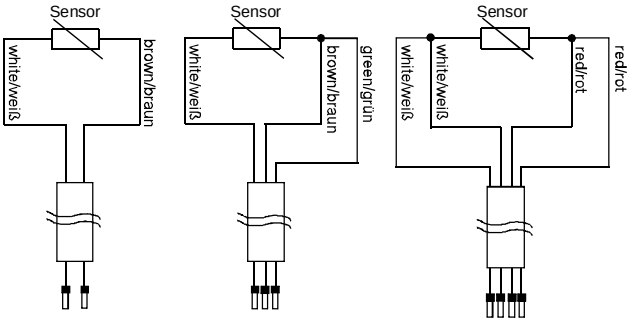
The devices are constructed for the operation of protective low voltage (SELV). For the electrical connection, the technical data of the corresponding device are valid. Specially with regard to passive sensors (e.g. PT100 etc.) in 2-wire conductor versions, the wire resistance of the supply wire has to be considered. Probably, the same has to be compensated by the following electronics. Due to the self-heating, the wire current affects the accuracy of the measurement. Thus, the same should not exceed 1mA.
Sensing devices with transducers should in principle be operated in the middle of the measuring range to avoid deviations at the measuring end points. The ambient temperature of the transducer electronics should be kept constant.
The transducers must be operated at a constant supply voltage (±0,2V). When switching the supply voltage on/off, power surges must be avoided on site.
The adjustment of the measuring ranges is made by changing the bonding jumpers (see terminal connection diagram). The output value in the new measuring range is available after approx. 2 seconds.

Optional Accessories

(SB2“)	Tightening strap for 2“ pipes and syringe with contact fluid approx. 0,5cm³
(SB900)	Tightening strap L=900mm and syringe with contact fluid approx. 0,5cm³

AF25/AF50/PR25

Sensor



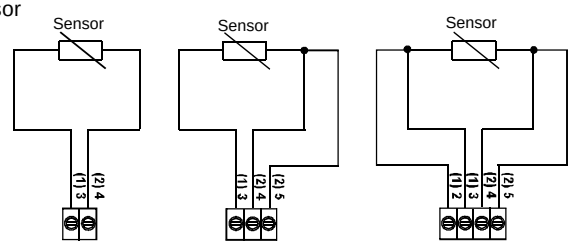
2-Leiter
2-*wire*

3-Leiter
3-*wire*

4-Leiter
4-wire

VFG54

Sensor



2-Leiter
2-wire

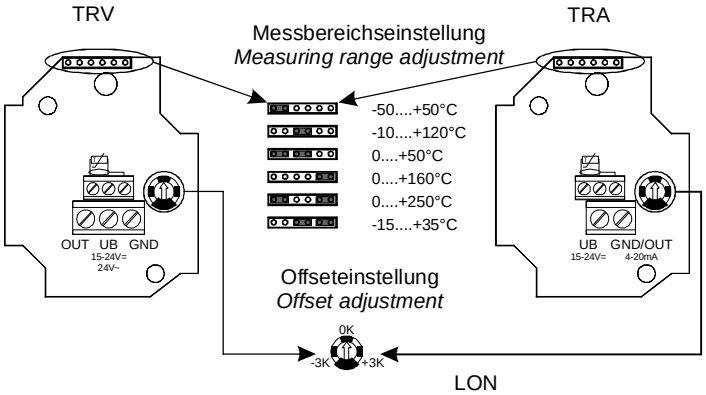
3-Leiter
3-wire

4-Leiter
4-wire

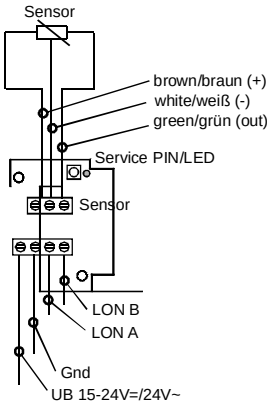
Achtung

Bei eletronischen Sensoren wie z.B. **AD592, SMT160, LM235, DS1820** gilt: braun= plus (+), weiß= minus (-) , grün=out

AF25/AF50/PR25AGS54



LON

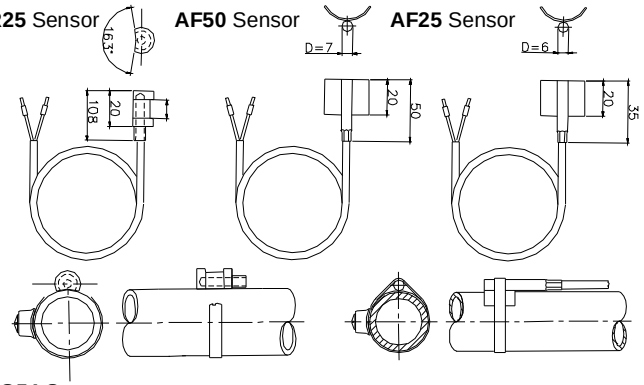


Caution

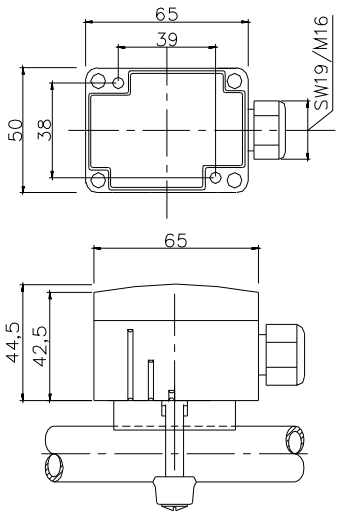
With electronic sensors such as **AD592, SMT160, LM235, DS1820** the following applies: brown= plus (+), white= minus (-) , green=out

Abmessungen (mm)

PR25 Sensor **AF50** Sensor **AF25** Sensor

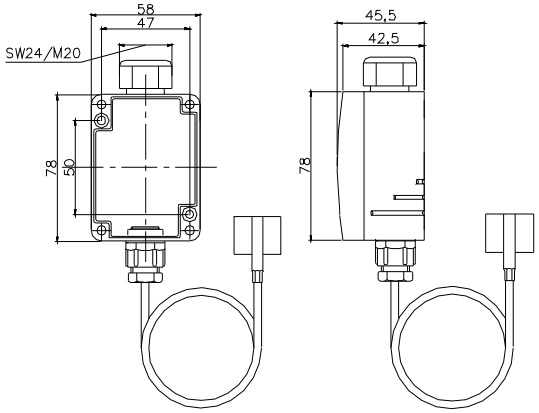


VFG54 Sensor

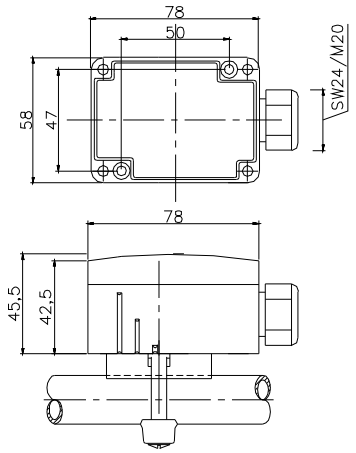


Dimensions (mm)

AF25/AF50/PR25 TRA/TRV/LON



VFG54 TRA/TRV/LON



AKF.100.62.07PT1000 duct temperature sensor

AKF10 / KFK01

Kanal-/Tauchtemperaturfühler
Duct-/Immersion temperature sensors

thermokon
Sensortechnik GmbH

DE - Datenblatt

Technische Änderungen vorbehalten
Stand 06.10.2009

EN - Data Sheet

Subject to technical alteration
Issue date 2009/10/06

AKF10

KFK01

Anwendung

Kanal-/Tauchfühler zur Temperaturmessung in gasförmigen Medien von Heizungs-, Lüftungs- und Klimaanlagen (z.B. in Zuluft-/Abluftkanälen).

Ausgelegt zur Aufschaltung an Regler- und Anzeigesysteme.

In Verbindung mit einer Tauchhülse auch zur Messung in flüssigen Medien (z.B. Rohrleitungssystemen) geeignet.

Typenübersicht

AKF10	Sensor	passiv, mit Sensor nach Kundenwunsch*
Ø= 7mm	TRA	aktiv, 4...20mA
	TRV	aktiv, 0...10V
	LON	aktiv, FTT
AKF10	Sensor	passiv, mit Sensor nach Kundenwunsch*
Ø= 4mm	TRA	aktiv, 4...20mA
	TRV	aktiv, 0...10V
KFK01	Sensor	passiv, mit Sensor nach Kundenwunsch*
Ø= 7mm		
KFK01	Sensor	passiv, mit Sensor nach Kundenwunsch*
Ø= 4mm		

*z.B.: PT100/PT1000/NI1000/NI1000TK5000/LM235Z/NTC.../PTC...und andere Sensoren auf Anfrage.

Application

Duct-/Immersion temperature sensor for measuring temperature in gaseous media of heating, cooling and air-conditioning systems (e.g. fresh air / exhaust air ducts).

Designed for locking on to control and display systems.

In conjunction with an immersion pocket also suitable for temperature measurment in liquid fluids (e.g. pipeline systems).

Types Available

AKF10	Sensor	passive, with sensor acc. to customer´s need*
Ø= 7mm	TRA	active, 4...20mA
	TRV	active, 0...10V
	LON	active, FTT
AKF10	Sensor	passive, with sensor acc. to customer´s need*
Ø= 4mm	TRA	active, 4...20mA
	TRV	active, 0...10V
KFK01	Sensor	passive, with sensor acc. to customer´s need*
Ø= 7mm		
KFK01	Sensor	passive, with sensor acc. to customer´s need*
Ø= 4mm		

* eg: PT100/PT1000/NI1000/NI1000TK5000/LM235Z/NTC.../PTC... and other sensors on request.

Normen und Standards

CE-Konformität:	2004/108/EG Elektromagnetische Verträglichkeit
Produktsicherheit:	2001/95/EG Produktsicherheit
EMV:	EN 607301:2002
Produktsicherheit:	EN 607301:2002

Norms and Standards

CE-Conformity:	2004/108/EG Electromagnetic compatibility
Product safety:	2001/95/EG Product safety
EMC:	EN 607301:2002
Product safety:	EN 607301:2002

Technische Daten

Allgemein:

Einbaulänge L:	AKF10/KFK01 Ø= 7mm: 62mm/135mm/192mm/240mm/320mm/ 392mm/465mm AKF10/KFK01 Ø= 4mm: 40mm/90mm/140mm/190mm
Einsatztemperatur Fühlerhülse:	Standard: -50...160°C 260°C Ausführung: -80...260°C
Fühlerhülse:	Edelstahl Mat. 1.4571
Anschlusskopf:	AKF10: Polyamid, Farbe weiß, KFK01: Form J, Material Alu Druckguss
Schutzart:	IP65 gemäß EN60529

Typ Sensor:

Messelement:	Sensor nach Kundenwunsch,
Messbereich :	Abhängig v. verwendeten Sensor,
Genauigkeit:	Abhängig v. verwendeten Sensor
Messstrom:	Typ. <1mA
Anschlußklemmen:	2polig (Zweileiter) 3polig (Dreileiter) 4polig (Vierleiter) Schraubklemme max 1,5mm²
Kabeleinführung:	AKF10: einfach, M16 für Kabel mit max. D=8mm KFK01: M16
Umgebungstemperatur Anschlusskopf:	AKF10: -35...90°C KFK01: -25...90°C
Gewicht:	AKF10: ca. 100g KFK01: ca. 140g

Typ TRA (nur AKF10):

Versorgungsspannung:	15-24V= (±10%)
Leistungsaufnahme:	max. 20mA/24V=
Messbereich:	am Messumformer einstellbar TRA1: -50°C...+50°C TRA2: -10°C...+120°C TRA3: 0°C...+50°C TRA4: 0°C...+160°C TRA5: 0°C...+250°C TRA8: -15°C...+35°C
Ausgang:	4...20mA, max. Bürde 500Ω/24V=
Genauigkeit@21°C:	Typ. ±1% v. Messbereich
Anschlußklemme:	2polig (Zweileiter) Schraubklemme max. 1,5mm²
Kabeleinführung:	Einfach, M20 für Kabel mit max. D=8mm
Umgebungstemperatur Anschlusskopf:	-35...70°C
Transport:	-35...70°C / max. 85%rF, nicht kond..
Gewicht:	ca. 115g

Typ TRV (nur AKF10):

Versorgungsspannung:	15-24V= (±10%) oder 24V~ (±10%)
Leistungsaufnahme:	typ. 0,35W / 0,82VA
Messbereich:	am Messumformer einstellbar TRV1: -50°C...+50°C TRV2: -10°C...+120°C TRV3: 0°C...+50°C TRV4: 0°C...+160°C TRV5: 0°C...+250°C TRV8: -15°C...+35°C
Ausgang:	0...10V, min. Belastung 5kΩ
Genauigkeit@21°C:	Typ. ±1% vom Messbereich
Anschlußklemme:	3polig (Dreileiter) Schraubklemme max. 1,5mm²
Kabeleinführung:	Einfach, M20 für Kable mit max. D=8mm
Umgebungstemperatur Anschlusskopf:	-35...70°C
Transport:	-35...70°C / max. 85%rF, nicht kond..
Gewicht:	ca. 115g

Technical Data

General:

Mounting lengths L:	AKF10/KFK01 Ø= 7mm: 62mm/135mm/192mm/240mm/320mm/ 392mm/465mm AKF10/KFK01 Ø= 4mm: 40mm/90mm/140mm/190mm
Operating temperature sensor bushing:	Standard: -50...160°C 260°C Version: -80...260°C
Sensor bushing:	Stainless steel mat. 1.4571
Connection head:	AKF10: Polyamide, Colour white, KFK01: Form J, Material Aluminium
Protection:	IP65 according to EN60529

Type Sensor:

Measuring element::	Sensor according to customer's request,
Measuring range :	Depending on sensor used,
Accuracy:	Depending on sensor used
Measuring current:	Typ. <1mA
Clamps:	2pole (two-wire) 3pole (three-wire) 4pole (four-wire) Terminal screw max 1,5mm²
Cable entry:	AKF10: Single entry, M16 for cable max. D=8mm KFK01: M16
Ambient temperature connection head:	AKF10: -35...90°C KFK01: -25...90°C
Weight:	AKF10: approx. 100g KFK01: approx. 140g

Type TRA (only AKF10):

Power supply:	15-24V=(±10%)
Power consumption:	max. 20mA/24V=
Measuring range:	adjustable at the transducer TRA1: -50°C...+50°C TRA2: -10°C...+120°C TRA3: 0°C...+50°C TRA4: 0°C...+160°C TRA5: 0°C...+250°C TRA8: -15°C...+35°C
Output:	4...20mA, max. load 500Ω/24V=
Accuracy@21°C:	Typ. ±1% of measuring range
Clamps:	2pole (two-wire) Terminal screw max. 1,5mm²
Cable entry:	Single entry, M20 for cable max. D=8mm
Ambient temperature connection head:	-35...70°C
Transport:	-35...70°C / max 85%rH, no condensation
Weight:	approx. 115g

Type TRV (only AKF10):

Power supply:	15-24V=(±10%) or 24V~ (±10%)
Power consumption:	typ. 0,35W / 0,82VA
Measuring range:	adjustable at the transducer TRV1: -50°C...+50°C TRV2: -10°C...+120°C TRV3: 0°C...+50°C TRV4: 0°C...+160°C TRV5: 0°C...+250°C TRV8: -15°C...+35°C
Output:	0...10V, min. load 5kΩ
Accuracy@21°C:	Typ. ±1% of measuring range
Clamps:	3pole (three-wire) Terminal screw max. 1,5mm²
Cable entry:	Single entry, M20 for cable max. D=8mm
Ambient temperature: connection head:	-35...70°C
Transport:	-35...70°C / max 85%rH, no condensation
Weight:	approx. 115g

Typ LON (nur AKF10 Ø= 7mm):

Versorgungsspannung:	15-24V= (±10%) oder 24V~ (±10%)
Leistungsaufnahme:	typ. 0,5W / 1,7VA
Messbereich:	-45°C...+130°C
Ausgang:	LON FTT (free topology)
Genauigkeit@21°C:	Typ. ±0,5K
Klemmen:	4polig (Vierleiter) Schraubklemme max 1,5mm²
Kabeleinführung:	Einfach, M20 für Kabel mit max. D=8mm Doppelt, M20 für 2 Kabel mit max. D=7mm
Umgebungstemperatur Anschlusskopf:	-35...70°C
Transport:	-35...70°C / max. 85%rF, nicht kond..
Gewicht:	ca. 160g

Achtung

Sicherheitshinweis

Einbau und Montage elektrischer Geräte dürfen nur durch eine Elektrofachkraft erfolgen.

Die Module dürfen nicht in Verbindung mit Geräten benutzt werden, die direkt oder indirekt menschlichen, gesundheits- oder lebenssichernden Zwecken dienen oder durch deren Betrieb Gefahren für Menschen, Tiere oder Sachwerte entstehen können.

Montagehinweise

Das Modell AKF10 kann wahlweise mittels Montageflansch oder Schrauben direkt am Lüftungskanal befestigt werden.

Beim Modell KFK01 ist eine Montage nur mittels Flansch möglich.

Bei möglicher Kondensatbildung im Fühlerrohr bzw. Tauchhülse unbedingt die Hülse so einbauen, dass entstehendes Kondensat ablaufen kann.

Bitte beachten Sie auch die allgemeinen Hinweise in unserem INFOBLATT THK.

Elektrischer Anschluss

Die Geräte sind für den Betrieb an Schutzkleinspannung (SELV) ausgelegt. Beim elektrischen Anschluss der Geräte gelten die techn. Daten der Geräte.

Speziell bei passiven Fühler (z.B. PT100 etc.) in Zweileiter-Ausführung ist der Leitungswiderstand der Zuleitung zu berücksichtigen. Gegebenenfalls muss dieser in der Folgeelektronik korrigiert werden.

Infolge der Eigenerwärmung beeinflusst der Messstrom die Genauigkeit der Messung. Daher sollte dieser nicht größer 1mA liegen.

Bei Fühlern mit Messumformer sollte dieser in der Regel in der Messbereichsmitte betrieben werden, da an den Messbereichsendpunkten erhöhte Abweichungen auftreten können. Die Umgebungstemperatur der Messumformerelektronik sollte konstant gehalten werden.
Die Messumformer müssen bei einer konstanten Versorgungsspannung betrieben werden.
Die Messbereichsumstellung erfolgt durch Umstecken der Kurzschluß-brücken (siehe Anschlußplan).
Der Ausgangswert im neuen Messbereich liegt dann nach ca. 2s vor.

Zubehör optional

(THMS)	Tauchhülse für ∅=7mm, Material Messing vernickelt, zulässig bis 16bar
(THVA)	Tauchhülse für ∅=7mm, Material Edelstahl, zulässig bis 40bar
(MF7)	Montageflansch für ∅=7mm
(MF4)	Montageflansch für ∅=4mm
(MF7/TPO)	Montageflansch für ∅=4/6/7mm

Type LON (only AKF10 Ø= 7mm):

Power supply:	15-24V= (±10%) or 24V~ (±10%)
Power consumption:	typ. 0,5W / 1,7VA
Measuring range:	-45...+130°C
Output:	LON FTT (free topology)
Accuracy@21°C:	Typ. ±0,5K
Clamps:	4pole (four-wire) Terminal screw max 1,5mm²
Cable entry:	Single entry, M20 for cable max. D=8mm Double entry, M20 for 2 cable max. D=7mm
Ambient temperature connection head:	-35...70°C
Transport:	-35...70°C / max 85%rH, no condensation
Weight:	approx. 160g

Caution

Security Advice

The installation and assembly of electrical equipment may only be performed by a skilled electrician.

The modules must not be used in any relation with equipment that supports, directly or indirectly, human health or life or with applications that can result in danger for people, animals or real value.

Mounting Advices

The model AKF10 can be mounted on the ventilation duct either by means of a mounting flange or by screws.

For model KFK01, the sensor can only be mounted on the duct by means of a flange.

For risk of condensate permeation in the sensor tube respectively in the immersion pocket, the bushing must be installed in that way, that occurred condensate can run off.

Please also note the general remarks in our INFOBLATT THK.

Electrical Connection

The devices are constructed for the operation of protective low voltage (SELV). For the electrical connection, the technical data of the corresponding device are valid.

Specially with regard to passive sensors (e.g. PT100 etc.) in 2-wire conductor versions, the wire resistance of the supply wire has to be considered. Probably, the same has to be compensated by the following electronics.
Due to the self-heating, the wire current affects the accuracy of the measurement. Thus, the same should not exceed 1mA.

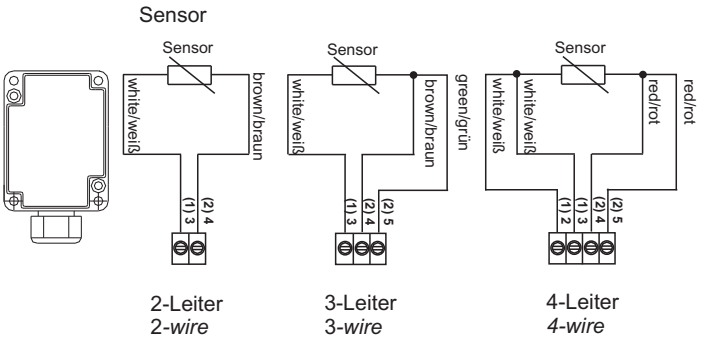
Sensing devices with transducers should in principle be operated in the middle of the measuring range to avoid deviations at the measuring end points. The ambient temperature of the transducer electronics should be kept constant.
The transducers must be operated at a constant supply voltage.
The adjustment of the measuring ranges is made by changing the bonding jumpers (see terminal connection diagram). The output value in the new measuring range is available after approx. 2 seconds.

Optional Accessories

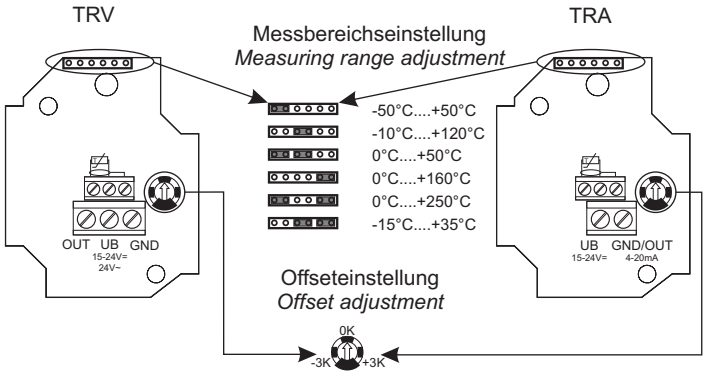
(THMS)	Immersion pocket for ∅=7mm, mat. brass nickel-plated, safe up to 16bar
(THVA)	Immersion pocket für ∅=7mm, mat.stainless steel, safe up to 40bar
(MF7)	Mounting flange for ∅=7mm
(MF4)	Mounting flange for ∅=4mm
(MF7/TPO)	Mounting flange for ∅=4/6/7mm

Anschlussplan (Auswahl)

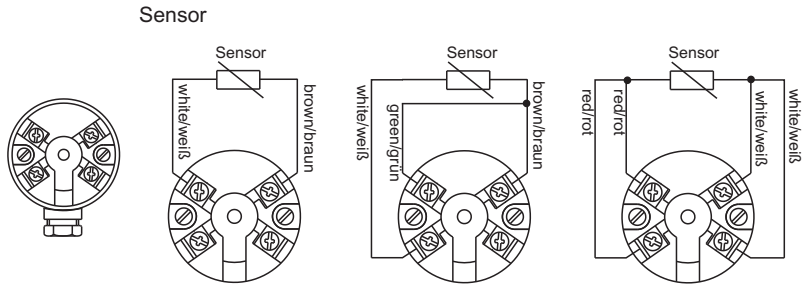
AKF10



Terminal Connection Plan (Selection)



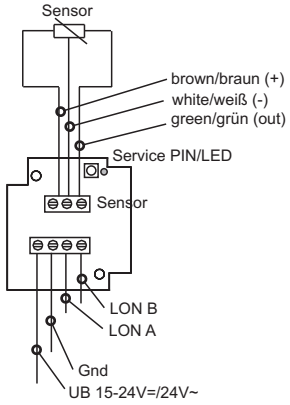
KFK01



Achtung

Bei eletronischen Sensoren wie z.B. **AD592, SMT160, LM235, DS1820** gilt: braun= plus (+), weiß= minus (-) , grün=out

LON

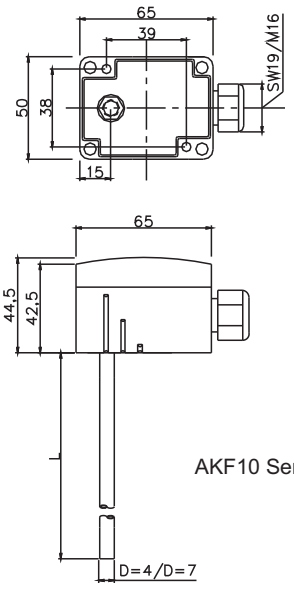


Caution

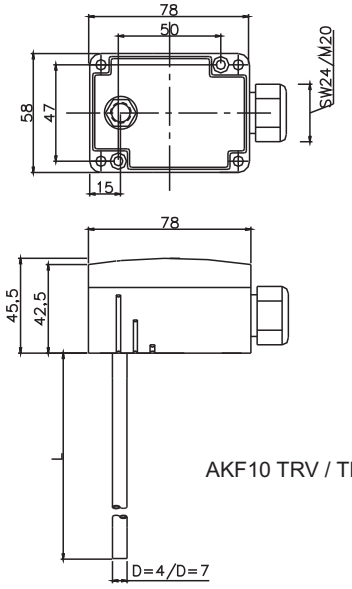
With electronic sensors such as **AD592, SMT160, LM235, DS1820** the following applies: brown= plus (+), white= minus (-) , green=out

Abmessungen (mm)

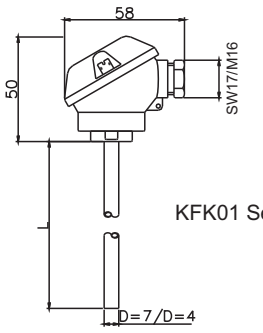
Dimensions (mm)



AKF10 Sensor



AKF10 TRV / TRA / LON

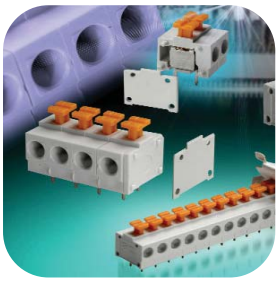


KFK01 Sensor

6.6 Axxatronic components data sheets

AXXATRONIC



catalogue

pcb terminal blocks

interconnection

fuses & fuseholders

batteries

leds

miniature switches

relay bases

interface modules

enclosures

ic & plcc sockets

control products

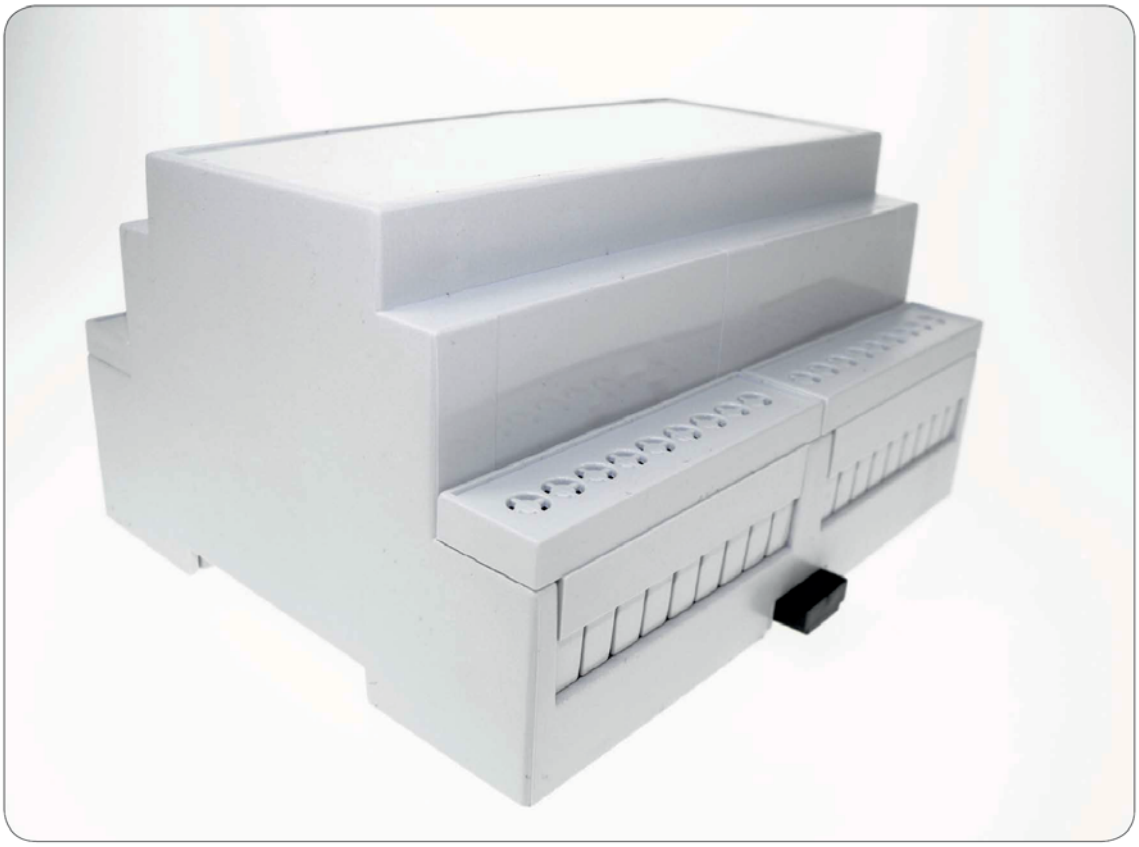
Ansprechpartner für Deutschland:

AXXATRONIC GmbH, Alemannenstrasse 10, 71296 Heimsheim

Telefon: (0 70 33) 46 66 1 - 0, Fax: (0 70 33) 46 66 1 - 23, www.axxatronic.de, info@axxatronic.de

ENCLOSURES

Assembly of CNMB Enclosure



- *Finished Module Box*

- *Various Terminal Guards are available allowing for different capabilities*

- *Terminal Guards also snap fit into place and are inter-changeable*

Ansprechpartner für Deutschland:

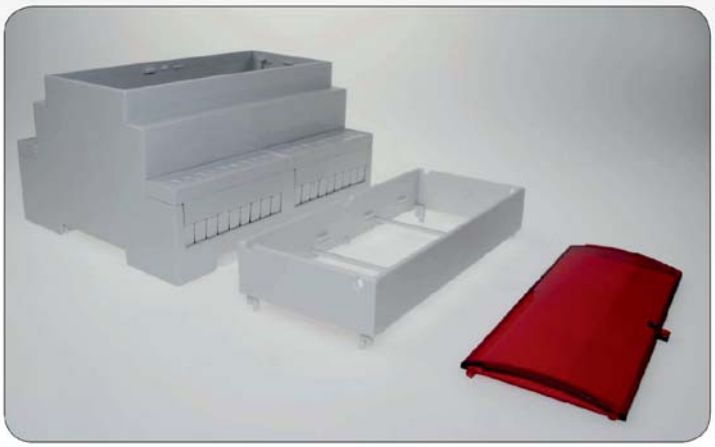
AXXATRONIC GmbH, Alemannenstrasse 10, 71296 Heimsheim

Telefon: (0 70 33) 46 66 1 - 0, Fax: (0 70 33) 46 66 1 - 23, www.axxatronic.de, info@axxatronic.de

FM28614
BS EN ISO
9001:
2000

ENCLOSURES

Assembly of CNMB Enclosure



- *Also available for the CNMB series are the Extended Height Module range*

- *The Height Module snap clicks into place and can house an additional PCB*

- *The curved and hinged lids also are available in grey and transparent*

- *The moveable lid allowing easy access to the housed PCB board*

Ansprechpartner für Deutschland:

AXXATRONIC GmbH, Alemannenstrasse 10, 71296 Heimsheim
Telefon: (0 70 33) 46 66 1 - 0, Fax: (0 70 33) 46 66 1 - 23, www.axxatronic.de, info@axxatronic.de

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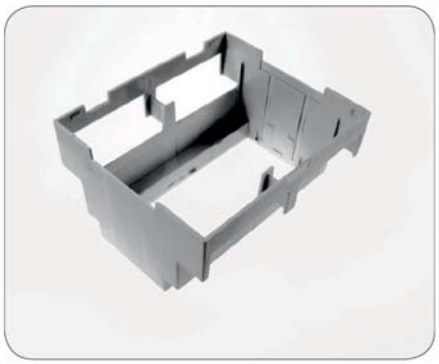
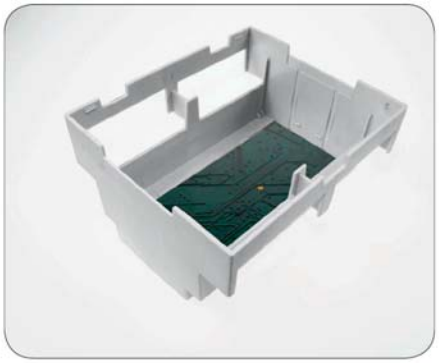
ENCLOSURES

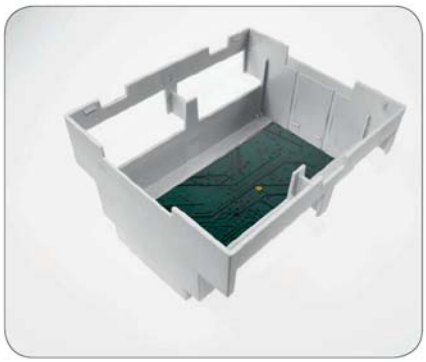
Assembly of CNMB Enclosure



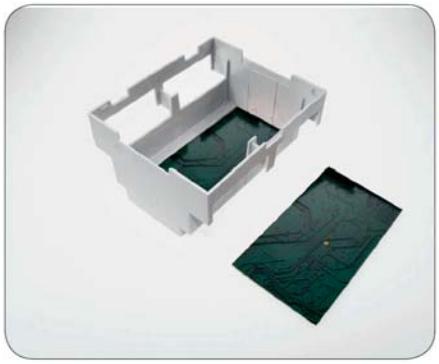
- The Module Box is designed to hold a number of PCB's which snap fit into place

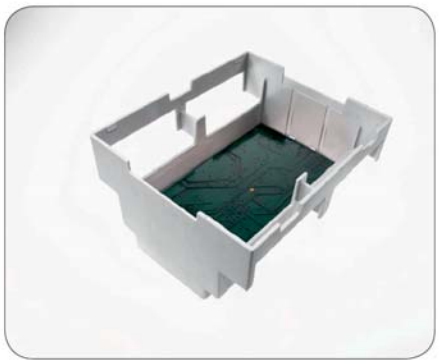


- Each Module Box can hold up to 3 PCB's horizontally and 2/4 vertically

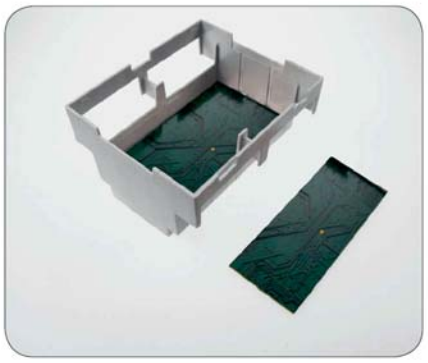


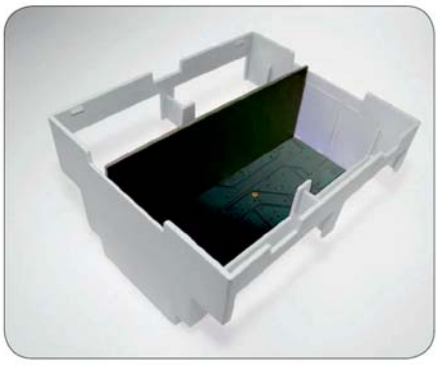
- PCB in top position



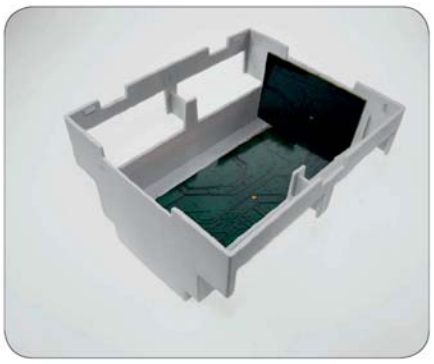


- PCB second position

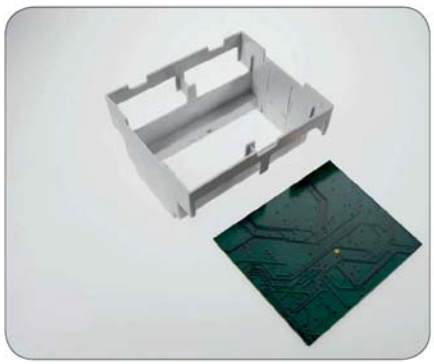




- PCB vertical mount



- PCB vertical mount second option



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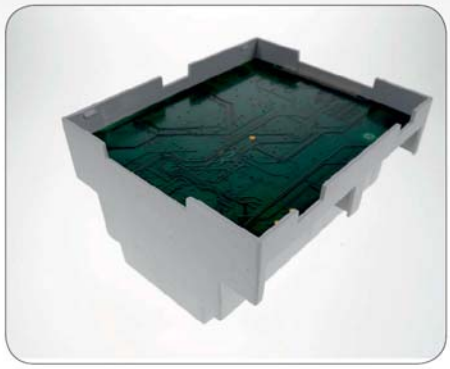
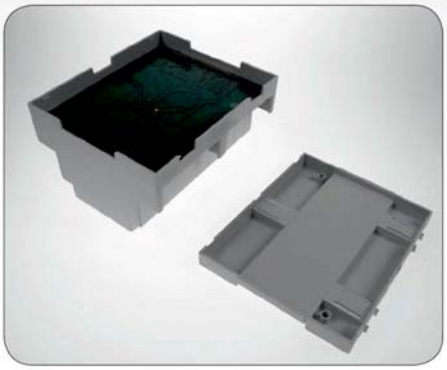
ENCLOSURES

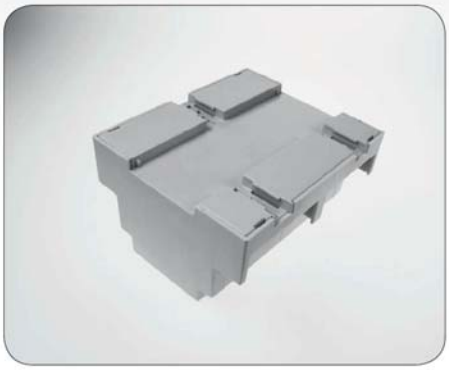
Assembly of CNMB Enclosure



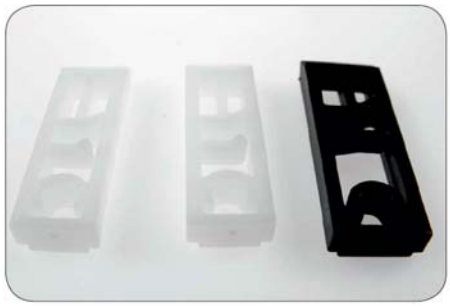
- PCB base position



- Once the required circuitry is in place the base and top can be put on. These also snap fit into place.



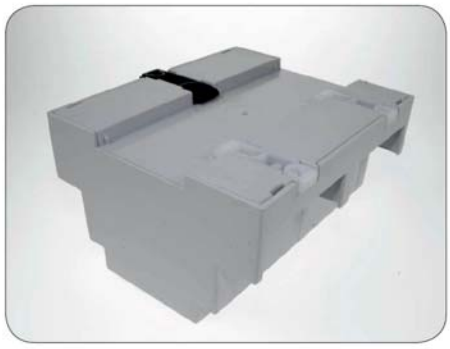
- Base is now connected



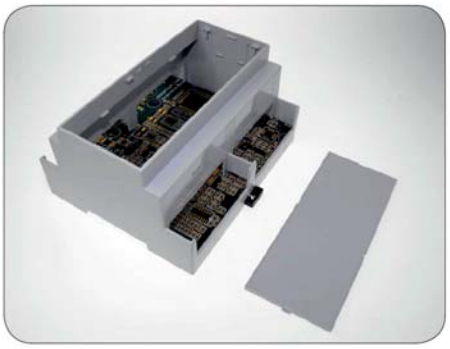
- The Module box kit comes with clips, allowing steady fastening of its base and snap fit connection to Din Rails.

- Each clip slides and clicks into place

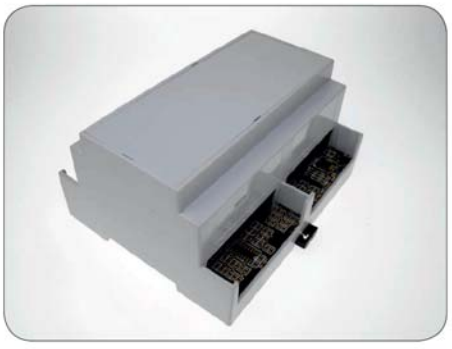
- Push in from the inside toward the outside



- Clips are now connected



- Module Box with top cover. (These are available in grey transparent and red)



- Top cover connected

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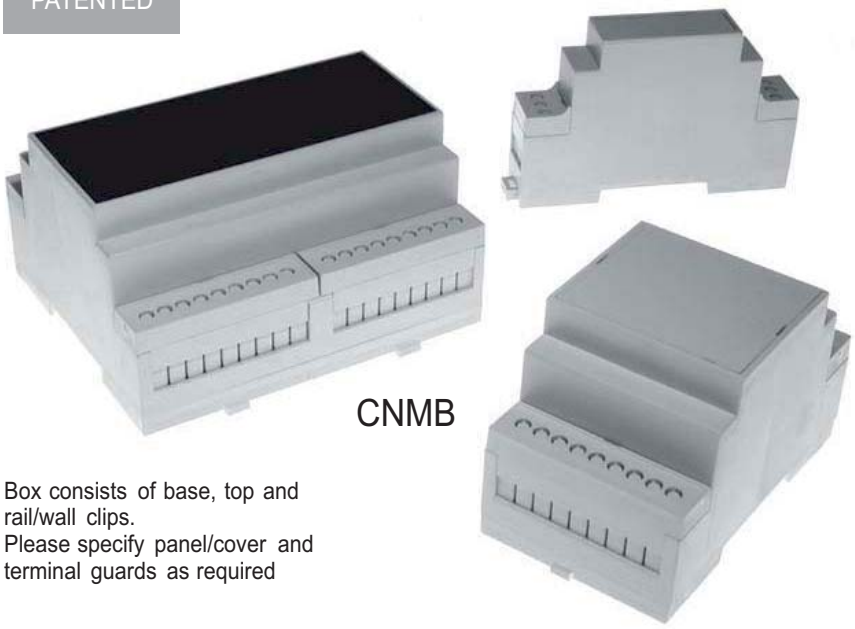
ENCLOSURES

DIN Rail Module Boxes

Features

- Snap fit kit for easy assembly
- Boxes fit 35mm DIN rail or direct surface mount
- Self customised perforated terminal covers as standard
- Snap fit terminal covers for IP20 finger protection
- Can carry up to 3 PCB's horizontally and 2/4 vertically
- Grey, transparent red or clear snap-in covers
- Front panel ideal for screen printing logo's etc
- Moulded in grey UL94-V0 flame retardant PC
- Enclosed base eliminates any need for additional insulation
- Optional adaptor for G rail mounting

PATENTED



CNMB

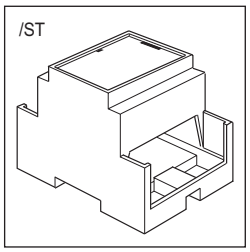
Box consists of base, top and rail/wall clips.
Please specify panel/cover and terminal guards as required

N.B. CNMB/-/2 = terminal access + covers on both sides of box
CNMB/-/1 = terminal access + covers on one side only other side closed

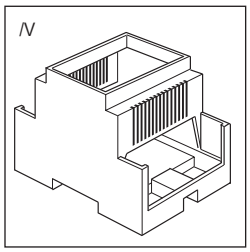
Optional Special Features

- Customised terminal guards
- Alternative black higher rated RTI material
- Other colours including Black, Green and Blue
- EMC shielded metallic coated boxes

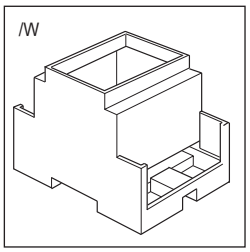
Box options



/ST – is a recessed solid top box, usually used for a membrane keypads or with a clear lid to enclose a label

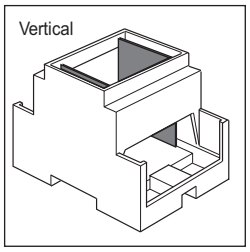


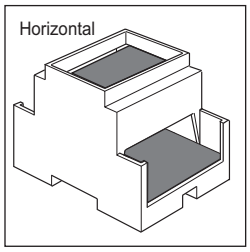
/V – has cooling vents both sides



/W – has extended walls which meet the lower pcb behind the usual positions for the pcb terminals

PCB mounting options





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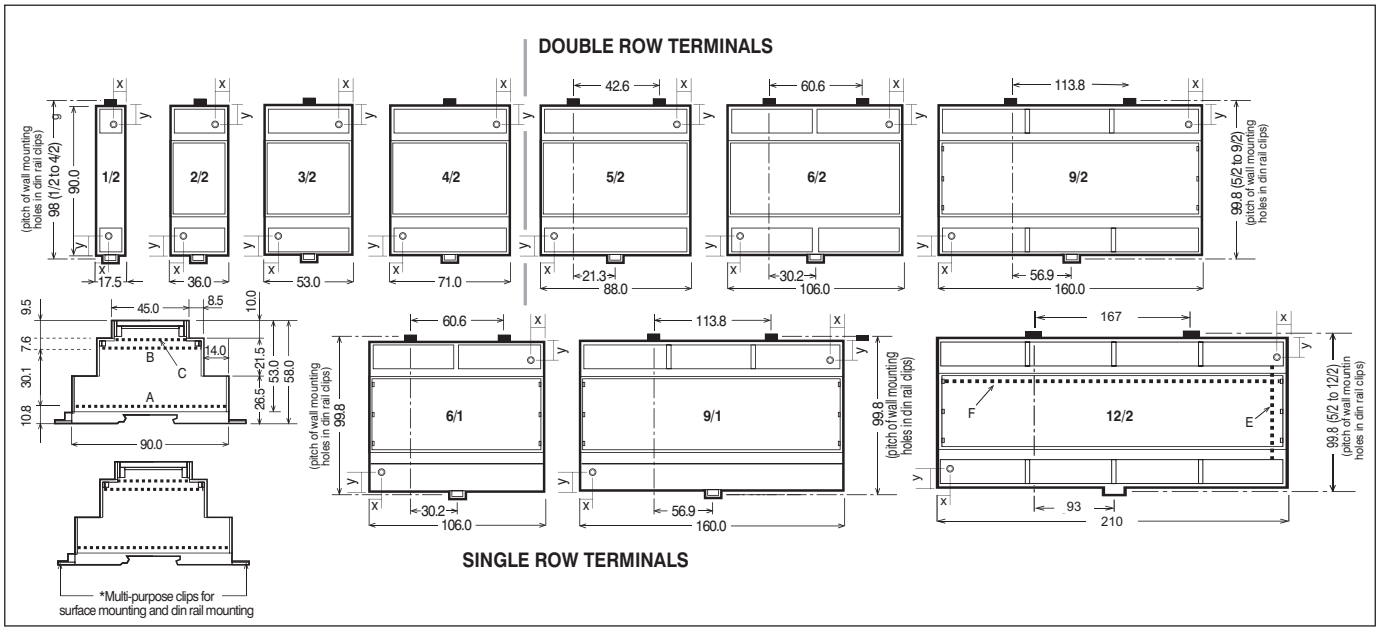
ENCLOSURES

DIN Rail Module Boxes



PCB dimensions

Part No	Box size	Box length	A horizontal	B horizontal	C horizontal	E vertical	F vertical
CNMB/1-	1	17.5 mm	86.5x14	57x14	41.8x14	34x59.6	40x14.8
CNMB/2-	2	36 mm	86.5x33	57x32	42x32	34x59.7	40x33
CNMB/3-	3	53 mm	86.5x50	57x49	42x49	34x59.8	40x50
CNMB/4-	4	71 mm	86.5x68	57x67	42x67	34x59.9	40x68
CNMB/5-	5	88 mm	86.5x84	57x83	42x83	34x59.10	40x84
CNMB/6-	6	106 mm	86.5x103	57x102	42x102	34x59.11	40x103
CNMB/9-	9	160 mm	86.5x155	57x155.4	42x154	34x59.12	40x155
CNMB/12-	12	210 mm	86.5x207.5	57x207	42x207	34x59.6	40x207.5

Fixing boss dimensions

Part No	Box size	x	y
CNMB/1-	1	6.2	18.3
CNMB/2-	2	6.2	18.3
CNMB/3-	3	8.8	18.3
CNMB/4-	4	8.8	18.3
CNMB/5-	5	8.8	18.3
CNMB/6-	6	8.9	18.3
CNMB/9-	9	8.9	18.3
CNMB/12-	12	8.9	18.3

Boss Internal dia = 3mm
Boss External dia = 5mm

There are two mounting bosses on the base of the boxes to allow fixing of the lower pcb if required. This may be useful if the pcb is carrying heavy components e.g. tranformers. The bosses are designed to accept 'plastite' type screws.

Din clip hole diameter

The diameter of the hole in the din clip is 4mm +0.0/-0.1

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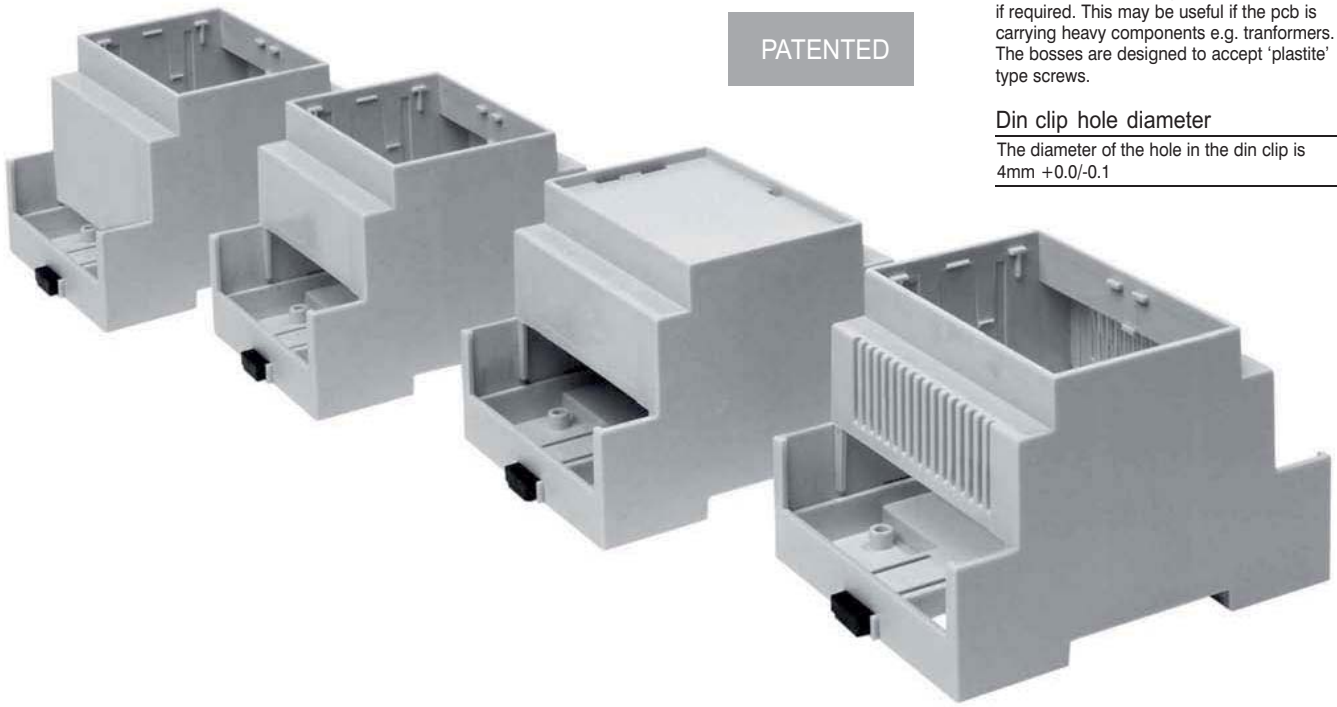

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ENCLOSURES

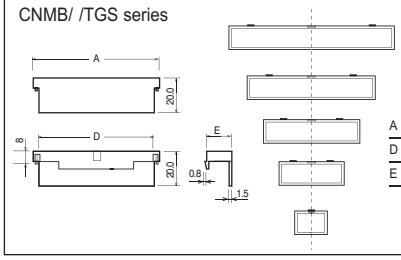
Terminal Guards

CNMB/ /TGS

Type No.	
CNMB/1/TGS	Solid
CNMB/2/TGS	Solid
CNMB/3/TGS	Solid
CNMB/4/TGS	Solid
CNMB/5/TGS	Solid

For 6, 9 & 12 size module use CNMB/3TGS

CNMB/ /TGS series



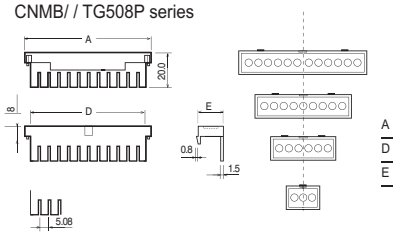
	CNMB/1/TGS	CNMB/2/TGS	CNMB/3/TGS	CNMB/4/TGS	CNMB/5/TGS
A	17.5	35.5	52.8	70.6	87.6
D	15.0	29.9	45.5	59.9	79.5
E	14.3	13.8	13.8	13.8	13.8

CNMB/ /TG508P

Type No.		Poles
CNMB/1/TG508P	Perforated	3
CNMB/2/TG508P	Perforated	6
CNMB/3/TG508P	Perforated	9
CNMB/4/TG508P	Perforated	12
CNMB/5/TG508P	Perforated	15

For 6, 9 & 12 size module use CNMB/3/TG508P

CNMB/ / TG508P series



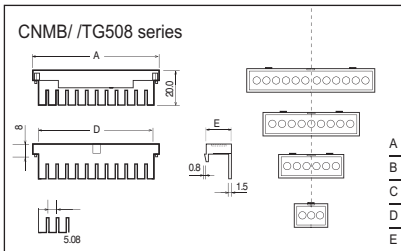
	CNMB/1/TG508P	CNMB/2/TG508P	CNMB/3/TG508P	CNMB/4/TG508P	CNMB/5/TG508P
A	17.5	35.5	52.8	70.6	87.6
D	15.0	29.9	45.5	59.9	79.5
E	14.3	13.8	13.8	13.8	13.8

CNMB/ /TG508

Type No.		Poles
CNMB/1/TG508	Pre-drilled	3
CNMB/2/TG508	Pre-drilled	6
CNMB/3/TG508	Pre-drilled	9
CNMB/4/TG508	Pre-drilled	12
CNMB/5/TG508	Pre-drilled	15

For 6, 9 & 12 size module use CNMB/3/TG508

CNMB/ /TG508 series



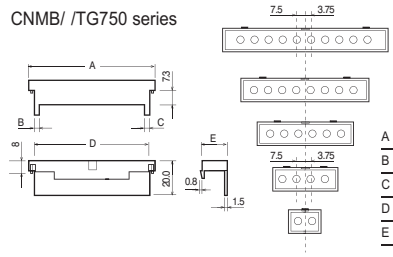
	CNMB/1/TG508	CNMB/2/TG508	CNMB/3/TG508	CNMB/4/TG508	CNMB/5/TG508
A	17.5	35.5	52.8	70.6	87.6
B	2.3	0.9	2.3	2.7	2.7
C	2.3	2.7	2.3	5.8	5.8
D	15.0	29.9	45.5	59.9	79.5
E	14.3	13.8	13.8	13.8	13.8

CNMB/ /TG750

Type No.		Poles
CNMB/1/TG750	Pre-drilled	2
CNMB/2/TG750	Pre-drilled	4
CNMB/3/TG750	Pre-drilled	6
CNMB/4/TG750	Pre-drilled	8
CNMB/5/TG750	Pre-drilled	10

For 6, 9 & 12 size module use CNMB/3/TG750

CNMB/ /TG750 series



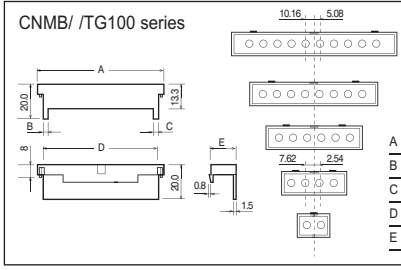
	CNMB/1/TG750	CNMB/2/TG750	CNMB/3/TG750	CNMB/4/TG750	CNMB/5/TG750
A	17.5	35.5	52.8	70.6	87.6
B	2.3	0.9	2.3	2.7	2.7
C	2.3	2.7	2.3	5.8	5.8
D	15.0	29.9	45.5	59.9	79.5
E	14.3	13.8	13.8	13.8	13.8

CNMB/ /TG100

Type No.		Poles
CNMB/1/TG100	Pre-drilled	2
CNMB/2/TG100	Pre-drilled	3
CNMB/3/TG100	Pre-drilled	5
CNMB/4/TG100	Pre-drilled	6
CNMB/5/TG100	Pre-drilled	7

For 6, 9 & 12 size module use CNMB/3/TG100

CNMB/ /TG100 series



	CNMB/1/TG100	CNMB/2/TG100	CNMB/3/TG100	CNMB/4/TG100	CNMB/5/TG100
A	17.5	35.5	52.8	70.6	87.6
B	1.0	0.9	1.0	2.7	2.7
C	1.0	0.9	1.0	2.7	5.8
D	15.0	29.9	45.5	59.9	79.5
E	14.3	13.8	13.8	13.8	13.8

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ENCLOSURES

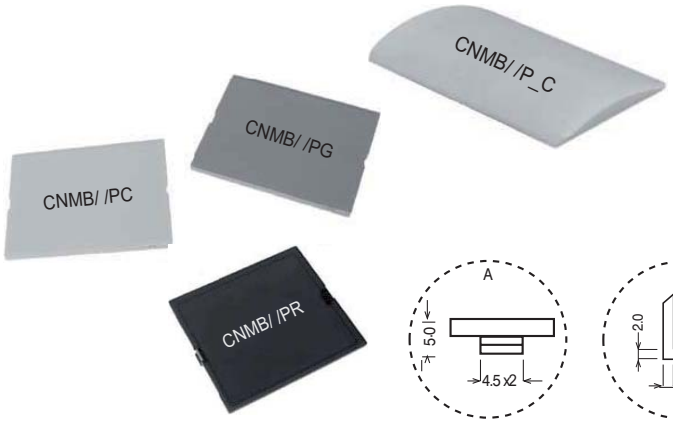
Extended Height module

Features

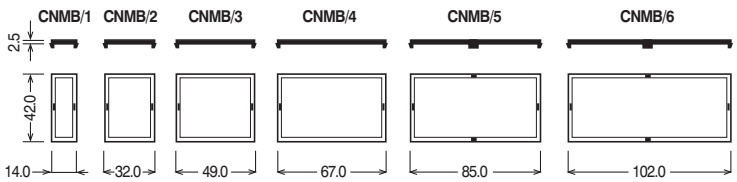
- 16mm high
- Accepts hinged, curved lid only
- Can house an additional horizontal pcb

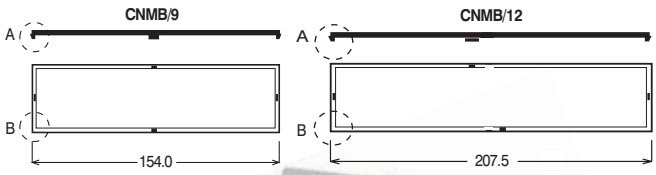
Type No.	Description	Width
CNMB/2/E	Extended height module	34.7 mm
CNMB/3/E	Extended height module	52.0 mm
CNMB/4/E	Extended height module	70.0 mm
CNMB/5/E	Extended height module	86.5 mm
CNMB/6/E	Extended height module	104.5 mm
CNMB/9/E	Extended height module	157.7 mm

Panel/Covers



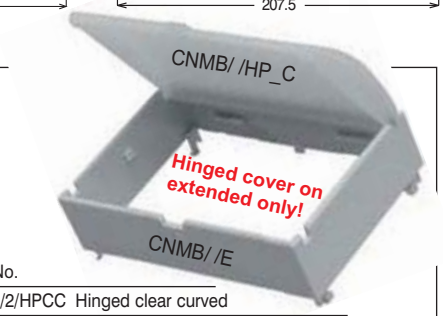
CNMB/ /P series





Type No.	Clip on covers
CNMB/1/PR	Red transparent
CNMB/2/PR	Red transparent
CNMB/3/PR	Red transparent
CNMB/4/PR	Red transparent
CNMB/5/PR	Red transparent
CNMB/6/PR	Red transparent
CNMB/9/PR	Red transparent
CNMB/1/PRC	Red transparent curved
CNMB/2/PRC	Red transparent curved
CNMB/3/PRC	Red transparent curved
CNMB/4/PRC	Red transparent curved
CNMB/5/PRC	Red transparent curved
CNMB/6/PRC	Red transparent curved
CNMB/9/PRC	Red transparent curved
CNMB/1/PC	Clear transparent
CNMB/2/PC	Clear transparent
CNMB/3/PC	Clear transparent
CNMB/4/PC	Clear transparent
CNMB/5/PC	Clear transparent
CNMB/6/PC	Clear transparent
CNMB/9/PC	Clear transparent
CNMB/9/PC	Clear transparent
CNMB/12/PC	Clear transparent
CNMB/2/PCC	Clear transparent curved
CNMB/3/PCC	Clear transparent curved
CNMB/4/PCC	Clear transparent curved
CNMB/5/PCC	Clear transparent curved
CNMB/6/PCC	Clear transparent curved
CNMB/9/PCC	Clear transparent curved
The above fit the standard height boxes	

Type No.	Clip on covers
CNMB/1/PS	Smoked transparent
CNMB/2/PS	Smoked transparent
CNMB/3/PS	Smoked transparent
CNMB/4/PS	Smoked transparent
CNMB/5/PS	Smoked transparent
CNMB/6/PS	Smoked transparent
CNMB/9/PS	Smoked transparent
CNMB/1/PSC	Smoked transparent curved
CNMB/2/PSC	Smoked transparent curved
CNMB/3/PSC	Smoked transparent curved
CNMB/4/PSC	Smoked transparent curved
CNMB/5/PSC	Smoked transparent curved
CNMB/6/PSC	Smoked transparent curved
CNMB/9/PSC	Smoked transparent curved
CNMB/1/PG	Grey
CNMB/2/PG	Grey
CNMB/3/PG	Grey
CNMB/4/PG	Grey
CNMB/5/PG	Grey
CNMB/6/PG	Grey
CNMB/9/PG	Grey
CNMB/12/PG	Grey
CNMB/1/PGC	Grey curved
CNMB/2/PGC	Grey curved
CNMB/3/PGC	Grey curved
CNMB/4/PGC	Grey curved
CNMB/5/PGC	Grey curved
CNMB/6/PGC	Grey curved
CNMB/9/PGC	Grey curved
The above fit the standard height boxes	



Type No.	
CNMB/2/HPCC	Hinged clear curved
CNMB/3/HPCC	Hinged clear curved
CNMB/4/HPCC	Hinged clear curved
CNMB/5/HPCC	Hinged clear curved
CNMB/6/HPCC	Hinged clear curved
CNMB/9/HPCC	Hinged clear curved
CNMB/2/HPRC	Hinged transparent red curved
CNMB/3/HPRC	Hinged transparent red curved
CNMB/4/HPRC	Hinged transparent red curved
CNMB/5/HPRC	Hinged transparent red curved
CNMB/6/HPRC	Hinged transparent red curved
CNMB/9/HPRC	Hinged transparent red curved
CNMB/2/HPGC	Hinged grey curved
CNMB/3/HPGC	Hinged grey curved
CNMB/4/HPGC	Hinged grey curved
CNMB/5/HPGC	Hinged grey curved
CNMB/6/HPGC	Hinged grey curved
CNMB/9/HPGC	Hinged grey curved

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6.7 PLC program for HVAC control

Dateiname:	TGA-Target_PID_toolbox.pro
Verzeichnis:	C:\TwinCAT\Plc\Projects\PLC\TGA-Target
Geändert am:	2.12.15 22:26:40 / V2.9
Bezeichnung:	TGA Target
Author	Balazs Bezeczky
Version:	1.0
Beschreibung:	

```
0001 FUNCTION_BLOCK FB_PROTECT_OUT
0002 VAR_INPUT
0003     rIN          :   LREAL; (* connect actuators with 0-100% input values on this input *)
0004     bIN          :   BOOL; (* connect BOOL (ON/OFF) actuators on this input *)
0005     rPercent     :   LREAL      := 0; (* value in 0-100%, over which the output will be
0006                      set to the new value. DON'T use this for binary in- & output values. Use tTimeOn instead.  *)
0007     tTimeOn      :   TIME        := t#0s;(* time value for its duration the output will be switched on,
0008                      at the minimum. Use this for binary values. *)
0009 END_VAR
0010 VAR_OUTPUT
0011     rOUT         :   LREAL;
0012     bOUT         :   BOOL;
0013     bBlocked     :   BOOL;
0014     tTimeLeft    :   TIME;
0015 END_VAR
0016 VAR
0017     rIN_OLD      :   LREAL;
0018     bIN_OLD      :   BOOL;
0019     timer1       :   TON;
0020     iStep        :   INT;
0021     bStartTimer  :   BOOL;
0022
0023 END_VAR
```

```
0001
0002 IF rIN <> 0 AND tTimeOn = t#0s THEN
0003     (* Analog values are handled here: rIN must not be zero and tTimeOn is zero, as the change is measured in percent *)
0004     (* the output is only altered if the difference from the old to the new value is greater then rPercent *)
0005     IF rPercent <> 0 THEN
0006         IF ABS( (1 - (rIN_OLD / rIN )) * 100 ) > rPercent THEN
```

```
0007                rOUT := rIN;
0008                rIN_OLD := rIN;
0009                bBlocked := FALSE;
0010            ELSE
0011                rOUT := rIN_OLD;
0012                bBlocked := TRUE;
0013                (* rIN_OLD := rIN; *)
0014            END_IF
0015        ELSE
0016            rOUT := rIN;
0017            bBlocked := FALSE;
0018        END_IF
0019
0020    ELSE
0021        IF tTimeOn = t#0s THEN
0022            rIN_OLD := rIN;
0023            rOUT := rIN_OLD;
0024            bBlocked := FALSE;
0025        END_IF
0026    END_IF
0027
0028    (* digital values are handled here: tTimeOn must not be zero *)
0029    (* the output stays at least for the duration of tTimeOn high to protect it from cyclic toggling *)
0030    IF tTimeOn <> t#0s THEN
0031        (*IF rIN <> rIN_OLD AND iStep = 0 THEN
0032            rOUT := rIN;
0033            rIN_OLD := rIN;*)
0034        IF bIN <> bIN_OLD AND iStep = 0 THEN
0035            bOUT := bIN;
0036            bIN_OLD := bIN;
```

```
0037
0038            iStep := 10;
0039            bStartTimer := TRUE;
0040            bBlocked := TRUE;
0041        END_IF
0042
0043        (* if rIN has changed while timer1 was running, then the new state will be held for tTimeOn,
0044        otherwise rOUT stays the same until the next status change *)
0045        IF timer1.Q AND iStep = 10 THEN
0046            iStep := 0;
0047            bStartTimer := FALSE;
0048            bBlocked := FALSE;
0049        END_IF
0050
0051        tTimeLeft := timer1.ET;
0052    END_IF
0053
0054    timer1(IN:= bStartTimer, PT:= tTimeOn, Q=> , ET=> );
```

FB_SEQ_CTRL (FB-ST)

```
0001    FUNCTION_BLOCK FB_SEQ_CTRL
0002    VAR_INPUT
0003        fSetpointHeat           : INT;
0004        fSetpointCool           : INT;
0005        fExaustTemp             : INT;
0006    END_VAR
0007    VAR_OUTPUT
0008        fSetpointTemp       : INT;
0009        eMode               : E_CTRL_MODE;
0010        iSeqMode            : INT; (* 0 = heat, 1 = deadband, 2 = cool *)
0011    END_VAR
```

```
0012 VAR
0013 END_VAR
```

```
0001 (* This function decides whether the controller should be in a heating, a deadband or cooling zone
0002    When in the deadband zone, the PID controller has to be set to manual mode, so that it blocks
0003 *)
0004 IF fExaustTemp < fSetpointHeat THEN
0005     (* heat *)
0006     fSetpointTemp      := fSetpointHeat;
0007     eMode              := eCTRL_MODE_ACTIVE;
0008     iSeqMode       := 0;
0009 ELSIF fExaustTemp > fSetpointHeat AND fExaustTemp < fSetpointCool THEN
0010     (* deadband *)
0011     fSetpointTemp      := fSetpointHeat;
0012     eMode              := eCTRL_MODE_MANUAL;
0013     iSeqMode       := 1;
0014 ELSIF fExaustTemp > fSetpointCool THEN
0015     (* cooling *)
0016     fSetpointTemp      := fSetpointCool;
0017     eMode              := eCTRL_MODE_ACTIVE;
0018     iSeqMode       := 2;
0019 END_IF
```

FB_SIM (FB-ST)

```
0001 FUNCTION_BLOCK FB_SIM
0002 VAR_IN_OUT
0003     iValue             : INT;
0004     bPlus              : BOOL;
0005     bMinus             : BOOL;
0006 END_VAR
0007 VAR_INPUT
0008     iScale             : INT := 10;
```

```
0009 END_VAR
0010 VAR_OUTPUT
0011 END_VAR
0012 VAR
0013     rtPlus              : R_TRIG;
0014     rtMinus             : R_TRIG;
0015 END_VAR
```

```
0001 rtPlus(CLK:= bPlus , Q=> );
0002 rtMinus(CLK:= bMinus, Q=> );
0003
0004 IF rtPlus.Q THEN
0005     iValue := iValue + iScale;
0006     bPlus := FALSE;
0007 END_IF
0008
0009 IF rtMinus.Q THEN
0010     iValue := iValue - iScale;
0011     bMinus := FALSE;
0012 END_IF
```

FN_SCALE (FUN-ST)

```
0001 FUNCTION FN_SCALE :REAL
0002
0003 VAR_INPUT
0004     x          :       REAL  ;
0005     x1         :       REAL  ;
0006     y1         :       REAL  ;
0007     x2         :       REAL  ;
0008     y2         :       REAL  ;
0009 END_VAR
0010
```

```
0011 VAR
0012     k              :        REAL  ;
0013     d              :        REAL  ;
0014 END_VAR
```

```
0001 (* Division durch 0 abfangen *)
0002 IF (x2 - x1) <> 0 THEN
0003     k := (y2 - y1) / (x2 - x1) ;
0004 ELSE
0005     k := 10000 ;
0006 END_IF
0007
0008 d := y1 - ( k * x1 ) ;
0009
0010 FN_SCALE := k * x + d ;
```

JQM (PRG-ST)

```
0001 PROGRAM JQM
0002 VAR
0003
0004     V0004sText : T_MAXSTRING; (*~   ( JQM  : sLevelPath  : Startseite )
0005                                     ( JQM  : eObjType  : e_JQ_StringOutput )
0006                                     ( JQM  : sObjDesc    : Das ist eine Textanzeige )
0007                                     ( JQM  : sObjTextBefore  : Text vor dem Text >> )
0008                                     ( JQM  : sObjTextAfter  : << Text nach dem Text )
0009                                     ( JQM  : usiFontSize    : 4 )
0010                                     ( JQM  : sReferenz    : TEXT1 ) *)
0011
0012
0013     V1004iIcon2 : INT;(*~  (    JQM    : sLevelPath                    : Startseite )
0014                            (    JQM    : eObjType                  : e_JQ_ImageShowHide )
0015                            (    JQM    : sObjDesc: Institute of Computer Aided Automation - Automation Systems Group )
```

```
0016                            (    JQM    : sImgFName                : images/asg-logo.gif )
0017                            (    JQM    : uiImgWidth                   : 144 )
0018                            (    JQM    : uiImgHeight              : 60 )
0019                            (    JQM    : sAlignment               : Center )
0020                            (    JQM    : usiFontSize              : 3 )
0021                        *)
0022
0023
0024    stPlot1: ST_JQ_PLOT;        (*~ (     JQM    : sLevelPath               : Plot|Temperature-diagram )
0025                            (    JQM    : sObjDesc                 : Temperature diagramm )
0026                        *)
0027
0028
0029    V0080lrSlider_Summer : LREAL; (*~ (     JQM    : sLevelPath               : Plot|Setpoints )
0030                            (    JQM    : eObjType                 : e_JQ_Slider )
0031                            (    JQM    : sObjDesc                 : setpoint summer/cooling )
0032                            (    JQM    : sAlignment                   : Center )
0033                            (    JQM    : iMin                     : 18 )
0034                            (    JQM    : iMax                     : 28 )
0035                            (    JQM    : usiFontSize              : 5 )
0036                           *)
0037    V0090lrSlider_Winter : LREAL; (*~ (   JQM    : sLevelPath               : Plot|Setpoints )
0038                            (    JQM    : eObjType                 : e_JQ_Slider )
0039                            (    JQM    : sObjDesc                 : setpoint winter/heating )
0040                            (    JQM    : sAlignment                   : Center )
0041                            (    JQM    : iMin                     : 18 )
0042                            (    JQM    : iMax                     : 28 )
0043                            (    JQM    : usiFontSize              : 5 )
0044                           *)
0045
```

```
0046    stPlot2: ST_JQ_PLOT;        (*~ (    JQM    : sLevelPath              : Plot|PID-diagram )
0047                                (    JQM    : sObjDesc                    : PID diagramm )
0048                                *)
0049
0050
0051
0052
0053    fbjQueryMobileSite: FB_GENERATE_JQM_HTML_FILE;
0054
0055    bBusy  : BOOL;
0056    bError  : BOOL;
0057    bExecute: BOOL;
0058 (*
0059
0060    iTemp               AT%I*  : INT;
0061    fTemp                      : REAL;
0062    iSollTemp                  : INT;
0063    fSollTemp                  : REAL;
0064 *)
0065    TON1                       : TON;
0066    i                          : INT;
0067    j                          : INT;
0068    k                          : INT;
0069    fbGetTime                  : NT_GetTime;
0070
0071 END_VAR
```

```
0001 fbjQueryMobileSite(
0002    bExecute:= bExecute,
0003    nPlcRunTimePort:= 801,
0004    sPageTitle:= 'TGA-Target HMI',
```

```
0005        eThemes:= ,
0006        eIcon := ,
0007        eTransition := eJQ_Transition_None,
0008        bNavigation := TRUE,
0009        sNetId:= ,
0010        sPath:= 'C:\inetpub\wwwroot\jqm\',
0011        sFilename:= 'visu.htm',
0012        tTimeout:= ,
0013        bBusy=> bBusy ,
0014        eState=> ,
0015        bError=> bError,
0016        eErrID=> ,
0017        dwFileSize=> );
0018
0019
0020    V0080lrSlider_Summer := P_PID.fSetPointCool;
0021    V0090lrSlider_Winter := P_PID.fSetPointHeat;
0022
0023
0024    (*
0025    TON1(IN:= NOT TON1.Q, PT:= T#1s, Q=> , ET=> );
0026    *)
0027    IF ton1.Q THEN
0028        k := k +1;
0029    END_IF
0030
0031    V0004sText := INT_TO_STRING(k);
0032
0033
0034    H5Elements();
```

```
0035
0036
0037
0038
```

H5Elements (ST)

```
0001
0002 (* Plot Definition Temperature*)
0003 (* Diagramm *)
0004
0005 stPlot1.sTitle := 'Temperature';
0006 stPlot1.bLegend := TRUE;
0007 stPlot1.eLegendPos := eJQLegendPos_South;
0008 stPlot1.diMaxNrOfDataraws := 3;
0009 (* Achsen *)
0010 stPlot1.stXbottom.bOn := TRUE;
0011 stPlot1.stXbottom.bDT := TRUE;
0012 stPlot1.stXbottom.sTitle := 'Seconds';
0013 stPlot1.stXbottom.sIntervall := '2 second';
0014 stPlot1.stXbottom.sMin := stPlot1.stData[0].aX[0];
0015 stPlot1.stXbottom.sMax := stPlot1.stData[0].aX[29];
0016 stPlot1.stXbottom.sFormat := '%H:%M:%S';
0017
0018 stPlot1.stXtop.bOn := FALSE;
0019 stPlot1.stXtop.bDT := TRUE;
0020 stPlot1.stXtop.sTitle := 'Seconds';
0021 stPlot1.stXtop.sIntervall := '2 second';
0022 stPlot1.stXtop.sMin := stPlot1.stData[0].aX[0];
0023 stPlot1.stXtop.sMax := stPlot1.stData[0].aX[29];
0024 stPlot1.stXtop.sFormat := '%H:%M:%S';
0025
```

```
0026 stPlot1.stYleft.bOn := TRUE;
0027 stPlot1.stYleft.sMin := '10';
0028 stPlot1.stYleft.sMax := '35';
0029 stPlot1.stYleft.sTitle := '°C';
0030 stPlot1.stYleft.sIntervall := '5';
0031
0032 stPlot1.stYright.bOn := TRUE;
0033 stPlot1.stYright.sMin := '10';
0034 stPlot1.stYright.sMax := '35';
0035 stPlot1.stYright.sTitle := '°C';
0036 stPlot1.stYright.sIntervall := '5';
0037
0038 (* Daten *)
0039 stPlot1.stData[0].sLabel := 'Exaust temp B04';
0040 stPlot1.stData[0].dwLastElement := 30;
0041
0042 stPlot1.stData[1].sLabel := 'Setpoint summer/cooling';
0043 stPlot1.stData[1].bXtop := FALSE;
0044 stPlot1.stData[1].dwLastElement := 30;
0045
0046 stPlot1.stData[2].sLabel := 'Setpoint winter/heating';
0047 stPlot1.stData[2].bXtop := FALSE;
0048 (* stPlot1.stData[2].bYright := TRUE; *)
0049 stPlot1.stData[2].dwLastElement := 30;
0050
0051
0052 (* Plot Definition PID *)
0053 (* Diagramm *)
0054 stPlot2.sTitle := 'PID heating/cooling';
0055 stPlot2.bLegend := TRUE;
```

```
0056 stPlot2.eLegendPos := eJQLegendPos_South;
0057 (* Achsen *)
0058 stPlot2.stXbottom.bOn := TRUE;
0059 stPlot2.stXbottom.bDT := TRUE;
0060 stPlot2.stXbottom.sTitle := 'Seconds';
0061 stPlot2.stXbottom.sIntervall := '2 second';
0062 stPlot2.stXbottom.sMin := stPlot2.stData[0].aX[0];
0063 stPlot2.stXbottom.sMax := stPlot2.stData[0].aX[29];
0064 stPlot2.stXbottom.sFormat := '%H:%M:%S';
0065
0066 stPlot2.stXtop.bOn := FALSE;
0067 stPlot2.stXtop.bDT := TRUE;
0068 stPlot2.stXtop.sTitle := 'Seconds';
0069 stPlot2.stXtop.sIntervall := '2 second';
0070 stPlot2.stXtop.sMin := stPlot2.stData[0].aX[0];
0071 stPlot2.stXtop.sMax := stPlot2.stData[0].aX[29];
0072 stPlot2.stXtop.sFormat := '%H:%M:%S';
0073
0074 stPlot2.stYleft.bOn := TRUE;
0075 stPlot2.stYleft.sMin := '-100';
0076 stPlot2.stYleft.sMax := '100';
0077 stPlot2.stYleft.sTitle := '%';
0078 stPlot2.stYleft.sIntervall := '20';
0079
0080 stPlot2.stYright.bOn := TRUE;
0081 stPlot2.stYright.sMin := '15';
0082 stPlot2.stYright.sMax := '40';
0083 stPlot2.stYright.sTitle := '°C';
0084 stPlot2.stYright.sIntervall := '5';
0085
```

```
0086 (* Daten *)
0087 stPlot2.diMaxNrOfDataraws := 3;
0088
0089 stPlot2.stData[0].sLabel := 'PID-Out';
0090 stPlot2.stData[0].bYright := FALSE;
0091 stPlot2.stData[0].dwLastElement := 30;
0092
0093 stPlot2.stData[1].sLabel := 'PID actual value';
0094 stPlot2.stData[1].bXtop := FALSE;
0095 stPlot2.stData[1].bYright := TRUE;
0096 stPlot2.stData[1].dwLastElement := 30;
0097
0098 stPlot2.stData[2].sLabel := 'PID setpoint value';
0099 stPlot2.stData[2].bYright := TRUE;
0100 stPlot2.stData[2].bXtop := FALSE;
0101 stPlot2.stData[2].dwLastElement := 30;
0102 (*
0103 V1004iIcon2 := 1;
0104 *)
0105
0106 TON1(IN:= NOT TON1.Q, PT:= T#1s, Q=> , ET=> );
0107
0108 fbGetTime(
0109     NETID:= ,
0110     START:=ton1.Q ,
0111     TMOUT:= ,
0112     BUSY=> ,
0113     ERR=> ,
0114     ERRID=> ,
0115     TIMESTR=> );
```

```
0116
0117 IF TON1.Q THEN
0118     (* shift data one position to the left and make room for new value *)
0119     FOR j := 1 TO 29 DO
0120
0121         (* Exaust temp B03 *)
0122         stPlot1.stData[0].aY[j-1] := stPlot1.stData[0].aY[j];
0123         stPlot1.stData[0].aX[j-1] := stPlot1.stData[0].aX[j];
0124         (* Setpoint summer/cooling *)
0125         stPlot1.stData[1].aY[j-1] := stPlot1.stData[1].aY[j];
0126         stPlot1.stData[1].aX[j-1] := stPlot1.stData[1].aX[j];
0127         (* Setpoint winter/heating *)
0128         stPlot1.stData[2].aY[j-1] := stPlot1.stData[2].aY[j];
0129         stPlot1.stData[2].aX[j-1] := stPlot1.stData[2].aX[j];
0130
0131         (* PID Plot *)
0132         (* PID out *)
0133         stPlot2.stData[0].aY[j-1] := stPlot2.stData[0].aY[j];
0134         stPlot2.stData[0].aX[j-1] := stPlot2.stData[0].aX[j];
0135         (* PID actualvalue *)
0136         stPlot2.stData[1].aY[j-1] := stPlot2.stData[1].aY[j];
0137         stPlot2.stData[1].aX[j-1] := stPlot2.stData[1].aX[j];
0138         (* PID setpointvalue *)
0139         stPlot2.stData[2].aY[j-1] := stPlot2.stData[2].aY[j];
0140         stPlot2.stData[2].aX[j-1] := stPlot2.stData[2].aX[j];
0141     END_FOR
0142
0143     (* Exaust temp B03 *)
0144     stPlot1.stData[0].aY[29] := P_PID.fExhaustTemp;
0145     stPlot1.stData[0].aX[29] := SYSTEMTIME_TO_STRING(fbGetTime.TIMESTR);
```

```
0146      (* Setpoint summer/cooling *)
0147      stPlot1.stData[1].aY[29] := V0080lrSlider_Summer;
0148      stPlot1.stData[1].aX[29] := stPlot1.stData[0].aX[29];
0149      (* Setpoint winter/heating *)
0150      stPlot1.stData[2].aY[29] := V0090lrSlider_Winter;
0151      stPlot1.stData[2].aX[29] := stPlot1.stData[0].aX[29];
0152
0153      (* PID out *)
0154      stPlot2.stData[0].aY[29] := P_PID.fbPID_Temp.fOut;
0155      stPlot2.stData[0].aX[29] := stPlot1.stData[0].aX[29];
0156      (* PID actualvalue *)
0157      stPlot2.stData[1].aY[29] := P_PID.fbPID_Temp.fActualValue / 100;
0158      stPlot2.stData[1].aX[29] := stPlot2.stData[0].aX[29];
0159      (* PID setpointvalue *)
0160      stPlot2.stData[2].aY[29] := P_PID.fbPID_Temp.fSetpointValue / 100 ;
0161      stPlot2.stData[2].aX[29] := stPlot2.stData[0].aX[29];
0162
0163      IF i < 29 THEN
0164          i := i + 1;
0165      ELSE
0166          i := 0;
0167      END_IF
0168
0169  (*    V1013sText2 := INT_TO_STRING(i);*)
0170
0171  (*    TON1.IN := TRUE; *)
0172  END_IF
```

MAIN (PRG-ST)

```
0001  PROGRAM MAIN
0002  VAR
```

```
0003 END_VAR
0001
0002 (* ################ Temp Controller  ################ *)
0003 P_PID();
0004 (* ################ Humidity Controller  ################ *)
0005 rH_Control();
0006 (* ################ JQuery Visu  ################ *)
0007 JQM();
0008 (* ################ Simulation  ################ *)
0009 P_SIMULATION();
```

P_PID (PRG-ST)

```
0001 PROGRAM P_PID
0002 VAR
0003
0004     iSetPointHeat          : INT:= 2200;
0005     iSetPointCool          : INT:= 2400;
0006 (*aKM2652Visu                  : ARRAY[0..8] OF POINTER TO FB_KM2652;*)
0007 END_VAR
0008
0009 VAR
0010     (* ########## SOFTWARE VARIABLES ########## *)
0011     iSetPointTemp          : INT := 2500;
0012     fbSEQ_CTRL             : FB_SEQ_CTRL;
0013
0014     (* tempPID params *)
0015     bManual                : BOOL;
0016     bResetOscat                : BOOL;
0017     rKP_Heat               : REAL := 5;
0018     tTN_Heat               : TIME := t#1m45s;
0019     tTV_Heat               : TIME := t#150ms;
```

```
0020    rKP_Cool                : REAL := 5;
0021    tTN_Cool                : TIME := t#1m45s;
0022    tTV_Cool                : TIME := t#150ms;
0023    rLL                     : REAL := -100;
0024    rLH                     : REAL := 100;
0025    bLimitReached               : BOOL;
0026    rDiff                       : REAL;
0027    rOutput                     : REAL;
0028
0029
0030    (* DEAD_BAND / ZERO ENERGY BAND *)
0031    iHystPlus               : INT := 5;
0032    iHystMinus              : INT := -2;
0033    bDeadBandOn                 : BOOL;
0034
0035    (* CONTROL STRATEGY *)
0036    bSupplyTempControl          : BOOL := TRUE;
0037
0038    fbProtect_Fans              : FB_PROTECT_OUT;
0039    fbProtect_Fans2             : FB_PROTECT_OUT;
0040    fbProtect_AO            : FB_PROTECT_OUT;
0041    rTestAO                     : REAL;
0042    rTestPercent                : REAL;
0043    fbProtect_DO            : FB_PROTECT_OUT;
0044    rTestDI                 : REAL;
0045    rTestTimer              : TIME;
0046    rTestDO                     : REAL;
0047    rTestAI                 : REAL;
0048    bbTestAO                : BOOL;
0049    bTestDO                 : BOOL;
```

```
0050    tRestZeit                   : TIME;
0051    fbProtect_Cooler                : FB_PROTECT_OUT;
0052    fbProtect_Boiler                : FB_PROTECT_OUT;
0053    fbProtect_RH                : FB_PROTECT_OUT;
0054
0055    (* BECKHOFF PID Controller ToolBox *)
0056    fbPID_Temp                      : FB_CTRL_PID;
0057
0058    eMode                       : E_CTRL_MODE :=  eCTRL_MODE_ACTIVE;
0059
0060    stCTRL_PID_PARAMS           : ST_CTRL_PID_PARAMS := (
0061                                                        tCtrlCycleTime := T#1s,
0062                                                        tTaskCycleTime := T#10ms,
0063                                                        fKp := 60.0,
0064                                                        tTn := T#100s,
0065                                                        tTv := T#0ms,
0066                                                        tTd := T#0ms,
0067                                                        fOutMaxLimit := 100,
0068                                                        fOutMinLimit := -100);
0069
0070    eErrorId                        : E_CTRL_ERRORCODES;
0071    bError                      : BOOL;
0072    bARWactive                      : BOOL;
0073    fManSyncValue                   : FLOAT;
0074    bSync                       : BOOL;
0075    bHold                       : BOOL;
0076
0077    (* Visualisation colors and scaled variables *)
0078    dwFanSupplyCol              : DWORD;
0079    dwFanExhaustCol             : DWORD;
```

```
0080    dwPumpHeatCol           : DWORD;
0081    dwPumpCoolCol           : DWORD;
0082    iRotationAngle      : INT;
0083    iXOffset                : INT;
0084    iYOffset                : INT;
0085    iZoomfactor             : INT;
0086
0087    iLeftEdge           : INT;
0088    iTopEdge            : INT;
0089    iRightEdge          : INT;
0090    iBottomEdge         : INT;
0091
0092    fSetPointTemp       : REAL;
0093    (* Sequential control setpoint for heating *)
0094    fSetPointHeat       : REAL := 22.0;
0095    fSetPointHeatOld        : REAL;
0096    (* Sequential control setpoint for cooling *)
0097    fSetPointCool       : REAL := 24.0;
0098    fSetPointCoolOld        : REAL;
0099    fOutsideTemp        : REAL; (* B01 *)
0100    fCoolerTemp         : REAL; (* B02 *)
0101    fSupplyTemp         : REAL ; (* B03 *)
0102    fExhaustTemp        : REAL; (* B04 *)
0103    fSupplyTempBoiler       : REAL; (* B05 *)
0104    fRegisterTemp       : REAL; (* B06 *)
0105    fSupplyTempCooler       : REAL; (* B07 *)
0106
0107    dwColorOn               : DWORD := 16#0000FF00;
0108    dwColorOff              : DWORD := 16#00FFFFFF;
0109    dwTest3                 : DWORD;
```

```
0110     bTestBit1                  : BOOL;
0111
0112     sTN_Heat                   : STRING;
0113     sTN_Cool                   : STRING;
0114     sTV_Heat                   : STRING;
0115     sTV_Cool                   : STRING;
0116
0117     (* Triggers for capturing events, like value changes in the visualization *)
0118     trSetpointHeatChange          : R_TRIG;
0119     trSetpointCoolChange       : R_TRIG;
0120 END_VAR
```

```
0001 (* depending on the mode set the parameters for the PID controller *)
0002 tTV_Cool := STRING_TO_TIME(CONCAT(CONCAT('t#',INT_TO_STRING(ABS(iSetpointTemp - iExhaustTemp)) ),'ms'));
0003 tTV_Heat := tTV_Cool;
0004
0005 (* Set mode: cooling or heating *)
0006 IF fbPID_Temp.fOut > 0 THEN
0007     (* PID controller's output is greater than 0, heating mode *)
0008     stCTRL_PID_PARAMS.fKp := rKP_Heat;
0009     stCTRL_PID_PARAMS.tTn := tTN_Heat;
0010     stCTRL_PID_PARAMS.tTv := tTV_Heat;
0011 ELSE
0012     (* PID controller's output is less than 0, cooling mode *)
0013     stCTRL_PID_PARAMS.fKp := rKP_Cool;
0014     stCTRL_PID_PARAMS.tTn := tTN_Cool;
0015     stCTRL_PID_PARAMS.tTv := tTV_Cool;
0016 END_IF
0017
0018 (* detect changes in the HMI, like input fields were changed *)
0019 trSetpointHeatChange(CLK:= fSetPointHeat <> fSetPointHeatOld, Q=> );
```

```
0020 trSetpointCoolChange(CLK:=fSetPointCool <> fSetPointCoolOld, Q => );
0021
0022 IF trSetpointHeatChange.Q THEN
0023     iSetPointHeat := REAL_TO_INT(fSetPointHeat * 100);
0024     fSetPointHeatOld := fSetPointHeat;
0025 END_IF
0026
0027 IF trSetpointCoolChange.Q THEN
0028     iSetPointCool := REAL_TO_INT(fSetPointCool * 100);
0029     fSetPointCoolOld := fSetPointCool;
0030 END_IF
0031
0032
0033
0034 (* Call all FBs in a sub routine *)
0035 FBs();
0036
0037 (* FB_KM2652 *)
0038 bLightbulbLeft(bPLCValue:= , eStatus=> );
0039 bLightbulbRight(bPLCValue:= , eStatus=> );
0040 bSunblindDown(bPLCValue:= , eStatus=> );
0041 bSunblindUp(bPLCValue:= , eStatus=> );
0042 (* FB_KM4602 *)
0043 iFanSupply(iPLCValue:= , eStatus=> );
0044 iFanExhaust(iPLCValue:= , eStatus=> );
0045 iPumpCool(iPLCValue:= , eStatus=> );
0046 iPumpHeat(iPLCValue:= , eStatus=> );
0047 iHeatSource(iPLCValue:= , eStatus=> );
0048
0049 (* Calculate setpoint value based on dew-temp and setpoint for heating/cooling, then use the
```

```
0050 higher value as the setpoint *)
0051 fbPID_Temp.fSetpointValue :=  MAX( DEW_TEMP(RH := FN_SCALE( x := iExaustRH, x1 := 0, y1 := 0,
0052                                                            x2 := 100, y2 := 32767) ,
0053                                                            T:= iExhaustTemp), iSetPointTemp );
0054
0055 IF ABS(REAL_TO_INT(FN_SCALE( x := fbPID_Temp.fOut, x1 := 0, y1 := 0, x2 := 100, y2 := 32767) )) > 1 THEN
0056     fbProtect_Fans2.bIN := TRUE;
0057 ELSE
0058     fbProtect_Fans2.bIN := FALSE;
0059 END_IF
0060
0061 IF NOT(bError1) THEN
0062     fbProtect_Fans.bIN := TRUE;
0063     fbProtect_Fans.rIN := ABS(REAL_TO_INT(FN_SCALE( x := fbPID_Temp.fOut, x1 := 0, y1 := 0, x2 := 100, y2 := 32767)));
0064 ELSE
0065     fbProtect_Fans.bIN := FALSE;
0066 END_IF
0067
0068
0069 (* Set boiler, cooler and deadband according to the sequencer's output *)
0070 fbProtect_Boiler.bIN        := fbSEQ_CTRL.iSeqMode = 0;
0071 bDeadBandOn                 := fbSEQ_CTRL.iSeqMode = 1;
0072 fbProtect_Cooler.bIN        := fbSEQ_CTRL.iSeqMode = 2;
0073 iPumpHeat.iPLCValue         := BOOL_TO_INT(fbSEQ_CTRL.iSeqMode = 0) * ABS(REAL_TO_INT(
0074                             FN_SCALE( x := fbPID_Temp.fOut, x1 := 0, y1 := 0, x2 := 100, y2 := 32767) ));
0075 iPumpCool.iPLCValue         := BOOL_TO_INT(fbSEQ_CTRL.iSeqMode = 2) * ABS(REAL_TO_INT(
0076                             FN_SCALE( x := fbPID_Temp.fOut, x1 := 0, y1 := 0, x2 := 100, y2 := 32767) ));
0077
0078
0079 iFanSupply.iPLCValue        := REAL_TO_INT(fbProtect_Fans.rOUT);
```

```
0080 iFanExhaust.iPLCValue    := REAL_TO_INT(fbProtect_Fans.rOUT);
0081 bCoolerOn.bPLCValue     := fbProtect_Cooler.bOUT;
0082 bBoilerOn.bPLCValue := fbProtect_Boiler.bOUT;
0083 bFanExhaust.bPLCValue := fbProtect_Fans2.bOUT;
0084 bFanSupply.bPLCValue    := fbProtect_Fans2.bOUT;
0085
0086 (* ################ VISU ################ *)
0087 (* select colors for visu depending on the state of certain FBs *)
0088 dwFanSupplyCol       := BOOL_TO_INT(bFanSupply.bOutput = 0) * dwColorOff +
0089                         BOOL_TO_INT(bFanSupply.bOutput = 1) * dwColorOn;
0090 dwFanExhaustCol      := BOOL_TO_INT(bFanExhaust.bOutput = 0) * dwColorOff +
0091                         BOOL_TO_INT(bFanExhaust.bOutput = 1) * dwColorOn;
0092 dwPumpHeatCol        := BOOL_TO_INT(iPumpHeat.iOutput <= 0) * dwColorOff +
0093                         BOOL_TO_INT(iPumpHeat.iOutput > 0) * dwColorOn;
0094 dwPumpCoolCol        := BOOL_TO_INT(iPumpCool.iOutput <= 0) * dwColorOff +
0095                         BOOL_TO_INT(iPumpCool.iOutput > 0) * dwColorOn;
0096 (* convert variables for visual representation, like temperatures from integer to real values *)
0097 (* fSetPointHeat            := iSetPointHeat / 100.0; *)
0098 fSetPointTemp        := iSetPointTemp / 100.0;
0099 (*fSetPointCool            := iSetPointCool / 100.0; *)
0100 fExhaustTemp         := iExhaustTemp / 100.0;
0101 fOutsideTemp         := iOutsideTemp / 100.0;
0102 fSupplyTemp          := iSupplyTemp / 100.0;
0103 fCoolerTemp          := iCoolerTemp / 100.0;
0104 fRegisterTemp        := iRegisterTemp / 100.0;
0105 fSupplyTempBoiler        := iSupplyTempBoiler / 100.0;
0106 fSupplyTempCooler        := iSupplyTempCooler / 100.0;
0107 (* convert time values to string to be able to be used in the visu *)
0108 sTN_Heat             := TIME_TO_STRING(tTN_Heat);
0109 sTN_Cool             := TIME_TO_STRING(tTN_Cool);
```

```
0110 sTV_Heat               := TIME_TO_STRING(tTV_Heat);
0111 sTV_Cool               := TIME_TO_STRING(tTV_Cool);
0112
0113
```

FBs (ST)

```
0001
0002 (* Call all neccessary FBs in this subroutine
0003    only initial parameters are set here
0004 *)
0005 fbSEQ_CTRL(
0006      fSetpointHeat:= iSetPointHeat,
0007      fSetpointCool:= iSetPointCool,
0008      fExaustTemp:= iExhaustTemp,
0009      fSetpointTemp=> iSetPointTemp,
0010      eMode=> ,
0011      iSeqMode=> );
0012
0013 fbPID_Temp(
0014      fSetpointValue:= ,
0015      fActualValue:= iExhaustTemp,
0016      fManSyncValue:= fManSyncValue,
0017      bSync:= (bFreezeWarningOn OR bManual),
0018      eMode:= fbSEQ_CTRL.eMode,
0019      bHold:= bHold,
0020      stParams:= stCTRL_PID_PARAMS,
0021      fOut=> ,
0022      bARWactive=> bARWactive,
0023      eState=> ,
0024      eErrorId=> eErrorId,
0025      bError=> bError);
```

```
0026
0027 fbProtect_Cooler(
0028       rIN:= ,
0029       bIN:= ,
0030       rPercent:= ,
0031       tTimeOn:= t#1m,
0032       rOUT=> ,
0033       bOUT=> ,
0034       bBlocked=> ,
0035       tTimeLeft=> );
0036
0037 fbProtect_Boiler(
0038       rIN:= ,
0039       bIN:= ,
0040       rPercent:= ,
0041       tTimeOn:= t#1m,
0042       rOUT=> ,
0043       bOUT=> ,
0044       bBlocked=> ,
0045       tTimeLeft=> );
0046
0047
0048 fbProtect_Fans(
0049       rIN:= ,
0050       bIN:= ,
0051       rPercent:= 10,
0052       tTimeOn:= ,
0053       rOUT=> ,
0054       bOUT=> ,
0055       bBlocked=> ,
```

```
0056        tTimeLeft=> );
0057
0058    fbProtect_Fans2(
0059        rIN:= ,
0060        bIN:= ,
0061        rPercent:= ,
0062        tTimeOn:=  t#1m,
0063        rOUT=> ,
0064        bOUT=> ,
0065        bBlocked=> ,
0066        tTimeLeft=> );
```

P_SIMULATION (PRG-ST)

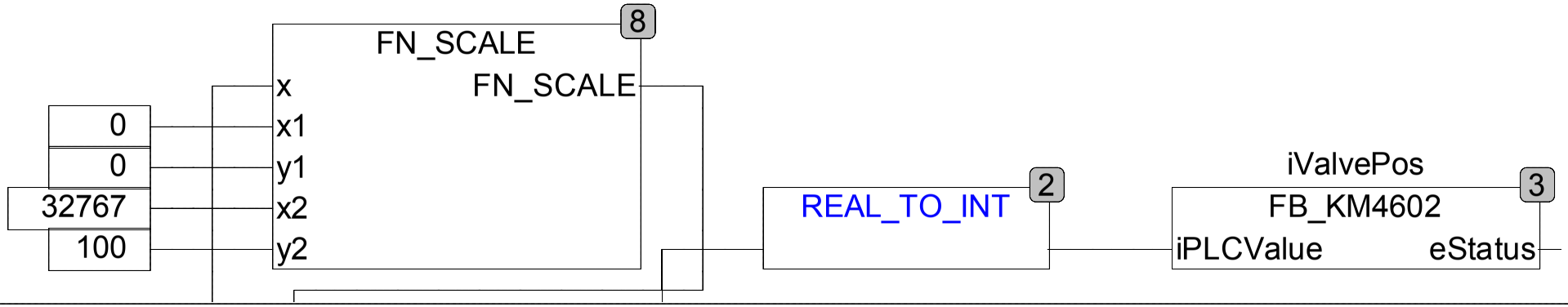
```
0001    PROGRAM P_SIMULATION
0002    VAR
0003        fbExaustTemp            : FB_SIM;
0004        bExaustPlus                 : BOOL;
0005        bExaustMinus            : BOOL;
0006    END_VAR
```

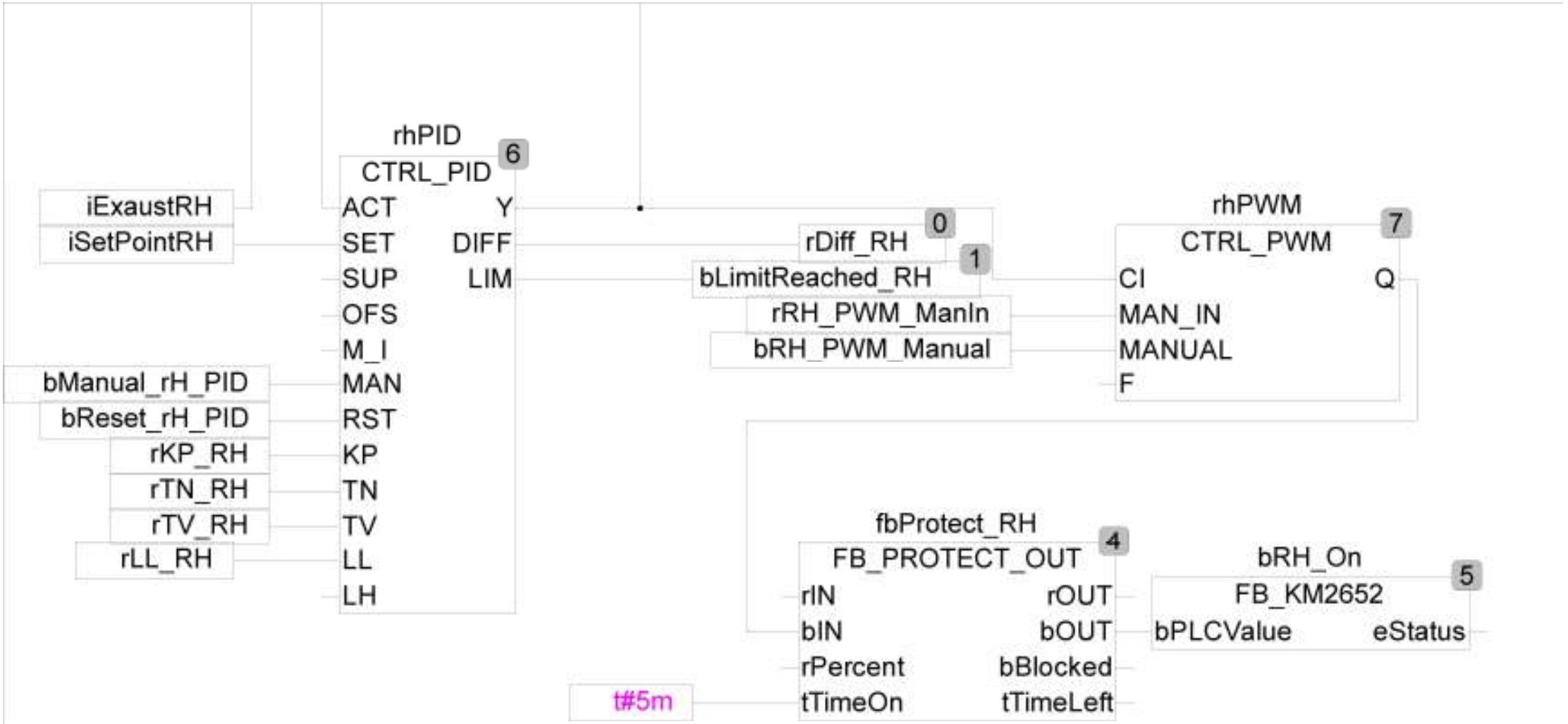
```
0001    fbExaustTemp(
0002        bPlus:= bExaustPlus,
0003        bMinus:= bExaustMinus,
0004        iScale:= 10,
0005        iValue:= iExhaustTemp);
```

rH_Control (PRG-CFC)

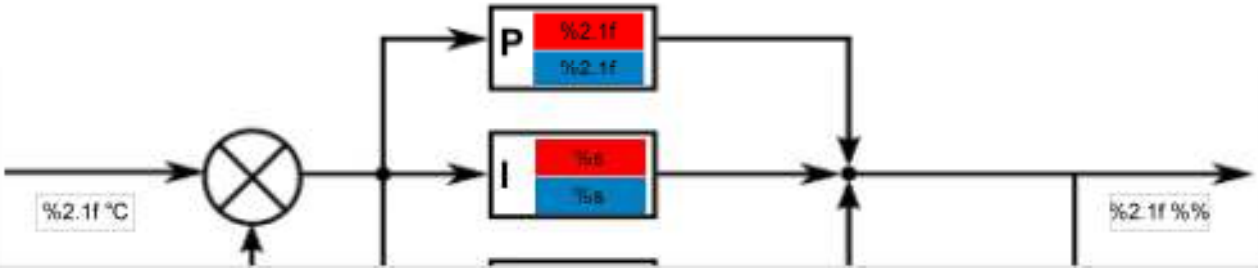
```
0001    PROGRAM rH_Control
0002    VAR
0003        (* rH control *)
0004        rhPID                       : CTRL_PID;
0005        iSetPointRH                     : INT := 50;
```

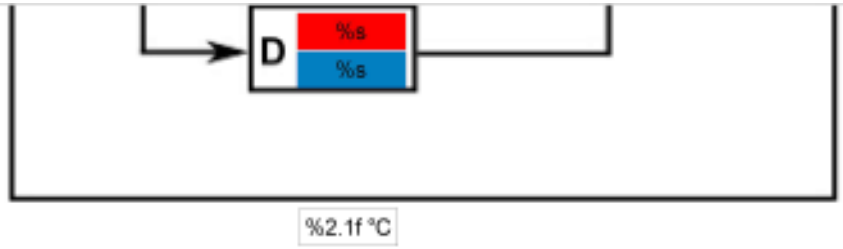
```
0006    rKP_RH                  : LREAL;
0007    rTN_RH                  : LREAL;
0008    rTV_RH                  : LREAL;
0009    bReset_rH_PID           : BOOL;
0010    bManual_rH_PID          : BOOL;
0011    rLL_RH                  : LREAL;
0012    rLH_RH                  : LREAL;
0013    rDiff_RH                : LREAL;
0014    bLimitReached_RH        : BOOL;
0015
0016    rhPWM                   : CTRL_PWM;
0017    bRH_PWM_Manual          : BOOL;
0018    rRH_PWM_ManIn       : LREAL;
0019
0020    fbProtect_RH        : FB_PROTECT_OUT;
0021 END_VAR
```


8
FN_SCALE
x
FN_SCALE
0
x1
0
y1
32767
x2
100
y2
2
REAL_TO_INT
iValvePos
3
FB_KM4602
iPLCValue
eStatus


rhPID
CTRL_PID
6
iExaustRH
iSetPointRH
ACT
SET
SUP
OFS
M_I
MAN
RST
KP
TN
TV
LL
LH
Y
DIFF
LIM
bManual_rH_PID
bReset_rH_PID
rKP_RH
rTN_RH
rTV_RH
rLL_RH
rDiff_RH
0
bLimitReached_RH
1
rRH_PWM_ManIn
bRH_PWM_Manual
rhPWM
CTRL_PWM
7
CI
MAN_IN
MANUAL
F
Q
fbProtect_RH
FB_PROTECT_OUT
4
rIN
bIN
rPercent
tTimeOn
rOUT
bOUT
bBlocked
tTimeLeft
t#5m
bRH_On
FB_KM2652
5
bPLCValue
eStatus

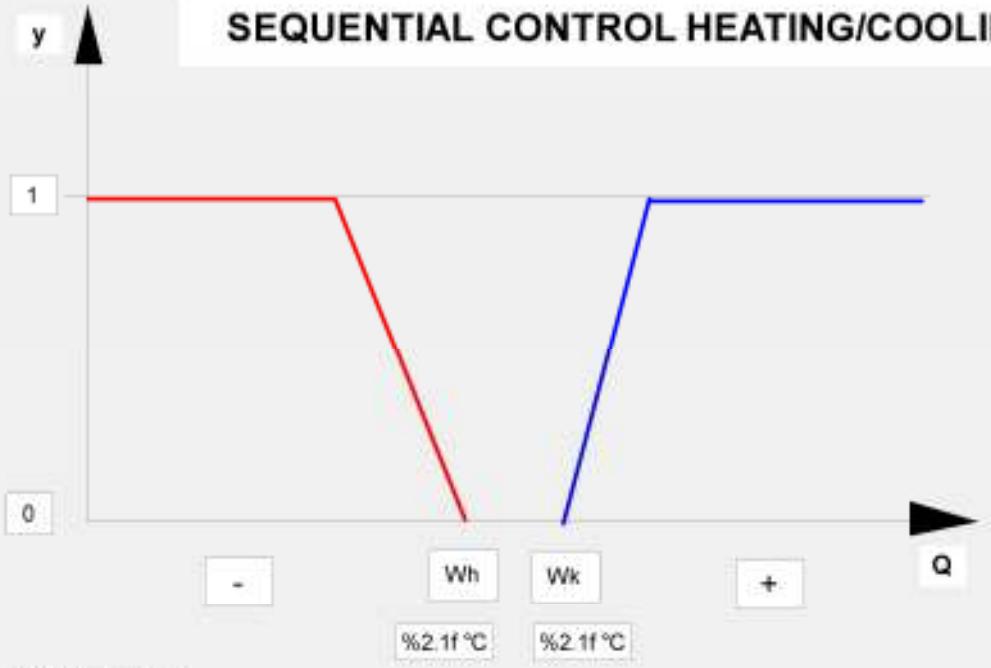
PID


P
%2.1f
%2.1f
I
%2.1f °C
%2.1f %%



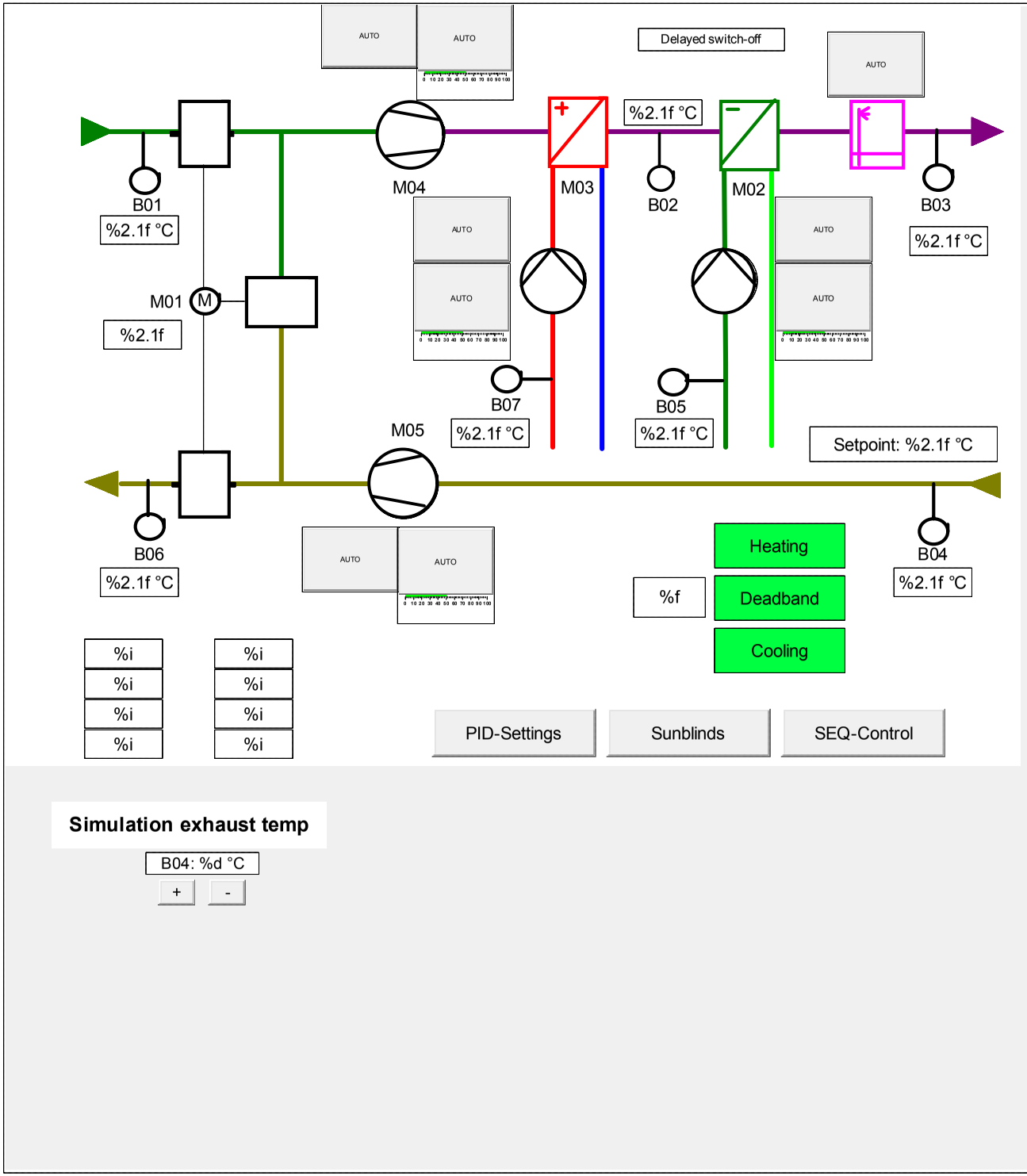
HOME

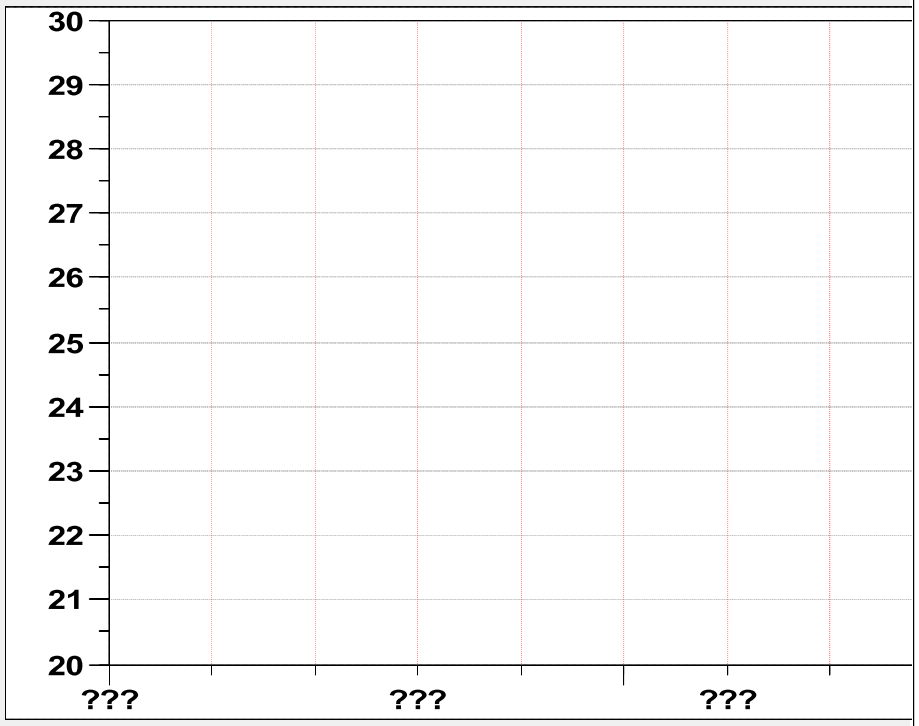
SEQUENTIAL_CONTROL



SUNBLINDS

TC_VISU

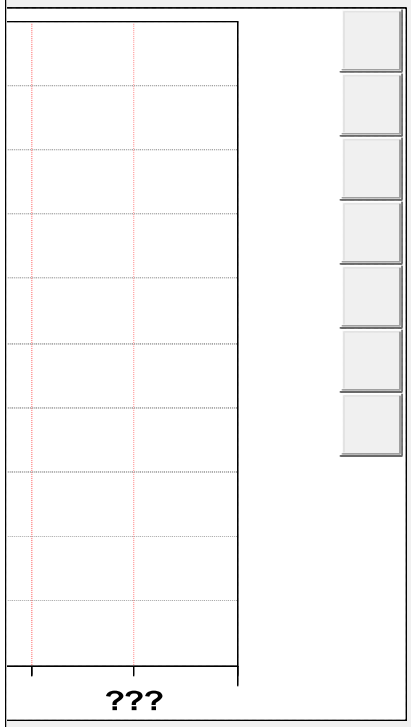


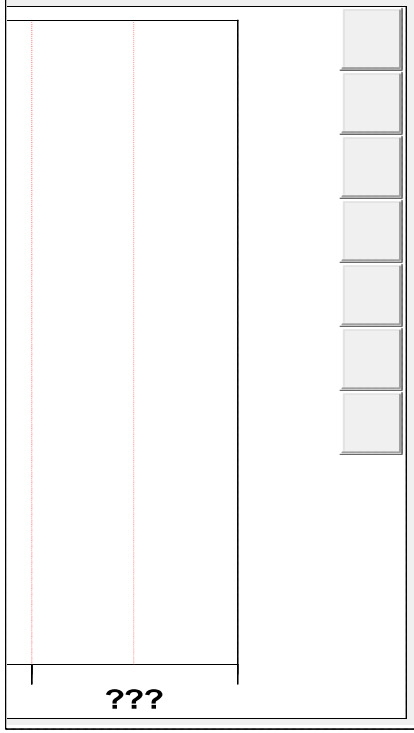


Simulation exhaust temp

B04: %d °C

\+ -





```
0001 VAR_GLOBAL
0002 END_VAR
```

Globale_Variablen

```
0001
0002 VAR_GLOBAL
0003
0004
0005
0006 END_VAR
```

Global_Variables

```
0001 VAR_GLOBAL
0002     (* ########## HARDWARE VARIABLES ##########  *)
0003     (* ##########  INPUTS ##########  *)
0004     (* Temp control *)
0005     iOutsideTemp       AT%I*  : INT;              (* Aussentemperatur B01 *)
0006     iCoolerTemp        AT%I*  : INT;              (* Registertemperatur Kühlregister B02 *)
0007     iSupplyTemp        AT%I*  : INT;              (* Zulufttemperatur B03 *)
0008     iExhaustTemp       AT%I*  : INT;              (* Ablufttemperatur B04 *)
0009     iSupplyTempBoiler      AT%I*  : INT;              (* Vorlauftemperatur Boiler B05 *)
0010     iRegisterTemp      AT%I*  : INT;              (* Registertemperatur Heizregister B06 *)
0011     iSupplyTempCooler      AT%I*  : INT;              (* Vorlauftemperatur Kühlung B07 *)
0012     bFreezeWarningOn       AT%I*  : BOOL;                 (* Frostschutzsignal *)
0013     bError1                AT%I*  : BOOL;                 (* Error1 signal *)
0014     (* rH control *)
0015     iExaustRH          AT%I*  : INT;              (* rH value measured at the exaust B04 *)
0016     (* ########## OUTPUTS ##########  *)
```

```
0017    (* all HW-outputs are implemented in the FB_KM2652 and FB_KM4602 ! *)
0018
0019    (* ########## KM-TERMINALS WITH HW-VARIABLES ########## *)
0020
0021    (* Sunblinds *)
0022    bSunblindUp             : FB_KM2652;
0023    bSunblindDown               : FB_KM2652;
0024    (* rH control *)
0025    bRH_On                  : FB_KM2652;            (* switching on/off of rH *)
0026    (* Test chamber *)
0027    bLightbulbLeft          : FB_KM2652;            (* Leuchtband 2 A13 *)
0028    bLightbulbRight             : FB_KM2652;            (* Leuchtband 1 A12 *)
0029
0030    bFanSupply                  : FB_KM2652;            (* Freigabe Zuluftventilator *)
0031    bFanExhaust             : FB_KM2652;            (* Freigabe Abluftventilator *)
0032    bBoilerOn               : FB_KM2652;            (* Boiler Ein/Aus *)
0033    bCoolerOn               : FB_KM2652;            (* Kaltwassersatz Ein/Aus *)
0034
0035    iFanSupply                  : FB_KM4602;            (* Zuluft M04 *)
0036    iFanExhaust                 : FB_KM4602;            (* Abluft M05 *)
0037    iPumpHeat                   : FB_KM4602;            (* Pumpe Heizen M03 *)
0038    iPumpCool               : FB_KM4602;            (* Pumpe Kühlen M02 *)
0039    (* Dampers *)
0040    iValvePos               : FB_KM4602;            (* variable for setting all three valve positions M01 *)
0041    (* Test chamber *)
0042    iHeatSource                 : FB_KM4602;            (* Wärmequelle A14 *)
0043    END_VAR
```

TwinCAT_Configuration

```
0001    (* Generated automatically by TwinCAT - (read only) *)
```

```
0002 VAR_CONFIG
0003     .iOutsideTemp AT %IB0 : INT;
0004     .iCoolerTemp AT %IB2 : INT;
0005     .iSupplyTemp AT %IB4 : INT;
0006     .iExhaustTemp AT %IB6 : INT;
0007     .iSupplyTempBoiler AT %IB8 : INT;
0008     .iRegisterTemp AT %IB10 : INT;
0009     .iSupplyTempCooler AT %IB12 : INT;
0010     .bFreezeWarningOn AT %IX16.0 : BOOL;
0011     .bError1 AT %IX16.1 : BOOL;
0012     .iExaustRH AT %IB14 : INT;
0013     .bSunblindUp.bSwitchAUTO AT %IX16.2 : BOOL;
0014     .bSunblindUp.bSwitchRELAIS AT %IX16.3 : BOOL;
0015     .bSunblindUp.bOutput AT %QX0.0 : BOOL;
0016     .bSunblindDown.bSwitchAUTO AT %IX16.4 : BOOL;
0017     .bSunblindDown.bSwitchRELAIS AT %IX16.5 : BOOL;
0018     .bSunblindDown.bOutput AT %QX0.1 : BOOL;
0019     .bRH_On.bSwitchAUTO AT %IX16.6 : BOOL;
0020     .bRH_On.bSwitchRELAIS AT %IX16.7 : BOOL;
0021     .bRH_On.bOutput AT %QX0.2 : BOOL;
0022     .bLightbulbLeft.bSwitchAUTO AT %IX17.0 : BOOL;
0023     .bLightbulbLeft.bSwitchRELAIS AT %IX17.1 : BOOL;
0024     .bLightbulbLeft.bOutput AT %QX0.3 : BOOL;
0025     .bLightbulbRight.bSwitchAUTO AT %IX17.2 : BOOL;
0026     .bLightbulbRight.bSwitchRELAIS AT %IX17.3 : BOOL;
0027     .bLightbulbRight.bOutput AT %QX0.4 : BOOL;
0028     .bFanSupply.bSwitchAUTO AT %IX17.4 : BOOL;
0029     .bFanSupply.bSwitchRELAIS AT %IX17.5 : BOOL;
0030     .bFanSupply.bOutput AT %QX0.5 : BOOL;
0031     .bFanExhaust.bSwitchAUTO AT %IX17.6 : BOOL;
```

```
0032        .bFanExhaust.bSwitchRELAIS AT %IX17.7 : BOOL;
0033        .bFanExhaust.bOutput AT %QX0.6 : BOOL;
0034        .bBoilerOn.bSwitchAUTO AT %IX18.0 : BOOL;
0035        .bBoilerOn.bSwitchRELAIS AT %IX18.1 : BOOL;
0036        .bBoilerOn.bOutput AT %QX0.7 : BOOL;
0037        .bCoolerOn.bSwitchAUTO AT %IX18.2 : BOOL;
0038        .bCoolerOn.bSwitchRELAIS AT %IX18.3 : BOOL;
0039        .bCoolerOn.bOutput AT %QX1.0 : BOOL;
0040        .iFanSupply.iSwitchAUTO AT %IB19 : USINT;
0041        .iFanSupply.iOutput AT %QB2 : INT;
0042        .iFanExhaust.iSwitchAUTO AT %IB20 : USINT;
0043        .iFanExhaust.iOutput AT %QB4 : INT;
0044        .iPumpHeat.iSwitchAUTO AT %IB21 : USINT;
0045        .iPumpHeat.iOutput AT %QB6 : INT;
0046        .iPumpCool.iSwitchAUTO AT %IB22 : USINT;
0047        .iPumpCool.iOutput AT %QB8 : INT;
0048        .iValvePos.iSwitchAUTO AT %IB23 : USINT;
0049        .iValvePos.iOutput AT %QB10 : INT;
0050        .iHeatSource.iSwitchAUTO AT %IB24 : USINT;
0051        .iHeatSource.iOutput AT %QB12 : INT;
0052    END_VAR
```

Variable_Configuration

```
0001    VAR_CONFIG
0002    END_VAR
```

Steuerungskonfiguration

    Hardware-Konfiguration

Taskkonfiguration

- Taskkonfiguration
  - Standard (PRIORITY := 0, INTERVAL := T#1ms)
    - MAIN