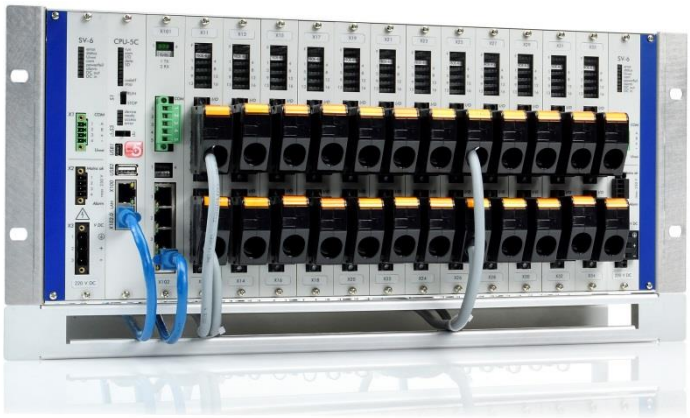
SAE IT-SYSTEMS



BCU-50 series5e Manual

Substation automation
Telecontrol system
Automation

■ intern | internal

This document was classified: ■ intern | internal

It is aimed at system administrators and those involved with the operation, diagnostics and installation of BCU-50 series5e bay station controllers.

Please follow the safety notices.

Our sales team in our Cologne headquarters will be happy to provide you with further information and technical details over the phone: +49 (0)221 59808-0.
In the case of technical problems, please contact our support hotline on +49 (0)221 59808-55.

Firmware using Open-Source openBSD/GPL/LGPL
The Firmware of mentioned products carries open source code according to openBSD/GPL/LGPL licenses. On demand we are obliged to deploy the source code according to Section 3b of GPL and Section 6b of LGPL. We will be happy to provide you with an offer for the delivery of the sources on data media; please send an e-mail to marketing@sae-it.de.

Substation Automation & Telecontrol BCU-50 series5e

Issue date 30.08.2023
File Manual_BCU-50_series5e_230830.docx
Link
https://sae-it.netexplorer.pro/dl/4PKx9NnGpZ1KXPqbGeObvULP2lzR5d

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1. Safety instructions

General

IMPORTANT: READ CAREFULLY BEFORE USE.
KEEP FOR FUTURE REFERENCE. Current specifications can be loaded at any time - see the link on Page 2 or by request to marketing@sae-it.de.

Read this documentation carefully, especially the safety instructions, the instructions for safe installation and commissioning and proper operation, as well as all other publications that must be consulted when working with this product. Observe all safety instructions and warnings when handling this product, otherwise personal injury or damage to the product may result. This also applies to any unauthorised modification and use of the unit that exceeds the mechanical, electrical or other operating limits.
When using the unit, the legal and safety regulations required for the respective application must also be observed.
This document contains the information required for the application and use of the product in the manner intended. It is intended for technically **qualified personnel** who have relevant knowledge in the field of automation technology or data transmission technology. Depending on the application, further qualifications such as working with dangerous voltages or natural gas may be required to regulate access to the system and reduce the hazard potential.

The appliance must only be installed, commissioned, operated and maintained by qualified personnel. Qualified technical personnel are:

- Persons who, due to their relevant training and experience, are capable of recognising dangers in good time and avoiding hazards.
- Persons who are authorised to access and work on equipment.
- Persons who have been trained as operating personnel in the handling of the equipment or the system and who know the required contents of this manual.
- Persons who have been trained as commissioning/service technicians on corresponding systems in accordance with the standards of safety technology.

Safe operation requires a detailed understanding and technically correct implementation of the installation guidelines, safety information and functions described in this manual.
Detailed knowledge and technically correct implementation of the installation guidelines / security instructions / functions described in this manual are a prerequisite for safe operation.
The components and units described can be employed in a wide variety of areas and facilities. It is therefore absolutely necessary to integrate their functions and the corresponding safety notes into the safety concept of the facility as a whole.

Scope

This manual applies to work and installations with net-line m5 in the field Telecontrol & Substation Automation.

IT security according to BDEW whitepaper

Using a station within the scope of an ISMS or the BDEW whitepaper requires special consideration and application to avert the risks in accordance with the specifications and to satisfy the IT security policy of your company with regards to safe deployment. However, a full description goes beyond the scope of this document. A setup recommendation for safe operation can be found in Section **Security relevant settings** or via 'Checklist IT-Security' https://sae-it.netexplorer.pro/dl/GhUifNZwQ46rEWEGsMT3Z2hNFcaED3.

It is imperative to follow the instructions in section Security relevant settings on page 203.

For specific questions in individual cases, please contact the support team on +49 221 59808-55 or PSIRT@sae-it.de.

Hazard warnings

Warnings highlighted specially with  serve to avert danger to the lives and health of personnel as well as material damage.

Warnings highlighted specially with  refer to a possible dangerous high voltage which may be harmful for the lives and health of personnel.

Signal words in accordance with DIN EN 82079-1:

DANGER:	Denotes a hazard with a **high level of risk** which can result in severe injury or death when not averted.
WARNING:	Denotes a hazard with a **medium level of risk** which can result in severe injury or death when not averted.
CAUTION:	Denotes a hazard with a **low level of risk** which can result in minor injury as a minimum when not averted.

DANGER

Commissioning, operation and maintenance of the product and accessories is reserved exclusively for qualified personnel.

DANGER

Opening the housing exposes parts of the unit which may be carrying dangerous voltages. Before any assembly, disassembly, troubleshooting or other work on the unit, switch off all power and voltage supplies at all poles.

WARNING

The bay station controller is designed for mounting in the horizontal position on a DIN rail NS 35, EN 60715, 19" frame or wall mounted. Ensure that adequate grounding is provided.

CAUTION

Adequate cooling of the bay station controller must be provided. The unit must be installed in the horizontal position for thermal convection. Ventilation grids must not be covered.
Operation outside the admissible ambient temperature range shortens the service life and may result in premature defects.

CAUTION

Do not exceed limits.
Observe the values of the power supply. Exceeding the values can lead to personal injury, damage to the unit or the system.

DANGER

Provide protection against accidental contact. The entire wiring of the power supply module must be touch-proof. When using the power supply module SV-6-x or SV-7, make sure that the protective earth or, in the case of protective extra-low voltage, the functional earth is additionally connected to the supply input X3.

WARNING

Use in racks of the BCU-50 and FW-50 series.

When using in the BCU-50, make sure that the front panel is securely screwed to the BGT. When using voltages > 75 V DC, make sure that the front panels are secured against unintentional removal when used in the FW-50. Unchanged operation is not permitted!

WARNING

The boards CPU-5C /5E are buffered with a rechargeable lithium battery. These cards must be stored in an isolated location;
a short circuit can cause a fire!


CAUTION

Avoid electrostatic discharge
The module contains electronic components that can be destroyed by electrostatic discharge when touched. Observe the safety measures against electrostatic discharge according to DIN EN 61340-5-1 and DIN EN 61340-5-3. Make sure that the environment is sufficiently earthed.


CAUTION

This is Class A equipment.
It may cause radio interference in residential areas. In such cases, the operator may be requested to take appropriate measures.


CAUTION

Warning of hot surface

Immediately after removing assemblies from the subrack, components may exhibit temperatures that are dangerous to touch.


CAUTION

Supply voltages > 75 V DC are not permissible and can cause internal safety components to trip!
Exceptions apply when using appropriate system cards.


CAUTION

Hot swapping live system cards can result in blocking of the extension bus.


CAUTION

Carry out connection according to standard
Connect all supply, measuring and data lines in accordance with the standards. Ensure the correct connection assignment.
The applicable EMC regulations must be observed.


DANGER

Intended use

If the unit is not operated in accordance with the operating instructions, protection is no longer assured and DANGER may result from the unit. The power supply assembly must NOT be operated in the unplugged state. Live parts may be accessible.


WARNING

Observe accident prevention regulations

Always observe all valid accident prevention regulations.


WARNING

Replace defective or damaged units

Replace malfunctioning units immediately.

Project planning / installation guidelines

The following guidelines are intended to provide information about how to integrate the product safely in larger systems or installations.

- Individually applicable safety and accident prevention regulations must be followed.
- Units may only be operated continuously when installed and when the housing is closed.
- It must be possible to de-energise the products at all times (for a fixed connection, from an all-pole mains disconnector, and as required a fuse rated at 2.1*I_N for voltages exceeding 75V DC or for radio applications).
- PE connectors must be connected to the protective conductor.
- Please make sure that the supply voltage matches the specifications in the manual, and that tolerances are maintained.
- Malfunctions cannot be ruled out if values fall below or exceed the tolerances specified.
- In the event of power failures or power interruptions, ensure that the entire installation/system is not transitioned to a dangerous, undefined state.
- Supply cords (especially data transmission cables) must be chosen and installed so as to insure that capacitive and inductive interferences do not impair the facility / system. Adequate measures must be taken to ensure that line interruptions do not result in any undefined states.
- The products must be installed so as to prevent the unintentional triggering of functions.
- Wherever malfunctions can result in material damage or personal injury, additional external safety circuits must be in place (e.g. limit stop switches, mechanical locking devices, etc.)
- The safety of the product relies on appropriate transportation and storage, installation and operation.
- Product repairs may only be carried out by qualified personnel who are familiar with the contents of the manual
(refer to Section "SERVICING").

Proper use

In accordance with the product information and/or the technical description, the components/the unit may only be used in a manner for which they are designed. The relevant safety standards were observed during the development, production, testing and documentation of the product. The product will normally not give rise to any risk of material or personal damage if the handling regulations and safety notes are observed.

Servicing

Products from LACROIX Environment SAE IT-systems GmbH & Co. KG (SAE) may only be serviced by LACROIX/SAE customer support or authorised personnel / companies. Only genuine modules and components may be used. Customers are only authorised to replace modules in cases that are explicitly mentioned in the manual. This work must be carried out by qualified personnel. Standard parts such as fuses must correspond to the specified values. Please also take note of the applicable ESD guidelines for work on open devices and manual contact with circuit boards and electronic components.

CE Conformity

The conformity of the products according to CE is declared in the CE conformity certificates Documents of Conformity DOC for each product, extension or combination of products. Relevant DOCs can be found in the appendix..

Disposal

Disposal of the packaging (if any) and the used parts must be in line with the regulations in the country in which the device is installed.

As defined within the scope of EU legislation, equipment introduced to the market after 13/08/2005 must be disposed of in line with the WEEE Directive (new version: 2012/19/EU). This directive classifies equipment from SAE IT-systems into Category 9 (monitoring and control equipment). Our general terms and conditions regulate potential returns.
WEEE-Reg.-No. DE 31034137

Material prohibitions in RoHS Directive 2011/65/EC

The revision of RoHS Directive 2002/95/EC and the resultant new version (2011/65/EC) mean the scope of this directive is extended further to include all electric and electronic products.

A transition period up to 22/07/2017 applies for SAE IT-systems equipment Category 9 (monitoring and control equipment). Thereafter, the banned substances from RoHS Directive 2011/65/EC enter into force for all newly sold equipment.

According to information from our sub-suppliers at the time, this document was written, no occurrences are known of SVHC substances of very high concern in our products which exceed the limit of notification.

Disclaimer

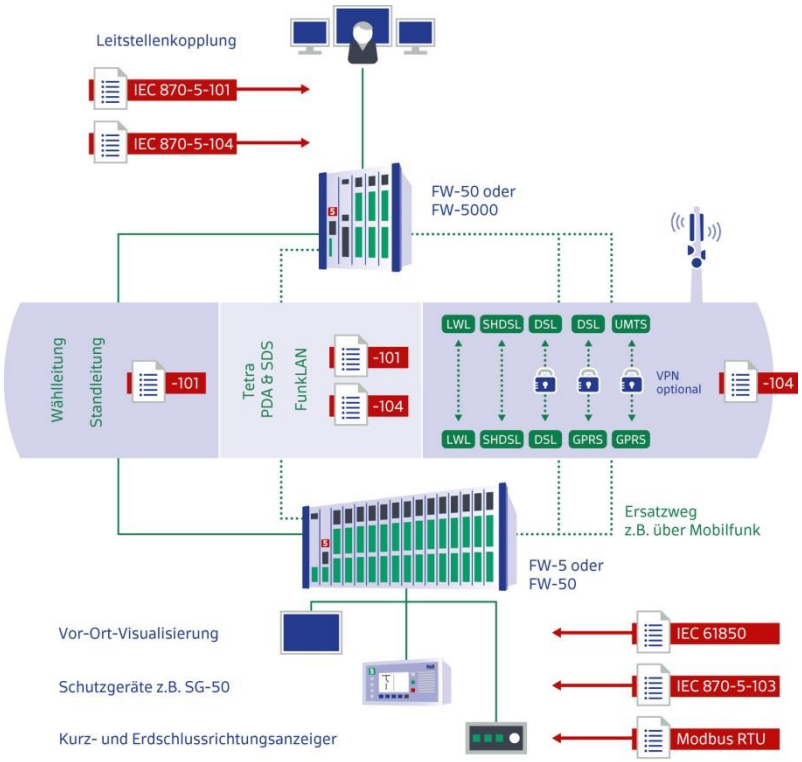
The product and its components must be installed as delivered in accordance with this manual and operated as intended. This applies to both the hardware and the software. Any unauthorised modification shall constitute "misuse" and/or "negligence" within the meaning of the warranty for the product and shall result in the exclusion of liability of LACROIX Environment SAE IT-systems GmbH & Co. KG.

If you wish to change the hardware or software properties, please contact SAE IT-systems GmbH & Co. KG, Cologne. For questions in specific individual cases, the support is available at +49 221 59808-55.

1 System design

Strengths of the BCU-50 series5e

series5e is a product series comprising advanced components proven in industrial use. It combines high performance and storage capacity with extremely simple use for rapid integration in substation automation and power system control. Systems with series5e technology are upwards compatible with better CPU, memory and functionality, and so can meet current requirements of strict IT security.
The BCU-50 series5e supplements the well established range of SAE FW-50 telecontrol systems with its optimum performance, extended functionality in the field of substation control, vibration/shock and insulation resistance to IEC 61850-3, and outstanding ease of operation.



Secure and stable

The net-line BCU-50 series5e is a universally deployable, compact telecontrol station and router that offers a high degree of stability. It meets the demands of ambitious applications of communication and automation, ranging from small to large. The concept offers great modularity thanks to plug-in assemblies with a high degree of interference immunity. Its powerful function modules and convenient cross-connections, flexible PLC functionality and integration of external components, such as the linking of protective units via IEC61850 and IEC 60870-5-103, enable it to be put to optimum use, as for example:

- **Station and bay controller**
  in medium and high-voltage switchgear in bay and power system control
- **Monitoring and control device**
  for utilities, waste management and manufacturing industry
- **Acquisition and communication system**
  in transport and infrastructure applications

Figure 1: BCU-50-M-W with 4 separate LAN segments and redundant 220 V DC supply

Advantages of the new series

The net-line BCU-50 series5e represents a genuine extension of the product range, which is downward-compatible with the successful FW-50 system. All the familiar components of this successful telecontrol system can be used as input/output cards or communication components.

The mechanical design and key adaptations in the electronics mean the BCU-50 is optimised as a bay station controller for substation automation.
The number of communication channels and capacity of the system have been increased considerably. The highly integrated CPU-5E with RISC technology, the optimised bus system and the multi-channel use of both autarkic TCP/IP network segments over integrated switches facilitate enhanced communication capabilities. This allows powerful integrations into structured networks with IEC61850 as well as into existing telecontrol systems (IEC 60870-5-10x) or optimally set up fieldbus systems.

IEC 61850-3

The BCU-50 series5e has been consistently developed towards product standard DIN EN 61850-3 (communication system for automation in the electric power supply) for the highest class of high-voltage switchboards "H" and connections "h", which also cover the other areas. Therefore, the dielectric strength of 2.5 kV AC/3.5 kV DC and 5-kV surge voltage also conforms to the VW3 class according to IEC 60870-2-1.

Vibration resistance

With vibration resistance of 10 m/s as per DIN EN 60068-2-6 and shock resistance of 15 g (150 m/s²) as well as a continuous shock load of 10g give a stress immunity of 6000 shocks in accordance with IEC 60068-2-27, the system is able to withstand a good deal.

Earthquake resistance

To withstand the mechanical stresses in areas exposed to the risk of earthquake as well, the system can also tolerate seismic vibrations up to 3.5 mm in accordance with EN 60255-21-3 (measuring relays and protection equipment) on each axis.

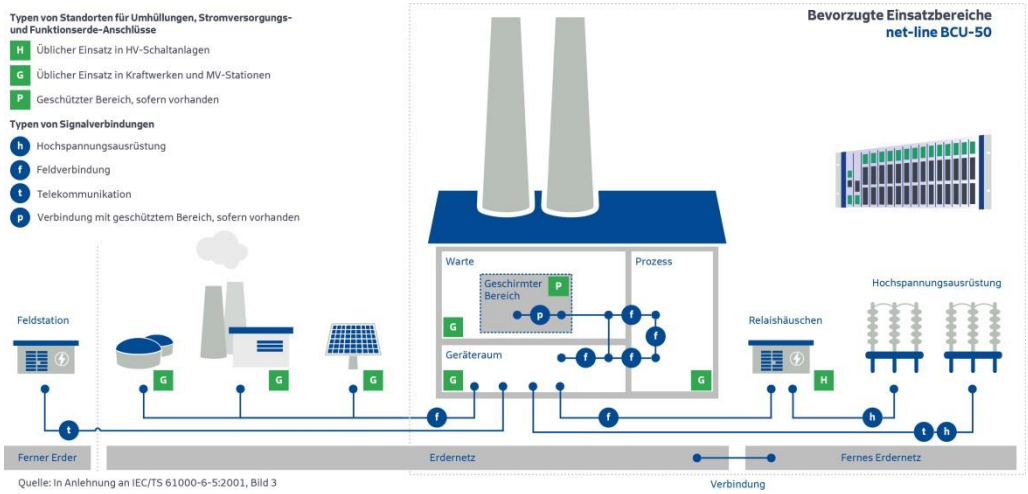


Figure 2 Suitability of the BCU-50 series5e as defined in IEC 61850-3

The latest series5e technology

What does the "**e**" offer?

The communication requirements of a telecontrol / station control system in an intelligent network are becoming increasingly demanding. At the same time, greater demands are being made of network security - greater dangers from unauthorised access and manipulation are arising due to increased levels of networking. To meet these requirements, we have implemented a yet more powerful processor core in the series5e technology.

The series5e is fully downwards compatible with the series5 and series5+. With a yet more powerful process core, the series5e boasts at least three times the performance of the series5+ with its general computing power. For computing intensive applications, more benefits are realised by the integrated FPU floating point unit. For purposes of distinction, the symbol on the left can be found on all new products.
The new technology is deployed in these telecontrol units:

- net-line **m5**
- net-line **FW-5 series5e**
- net-line **FW-5-GATE series5e**
- net-line **FW-5-GATE-4G**/ **FW-5-GATE-4G-2**
- net-line **FW-5-GATE-450**
- net-line **FW-50 series5e**
- net-line **BCU-50 series5e**
- net-line **FW-5000 series5e**

Increased performance of the series5e
series5e products offer better performance and greater memory depths:

- Full downward compatibility to series5+
- Hardened Linux kernel
- Secure platform for high levels of IT security to BDEW whitepaper
- Front LED for VPN-tunnel, interfaces and system
- 1200 MIPs RISC CPU with up to 3 times the processing speed
- 1 GB memory, 512 MB RAM / 512 MB Flash
- Real-time clock backed up with Li- ion cell for min. 60 days
- 512 kB SRAM backed up, 8 MB NOR Flash for reliable boot processes

Note: **setIT Version 5.004 or higher is required to use the series5e**

In addition to the exclusively technical hardware updates, numerous software functions can be used in the new releases:

setIT V5 features
series5e products offer better performance and greater memory depths:

- Complex integration of standard protocols for:
  - IEC 61850 client and server [e], GOOSE messages [e]
  - IEC 60870-5-104
  - IEC 60870-5-101/- 103
  - DNP3 outstation
- Protocol converter mode for conversion without process data configuration
- SMART meter link over SML or IEC 62056-21 meter protocol
- DSfG interface
- Various field buses, e.g. Modbus RTU/TCP, Profibus-DP, 3964R and MPI
- SNMPv3 protocol for status messages from network components
- Extensive upgrades of the redundancy concept
- Selective archive query via IEC-101/-104
- Flexible archive exports
- Some prerequisites for secure operation as per the BDEW whitepaper:
  - IPsec IKEv1/IKEv2 and OpenVPN [#6] for secure VPN tunnel
  - RBAC role-based access control user administration for setIT and web server with role assignments as per BDEW whitepaper
  - Central user management for the web-server via LDAP/RADIUS [#6]
  - SYSLOG: central logging of operational messages and processes Syslog filter [e] and Syslog process data indications [e]
  - setIT and embedded system patch management concept

  ...

e series5e only, [#6] from setIT V6

Products

The BCU-50 series5e system is so variable that division into router and custom configurations with fixed interface assignments can no longer be presented transparently in understandable product types. Nevertheless a differentiation was necessary due to the different housing sizes. Similarly, just using it as a router with up to 6 network segments and 4 serial interfaces is possible.

Figure 3: BCU-50 & BCU-50-M, 19" and wall-mounting

Different housing sizes are available, depending on the expansion, size and application. The BCU-50 series5e series also remains variable; it enables a free product choice from:

- **net-line BCU-50** field & station controller with up to 14 I/O cards in 19" installation frame
- **net-line BCU-50-W** field & station controller with up to 14 I/O cards Wall-mounting
- **net-line BCU-50-M** BCU-50 with up to 7 I/O cards, DIN top-hat rail
- **net-line BCU-50-M-W** BCU-50 with up to 7 I/O cards, wall-mounting

The assembly of the system is no longer determined by a product type, but can be freely configured and used within the scope of hardware limits and customer demands.

Product overview

The modular concept of the BCU-50 series5e enables custom-fit selection of system cards for the respective application. A large number of input/output modules and interfaces as well as a huge selection of software functions adapts the performance of the system to its requirements. If there is insufficient capacity, very high capacities can be provided in a station by cascading several racks.
A setIT licence is required for configuration see **Fehler! Verweisquelle konnte nicht gefunden werden.** on Page **Fehler! Textmarke nicht definiert.** and **Fehler! Verweisquelle konnte nicht gefunden werden.** on Page **Fehler! Textmarke nicht definiert.**. Additional run-time licences may be required depending on usage.

Item BCU-50 series5e

The units described here are ready-to-use sets comprising:

- Rack
- CPU modules
- Base software for series5e run-time system
- Power supply not absolute requirement for BCU-50-M

with the equipment features stated. These basic sets must be assembled with the desired interfaces and I/O cards and equipped with software functions configured with setIT. The technological development - to provide appropriate IT security in particular - led to an evolution of the CPU modules which are taken into consideration in the following sets.

Item no.	Item series5+ with CPU-5C	Function
310050500000	net-line BCU-50	Bay station controller, 14 slots, CPU-5C, 19"
310050500100	net-line BCU-50-W	BCU, 14 slots, CPU-5C, wall-mounting

Item no.	Item series5e with CPU-5E	Function
310050500001	net-line BCU-50-L series5e	Bay station controller, 14 slots, CPU-5E, 19" rack
310050500101	net-line BCU-50-L-W series5e	Bay station controller, 14 slots, CPU-5E, wall-mounting
310050500111	net-line BCU-50-M-W	Bay station controller, 7 slots, CPU-5E, wall-mounting
310050500311	net-line BCU-50-M-DIN	Bay station controller, 7 slots, CPU-5E, DIN top-hat rail mounting

Item no.	Racks & accessories	Function
310050502001	Rack BCU-50-L	19" housing, 14 slots, with FP, without PS/CPU
310050502002	Rack BCU-50-Ls	19" 14 slots, , BGTbus with FP, without PS/CPU
310050502100	Rack BCU-50-L-W	Wall housing, 14 slots, with FP, without PS/CPU
310050502101	Rack BCU-50-Ls-W	Wall, 14 slots,BGTbus with FP, without PS/CPU
310050502110	Rack BCU-50-M-W	Wall housing, 7 slots, with FP, without CPU
310050502310	Rack BCU-50-M-DIN	DIN top-hat rails, 7 slots, with FP, without CPU
310050502901	Cable tray BCU-50-L	Strain relief option for 19" rack frame
310050502910	Cable tray BCU-50-L-W	Strain relief option for BCU-50-W
310050502920	Cable tray BCU-50-M	Strain relief option for RACK-50-M

Software & Drivers

Item no.	Item	Function
310050015000	setIT V.5 DemoExtended 30 days	Demo version for setIT V5
310050015010	setIT V.5 single user licence (SUL)	Single user licence
310050015110	setIT V.5 multiple user licence (MUL)	Multiple user licence, per additional user
310050015210	setIT V.5 Company user license (CUL)	Company user license
310050014000	visIT V6 Designer Demo	visIT Designer demo version
310050014010	visIT V6 Designer L-E	Designer SUL 1000 days per station
310050014050	visIT V6 Designer MUL	visIT Designer MUL, network dongle
310000176000	codeIT PLC programming software (SUL)	Single user licence
310000176100	codeIT multiple user licence (MUL)	Multiple user licence
310000176200	codeIT company user licence (CUL)	Company user license
310000176300	codeIT DemoExtended 30 days	codeIT demo version
310050011101	codeIT runtime FW-5 (IEC-61131-3)	Runtime for codeIT (64 kB) Variant 2
310050010010	net-line Grundsoftware series5 BGT-S	Betriebssystem series5
310050010040	net-line Grundsoftware series5 BGT-M	Betriebssystem series5
310050010000	net-line Grundsoftware series5 BGT-L	Betriebssystem series5
310050501000	net-line Grundsoftware BCU-50	Betriebssystem BCU-50
310004010400	net-line driver for IEC-870-5-101/104	Included in the basic software
310004010800	net-line driver for 3964R/RK512	Included in the basic software
310004010900	net-line driver for Modbus	Included in the basic software
310004010910	net-line driver for DSfG	Interconnection of external device
310050010020	net-line driver for IEC-870-5-103	Protective coupler, 1x IEC 60870-5-103
310050010101	net-line driver for IEC-61850 FW-5	For FW-5-xxx
310050010200	net-line driver for SML	From series5+
310050010300	net-line driver for IEC 62056-21	From series5+
310050010400	net-line driver for DNP3 server	From series5+
310050010600	visIT runtime FW-5	Visualisation system runtime

Product features of the BCU-50 series5e

The BCU-50 series5e is available as different variants. Further versions are possible following customers requests.

Design	Modular station control, telecontrol and automation system, plastic/V2A/aluminium rack with 7/14 slots for integrated I/O and communication components
Configuration	**BCU-50-L** Examples: **Max. inputs/outputs** 14 I/O slots (up to 224 dedicated I/O) 2 Ethernet 10/100BaseTx auto-MDIX **Max. communication** 6 switches integrated with 4 RJ-45 100 Mbit/s or 2 RJ-45+ 2 FO FC connectors each 12 serial ports, 4 internal + 8 USB485# 28 FO couplers / star couplers -103, alternative to serial*
Input/output	Selection of more than **50 plug-in card**s for: Single-point, double-point, transformer step indications, measured values and integrated totals, single/double commands (1.5/2-pole), command termination, 1 of n monitoring, set-point values, integrated total outputs
IT security	● **BDEW whitepaper** compliant implementation and integration ● **Firewall** with hardened operating system / kernel ● **End-to-end tunnel via VPN** IPsec IKEv1/IKEv2, OpenVPN* ● SYSLOG server ● **System commands** for temporary enabling of diagnostics access ● **Signed firmware and database**
Capacity	**Flexible process data declaration** for: Single/double-point and step position information, alarms, measured values, integrated totals, single / double and regulating step commands, integrated total outputs
Communication	**2** **Ethernet LAN** TCP/IP, 10/100BaseTx, auto-MDIX, auto negotiation **4** **additional LAN segments** via switches with internal USB **4** **serial interfaces**, modularly configured, galv. isolated: RS-485, RS-422, RS-232, WT-12/96, BBM, TTY **8** other serial ports over USB485* extendable to 28 FO couplers / star couplers -103 **2** **USB service and diagnostic interfaces** USB device with DHCP server USB 2.0 host, 12 Mbit/s (configuration/archive via memory stick)
Protocols	● **IEC 61850** Station bus, client/server ● **IEC 60870-5-101** Telecontrol, bay control technology ● **IEC 60870-5-103** Interconnection of protective equipment ● **IEC 60870-5-104** Control centre link TCP/IP ● **DNP3** server telecontrol, serial/UDP ● **IEC 62056-21** Meter interface (formerly IEC 1107) ● **SYM²**/SML Meter interface via network ● **DSfG** Interface for natural gas ● **SNMP/SNMPv3** Read router status information ● **https/FTPs** Secure communication ● **IPsec IKEv1, IKEv2** Encryptions / VPN tunnel ● **SYSLOG** Central information server ● **Modbus** RTU/TCP Master/Slave ● **MPI / 3964R**/RK512 S7 link ● **HHH** Horstmann GSM reporter ● **NTP/DCF clock** synchronisation
PLC programming	IEC 61131-3 programming via codeIT, program memory 128 kB

use the same resources in part, * from setIT V6

Short-form profile of the net-line BCU-50-L
Compact, scalable IEC 61850-3 compatible bay station controller in BCU-50 housing for modular configuration with communication components and input/output cards in 7 or 14 I/O slots for the direct link-up of single-point/double-point/step position information, counter values, measured values, and single/double/regulating step commands, command termination with 1 of n switching commands (1.5 + 2-pole), set point values and flexible data cross-connection/inter-communication in the network, in the 5 HU 19" rack.

High-performance Ethernet integration in up to 6 isolated network segments (with SWI-2-x) via integrated switches each with 4*10/100BaseTx or FO +10/100BaseTx; up to 12 serial interfaces for linking via IEC 60870-5-10x protocol to integrate protective equipment via IEC 61850, IEC 60870-5-103 protocol, smart meter 62056-21, SML, SNMP or external bay station controllers with Modbus, DSfG and MPI fieldbuses. Installation: DIN top-hat rail, 19" rack, wall and rear wall. Voltage supply 24/ 48/ 60/ 110/ 220 V DC, also redundant.

Short-form profile of the net-line BCU-50-L-W
As BCU-50-L, with wall-mounting

Short-form profile of the net-line BCU-50-M-W
As BCU-50-L, with 7 slots for rack modules, wall-mounting

Short-form profile of the net-line BCU-50-M-DIN
As BCU-50-L, with 7 slots for rack modules, DIN top-hat rail mounting

Communication

A wide range of external communication modules using communication channels and protocols established on the market are available.

Protocols

- TCP-IP coupling for integration in networks at 10/100 BaseTx
  - IEC 61850 client and server
  - IEC 60870-5-104
  - IEC 62056-21 over IP
  - DNP3
  - SML
  - Modbus TCP
  - http/https, FTP/FTPs
  - SNMP/SNMPv3
  - VPN tunnel IPsec, OpenVPN[#6]
  - other services such as NTP, ...
- serial on RS-485, CL or V.24 /EIA/RS-232 depending on availability
  - IEC 60870-5-103 Interconnection of protective equipment
  - IEC 60870-5-101 Bay station controller interconnection
  - IEC 62056-21 Meter connectivity
  - DSfG
  - Modbus RTU/ASCII
  - MPI /3964R-RK512
  - PPP protocol

External communication units

- TCP-IP coupling for integration in network
  - GPRS/EDGE *
  - SHDSL*
- RS-485
  - Application of star couplers for linkage of protective equipment
- V.24 /EIA/RS-232
  - Dial-up modem analogue*
  - GSM*
  - ISDN adapter*
  - VFT modem*
  - Serial GPRS link*
  - TETRA packet data*
  - Profibus-DP master/slave*
  - ...

* External module required, [#6] from setIT V6

Configuration & diagnostics

Parameterisation by selection with setIT

All net-line systems are configured and diagnosed with the integrated setIT configuration tool. Combined with the new capabilities of series5/series5+/series5e, the functions provided here feature market-leading technology which enables intuitive setup and reliable startup, together with powerful diagnostics.

series5 offers multiple options for configuration and diagnostics:

- Loading the configuration from an SD card
- USB host for speedy transfer and backup of configuration and archives from USB memory stick
- TCP/IP network connection, internet connection
- USB device as configuration/diagnostics interface USB 2.0 cable

The setIT tool is available in user-oriented license models:

Article setITV7	Lizense model	
310050017010	**setIT V.7 Single-user (SUL)**	Single user licence
310050017015	setIT V.7 INT Single-user SUL	Single user licence International
310050017020	**setIT V.7 workbench (SUL)**	Single-user +PLC Programming
310050017025	setIT V.7 workbench INT (SUL)	SUL+PLC Programming International
310050017210	setIT V.7 Company license (CUL)	Company user licence
310050017215	setIT V.7 INT Firmenlizenz (CUL)	Company user licence international
310050017220	setIT V.7 workbench (CUL)	setIT & straton - Company license
310050017225	setIT V.7 workbench INT (CUL)	setIT & straton -Company International

Licences with workbench allow integrated PLC programming with straton according to IEC 61131-3.
Licences with INT are optimised for international use with easier selection through reduction to current components.

The relevant usage and license conditions apply EULA.

The ease of commissioning and maintenance

The real-time operating system renders possible the quantum leap to an open system featuring new milestones in terms of speed, memory depth and ease of use. A USB memory stick can be used to update the configuration and system within seconds, or to read and save existing systems and archives as backups.

There are also new means of performing system download and diagnosis. The high-speed upload for instance uses the http internet protocol to load stations quickly and without barriers – both locally and globally*. Diagnosis via web server offers immediate control of the system status and process values all the way to interface analysis; this does not require a setIT licence and can be accessed from any laptop.* For reachable network access from system

- High speed load via network connection or internet
- USB memory stick for speedy startup and updates
- Backup of configuration, system and archives to USB memory stick
- Archive memory expansion via SD card (to 8 GB)

##+straton
##+codeIT
##+visIT

2 Installation notes

Troubleshooting & installation guidelines

Telecontrol systems from SAE IT-systems GmbH & Co. KG (SAE) are state-of-the-art electronic devices. Both the mechanical structure and the setup of electronic components are designed for industrial applications.
It is nevertheless imperative to take certain essential measures when installing these units in order to ensure their smooth operation.


CAUTION

Please take note!

Earthing

Interference voltages injected into the unit via the supply and signal line and electrostatic voltages transferred by touching are diverted to the earthing point (Integrated earthing contact to the top-hat rail, own terminal or flat plug in the side panels).

This earthing point of the DIN top-hat rail must be connected to station earth with a low-resistance copper conductor which is as short as possible **min. 4 mm²** or must be included in equipotential bonding.
If this is neglected, all measures taken within the unit for reaching a high resistance to damage and interference may be rendered partly ineffective.

When selecting the installation site, make sure the greatest possible distance to electromagnetic interference fields is observed. This is particularly important if frequency converters are in place. In certain circumstances, it may be advisable to seal off any interference-creating devices with pass partition plates.

Inductive loads in the vicinity (e.g. contactor, relay and solenoid valve coils) must be fitted with snubbers (e.g. RC snubber circuits) if they share the same power supply.

The power supply and data line(s) should be realised so as to keep interference away. This can be done, e.g., by not laying the cables parallel to the high-voltage power lines that are likely to cause interference.

Surge protection

To increase isolation and protection against surges, supply lines (of interfaces in particular) can be configured with appropriate upstream surge protection. For FSK modems MOD12, WT12, WT96, SWT12, SWT96... and the baseband modem, a combination of AF-line transformer NFLÜ/BBÜ/PCM-FLÜ AF line transformer and surge protection is recommended.

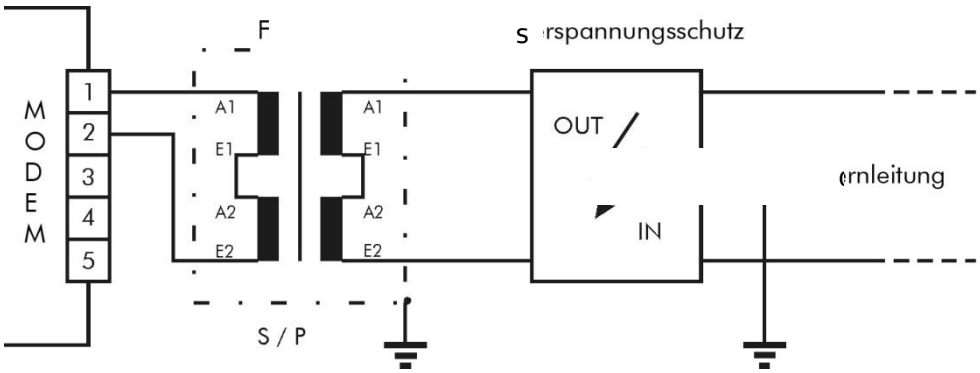


Figure 4: Example surge protection and baseband transformer in front of telecom modem

Shielding lines

Shielding is an important measure for weakening (attenuating) magnetic, electric and electromagnetic interference fields.

Shielding methods

When using shielded lines, only use lines with **braid** if possible (>80% coincidence recommended).
Avoid cables with **foil shielding** as the foil does not shield all frequencies uniformly. In addition, tension and pressure loads can damage foil shields during installation or operation and thus become ineffective.

One-sided or double-sided shielding connection

Using **double-sided shielding** is generally the only way of guaranteeing ideal reduction of all interference frequencies.

One-sided shielding can be more favourable when:
- a potential difference occurs and equipotential bonding is not possible
- there is foil shielding

Shielding connection

A low-impedance link to the protective conductor or protective conductor rail is essential to prevent the interference currents fed into the cable shielding from becoming sources of interference themselves.

We recommend stripping the shielded cable as a continuous strip and applying it to ground.
The shielding end at the interface is not re-applied in this case.
With this type of shield you should use cable clamps made of metal which comprehensive enclose the shielding braids and establish a good contact.

Serial interfaces

All serial interfaces with fixed reference potential such as RS-232/V.24, TTY should be connected with shielded cables.

Analogue inputs

Analogue inputs should always be connected with shielded lines.

Selection of cabinets

Please consider the following criteria for the selection and dimensioning of cabinets:

- Environmental operating conditions at the installation location of the cabinet
- Required distances for substation automation and telecontrol systems
- Total power dissipation of components contained in the cabinet
- Empty enclosure standard IEC/EN 62208 for cabinet construction

Ambient conditions on site (e.g. temperature, humidity, chemical evaporation, explosion hazard) predict the required protection category (IPxx) of the cabinet.

Appropriate ambient temperature and cooling

Cabinet dimensions must ensure that the telecontrol systems
are not exposed to ambient temperatures exceeding 70°C.
The temperature range can also be limited to below 50°C depending on configuration, activation and variant. The temperature sensor in the net-line m5 enables you to check the temperature in the inlet air in the housing. Self-heating means a temperature typically exaggerated by +10°K is measured - this can be calibrated with a calculated value.

Possible measures:

- Installation preferable in the lower area of the cabinet
- Sufficient air for convection on the left of the base system in particular
- Closed cabinet with natural convection and forced recirculation via fan
- Cabinet with open-circuit ventilation via natural convection
- Closed cabinet with heat exchanger

Devices may be damaged!
Adequate cooling of the station controller must be provided. The unit must be installed in the horizontal position for thermal convection.

Ventilation grids must not be covered..

Operation outside the ambient temperature permitted shortens the service life and may result in premature outage.

Example of ambient temperature:
At a cabinet ambient temperature of 30°C and a typical difference of 20°K between outside and inside temperature of the cabinet (for maximum permitted power loss of all internal components), a temperature of 50°C is reached inside the cabinet. For other temperature differences, refer to the temperature characteristics provided by cabinet manufacturers.

3 Installation of a telecontrol station

###

1. Mounting a telecontrol station

Installation guidelines

The housing of the FW-50 system is designed for wall-mounting, mounting to DIN top-hat rail or for installation in base frames or cabinets. The mounting dimensions can be derived from the following sections.

According to UL/CSA and EC Directive 73/23/EEC (Low Voltage Directive), installation in a cabinet, housing or enclosed operating room is required in order to satisfy the guidelines for electrical safety.

Under extreme environmental operating conditions, particularly, when using telecontrol systems in cabinets, it might be necessary to install a fan module to optimise the air flow.

Modules with high self-heating

Modules were developed for the telecontrol system FW-50 which demonstrated higher self-heating due to the stipulated requirements and performances.
If these cards are operated with their max. power consumption, additional air flow needs to be provided. This air flow should take place from the bottom of the telecontrol unit housing.

Module	Restrictions
4AA12-1	At ambient temperatures of >40°°C and without additional recirculating air no more than 50% of the output channels should be statically controlled with 20 mA.
16RA-1	At ambient temperatures of >40°°C and without additional recirculating air not more thar 50% of the card relays should be statically tightened.

Maintaining minimum distances

During installation in cabinets or housings it must be ensured that the internal cabinet temperature does not exceed the maximum operating temperature specified for the unit.

It must take specific minimum distances between the FW-50 system and neighbouring equipment into consideration.

These minimum distances are need during mounting and operation

- to assemble and disassembly system cards, taking down the individual front panels
- to ensure the air flow needed to heat the modules during operation

The following image shows which minimum distance you must provide for a telecontrol station (here FWR-40).

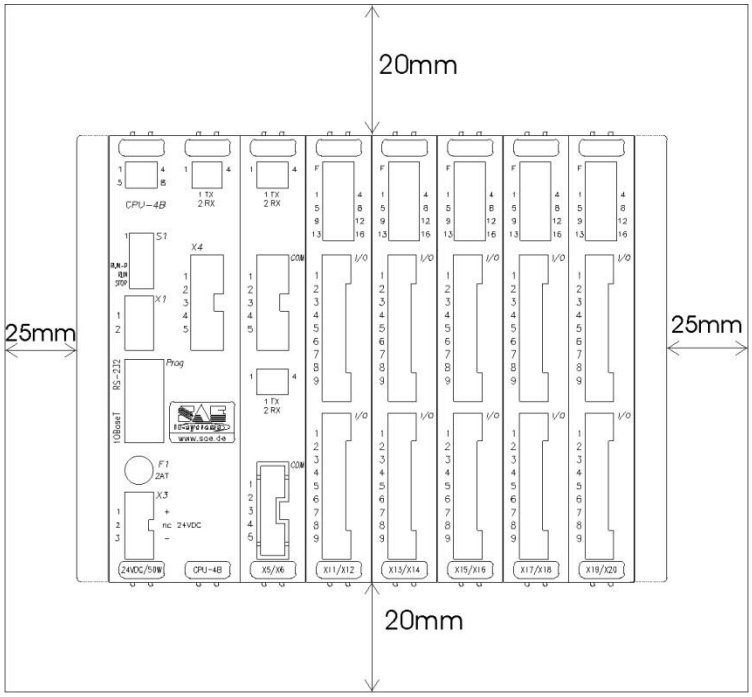


Figure 5: Recommended mounting in a cabinet

For the use of modules with high power consumption (e.g. RA16) we recommend scheduling bigger distances than those displayed above.

Housing mounted one below the other

If several FW-50 systems are mounted in the same cabinet or racks, additional distances need to be maintained and/or air flow/recirculating must be provided between the individual housings.
Depending on the cabinet size and thermal dissipation loss within the cabinet, the minimum distance of 20 mm between two housings mounted above one another can be increased to the necessary minimum distance of 60... 80 mm.

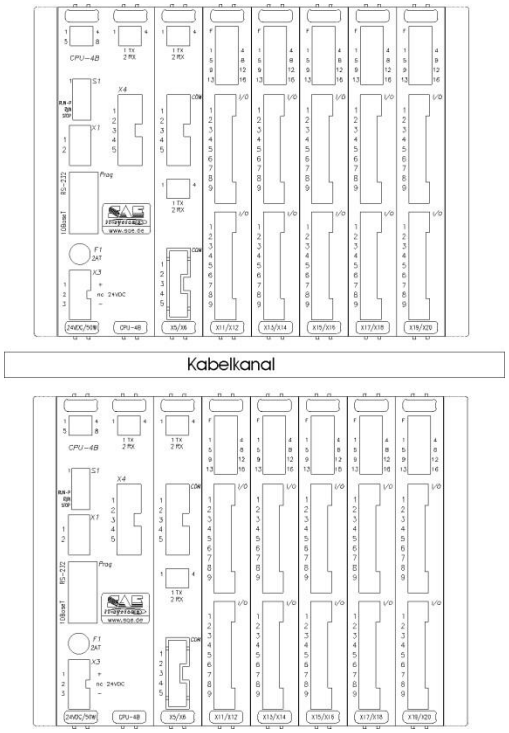


Figure 6: Recommendd mounting in a cabinet

Connecting telecontrol system with local ground

Connect the housing with the local ground. For this purpose, flat plugs 6.3 mm are provided on the left and right wall of the housing. If possible, use the flat plug on the left side. Here, there is a low impedance connection to the noise filter of the telecontrol system.

Minimum cross section of the cable to the local ground: 2.5 mm²

For an improved low impedance connection in a heavily disturbed environment, we recommend a cross section of 6 mm².

Cable cross section	Flat plug 6.3 mm
1.0 .. 2.5 mm²	according to DIN 46245
2.5 .. 6.0 mm²	according to DIN 46245

Installation dimensions BCU-50

BCU-50-M

The subrack of the BCU-50-M is prepared for DIN rail mounting. It can optionally be supplemented with a cable collecting tray.
The mounting type is not suitable for harsh environmental requirements according to IEC 61850-3 with shock and earthquake resistance, as the DIN rail TS35 does not fulfil sufficient stability in all axes here.
The subracks are manufactured according to standard DIN EN 485-T1.

Item no.	Subracks & Accessories	Function
310050502310	Subrack BCU-50-M-DIN	DIN top-hat rail 7 slots with FP without SV/CPU
310050502920	Cable collecting tray BCU-50-M	Strain relief option for BGT-50-M

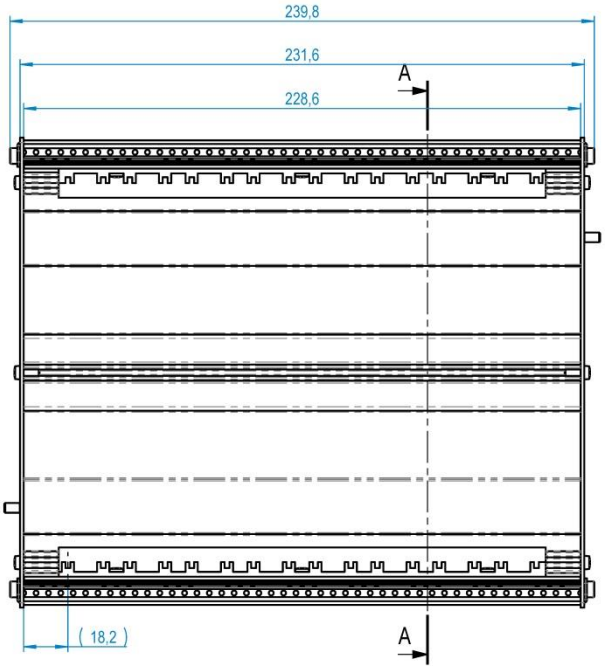


Figure 7 Mounting dimensions BCU-50-M DIN top-hat rail

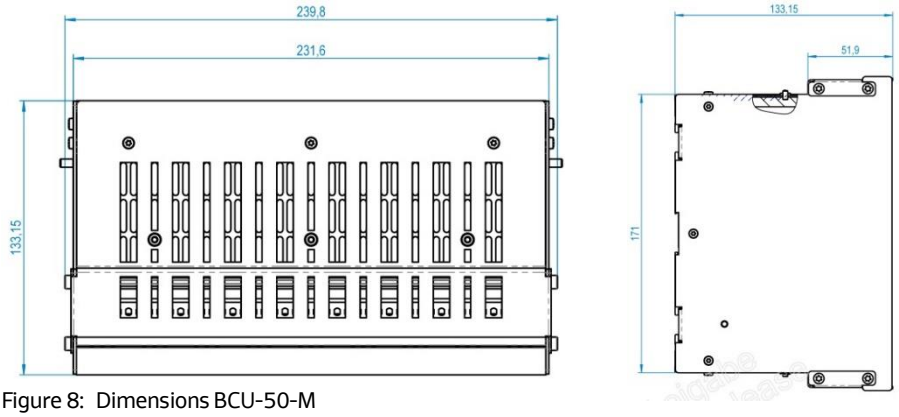


Figure 8: Dimensions BCU-50-M

BCU-50-M-W

The subrack of the BCU-50-M-W is prepared for wall mounting. It can optionally be supplemented with a cable collecting tray.
The subracks are manufactured according to standard DIN EN 485-T1.

Item no.	Subracks & Accessories	Function
310050502110	Subrack BCU-50-M-W	Wall-mounted enclosure 7 slots with FP without SV/CPU
310050502920	Cable collecting tray BCU-50-M	Strain relief option for BGT-50-M

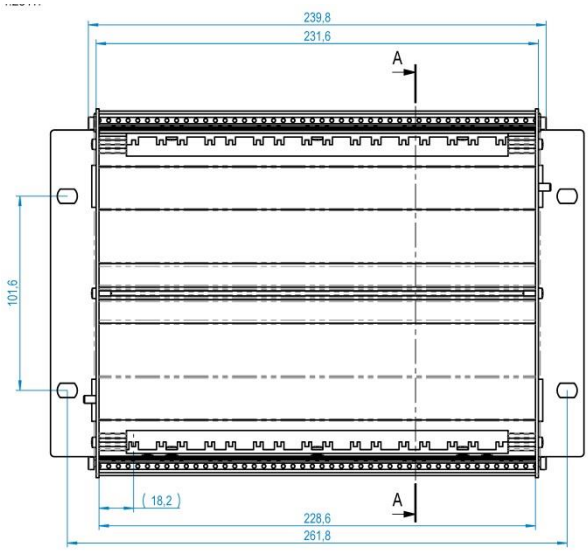


Figure 9 Mounting dimensions BCU-50-M-W for wall mounting

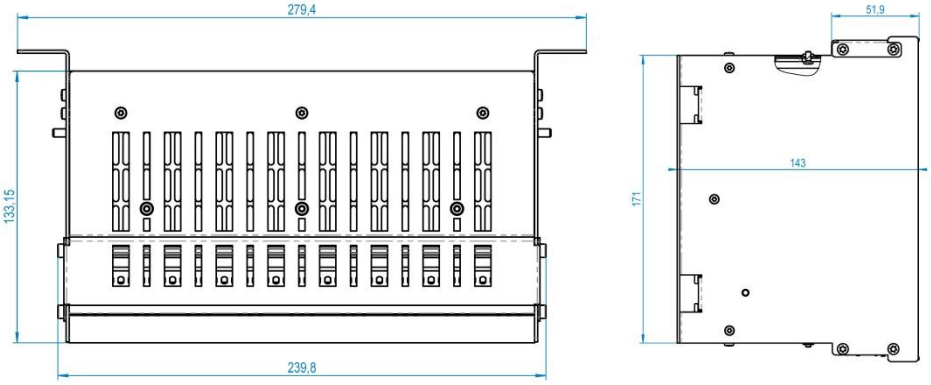


Figure 10: Dimensions BCU-50-M-W

BCU-50-twin

The BCU-50-twin is a mechanical variant in which two BCU-50-M systems are accommodated in a common housing of size BGT-L in 19" mounting frames. Two BCU-50-M backplanes are installed in one BCU-50-L enclosure/subrack.
This allows two heads to be used in a confined space in 19" frames.

Two BCU-50-M are mechanically mounted in a common housing:

- Both systems are only mechanically assembled together.
- Both systems are managed independently of each other separately in setIT.
- The equipment and power supply is identical to BCU-50-M
- Both systems are supplied with power separately;
  - there is no redundancy of the plugged supplies as they are separate systems; the buses are NOT coupled/connected to each other.
- The placement options are identical to BCU-50-M.

Item no.	Subracks & Accessories	Function
310050502010	Subrack BCU-50-twin 19"	19" case 2*7 slots with FP without CPU
310050502901	Cable collecting tray BCU-50-L	Strain relief option for BGT 19" frame

The installation dimensions and mounting options correspond to the BCU-50-L.

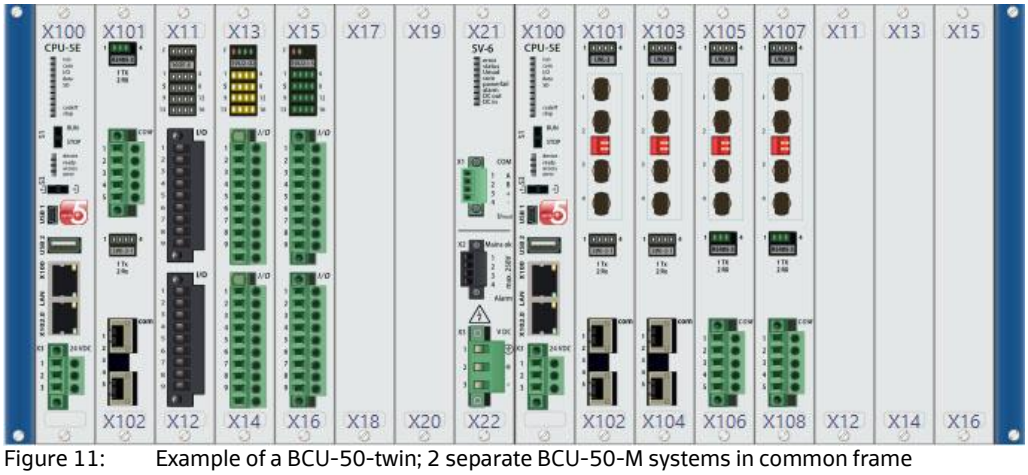


Figure 11: Example of a BCU-50-twin; 2 separate BCU-50-M systems in common frame

BCU-50-L

The subrack of the BCU-50-L is prepared for 19" mounting in a rack or appropriately equipped switch cabinet. Optionally, it can be supplemented with a cable collecting tray to form a unit with 5 HU.
The subracks are manufactured according to standard DIN EN 485-T1.

Item no.	Subracks & Accessories	Function
310050502001	Subrack BCU-50-L	19" case 14 slots with FP without SV/CPU
310050502002	Subrack BCU-50-Ls *	19" case 14 slots with FP without SV/CPU
310050502901	Cable collecting tray BCU-50-L	Strain relief option for BGT 19" frame

* supports the serial connection of the SV-6-x, SV-7

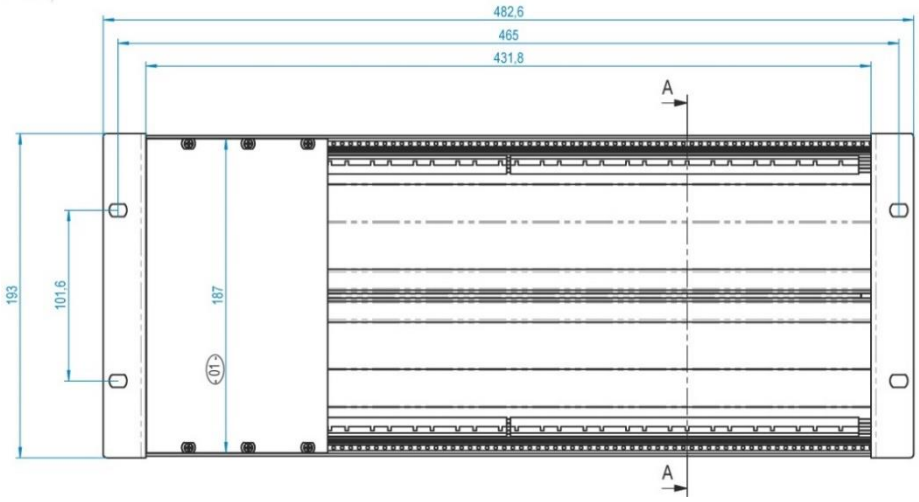


Figure 12 Mounting dimensions BCU-50-L 19" plug-in unit

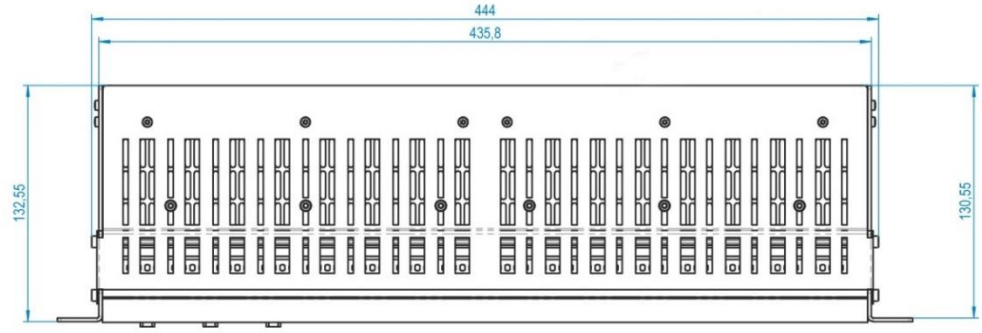


Figure 13: Dimensions BCU-50-L

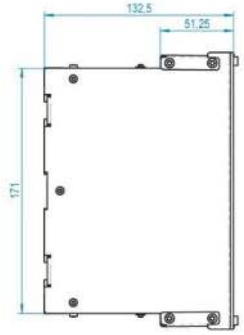


Figure 14: Installation depth BCU-50-L

BCU-50-L-W

The subrack of the BCU-50-L-W is prepared for wall mounting, e.g. on a mounting plate in an appropriately equipped control cabinet. It can optionally be supplemented with a cable collecting tray.
The subracks are manufactured according to standard DIN EN 485-T1.

Item no.	Subracks & Accessories	Function
310050502100	Subrack BCU-50-L-W	Wall-mounted enclosure 14 slots with FP without SV/CPU
310050502101	Subrack BCU-50-Ls-W *	Wall-mounted enclosure 14 slots with FP without SV/CPU
310050502910	Cable collecting tray BCU-50-LW	Strain relief option for BCU-50-W

* supports the serial connection of the SV-6-x, SV-7

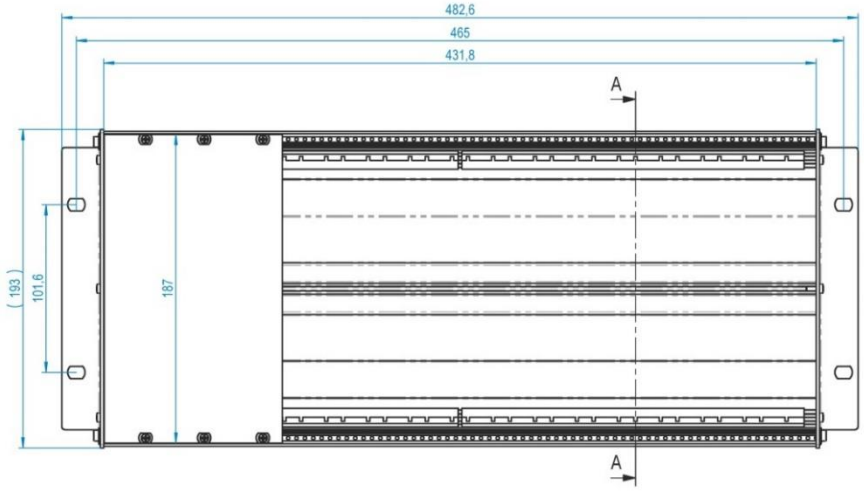


Figure 15 Mounting dimensions BCU-50-L-W

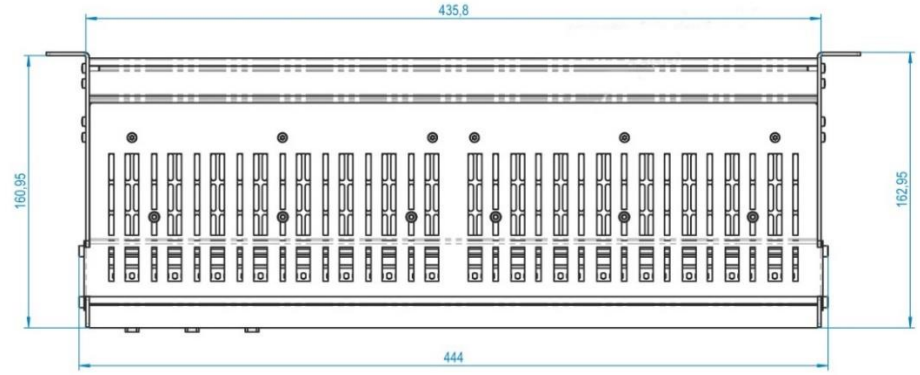


Figure 16: Dimensions BCU-50-L-W

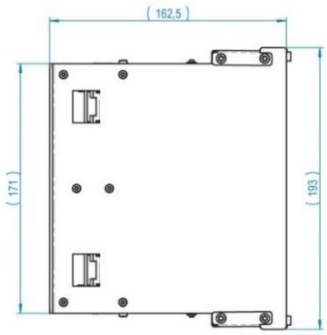


Figure 17: Installation depth BCU-50-L-W

Guidelines for operation

The FW-50 system is a modular system with detachable front panels. This results in the following guidelines:

WARNING - Danger

Once the front panels have been removed, parts of the unit which may be under dangerous voltage can become accessible. This is particularly applicable to alarm or command system cards (relay) with an operational voltage of more than 48 V AC or 60 V DC.

Approach for replacing system cards

1. Ensure that the supply voltage of the telecontrol system is switched off
2. Ensure that the process/switching voltage at the reporting or command channels is switched off.
3. Remove the respective plug connectors of reporting and command channels
4. Loosen the lock of the front panels and pull out the system card at the upper plug connector on the system card out of the telecontrol system.
5. Insert the system card to telecontrol system by applying pressure on the upper plug connector of the system card.
6. Insert the respective plug connectors for the reporting or command channels
7. Switch the process/switching voltage and supply voltages of the telecontrol system back on
8. Check the functionality of cards based on the LED status

ATTENTION

Removing or inserting system cards under voltage can lead to the destruction of these system cards and thus, to a defect of the telecontrol function.

Process/switching voltage

When selecting a switching voltage (supply), ensure the DC feed is adequately smoothed. The sensitive optocoupler and digital inputs may recognise excessively strong remaining ripples as signals - potentially resulting in incorrect information and incorrect switching.

Connection guidelines for signals and commands with voltages > 48 V AC or > 60 V DC

If information and command I/O are operated with dangerous voltages arrangements for the protection of individuals has got to be made. We use **black** terminals in the I/O area for colour coding of possible dangerous process voltages.

DANGER

Before starting work, break all pole, pull plugs and deenergize!

Plugs have to carry a sign "Danger High Voltage" using tensions > 75 V.
Only use power signals with unique source.
Only use the given black terminals to prevent any swap with signals ≤ 75 V DC by different of colour.
Single braids have to be fixed mechanically to prevent a jump over of a energized braid to a neighboured board below 75 V DC.

WARNING

Inobservance may be harmful for the lives and health of personnel!

CAUTION

To fulfill the requirements for an electrical safety, the mounting and operation of the devices only is permitted in a case or a housing with protection class IP 56 or better or in an enclosed operating room!

Connection guidelines for modems

All dial up- and dedicated line modems which are available for the system have a separation with doubled or increased isolation. The modules are verified with 3000 V burst and 2000 V surge AC.

In order to provide additional protection for dial-up modems and leased circuit modules, they should not be operated without external surge protection modules, and if required with further line disconnectors such as AF NFLÜ for WT12/SWT12 or broadband transmission transformers PCM-FLÜ using WT96/SWT96.

WARNING

When carrying out servicing work on modem modules or any neighbouring modules, please note that dangerously high voltages might be present on these modules.

Prior to any servicing work, remove the plug connectors from the modem modules.

Configuration of station with USB stick

The BCU-50 series5e is delivered in the cleared status (cold status). Only the basic system is active, there are no system drivers of configuration in the memory!

Initial startup is only possible with a USB memory stick with an 'initial load'
Exceptions: Preconfigured systems with station names

Preparation of USB memory stick

1. Start setIT and load designated project.
2. Plug USB stick to PC/laptop interface and wait until the setIT window for memory transfer pops up.
3. Select the desired station and transfer the initial configuration.
4. Now plug the memory stick into Port USB2 of the BCU-50 series5e.
   By the loading, the memory with the selected configuration is overwritten in the station.

Instructions for memory stick

USB LED		Colour			Function
1. Plug the USB stick					
device	●	green	●	ON	USB stick detected
ready	●	green	○	OFF	No data for loading on/detected on USB stick
device	●	green	●	ON	Detected setIT data on USB stick waiting for action or automatically after cold-start
ready	●	green	✳	flashing	
2. Move the USB switch to the right for 3 seconds to update the station **or** to the left to load archives from the station to the stick. Automatic performing on initial start.					
device	●	green	✳	flashing	USB/SD data transfer active: **Please do not remove the USB stick in this operating status.**
ready	●	green	●	ON	
access	●	yellow	●	ON	
3. Possible results:					
device	●	green	●	ON	Data transmission completed USB stick can be removed now. New data is activated after removal of USB stick
ready	●	green	●	ON	
access	●	yellow	✳	flashing	
error	●	red	✳	flashing	USB stick faulty and/or no new data for station on USB stick
access	●	yellow	✳	flashing	The USB stick which has been detected after cold starting contains no initial station files and can be removed.
error	●	red	●	ON	

4. Remove USB stick

LED lights: Diagnostics operating state

run com sys VPN 1 4	Colour	LED state	Function
	green	LEDs 1 - 4 flashing simultaneously	Operating system OK, **No system or configuration.**
	green	LEDs 1 - 4 forming a chasing light LED 1 to LED 4	Operating system and system OK, **no configuration** or system in initial state, loading of station from USB stick required
	green	LED 4...1 chasing light LED 4 to LED 1	**System in initial state**, loading of station from USB stick required
	green	LED 1...4 flashing alternately with LED1/2	The telecontrol manager of the system waits for all drivers to start and report they are ready.
	green	LEDs 1 - 4 flashing alternately with LED2	The sqlite Writer initialises its data area, or the telecontrol manager ascertains an error when the drivers start up.
	green	LED1 flashes at 1Hz / 4 Hz LED1 flashes at 2 Hz	Boot process active **Telecontrol station in operation**
	green	LED2 ON LED2 OFF	Communication to master system OK.. **Communication disrupted**.
	green	LED 3 ON LED 3 OFF	Card configuration OK. **Card configuration erroneous**.
	red	LED 3 ON LED 3 OFF	**System fault via group indication** Group indication not active
	green	LED 1/4 flashing LED 2/3 statically ON	On startup, momentary possible to reset to initial state with USB switch Operation USB switch on right: Factory setting USB switch on left: Trigger cold start
	green	LED1/4 ON LED2/3 OFF	Station cold start just performed
	green	LED1/4 flashing LED 2/3 OFF	Selection of Reset enabled by user
			Normal operation, operating fault

See also Display and diagnostics on Page 71

Memory extension with SD card

On the top of the device is a card holder readied for the use of SD cards [+] (Secure Digital Memory Card). A memory extension of up to 8 GB can be installed in this slot. This is restricted to 1 GB at the moment however for runtime reasons.
During the start the operating system automatically links the SD card. The information on a SD card is stored so as to be protected from power outages:

- Archive of system as backup if enabled in the configuration
  - Interval archive
  - Operational message log
  - Alarm log
- Configuration
  - Configuration data of station

[+] For FW-5-GATE, FW-5-GATE-4G and series5X microSD at front

Activating an SD card

To allow an SD card to be checked, it must be enabled at the units property page. This setting enables system messages 'SD card error' and 'SD card not plugged in'. Additionally, the units configuration and firmware can also be synchronised as a backup on the card.

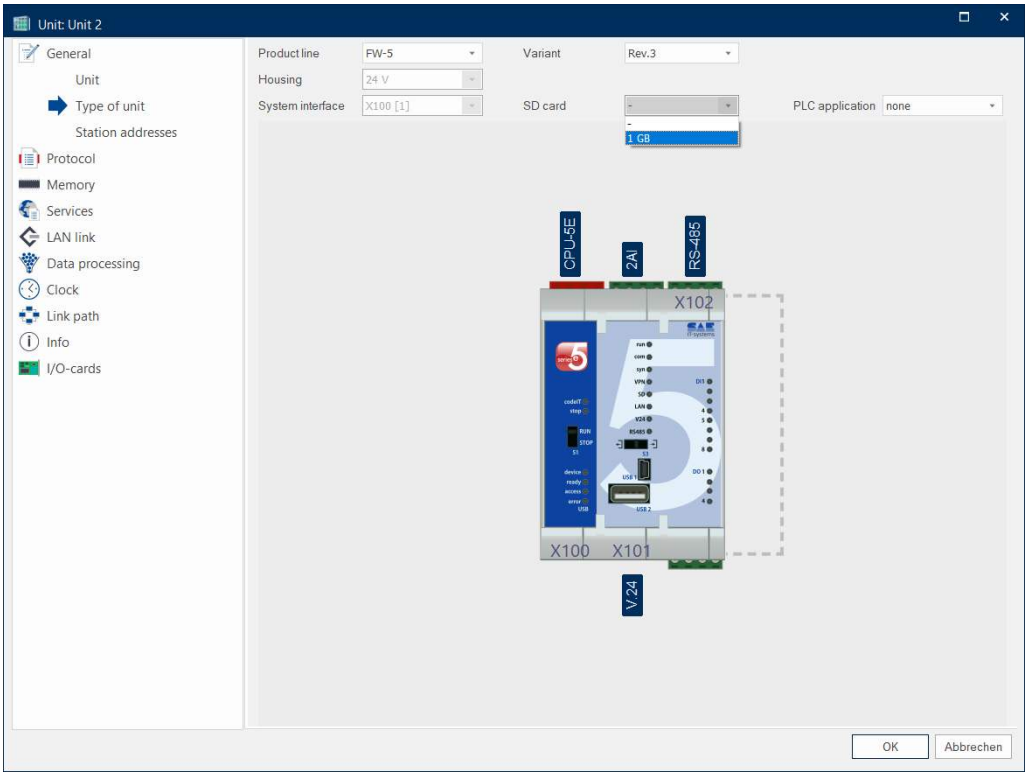


Figure 18: Enabling and selecting an SD card

Procedure when using SD cards

- Switch the target system off before plugging in and unplugging a card.
- Now remove the SD card from the packaging.
  !! Take special care to ensure **the contacts of the card are not touched**.
  Long-term contact faults can occur despite the gold-plated contact surfaces.
- Now insert the SD card into the card holder; the contacts should be facing the printed circuit board. Applying slight pressure audibly clicks the card into place.
- Switch the system back on;
  the **SD card is only integrated on a restart**.
- During operation, the 'SD' LED of the CPU shows with static lighting that an SD card has been identified as valid and has been started up.

Note **The SD card may not be plugged in or removed during operation.**

Reading archive data from the SD card by a reader

Insertion of the SD card also means that the archives are stored protected against power outages. If reading of the data directly from the SD card is required, remove the SD card from the card holder of the CPU.
A commercially available SD card reader or SD-USB adapter can now be used to read the data. Windows Explorer® and other suitable software now provide access to the archive data.

Ensure NOT to touch the contacts of the SD card with fingers.

Recording and archive depth

Archive recording in the series5 system is in two areas:

- Internal archive memory / RAM
- Archive backup on SD card

Events with archive entry are stored in the internal memory in real-time. When the SD card is activated, a sequential copy of the recordings is also written to the SD card as an archive backup. This also enables greater signal quantities of up to 9000 events to be recorded in the fast internal memory, sent and be backed up on the SD card.

Archive entries in the SD backup are stored so as to be protected from power outages. The internal memory is volatile and is initialised on a restart.

Internal archive memory

The recording depth of the memory depends on the configuration and corresponds to the archive specifications in setIT memory management. The automatic memory allocation calculates an optimum distribution for typical usage in consideration of the archive entries created. A different allocation of memory depth is possible on a case-by-case basis.

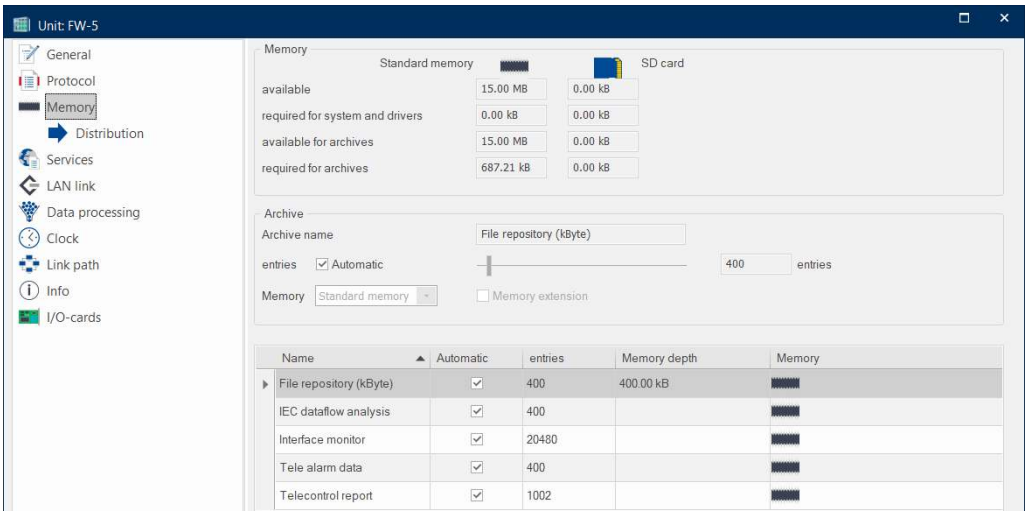


Figure 19: Memory depth of cache

Transfer to the control system/OPC server as per the respective transmission settings is performed from the internal memory. In the event of a communication outage to the control system/OPC server, all recordings are kept in the memory with their event time, and resubmitted when communication is restored.
Overrun messages of the internal archive can be created as process information in the system messages for the plant.

Archive backup on SD card

The recording capacity of the archive backup of the SD card is determined by the memory size of the SD card and the event density. The maximum write speed of the SD card means about 10 events per second can be written to the file system of the SD card. From series5+ technology, 1000 events per minute can be recorded without loss. A continually large recording density can mean overrun of the internal archive memory.

Memory depth of the SD card on series5

The maximum memory depth can be estimated approximately: The archive entries in csv format on the SD card require 80 bytes on average. A 1 GB card provides about 976 MB of user data. Minus the configuration storage of typically 3.5 MB, about 12 million entries can be stored in the SD archive. The maximum event density of 10 events/s means an overrun after about 14 days. For an assumed recording density of 100 events every 15 minutes, 3.6 years of recording time is mathematically available without memory overrun.

Storage of configuration as backup on SD card

As of version setIT 4.005.05 build 10, all of the firmware (system, operating system and configuration) can also be stored on the SD card. The firmware is automatically synchronised during a download if an SD card is entered in the station definition and 'Backup system to SD card' is enabled in the card parameters of the CPU. The latter can be opened by right-clicking the CPU in the station image.

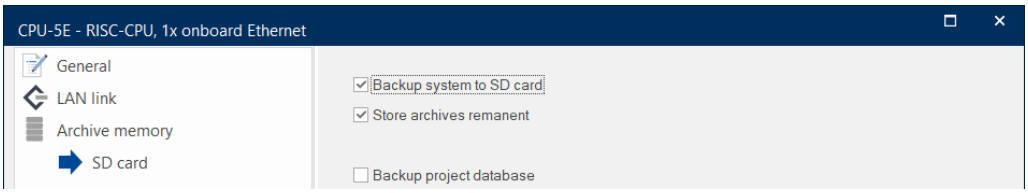


Figure 20: Backup of firmware on SD card

Using configuration from SD card

The configuration from the SD card is used automatically when the system finds no internal data on a restart but a valid configuration can be read from the SD card. This way an intact configuration on an SD card can be loaded from a defective device to new hardware without requiring anything else.

The LED unit flashes when booting from the SD card. Ensure to 'clean' a new CPU with a cold start before the backup from the SD card is used.

The backup on the SD card can also be used to load the configuration via USB (such as with a memory stick adapter).

Data stored on SD card

An overvew of data stored on the SD card and its protection is given in this table:

Data	Storage format	Protection	Condition
Archive	Sqlite3 Data base		Archives must be created and 'Archive resetfest' #1 must be activated
Firmware	ZIP	Symmetrically encrypted with SAE password or system password*.	Archives must be created and 'Backup system to SD card'#1 must be activated.
Telecontrol system & communication driver	Binary format		
Configuration (e.g. IP addresses, station and project name, VPN configuration & credentials)	Sqlite3 Data base / text		
Files for station website	Text		
User database	Sqlite3 database	Passwords as salted hashes	
System password	Binary format	Symmetrically encrypted with SAE password	'Sign Firmware'#2 and 'Backup system to SD Card'#1 must be activated
Public signature key	Text		'Sign Firmware'#2 and 'Backup system to SD Card'#1 must be activated

* Signed firmware must be activated, #1 Card parameters of CPU, #2 User management

Information on selecting SD cards

The overall performance of a system depends on the quality of the components used. Given that our bay station controllers and automation devices offer outstanding stability and prolonged service life, all accessories and upgrades should satisfy the same requirements.

Validated SD cards for an industrial environment

Continuous operation in rugged environments means only industry standard SD cards with SLC technology single level cell and enhanced temperature range should be used. These cards can certainly not be compared with the commercially available SD cards because the selected components only use high quality technology.
Commercially available consumer goods do not meet these requirements because of the rapidly growing mass market and the use of cheapest possible components; usually no more than 10,000 writing cycles are achieved.
The cards we recommend are subject to comprehensive functional and suitability tests prior to validation. We are unable to accept any guarantee for reliable storage when other cards are deployed.

Characteristics of SD cards for industrial/extended environment

Essential characteristics for SD cards capable of validation are:

Cell type.	SLC, single level cell technology
Temperature range	-20° to +85°C
Writing cycles	~ 20,000 cycles writing/deleting per sector
Data logging	≥ 10 years (without further write cycle)
MTBF @25 °C	≥ 2,000,000 hours
Environment	to 95% relative humidity, no condensation

The SD cards selected and validated by ourselves guarantee the parameters above as a minimum with the following values:

Writing cycles	~ 100,000 write/delete cycles
MTBF @25 °C	≥ 3,000,000 hours

Recommended SD cards

Product	Name
310050011510	SD card with 1 GB for FW-5 /CPU-5B/-5C/5E
310050011530	series5 memory/archive extension via SDHC 4 GB
310050011540	series5 memory/archive extension via SDHC 8 GB

Note: Only 1 GB cards supported up to setIT V6.000

Supply voltage connection

The 3-pole X3 terminal on the front panel of the SV-6 or the CPU is used to power the telecontrol system. A PSU filters the input voltage and makes available the internal voltages required by the system cards. Process and supply voltages from 24 to 220 V DC can be used by selecting the appropriate power supplies. The racks are powered with galvanic isolation and with no further converters or PSUs.

BCU supply voltage connector

- BCU-50-M X3 on the CPU
- BCU-50-L X3 on the SV-6

The supply can be configured as redundant by plugging a SV-6 into the last slot. This means it can also be a separate supply. It is possible to ground the Positive pole (apart from on LC variants).

Item no.	Product	Function
310050503400	SV-6-24-LC BCU	Power supply 24 V DC for BCU low-cost#
310050503410	SV-6-48 BCU~	Power supply 24/48 V DC for BCU
310050503412	SV-6-48-2 BCU	Power supply 48 V DC for BCU
310050503420	SV-6-60 BCU~	Power supply 60 V DC for BCU
310050503422	SV-6-60-2 BCU	Power supply 60 V DC for BCU
310050503421	SV-6-60-LC BCU	Power supply 60 V DC for BCU low-cost#
310050503430	SV-6-110 BCU	Power supply 110 V DC for BCU
310050503440	SV-6-220 BCU	Power supply 220 V DC for BCU

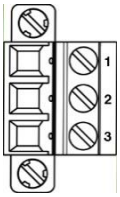
#not IEC 61850-3 suitable | ~withdrawn

Supply of the BCU-50-M

For the BCU-50-M housing variant, 24 V DC power to the station can be provided directly from the integrated PSU on the CPU unit.

CPU-5E Input voltage	24 V DC, -15% ... +20%
Power consumption	Max. 50 W
Power failure protection	Min. 20 ms

Voltage connection X3 on CPU-5E



+	**24 V DC**
	n.c.
-	**GND**

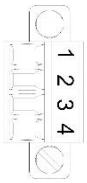
Another voltage level or redundant supply can be used via an additional SV-6 in the last slot.

Power supplied by SV-6

Service X1

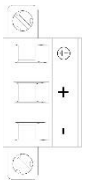
	COM A RS-485
	COM B RS-485
	Umod + 24 V DC 0.4 A max.
	Umod -

Signal relay X2



	Powerfail signal Relay 1 Break contact
	Powerfail signal Relay 2
	Alarm relay Contact 1 make contact
	Alarm relay Contact 2

Voltage connector X3:



	Protective earth / functional earth
+	24 | 24/48 | 24/60 | 110 | 220 V DC
-	**GND**

SV-6-24-LC/SV-6-60-LC

The LC variants are low-cost power supplies of the SV-6 series. To be able to provide a low-cost voltage supply, some of the functions on other SV-6-x variants have been left out:

- No galvanic isolation of the primary and secondary voltages
- No current or temperature measurements
- No alarm outputs
- No auxiliary voltage U_{mod}

It therefore does not comply with standard IEC 61850-3.

SV-6-24-LC	**Power supply FW-50/ BCU-50** Simple variant without galvanic isolation
Input voltage	24 V DC -15% ...+20%
Power consumption	max. 2.1 A @ 24 V DC, 50 W
Power failure protection	Min. 20 ms
Secondary power	max. 48 W 1 A @ 5 V, 1.8 A @ 24 V

SV-6-60 -LC	**Power supply FW-50/ BCU-50** Simple variant without galvanic isolation
Input voltage	60 V DC -30% ...+20%
Power consumption	max. 0.9 A @ 60 V DC, 54 W
Power failure protection	min. 20 ms @ 50% load
Secondary power	max. 48 W 1 A @ 5 V, 1.8 A @ 24 V

SV-6-48 /SV-6-60

The two power supplies are designed for the wide range supply between 24 and 60 V DC. They supply power to the unit (24 V DC or 48/60 V DC) The primary voltage monitor meant a separate 48 V variant had to be created. The full configuration gives them the full power and intelligence of the SV-6 series, and so they meet IEC 61850-3 (h).

SV-6-48	**Internal power supply 24 / 48 V DC 50 W** Input voltage 24 / 48 V DC ±20%
SV-6-60	**Internal power supply 24 / 60 V DC 50 W** Input voltage 24 / 60 V DC ±20%
Internal output voltage	System supply voltages 24 V DC, 5 V DC regulated
output current	2.5 A, regulated
Network failure suppression	50 ms
Isolation	2.5 kV PS ground, 2.5 kV primary/secondary EMC Level 4
Ambient conditions	-25° ... + 50°C (> 40°C derating)

SV-6-110

The SV- 6 voltage supply has been developed for harsh environments in field control and medium voltage network applications. In addition to converting different primary voltages, they also monitor the supply voltage, current and temperature of the module using fixed thresholds. When the voltage falls* below 85%, they enable the internal Power-Fail signal and also report this over the relay signal output. A second relay is used to indicate overvoltage, overload and overtemperature.

SV-6-110	**Internal power supply 110 V DC 50 W**
Input voltage	110 V DC ±20% (88 ...130 V DC)
Internal output voltage	System supply voltages 24 V DC, 5 V DC regulated
output current	2.5 A, regulated
Network failure suppression	50 ms
Voltage monitor	programmable threshold (default: 85% U_N = 95 V)*
Temperature control	Monitoring of the module temperature
Power-fail	Relay output: max. 240 V DC 10 µA to 40 mA
Overload/temperature	Relay output: max. 240 V DC 10 µA to 40 mA
Additional supply to modem	24 V DC 0.4 A for external modem
Isolation	2.5 kV PS ground, 2.5 kV primary/secondary EMC Level 4
Connection	UE: MSTB, 3-pole Screw terminal Ua: internal
dimensions	FW system card 20 x 160 x 100 mm (W x H x D)
Ambient conditions	-25° ... + 50°C (> 40°C derating)

* On a later variant, the thresholds can be set from setIT.

SV-6-220

SV-6-220	**Internal power supply 220 V DC 50 W**
Input voltage	220 V DC -15%/+10% (180 ... 240 V DC)
Internal output voltage	System supply voltages 24 V DC, 5 V DC regulated
output current	2.5 A, regulated
Network failure suppression	50 ms
Voltage monitor	programmable threshold (default: 85% U_N = 185 V)*
Temperature control	Monitoring of the module temperature
Power-fail	Relay output: max. 240 V DC 10 µA to 40 mA
Overload/temperature	Relay output: max. 240 V DC 10 µA to 40 mA
Additional supply to modem	24 V DC 0.4 A for external modem
Isolation	2.5 kV PS ground, 2.5 kV primary/secondary EMC Level 4
Connection	UE: MSTB, 3-pole Screw terminal Ua: internal
dimensions	FW system card 20 x 160 x 100 mm (W x H x D)
Ambient conditions	-25° ... + 50°C (> 40°C derating)

Redundant power supply

The power supply SV-6 or SV-7 is able to operate in redundant mode. In this case, a second power supply may be assembled to the very rightmost slot of the rack.
The SV-x automatically recognizes the redundant function. An additional parametrisation is not needed. An assembly in setIT may be given from setIT V5.003 by setting up a SV-6 in the stations pane.
The second power supply may be energized via a different source or tension to enlarge the availability of RTU.

Figure 21: BCU-50 with SV-6 main supply and redundant SV-6

Using a telecontrol station of type FW-50 a redundant operation is available as well. Mode of operation and set-up of SV-x is done in the same manner.

4 The CPU modules

The CPU-5-x modules are the heart of the series5 product family for the modular bay station controller net-line BCU-50 series5e. A series of CPU modules in the series5e generation have developed over the course of the evolution of technologies, and due to current component modifications. These CPU modules can be used in the BCU-50:

- CPU-5C CPU-5C with processor core series5+
- CPU-5E CPU-5C with processor core series5e
- CPU-5Es CPU-5E with internal BGTbus series5e

Both CPU modules use the same base PCB but have different processor modules; the CPU-5C features the series5+ technology, and the CPU-5E has the more powerful and latest series5e core. The CPU-5E uses the latest technology of the series5e, with another increase in performance yet raised level of IT security. It is based on a stronger still process core, with two separate network connections on the front, has twice as much RAM compared to the CPU-5C, a USB hub to expand the LAN segments and a slot for expansion using a fifth serial port. The limitation on the CPU-5C as regards lower serial ports does not apply on the CPU-5E.

For the exact features, please refer to the following sections.

Item CPU modules

Item no.	Item	Function
310050504000	Module CPU-5C, BCU-50 series5+ 512 MB	CPU-5C with G46, 256 MB RAM, 256 MB Flash
310050504100	**Module CPU-5E, BCU-50*** series5e 1 GB	CPU-5E with 335, 512 MB RAM, 512MB Flash
310050504110	**Module CPU-5Es, BCU-50*** series5e 1 GB	CPU-5E with 335 and BGTbus 512 MB RAM, 512MB Flash

* Card meets the requirements in IEC 61850-3 (h)

This documentation covers the series5e with CPU-5E.
Information on the net-line BCU-50 series5+ with CPU-5C is in a separate manual: https://sae-it.netexplorer.pro/dl/r1Mt6RltaDtawQRaUtBFTN5AWW_0YI.

CPU-5E series5e

The series5e processor core (800 MHz internal clock frequency) enables a processing speed of 1200 MIPS to be attained. This performance, integrated within a real-time operating system, makes this an open platform for future-proof applications with high data throughputs.
The base version of the BCU-50 series5e has an internal data memory of 1 GB (512 MB SDRAM and 512 MB Flash). In addition, the CPU card provides a memory enhancement for configuration and archives on a micro SD card (up to 8 GB). Limited to 1 GB in setIT V5.
The BCU-50 series5e provides a highly integrated and secure connection to infrastructures of supply networks (such as Smart Grids); all security features in the series5e technology are used.

- series5e processor with 1200 MIPS at 800 MHz
- 1 GB memory:
  512 MB SLC NAND Flash, 512 MB SDRAM, 8 MB NOR Flash, 512 KB SRAM
- RTC Realtimeclock ±10 ppm
  RTC and SRAM buffered via rechargeable Li-Ion battery
- opt. memory expansion with SD card (to 8 GB)

- 2 separate TCP/IP Ethernet interfaces (10/100 BaseTx)
- 4 additional network segments
  in combination with BGT-x-USB and SWI-2-x
- 4 serial nterfaces
  directly assembled via interface boards up to 115 kbit/s
- 8 additional serial interface lonis via USB485 up to 38,4 kbit/s
- up to 28 FO-media converters via LWL-2 up to 115 kbit/s
- PLC switch on front panel
- USB function button for copying and backing up configuration, and archive backup
- Display and diagnostics using 11 coloured system LEDs on front
- Temperature sensor for ambient temperature
- galvanical isolation of USB device
- the lower serial interfaces X102/X104.. are available for 870-5-10x communication without restrictions

Note: **setIT Version 5.004 or higher is required to use the BCU-50 series5e**

Assembly CPU-5E

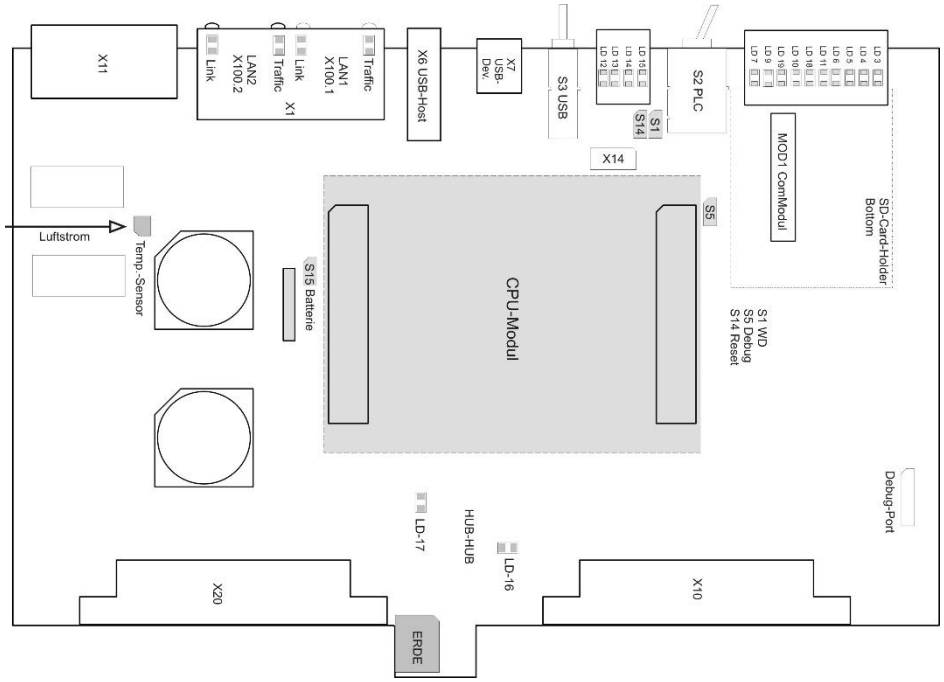


Figure 22: Placement of components CPU-5E

System LED CPU-5E

The LED on the front panel are equivalent to other CPU-boards. An additional LED shows a USB-link for communication via SWI-2-x at the PCB.

LED	Colour			Funktion
LED16 ●	green		off	no link
		●	static on	USB High-Speed active (480 Mbit/s)
LED17 ●	green		off	no link
		●	static on	USB-link moounted in system

Display and diagnostics

The display and diagnostics functions are identical for all BCU-50 series5e models. Located on the front panel are LEDs to indicate the operating states of the CPU unit and the statuses of mobile unit, PLC and USB.

System LED

LED	Colour			Function
power ●	green	●	static On	OK: Supply voltage being applied
		○	Off	Error/System OFF
run ●	green	✳	flashing 2 Hz	OK: System running
		✳	***flashing 4 Hz***	***System starting***
		●	static On	Fault
		○	Off	Error/System OFF
com ●	green	●	static On	OK: Communication to master system
		✳	flashing	System starting 1 Hz, communication with one of several NLS's
		○	Off	Communication down
sys ●	green	●	static On	OK: I/O valid
		✳	flashing	System starting
		○	Off	Fault in module or expansion unit
sys ●	red	●	static On	ERROR from group indication detected
		○	Off	OK: No error message active
VPN ●	green	●	static On	all VPN tunnels established
		○	Off	No VPN tunnel established
		✳	***flashing***	at least one VPN tunnel not established ***or system starting***
SD ●	green	●	static On	Card detected; writing archives
		○	Off	No SD card detected or available
		✳	***flashing***	SD card write protected: no more archives may be written /System indication SD-card error is set

Note: ***Functions shown in italics must only be active for a few seconds***.

During the start process, the LEDs show a changing picture:
Light sequence = start process, system initialised.

Synchronous flashing light run + data = cold start option by pushing switch S3 to the right for 3 s.

PLC LED codeIT

PLC LED	Colour			Function
codeIT ●	green	○	Off	PLC STOP or inactive
		●	On	PLC RUN
		✳	flashing	PLC PROG, loading program
stop ●	red	○	Off	OK, normal operation or inactive
		●	On	Fault
		✳	flashing	Prog. operating method Loading program

USB LED

Via the USB LED the states of a pushed in USB-memory stick or a USB-link via cable to setIT will be shown. If the device LED is illuminated, a link was recognised and a data transmission may be established. If the download will be performed via setIT or the webserver, the ready LED is shining for a short period.

USB-LED	Colours		Function
device	green	static ON	USB link recognised
ready	green	OFF	passive state, no data, no USB link
		flashing	Data transmission
		static ON	**Don't pull the stick in this case**, except access is flashing
access	yellow	static ON	**Data transfer active, do not cut the transmission**
		flashing	Data transmission completed, ready
error	red	OFF	no error
		flashing	wrong transmission or information
		static ON	Error: wrong type of device, wrong kernel

Operating functions

The operating functions are identical for all FW-5 models of series5, series5+ and series5e.

S1: PLC switch for Soft PLC

The PLC switch is on the front panel of the system.

Position	Name	Function
Up	RUN	PLC program running
Down	STOP	PLC program stopped

refer to PLC programming information on Page 199

S3: USB switch

The USB function button is on the front panel of the system.

Position	Name	Function
Left		Archiving of archives to stick
Middle	-	Idle position
Right		Data transfer from USB stick to system

Cold start/Factory setting

During a restart, the system shows changing system LEDs (run & data flash simultaneously). Pressing S3 to the right for three seconds in this phase triggers a cold start, and therefore a reset of the system memory. An initial load is then required.

Position	Name	Function
3 s left		launch cold start in start phase only
middle	-	Idle position
3 s right		resett o Factory setting in start phase only

- Fact-setting Everything is deleted and reset to factory settings, Can be activated after restarting with chasing light.
- Cold start Like reset to factory settings; but the Ethernet parameters are saved and set again after restart. Can be activated after restart with chasing light.

Fault indicator output

A fault indicator contact can be switched potential-free to free command output DO on an expansion module with a cross-connection of group information of selected system information. The red sys LED on the front panel signals the status.

Technical details for the BCU-50 series5e

BCU-50 series5e	**series5e RISC process core**, ARM Cortex A8, 1200 MIPS @800 MHz, FPU, watchdog, real-time clock
Data memory	**1 GB memory**: 512 MB SDRAM**,** 512 MB SLC NAND Flash, 512 kB SRAM backed up, 8 MB NOR Flash
Memory extension	**SD card** to 8 GB optional currently 1 GB usable
Capacity	Modular expansion using a maximum of 14 I/O modules, cascadable **Expansion** via communication up to 16,000 process data points **IEC 61850** up to 40 IED **Temperature sensor** internal Measuring range -25°C - +100°C , measuring error ±3°C max.
Real-time clock	Variance max. ±10 ppm in use, buffered maintenance-free ±20 ppm 60 days @25°C, Summer / winter time changeover, leap year correction
Status indicators	CPU: 11 labelled LEDs on front panel, green, red for system, communication and process values (binary) **Web server** integrated LAN: Traffic green, speed yellow, hdx/vdx on-board
Controls	**PLC switch** on front panel RUN/STOP **USB button** for configuration / backup / recovery functions
Communication	**2 Ethernet LAN** 10/100BaseTx, auto-MDIX, galv. isolated, on the front or via SWI-1-x on X102/X104 **4 serial interfaces** 128-byte FIFO, 300 to 115 Kbit/s opt. 5th interface via subprint module com5C-RS-485 opt. 8 more ports over USB485 opt. 28 FO star couplers over FO-2
Programming interface	Ethernet LAN 10/100BaseTx, auto-MDIX, USB 2.0 device, 480 Mbit/s, mini type B socket, galv. isolation, 1.5 kV USB 2.0 host, 480 Mbit/s, Type A socket
Fault indication output	Configurable on relay or expansion module
Supply voltage	**Via SV-6 : 24 / 48 / 60 / 110 / 220 V DC ±20%** Power failure management with protection against network interruption
Power failure protection	typical 50 ms depending on SV-6 and I/O configuration
Dielectric strength	5kV surge supply & process I/O to PE, according to class VW3 2.5 kV surge, supply for measured values, EIA / RS-232, USB
EMC immunity:	IEC 61850-3 (H/h), EN 60255-26, EN 61000-4-2, /-3, /-4, /-5, /-6, /-8, /-9, /-16, /-17, /-18, /-29
EMC transient emissions	IEC 61850-3, EN 55022 /CISPR22 device class A
Vibration	EN 60870-2-2, EN 60255-21-1, IEC 60068-2-6 1 g
Shock	EN 60870-2-2, EN 60255-21-2, IEC 60068-2-27 15 g 11 ms /2-29 10g 6 ms
Earthquake	EN 60870-2-2, EN 60255-21-3 3.5 mm 1 g
Environment	IEC 61850-3, IEC 60068-2-1, /-2, /-30, /-78, EN 60721-3-3 Class 3C1 3S1
Housing	BCU-50 rack, metal, IP30
Installation	**BCU-50** 19" frame, 5HE including cable tray **BCU-50-W** wall-mounting **BCU-50-M** wall-mounting, DIN top-hat rail DIN EN 60715 TH35

dimensions	**BCU-50**	432 x 222 x 135 mm (W x H x D) 5HE including cable tray
	BCU-50-W	432 x 193 x 135 mm (W x H x D) without cable tray
	BCU-50-M	432 x 193 x 135 mm (W x H x D) without cable tray
Terminals	Screw terminal MSTB,	0.2 to 2.5 mm^2 or
	Combicon spring terminal,	0.2 to 2.5 mm^2
Ambient temperature	**-20° ... +70° C,** ø24h max. 50°C, from 48 V DC +60°C	
Installation height	Max. 3000 m above sea level, > 70 kPa	
Relative air humidity	< 95% @ 25°C without condensation (Class F)	

CAUTION

The new CPU cards are buffered with a rechargeable lithium battery. These cards must be stored in an isolated place; a short-circuit can cause a fire. Therefore always store them so as to be isolated.

Onboard interface com5C_RS-485

The CPU-5E can have an additional TIA/EIA/RS-485 interface, used as a 5th field interface or internal interface to the bus for communication of intelligent cards. From setIT V5, this can be enabled in the card properties of the CPU-5C/CPU-5E. Using this interface as a field interface is currently only possible in special projects such as the FWG-50. This is because the signals in standard racks cannot currently be routed via terminals from the frame.
If BGTbus is needed, the CPU-5Es uses the serial interface for internal communication, thus com5C_RS-485 will not be supported.

Item no.	Product	Properties
310000025910	com5C_RS-485 module for CPU-5C/5E	Additional field interface
310000025911	com5C_RS-485i module for CPU-5C/5E	Interface for internal communication

Mounting diagram for com5C_RS-485-1

The interface is plugged onto the CPU-5C/CPU-5E as a plug-in module at Position "MOD1 ComModule". Connector S1 routes the signals to the outside. In addition to communication, the Tx/Rx LEDs can also be activated.

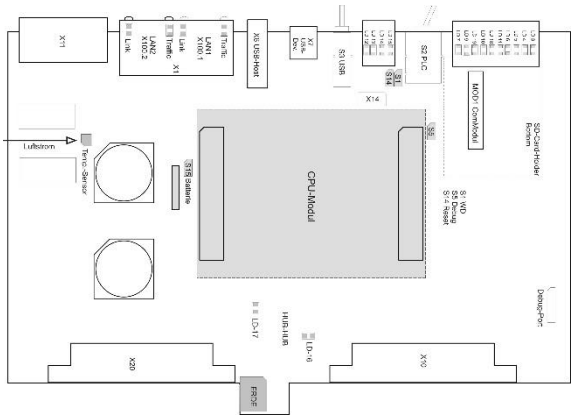


Figure 23: CPU-5C/CPU-5E

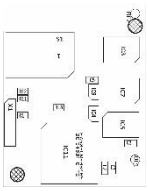


Figure 24: com5C_RS-485

Terminal connections

S1	Signal	Function
1	**A** (RS-485)	**Interface signal** RS-485
2	**B** (RS-485)	**Interface signal** RS-485
3	GND	Ground (for LED)
4	Tx LED	Send signal (5 V) for external LED with series resistor
5	Rx LED	Receive signal (5 V) for external LED with series resistor

Connector type S1: JST S5B-PH-SM4-TB (5-pin, 2 mm grid)

Technical details for com5C_RS-485

com5C_RS-485	Interface RS-485 (ANSI/TIA/EIA-485-A-98 R2003)
Operating methods	Half-duplex, Bus mode
Line	2 lines, twisted and shielded in pairs, e.g. LiYCY 2x2x0.25 mm²
Transmission mode	symmetrical
Baud rate	300 bit/s to 38.4 Kbit/s
Keying	Automatic, lead/lag times can be set in setIT
Range	1200 m
Function indicator	Tx, Rx LEDs activatable externally via S1 terminals
Signal sensitivity	+/- 200 mV
Termination	270 Ω, each with 2.2 kΩ pull-up/down for interference suppression
Electrical isolation	between logic and transmission line
Test voltage	AC signal/logic 1000 V AC / air & creepage distances >1 mm
Power consumption	140 mW from internal supply
Operating temperature	-20 to 60°C (short-term 70°C)
Relative air humidity	95% at 40°C without condensation (class F)

5 Interface cards

Interface types

Ethernet network

SWI-1-1[*]	Ethernet	quadruple switch 10/100BaseTx, RJ45
SWI-1-2[*]	Ethernet	Multimode FO, SC + twice 10/100BaseTx
SWI-1-3[*]	Ethernet	quadruple switch 10/100BaseTx, RJ45 with port mirror
SWI-1-4[*]	Ethernet	Multimode FO, SC + twice 10/100BaseTx, port mirror
SWI-1-5	Ethernet	quadruple switch 10/100BaseTx, RJ45, port mirror
SWI-1-6[#]	Ethernet	Multimode FO, SC/ST + 10/100BaseTx, port mirror
SWI-1-7[#]	Ethernet	Single-mode FO, SC/ST + 10/100BaseTx, port mirror
SWI-2-1[#]	Ethernet	additional LAN segment via internal USB connection quadruple switch 10/100BaseTx, RJ45
SWI-2-2[#]	Ethernet	additional LAN segment via internal USB connection multimode FO, SC +10/100BaseTx,
SWI-2-3[#]	Ethernet	USB-LAN single-mode FO, SC/ST + 10/100BaseTx
SWI-3-1[#]	Ethernet	HSR/PRP-Switch via SFP 100Base-T/Fx
ENET-1[*]	Ethernet	TCP/IP LAN connection, RJ-45, 10/100 Mbit/s

Dedicated line

RS-485-2[#]	RS-485	Symmetric, max. 38.4 kbit/s, 1.2 km, up to 31 participants
RS-422-2[#]	RS-422	Symmetric, max. 38.4 kbit/s, 1.2 km, up to 31 participants
BBM-1[*]	baseband modem	Max. 19,2 kbit/s, 10 km, up to 8 participants
MOD12-2[*]	FSK modem	BZT approved, 1200 bit/s max. 25 km, up to 15 participants
WT12-2/4[#]	FSK modem	BZT approved, 1200 bit/s max. 30 km, up to 17 participants
WT96-2/4[#]	FSK modem	9600 bit/s max. 20 km, up to 17 participants
TTY-1[*]	TTY	20 mA current loop, 2-/4-wire, max. 9.6 kbps, 1 km
V24-2	V.24 /RS-232	Asymmetric, max. 115 kbit/s, point-to-point
V24-3	V.24 /RS-232	V.24 redundancy link, max. 115 kbit/s, party line
V24-4	V.24 /RS-232	V.24 for RJ-45 links according to ETSI EN 392-300-5

[#] fulfills requirements from IEC 61850-3

• legacy component, replaced by newer variant and may be EOL;
may be assembled, but is out of scope of this manual
s. https://sae-it.netexplorer.pro/dl/r1Mt6RltaDtawQRaUtBFTN5AWW_0YI

Fieldbuses

DPM-1•	Profibus master/slave	Profibus-DP, 1.2 km, up to 31 participants occupies 2 interfaces and/or an I/O slot
DPS-1•	Profibus master/slave	Profibus-DP, 1.2 km, up to 31 participants occupies 2 interfaces and/or an I/O slot

Additional fieldbuses (e.g. Modbus) are operated over dedicated line interfaces

Analogue switched line (PSTN)

WM336-3•	Dial-up modem	Dial-up modem up to 33.6 kbit/s 1500 V DC
WM336-4•	Dial-up modem	Dial-up modem up to 33.6 kbit/s 3000 V DC

Switched lines (ISDN)

ISDN-1•	ISDN-TA	ISDN terminal adapter, 64 kbit/s

Switched lines (GSM)

GSM-1•	Dual band GSM	GSM dual band with up to 9600 bit/s
GSM-2	Dual band GSM/GPRS	GSM/GPRS dual band with up to 9600 bit/s

fulfills requirements from IEC 61850-3
• legacy component, replaced by newer variant and may be EOL;
may be assembled, but is out of scope of this manual
s. https://sae-it.netexplorer.pro/dl/r1Mt6RltaDtawQRaUtBFTN5AWW_0YI

Communication over Ethernet

The CPU-5Eprovides two separate Ethernet interfaces with their own address spaces (network segments) and autarkic IP stacks. The connection to networks can be established in several ways.

- The first Ethernet interface is on the front of the CPU-5E on X100.1. This can be moved to a pluggable switch in Position X104.
- The second Ethernet interface is on the front of the CPU-5E on X100.2 This can be moved to a pluggable switch in Position X102.
- Four more SWI-2 modules can provide one more segment each at Positions X101/X103/X105/X107.

Figure 25: Example BCU-50-M-W with 4 network segments

Switch SWI-1-x

Fixed positions are specified for the switch cards given the strict physical requirements for fast Ethernet connection. All switch types (SWI-1-1 to SWI-1-7) can be used.

- As integrated FW interface cards, the switch cards occupy the lower part of slot 1 or 2, i.e. at Pos L-1 or L-2.
  The upper part can be used freely (e.g. with serial interfaces).
- At position X100.2 (L-1), the second Ethernet interface of the CPU-5E is provided as an option. When X102 is configured with a switch card, the channel is automatically switched from X100.2 to X102.
  The connector on X100.2 then has no function.
- At position X104 (L-2), the 1st Ethernet interface of the CPU-5E is provided as an alternative to X100.1. When X104 is configured with a switch card, the channel is automatically switched from X100.1 to X104.
  The connector on X100.1 then has no function.

Switch modules SWI-1-x

The interface card SWI-1 offers different Ethernet connections as an integrated module in two versions:

- SWI-1-1 quadruple switch 10/100BaseTx, 4* RJ45
- SWI-1-2 FO 100BaseFx Multimode SC + 2* RJ45/ 10/100BaseTx
- SWI-1-3 as SWI1-1 but with port mirroring, 4* RJ45
- SWI-1-4 FO as SWI1-3 Multimode SC + 1* RJ45/ 10/100BaseTx
- SWI-1-5 as SWI1-3 but with additional traffic shaping (protection from DOS attacks)
- SWI-1-6 FO as SWI-1-5 but with 100BaseFx Multimode SC/ST
- SWI-1-7 FO as SWI-1-5 but with 100BaseFx Singlemode SC/ST

Additional cabling, mounting and power supply to external components are omitted by integrating the switch in the rack.
As an unmanaged switch, the module forwards the incoming Ethernet frames to the target port in a targeted manner and avoids collisions while operating in the full-duplex mode.
The 10/100BaseTx connectors provide support with half and full-duplex modes. The connections automatically adjust to the network speed via automatic speed recognition (auto negotiation). Automatic adjustment to the cable polarity (auto-MDIX /cross-over-detection) enables crossed or 1:1 network cables to be used.

The SWI-1 switch is a OSI-layer 2 unit and can be connected with various networks with the same protocol (layers 3 to 7). The SWI-1 is therefore protocol-transparent.

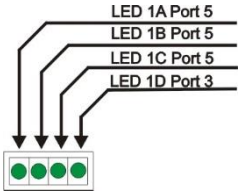
The state and speed of the ports are indicated with multiple LEDs.
The display of the respective port status of the connections A to D take place on the front via the LEDs integrated in RJ45. This issues information on "Traffic" and "Speed".
The information "Full-/Half-Duplex" of the respective ports is displayed using the SMD-LEDs LD2-5 on the printed circuit board.

Figure 26: Quadruple switch SWI-1-1

Figure 27: Switch SWI-1-2

Status LEDs

The internal port status for the CPU system is displayed on LEDs 1A to 1C of the upper row of LEDs in the front panel. LEDs 1A-1C lights up in a faultless condition. LED 1D indicates the status of the fibre optic ports on fibre glass variant SWI-1-2.



LED1A= Duplex: lights for full-duplex mode
LED1B= Speed: lights at 100 Mbit/s
LED1C= Link/Activity: Off when pressed/flashing at Traffic

LED1D= Activity Port Fx: Link/Activity of the fibre glass/FO port

Status of connection LED 1- 4

LED port A to D	Function	
Yellow	On	100·Mbit/s
Speed	Off	10 Mbit/s
Green	Off	No connection/link
Connection / activity	On	Connection established
	Flashing	Activity transmitting/receiving

Internal status LD2 to LD5

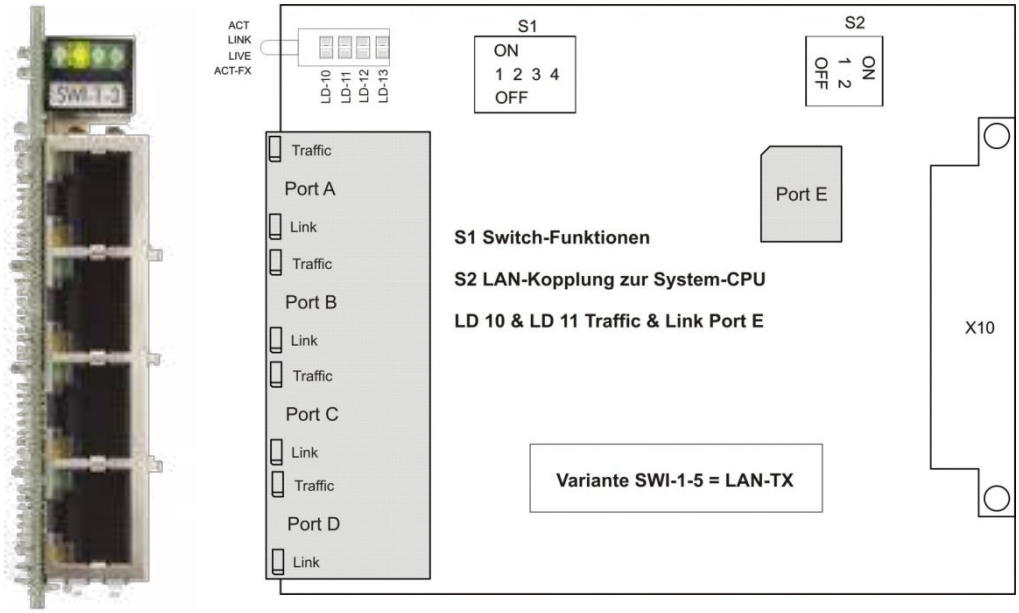
The connection statuses of the respective ports (1 to 4) with half/full duplex, and collision, are displayed by yellow, internal SMD LEDS on the PCB.

Duplex diagnose LED	State	Function
LD2 = Port 1	On	Full-duplex connection
	Flashing	Collision
LD3 = Port 2	On	Full-duplex connection
	Flashing	Collision
LD4 = Port 3	On	Full-duplex connection
	Flashing	Collision
LD5 = Port 4	On	Full-duplex connection
	Flashing	Collision

SWI-1-5 • fourfold Ethernet 10/100BaseTx with port mirror

The SWI-1-5 switch, in term of technology, is based on the SWI-2-x module but it is designed to be upward compatible with the SWI-1-3 module. A port mirrored can be activated via a switch field. For port mirroring, all incoming and outgoing frames for purposes of diagnostics are mirrored in port 1 (above). Furthermore, a bandwidth restriction (traffic shedding) is possible to avoid DOS/brute force attacks. **Pay attention to the slot coding**!

Front layout/location plan

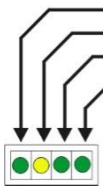


Managed functions SWI-1-5/SWI-1-6 /SWI-1-7

S1	Function	ON	OFF
1	Port mirror mode	**Port mirroring active**# Port 1/A is diagnosis port	Standard function all ports are equal
2	Traffic shaping	no limitation	**Traffic shaping** activated (Data rates limitation)
3/4		-	-

The settings are only read and become active after a restart of the module

LED SWI-1-5 /SWI-1-6 /SWI-1-7



LED1B	Colour			Function
LED10 ●	Green	-	OFF	No communication
LED10 ●	Green	✳	Flashing	Transmission signal, traffic
LED11 ●	Yellow	●	Statically ON	Connection to CPU (duplex)
LED11 ●	Yellow	-	OFF	No connection to CPU system
LED12 ●	Green	✳	4 Hz	Port mirroring active
LED12 ●	Green	-	OFF /Flash ON	Standard - no mirroring

Technical data, cable and line length SWI-1-5

Port 1-4	4 port Ethernet switch 10/100BaseT(X) unmanaged
RJ45 Ports	10/100BaseT(X) speed, auto negotiation, Full/Half duplex mode, auto MDI/MDI-X connection
Diagnostics	Port A – D each with status LED link & traffic Port E internal to the system System LED Live & Functional
Standards	IEEE 802.3 10BaseT, IEEE 802.3u 100BaseT(X), IEEE 802.3x Flow Control
Port mirroring	Can be activated on port A from all data ports
Security	Traffic shaping at port E incl. broadcast storm control
Internet protocol	IPv4, IPv6
Insulation	Class VW2 according IEC 60870-2-1
Cables	4x2 twisted-pair copper cable min. Cat 5e
Line length	Max. 100 m to unit or next hub/switch
Environment	-20°C .. +70°C

Manual selection of the slot SWI-1-5/SWI-1-6/SWI-1-7

The physical interface (PHY) between the components must be right in order to implement an internal Ethernet connection in a cost-effective and space-saving manner. In the meantime, the connection technology has changed so that an automatic adjustment of the PHY between the installed technologies is no longer possible.

ATTENTION **Depending on the unit and slot, a manual selection of the PHY settings must be carried out.**

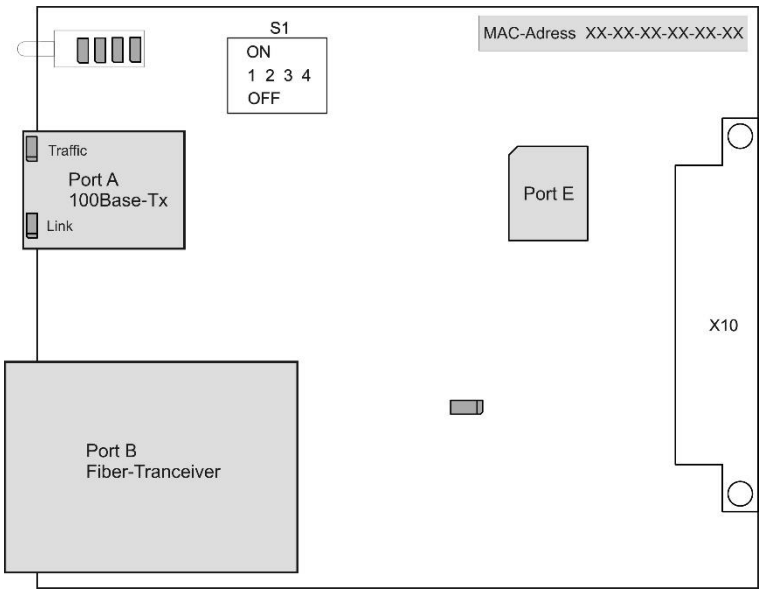
Product	Slot	S2: DIL-1	S2: DIL-2
CPU-5B /5B+	X102	**OFF**	**ON**
	X104	**ON**	**ON**
CPU-5C	X102	**ON**	**ON**
	X104	**ON**	**ON**

Product	Slot	S2: DIL-1	S2: DIL-2
CPU-D5 rev1	LAN1	**ON**	**ON**
	LAN2	**OFF**	**ON**
CPU-D5B/D5C	X100	**ON**	**ON**
	X101	**ON**	**ON**
	X200 (5000-server)	**OFF**	**OFF**
CPU-D5C	X300-X309	**?**	**?**
	X400-X409	**?**	**?**

SWI-1-6 • fibre glass multimode & 1*RJ45 with port mirror

The SWI-1-6 version is identical in construction to SWI-1-5, but via a FO/fibre optic connector with 100 Mbit/s it has a connection via multimode fibre optic cable at port ¾ with duplex SC connection or ST connection.

Front layout/location plan



SWI-1-6: Technical data, cable and line length

FO port 3/4	Fibre glass **multimode SC/ST-Connector**, FO/LWL 100BaseFx	
Connector	**SWI-1-6**: Duplex SC **SWI-1-6-ST**: Duplex ST	
Cables	50/125µm multimode-FO (MM) 62.5/125µm multimode-FO (MM)	0-8 dB 0-11 dB
Wavelength	1310 nm (Tx: 1260 ..1360 nm, Rx: 1260..1610 nm [LM32-A3S-PI-N])	
Insulation	Class VW3 according to IEC 60870-2-1	
Line length	Approx. 2 km fibre data 1.0 dB/km (example)	
Port 1	10/100BaseTx , 1 * RJ45 with Status LED unmanaged Ethernet Switch half/full duplex auto negotiation 10/100 Mbit/s, auto-MDIX	
Topology	Radiating wiring	
Insulation	at connector to port 1 class VW2 according to IEC 60870-2-1	
Cables	4 x 2 Twisted pair copper cable min. cat 5	
Line length	Max. 100 m to unit or next hub/switch	

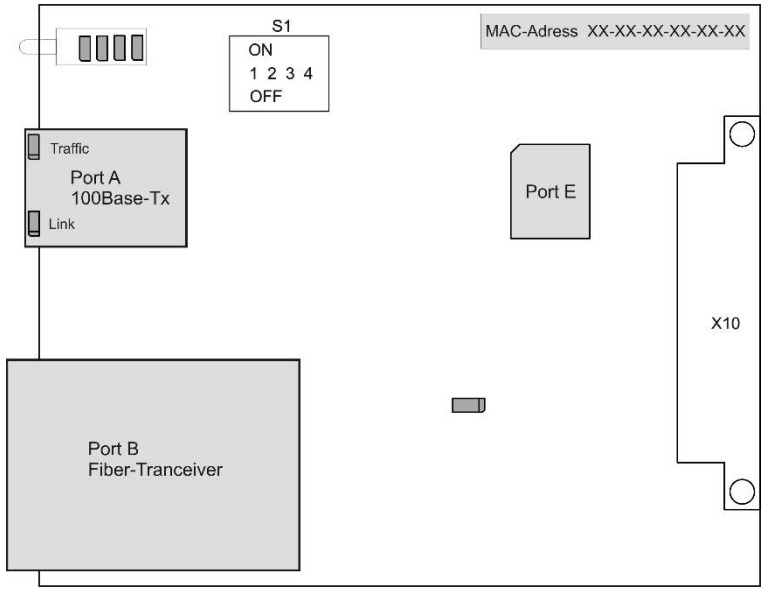
Managed functions & LED function and

ATTENTION **Depending on the unit and slot, a manual selection of the PHY settings must be carried out, see SWI-1-5.**

SWI-1-7 • fibre glass single-mode & 1*RJ45 with port mirror

The SWI-1-7 version is identical in construction to SWI-1-6, but via a single-mode FO/fibre optic connector with 100 Mbit/s, it has a connection at port ¾ with duplex SC connection or ST connection.

Front layout/location plan



SWI-1-7: Technical data, cable and line length

FO port 3/4	Fibre glass **Single-mode SC/ST-Connector**, FO/LWL 100BaseFx,
Connector	**SWI-1-7**: Duplex SC **SWI-1-7-ST**: Duplex ST
Cables	9/125 µm single-mode-FO (MM)
Wavelength	1310 nm (Tx: 1260 ..1360 nm, Rx: 1260..1610 nm [LS32-A3S-PI-N])
Insulation	Class VW3 according to IEC 60870-2-1
Eye safety	IEC 80825-1, FDA CDRH 21-CFR 1040 **Class 1**
Line length	approx. 32 km fibre data 1.0 dB/km (example)
Port 1	10/100BaseTx , 1 * RJ45 with Status LED unmanaged Ethernet Switch half/full duplex auto negotiation 10/100 Mbit/s, auto-MDIX
Topology	Star-shaped wiring
Insulation	at connector to port 1 class VW2 according to IEC 60870-2-1
Cables	4 x 2 Twisted pair copper cable min. cat 5
Line length	Max. 100 m to unit or next hub/switch

Managed functions, LED function and slot coding such as SWI-1-5

ATTENTION **Depending on the unit and slot, a manual selection of the PHY settings must be carried out, see SWI-1-5.**

Switch module SWI-2

The switch modules SWI-2 enable the number of network segments of an FW-50 station to be expanded from two to maximum 6 network segments in a rack via an internal USB connection. Prerequisites for this are:

- Rack BGT-x-USB
- CPU module CPU-5C
- setIT from V5.0
- SWI-2-x module, inserted into X101 /X103 /X105 /X107

The SWI-2-x modules can be configured to positions X101, X103, X105 and/or X107 and can be coupled with an internal USB connection (USB 2.0 480 Mbit/s) to the series5+ core. For each SWI-2 module, an additional IP socket is opened which works as an autarkic network segment in an independent IP address space. In addition to both of the fixed network connectors of the CPU-5C, there are a total of 6 network segments available in FW-50 BGT.

The interface card SWI-2 is available in 3 versions; all have an addition LAN segment available via an internal USB connection.

- SWI-2-1 quadruple switch 10/100BaseTx, 4*RJ45, internal USB-link
- SWI-2-2 multimode FO, SC/ST + RJ45,
  Fibre glass 100BaseFx + 10/100BaseTx
- SWI-2-3 Single-mode FO, SC/ST + RJ45,
  Fibre glass 100BaseFx + 10/100BaseTx

In addition to the expansion of the network segments via SWI-2, the integrated chip-set also enables data transfer management with port mirroring of all transferred frames to connector A (upper RJ-45) and traffic shedding that can be switch offer, a bandwidth limitation to avoid DOS attacks (brute force attacks).

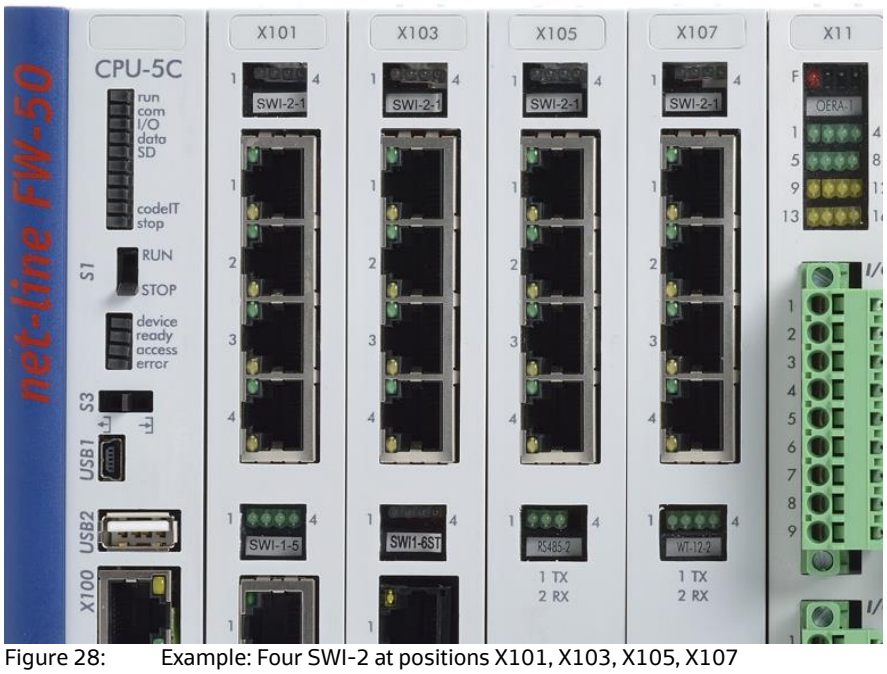
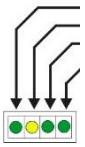


Figure 28: Example: Four SWI-2 at positions X101, X103, X105, X107

Managed functions SWI-2-1/SWI-2-2

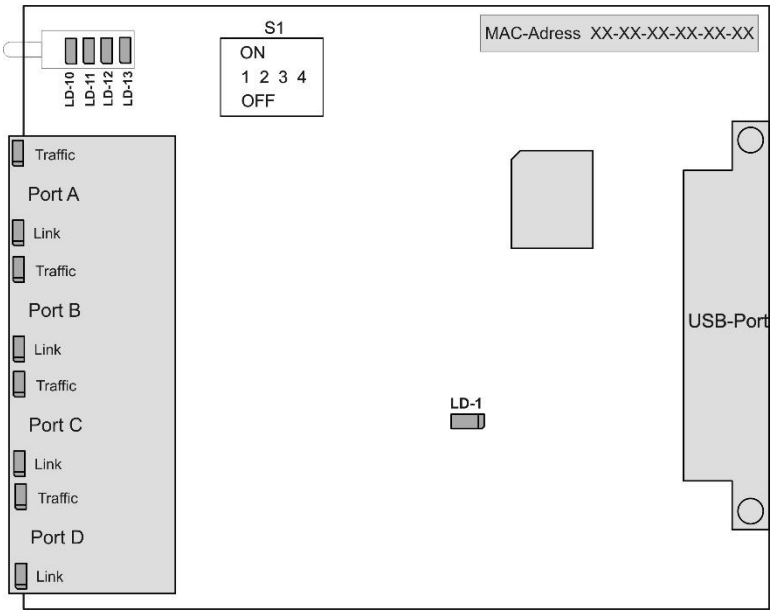
S1	Function	ON	OFF
1	Port mirror mode	**Port mirroring active#** Port 1/A is diagnosis port	Standard function all ports are equal
2	Traffic shaping	No limitation	**Traffic shaping** activated (Data rates limitation)
3-4		-	-

LED SWI-2-1 /SWI-2-2



LED1B	Colour			Function
LED10 ●	Green	-	OFF	no communication
LED10 ●	Green	✳	Flashing	Transmission signal, traffic
LED11 ●	Yellow	●	Statically ON	Connection to CPU (duplex)
LED11 ●	Yellow	-	OFF	no connection to CPU system
LED12 ●	Green	✳	4 Hz	Port mirroring active
LED12 ●	Green	-	OFF/Flash ON	Standard - no mirroring
LED13 ●	Green	-	OFF	no communication FX
LED13 ●	Green	✳	Rapid flashing	Transmission signal, FX-port for SWI-2-2

Layout plan SWI-2-1



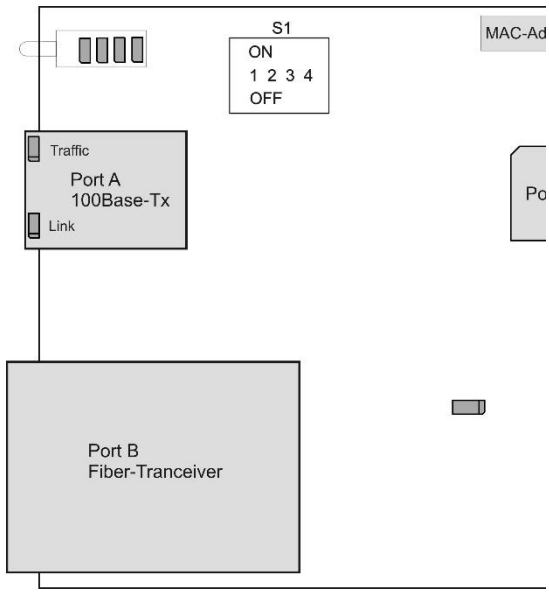
Technical data SWI-2-1

USB	Internal connection to system via USB 2.0 480 Mbit/s
Port 1-4	4 port Ethernet switch 10/100BaseT(X)
RJ45 Ports	10/100BaseT(X) speed, auto negotiation, Full/Half duplex mode, auto MDI/MDI-X connection
Diagnostics	Port A – D each with status LED link & traffic Port E internal to the system System LED Live & Functional
Standards	IEEE 802.3 10BaseT, IEEE 802.3u 100BaseT(X), IEEE 802.3x Flow Control
Port mirroring	can be activated on port A from all data ports
Security	Traffic shaping at port E incl. broadcast storm control
Internet protocol	IPv4, IPv6
Insulation	Class VW2 according IEC 60870-2-1
Cables	4x2 twisted-pair copper cable min. Cat 5e
Line length	max. 100 m to unit or next hub/switch
Environment	-20°C .. +70°C

SWI-2-2 • multimode fibre glass & 1*RJ45 with port mirror

The SWI-2-2 version provides an additional network segment with fibre glass multimode via an internal USB interface. It is identical in construction to SWI-2-1, but via a FO/fibre optic connector with 100 Mbit/s it has a connection via multimode fibre optic cable at port ¾ with duplex SC connection or ST connection.

Front layout/location plan



SWI-2-2: Technical data, cable and line length

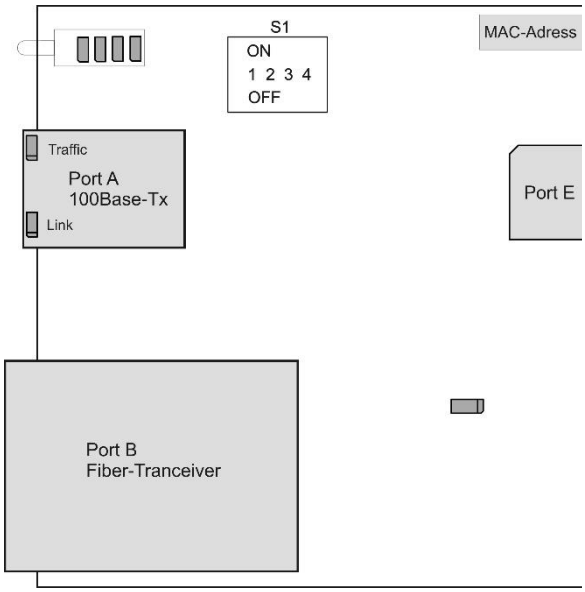
USB	Internal connection to system via USB 2.0 480 Mbit/s
FO port 3/4	Fibre glass **multimode SC/ST-Connector**, FO/LWL 100BaseFx
Connector	**SWI-2-2**: Duplex SC **SWI-2-2-ST**: Duplex ST
Cables	50/125µm multimode-FO (MM) 0-8 dB 62.5/125µm multimode-FO (MM) 0-11 dB
Wavelength	1310 nm (Tx: 1260 ..1360 nm, Rx: 1260..1610 nm [LM32-A3S-PI-N])
Insulation	Class VW3 according to IEC 60870-2-1
Line length	Approx. 2 km fibre data 1.0 dB/km (example)
Port 1	10/100BaseTx , 1 * RJ45 with Status LED unmanaged Ethernet Switch half/full duplex auto negotiation 10/100 Mbit/s, auto-MDIX
Topology	Star-shaped wiring
Insulation	at connector to port 1 class VW2 according to IEC 60870-2-1
Cables	4 x 2 Twisted pair copper cable min. cat 5
Line length	Max. 100 m to unit or next hub/switch

Managed functions and LED such as SWI-2-1

SWI-2-3 • single-mode fibre glass & 1*RJ45 with port mirror

The SWI-2-3 version provides an additional network segment with single-mode fibre glass via an internal USB interface. It is identical in construction to SWI-2-2, but via a single-mode FO/fibre optic connector with 100 Mbit/s it has a connection at port ¾ with duplex SC connection or ST connection.

Front layout/location plan



SWI-2-3: Technical data, cable and line length

USB	Internal connection to system via USB 2.0 480 Mbit/s
FO port 3/4	Fibre glass **single-mode SC/ST-Connector**, FO/LWL 100BaseFx,
Connector	**SWI-2-3**: Duplex SC **SWI-2-3-ST**: Duplex ST
Cables	9/125 µm single-mode-FO (MM)
Wavelength	1310 nm (Tx: 1260 ..1360 nm, Rx: 1260..1610 nm [LS32-A3S-PI-N])
Insulation	Class VW3 according to IEC 60870-2-1
Eye safety	IEC 80825-1, FDA CDRH 21-CFR 1040 **Class 1**
Line length	typ. 15 km fibre data 1.0 dB/km (example)
Port 1	10/100BaseTx , 1 * RJ45 with Status LED unmanaged Ethernet Switch half/full duplex auto negotiation 10/100 Mbit/s, auto-MDIX
Topology	Radiating wiring
Insulation	at connector to port 1 class VW2 according to IEC 60870-2-1
Cables	4 x 2 Twisted pair copper cable min. cat 5
Line length	Max. 100 m to unit or next hub/switch

Managed functions and LED such as SWI-2-1

SWI-3-1 • HSR/PRP Switch

The SWI-3 is an intelligent switch module for BCU-50 series5e that supports a redundant LAN connection based on Layer 2 to networks with HSR high-availability seamless redundancy or PRP parallel redundancy protocol on slots X102 and X104. Both redundancy protocols operate without interruption time as they simultaneously provide the frames to be transmitted on both ports. Connection failures are mapped via system messages in the station.
The description of the protocols goes beyond the scope of this technical data, therefore we refer to sources such as wikipedia.de
Due to the reduced power requirement for 100 Mbit/s networks, a Gbit connection has been dispensed with and the PTP Precision Time Protocol according to IEEE15888 is currently not supported.
The two SFP cages on ports A and B allow the optional fitting of transponders according to conditions. There is no manufacturer-specific restriction as long as the technical data is complied with. Only the additional current consumption of the SFP transponders must be taken into account in the station demand calculation and the heat loss calculation of the cabinet.
Note: The SWI-3 requires a front panel with COM cut-out at the bottom.

Item number	Function	
310004002311	Front pane COM / SWI3 series FW-50	top COM, bottom Switch SWI-3
310004007201	Front pane SWI / SWI3 series FW-50	top Switch, bottom Switch SWI-3
310050502711	Front pane COM / SWI3 series BCU-50	top COM, bottom Switch SWI3
310050502721	Front pane SWI / SWI3 series BCU-50	top Switch bottom Switch SWI-3

Approved SFP-variants

Item	type	mode	wavelength	coverage
310000023010	**SFP Modul SWI-3 MM-LC**	100BaseFX multimode	850 nm	2 km
310000023011	SFP Modul SWI-3 MM-LC 1310 nm, 2 km	100BaseFX multimode	1310 nm	2 km
310000023020	**SFP Modul SWI-3 SM-LC**	100BaseFX singlemode	1310 nm	30 km

Note: SFP- slots in fibre optic are equipped with LC connectors.
Note: When using the PTP protocol and SFP copper, there is an increased jitter which can lead to time errors.

Configuration SWI-3

The current configuration of the module requires one of the serial interfaces of the lower bus. This interface is not available for other protocols, since the status messages of the ports are queried via it. The interface selection is carried out on the board by means of a jumper. Further configuration of the module is carried out exclusively via setIT from V6.001.

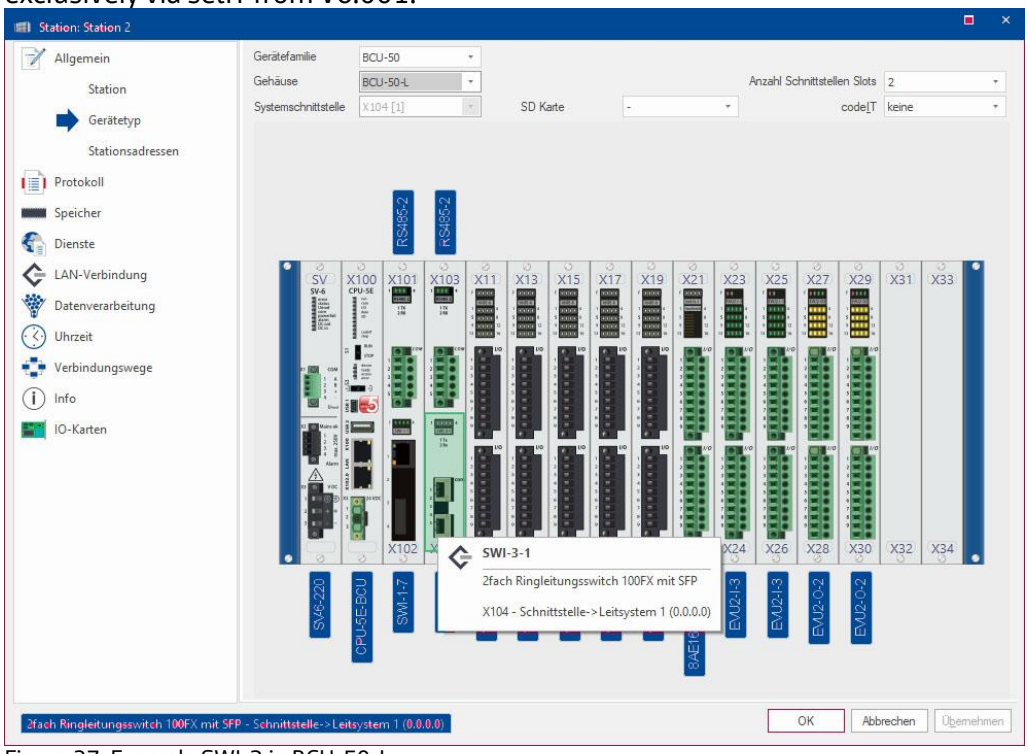


Figure 27: Example SWI-3 in BCU-50-L

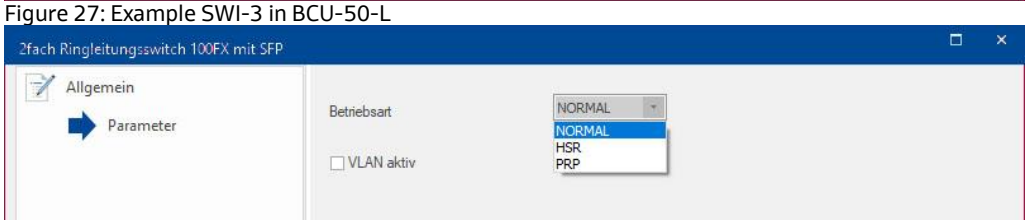


Figure 28: properties of the SWI-3 card

Operation Modes

Operation Mode	Function
Normal	Ports A and B are operated equally, no system monitoring
HSR	Activation of the HSR redundancy protocol
PRP	Activation of the PRP redundancy protocol
VLAN aktive	Only frames with VLAN are passed through

Interface selection

S2 Tx/Rx	**S3** Tx/Rx	**Serial channel**	**Remarks**
1-2	1-2	COM2	1. serial in lower bus
2-3	1-2	COM4	2. serial in lower bus
-	2-3	COM/TBUS	system interface

Layout plan SWI-3-1

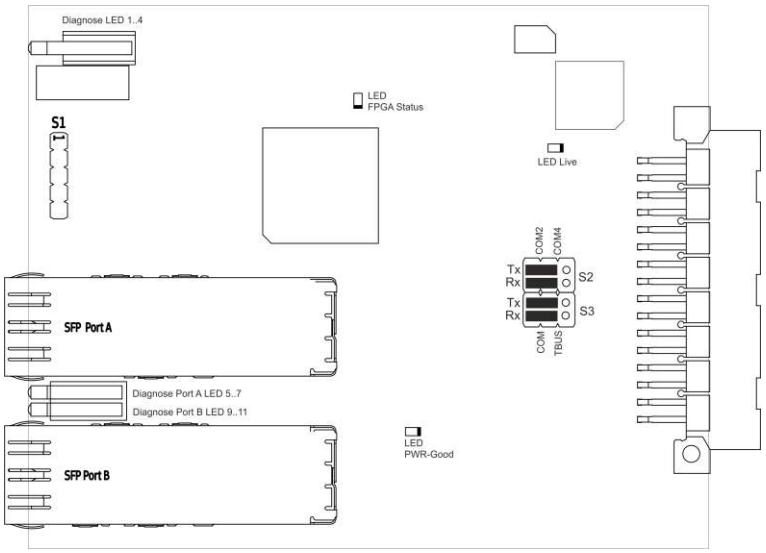


Figure 29: SWI-3 lay out- and assembly diagram

LED FPGA	**Colour**			**Function**
FPGA ●	Green	-	Off	error: Module error, no release
		✳	flash 2 Hz	operation: RUN initialisation OK and Ring active
		✳	flash 4 Hz	error: waits for initialisation
		✳	flash 8 Hz	Boot : FPGA starts

LED SWI-3-1

LED 1●●●●4	Colour			Function
LED1 ●	Red	-	off	operation: module release
		●	on	error: module error, no release
		✳	flash 2 Hz	error: Slot address/ internal defect
		✳	flash 8 Hz	error: communication CPU
LED2 ●	Yellow	-	off	operation: error-free
		●	on	error: Port A/B disturbed
		✳	flash 2 Hz	error: missing configuration
LED3 ●	Green	●	on	HSR protocol aktive
LED3 ●	Yellow	●	on	PRP protocol aktive
		-	off	Normal mode
LED4 ●	green	●	on	VLAN aktive

LED 5●●●-				Funktion SFP-Port A
LED5 ●	Green	●	on	Port A physical LINK OK source PHY LINK without Supervision Frames light & SFP OK
		✳	short off	Dark keys: Supervision frames are sent by the HSR/PRP core
LED6 ●	Green	●	on	Port A logic LINK OK source FPGA Ring protocol is set correctly
		-	off	OFF & LED5 on = wrong protocol
LED7 ●	Yellow	●	on	error: Port A malfunction
**LED 9●●●- **				**Function SFP-Port B**
LED9 ●	Green	●	on	Port B logic LINK OK source FPGA LINK without Supervision Frames light & SFP OK
		✳	short off	Dark keys: Supervision frames are sent by the HSR/PRP core
LED10 ●	Green	●	on	Port B physical LINK OK source PHY Ring protocol is set correctly
		-	off	OFF & LED9 on = wrong protocol
LED11 ●	Yellow	●	on	error: Port B malfunction

Note: The detection of a port error via timeout of the supervision frames of the HSR/PRP protocols and their secure transmission via system message can take several seconds.

Technical data SWI-3-1

SWI-3	Intelligent layer-2 Switch HSR/PRP 100 MBit/s full duplex for redundant LAN connection/DAN via 2 SFP	
Ports	2 * 100 MBit/s SFP Small Formfactor Pluggable, optional type MMF / SMF according to SFF INF-8074i with any frontend, therefore free choice of connectors and media	
Redundancy protocol	HSR	by IEC 62439-3 rev3 mode H & X
	PRP	by IEC 62439-3 rev3
Diagnostics	LED for status and Ports A/B, system-LED Live & Function	
Specials	Priority tagging of GOOSE messages VLAN tagging	
Internet Protocol	IPv4	
Isolation	EMI:	EN 55032 Class A
	EMS:	IEC 61000-4-2 ESD: Contact: 8 kV; Air: 15 kV IEC 61000-4-3 RS: 80 MHz to 1 GHz: 10 V/m IEC 61000-4-4 EFT: Power: 4 kV; Signal: 2 kV IEC 61000-4-5 Surge: Power: 2 kV; Signal: 2 kV IEC 61000-4-6 CS: 10 V
Shock/Vibration	by IEC 61850-3 (f)	
Current consumption	2,9 W typ., min. 1,7 W + SFP consumption	
Heat loss capacity	2,9 W typ., corresponds to power consumption	
Cable/Media/Length	Fibre optic or cupper, free choice by SFP	
Connector	LC or RJ-45, depends on SFP-type	
Environment	-20°C ... +65°C Ø24h max. +55°C	
Installation height	max. 2000 m ü.NHN	
Relative humidity	<95% at 25°C without condensation (class F)	
Item	310000023840 interface SWI-3-1 HSR/PRP-Switch	

Serial telecontrol interfaces

The serial interfaces in FW-50 can be used in a completely upward compatible manner with the FW-40 system. The position is no longer rigidly defined. The form factor ½ Euro-format enables two different interface cards in one slot (slot position top and bottom).

- The FW-50 bus offers a total of 4 serial interfaces, two in the upper (U) and two in the lower (L) section of the FW-50 bus. Interface signals are available up to slot U-7 and/or L-7. (This is the area covered by the standard housing BGT-M) The selection of the card continues to take place on the card via J11-14 (COM1 /COM2).
- Terminal designations depend on the position in the system. This is determined by using switch cards and the (expansion) requirements of the customer.
- At the positions U-1 to U-4 and L-1 to L-4 (X101 to X108) a reset signal for selective reinitialisation of the modules is available. Therefore, these positions are particularly suitable for serial interfaces.
- In the rear bus segment of FW--14, the serial interfaces are not available from U/L-8 onwards.
- A FW-50 system can also be used sensibly without a serial interface (as is the case with CPU-4B-ENET) via the Ethernet interface at the front of the CPU-5. This expands the usable space for I/O cards at one slot.

Selection of interfaces

Jumpers S11 to S14 hold the same function in all interface cards. Determining which serial channel (X4-X7) should operate the module is set with these jumpers.

S11 - S14	COM of the serial card	Slots for FW-50	Comment
1-2	COM1	**X101** and **X102**	**Default setting**
2-3	COM2	X103 and X104	

Interfaces for dedicated lines

Interface card RS485-2 / RS422-2

With the RS485-2 interface card, the following functions

- Interfaces according to RS485, 2-wire half-duplex or
- Interface according to RS422, 4-wire full duplex

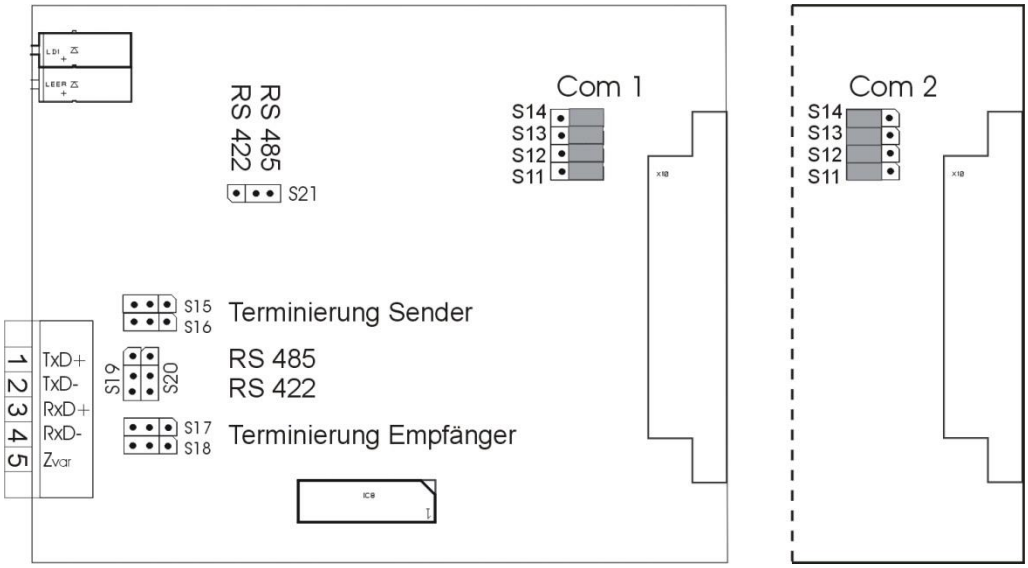
which are selected via jumpers can be implemented. The factory settings of these cards are shown on the name plate. Transforming an RS-485-2 to a RS-422-2 is performed with a few jumpers.

Furthermore, the jumpers are available to activate the integrated termination resistors (150 Ω, alternatively Tx and Rx), with simultaneous termination for noise signal rejection in the half duplex mode for MODBUS and IEC protocol.

RS485-2 / RS422-2	Interface RS/EIA/TIA-485 / -422
Operating methods	Full duplex, point-to-point or half-duplex, bus mode
Line	2x2 conductors, twisted pair and shielded e.g. LiYCY 2x2x0.25 mm
Transmission mode	Symmetrical
Baud rate	300 - 64k bits/s
Range	1200 m
Function indicator	Green TD/RD/ RTS LEDs at the front
Signal without load	Max. +/- 5.0 V
Signal with load	Max. +/- 1.5 V
Short circuit power	Max. +/- 70 mA
Signal level	Permissible range - 7 to + 12 V
Signal sensitivity	+/- 200 mV
Electrical isolation	Between logic and transmission line
Test voltage	3000 V AC
Power consumption	30 mA typically (at +Ub=24 V DC)
Operating temperature	0 to +50°C
Relative humidity	95% at 25°C without condensation (class F)

LED 1●●●●4	Colour	Function
1●	Green	"TD" Transmission signal
2●	Green	"RD" Received signal
3●	Green	"RTS" Request To Send signal

Configuration plan RS485-2 / RS422-2



Selection of serial interface (COMx) via jumpers S11 - S14, see p. 98

Operating methods

Interface type	S19 + S20	S21	Comment
RS485	**1-2**	**2-3**	Function such as RS 485-1
RS422	2-3	1-2	Function such as RS422-1
RS422, pressed	2-3	2-3	Setting the driver at RS485

Transforming a RS485-2 into to a RS422-2

It is easy to change the operating method of a RS-485-2 in the RS-422 mode by inserting a few jumpers. There is label on the card, which states the jumper positions for RS-422.

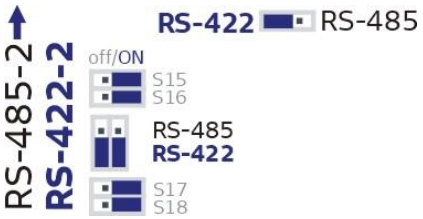
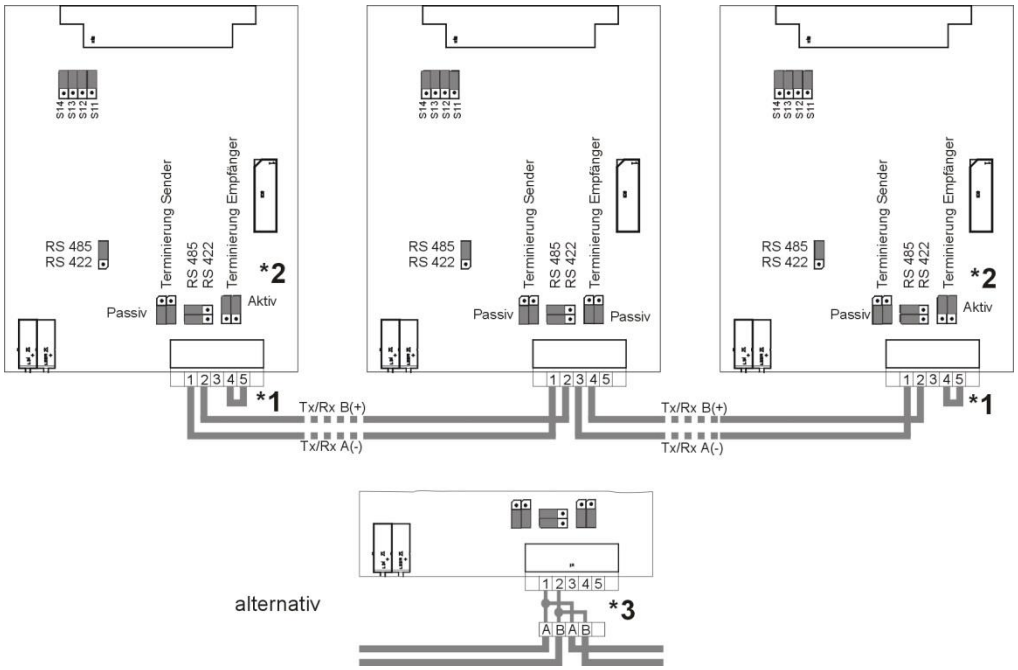


Figure 30: Switching to operating method RS-422

Line connector RS 485-2



The termination of the lines (270 Ohm resistance) is achieved via bridge circuit *1. This bridge circuit must be configured on the first and last card in the system. A noise signal rejection is not achieved through this termination. This version is compatible with card RS 485-1.

Termination with interference rejection

The RS 485-2 modules offer the option of activating a termination with interference rejection (*2). In doing so the line is concluded with 150 Ohm and simultaneously pulled to a defined level via pull up/pull down resistors (1 kΩ); this rejects the noise signal. This is absolute necessary for some protocols (such as Modbus, IEC ...). The respective jumpers (S17/S18) are already inserted in the delivery status. In the case of several participants, **only the first and last station must be terminated**; the termination in the other stations must be deactivated accordingly.

Attention: Only use one type of termination (*1 or *2).
An alternative connector option is presented in the switchboard at position *3. Essentially, it only offers the option of replaced the card in a running system.

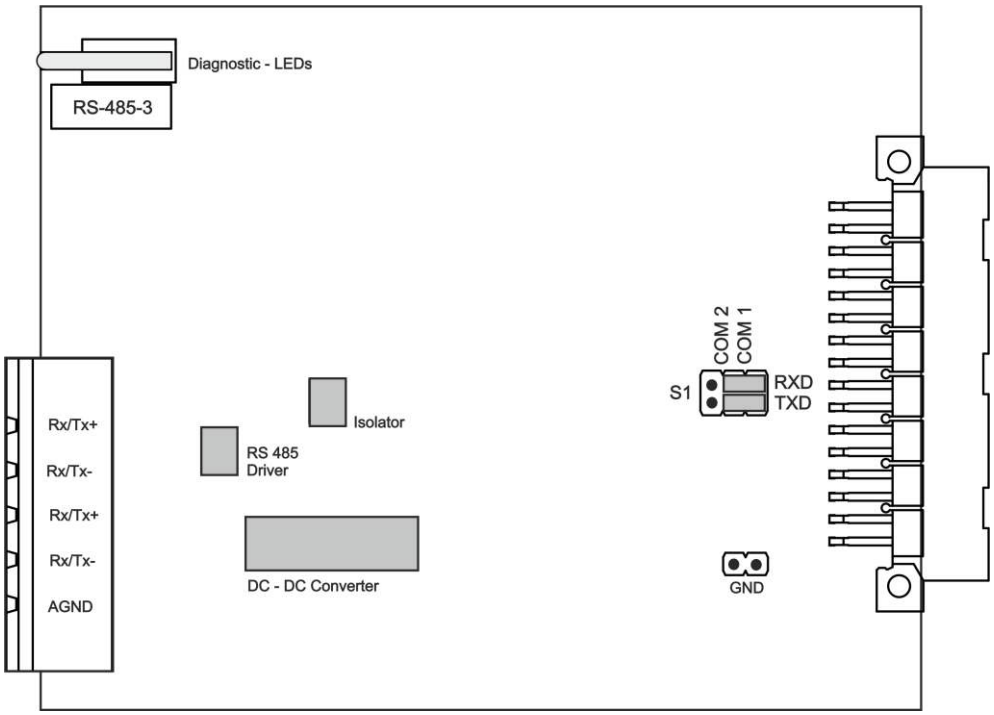
Interface card RS485-3

The interface card RS485-3 makes an 2-line connection according to the standard TIA/EIA/RS-485 with automatic keying available.
To achieve minimum key times in time-critical transmission protocols, such as Modbus or DSfG, the asynchronous data transfer is controlled via hardware; it is sampled with each transmission dada byte. A configuration of the key times is therefore not possible.
The scheduling for characters corrupting the structure of the file in half-duplex mode for Modbus and IEC protocol is firmly activated.

RS485-3	**Interface RS/EIA/TIA-485**
Operating methods	Point-to-point or half-duplex, bus mode
Line	2 Conductors, drilled as a pair and shielded (LiYCY 2 x 0.25 mm2)
Transmission mode	symmetrical
Key times	automatic keying in & blanking out time synchronously with transmission data byte, wire/signal charging pulse type 5 µs
Transmission rate	300 to 115.2 kbit/s
Line length	depending on transmission rate and cable type max. 1000 m
Number of participants	with RS485-3 max. 6/with RS485-2 max. 31 participants
Function indicator	LED's TxD, RxD (active green with data stream)
Output signal level	± 4 V
Input voltage	max. - 7 to + 12 V
Input sensitivity	+/- 200 mV
Terminating resistor	220 Ω (integrated resistance)
EMC Protection	ESD to 15 kV/max. 400 watt pulse (tp = 8/20 µs)
Electrical isolation	between logic and transmission line
Isolation	Signal/logic 2500 V AC / air & creepage distance >4 mm
Power consumption	225 mW from internal 5 V supply
Operating temperature	-20 to 60°C (short-term 70°C)
Relative air humidity	95% at 40 °C without condensation (Class F)

LED 1●●○○4	**Colour**	**Function**
1●	green	"TD" Transmission signal
2●	green	"RD" Received signal

Mounting diagram RS485-3



Selection of a serial interface (COMx) through jumpers S1/S2

S1/S2	COM of the ser. Card	Slots for FW-50	Comment
1-2	COM1	**X101** and **X102**	**Default setting**
2-3	COM2	X103 and X104	

Line interface RS485-3

The cable connection is made as for RS-485-2 with further pairs of X10n.3/X10n.4, but without terminating resistor bridge.

X10n	Function	Comment
1	Rx/Tx+	**RS-485 Level A** arriving conductor
2	Rx/Tx-	**RS-485 Level B** arriving conductor
3	Rx/Tx+	RS-485 Level A departing conductor
4	Rx/Tx-	RS-485 Level B departing conductor
5	AGND	Analogue ground (no shield)

Interface card LWL-2

The LWL-2 interface card is a media converter of serial signals to fibre optic FO with its own custom functions:

- Every LWL-2 has two receiver/transceiver pairs to connect two fibre optic segments
- Up to 7 LWL-2 can be plugged into a bus segment in a rack
- Every card can be assigned individually to COM1 or COM2 of the bus segment
- Any bus-compatible serial protocol with tolerant response time can be used
- The idle level (light) of the segment can be set

The LWL-2 card accesses one of the four serial interfaces in the rack, and provides the data link to two FO ports. It works like a star coupler already integrated in the rack. The LWL-2 card uses here a multidrop configuration bus mode. All cards assigned on the same interface send the same signal over the fibre optic links, but only the station addressed replies. This corresponds to the multidrop configuration bus mode of RS-485 for example; no common segment is cabled to the stations however, only individual FO segments in a star configuration are laid. Every LWL-2 couples two protective devices for example, for 2 bus segments top/bottom, 7 slots and 2 couplers (2*7*2 = 28 protective devices) can be connected serially in a rack over FO.

A differentiation is made in setIT between LWL-2 and LWL-2(S). The LWL-2 denotes a card with new COM assignment. The LWL-2(S) slave uses the same COM as the LWL-2 before it on the left, and so is in the same communication segment.

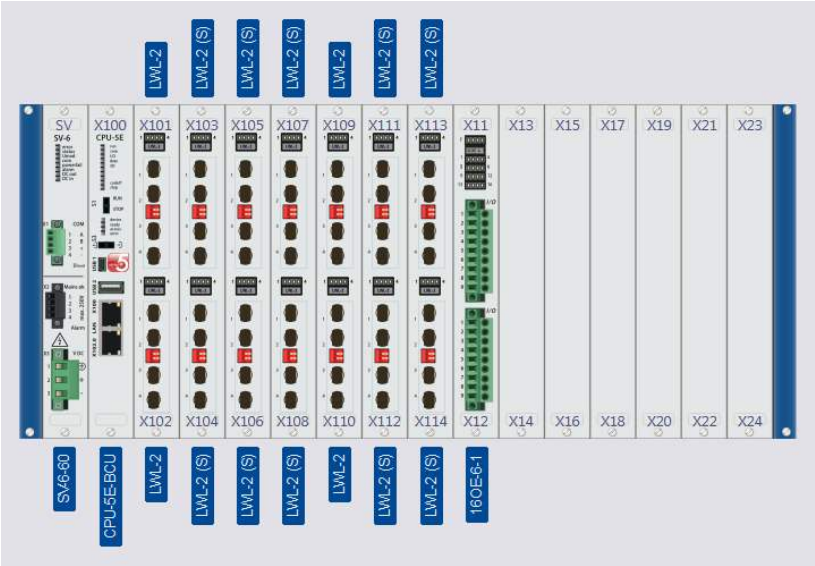


Figure 31: Using the LWL-2 in the BGT-L rack

Recommendation: Do not group more than 8 protective devices in one segment. When there are too many units or the data volume is too high, the addressing and response times of the protective devices add up.

Using the LWL-2 as a star coupler in the project

The LWL-2 can be used as a single media converter or in a group as a star coupler. setIT V5.005 is required to fully integrate the LWL-2 card. This enables the interfaces to be assigned as usual in the station configuration. First, the number of slots required must be reserved for the interfaces.
Unlike for the standard interface cards, the number of interfaces is not restricted to 4, and 7 LWL-2 cards per bus segment can be used for expansion to the full configuration. Each card can be set individually to COM1 or COM2 of the bus segment using jumpers. setIT assumes that the LWL-2 cards are not mixed as regards COM assignment, and are assigned in groups of one interface. LWL-2 is used as the name for a card with new COM assignment, and LWL-2(S) for another card in the same communication segment as the LWL-2 next to it on the left.

The LWL-2 can also be used without V5.005 - because the interface can be configured functionally to RS485-2 instead of the first LWL-2. Proceed as described above, reserve the slots required, configure a RS485-2 for every COM - but plug in the required number of LWL-2s into the housing. The complete visual picture, and the assignments of the external stations to the interface, are lacking however.

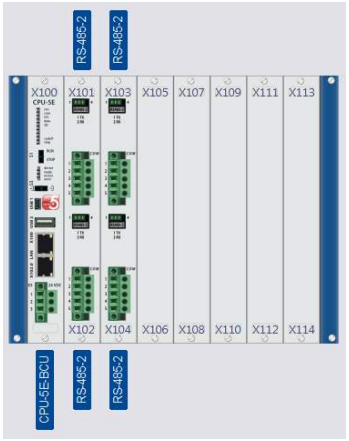


Figure 32: Interface assignment for when using the LWL-2 star coupler up to setIT V5.004

Technical details LWL-2

LWL-2	FO star coupler
Operating methods	Half-duplex, Bus mode
Fibre glass	Wavelength 820 nm, Fibre Ø: 50/125 µm, 62.5/125 µm, 100/140 µm, 200 µm HCS®
Optical power for sending	50/125 µm: -19 dBm, 62.5/125 µm: -16 dBm
Optical power for receiving	-24 dBm
Speed	to 38.4 kbit/s
Range	1400 m
Plug-in connector	ST connector with bayonet fitting, BFOC connector to IEC 60874-10-1
Function indicator	LEDs at the front, TxD, RxD, fault
Electrical isolation	between logic and transmission line
Power consumption	30 mA generally (at +Ub=24 V DC)
Operating temperature	-20° to +70°C, recommended max. 55°C
Relative air humidity	< 95% at 25°C no condensation (Class F)

Diagnostic LED

LED 1●●●●4	Colours	Function
1●	green	TxD Send signal
2●	green /yellow	RxD / FO port 1
3●	green /yellow	RxD / FO port 2
4●	red	Errors: Fault on FO port 1 or 2

LED	Colours		Status	Function
TxD	●green	○	statically Off	No activity
		✳	flashing	Data being sent
RxD port 1	●green	○	statically Off	No reception
		✳	flashing	Data being received on FO port 1
	●yellow	●	static ON	Error: FO port 1 fault / fibre optic break detected
RxD port 2	●green	○	statically Off	No reception
		✳	flashing	Data being received on FO port 2
	●yellow	●	static ON	Error: FO port 2 fault / fibre optic break detected
Error	●red	○	OFF	Running: no fault
		●	On	Error: Monitoring active / collective fault fibre optic glass break detected

Mounting diagram LWL-2

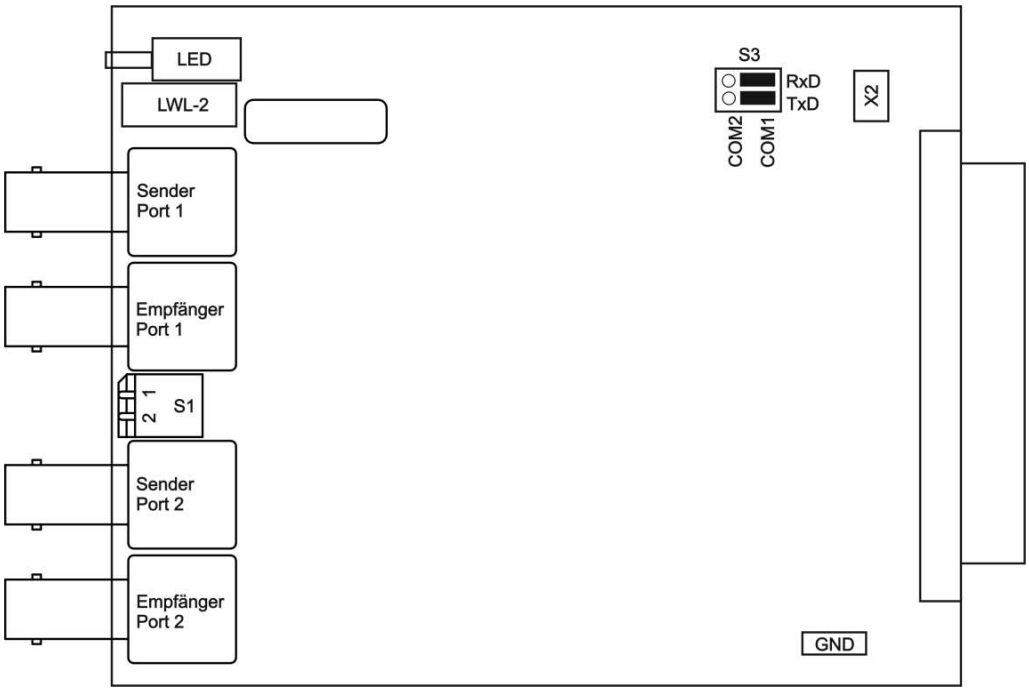


Figure 33: Mounting diagram for LWL-2

Selection of interfaces

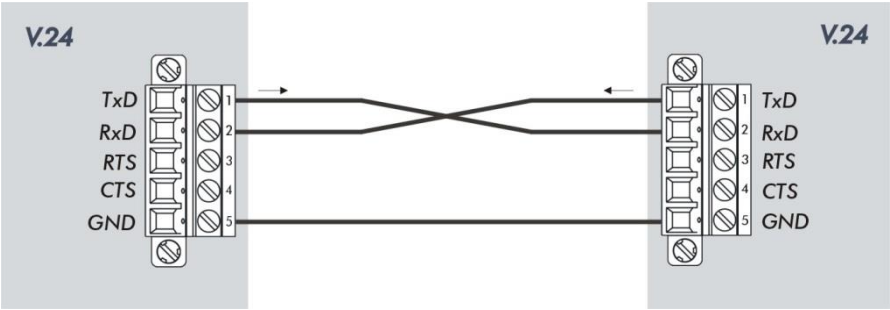
S3	Serial channel	Comment
1-2	COM1	**Default setting** COM1 grouped in front slots
2-3	COM2	COM2 grouped in back slots

Idle level modes

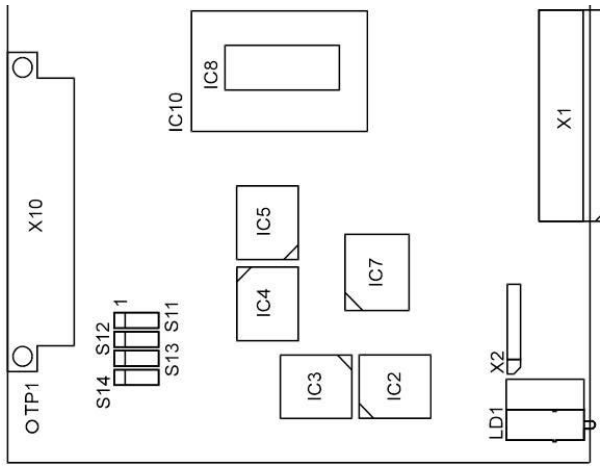
Interfaces	S1	Comment
Idle level P1	**S1 1 off**/right	Idle level light On Port 1
	S1 1 on/left	Idle level light Off, no monitoring possible
Idle level P2	**S1 2 off**/right	Idle level light On Port 2
	S1 2 on/left	Idle level light Off, no monitoring possible

Interface card V.24-1/-2

V24-1 / V24-2	RS-232 interface
Operating methods	Full duplex, point-to-point
Line	Shielded cable, min. 3-wire
Transmission mode	Asymmetric point-to-point
Baud rate	300 - 19200 bits/s
Range	Typically 20 m max. 100 m
Function indicator	Green LED in front TD, RD, RTS, CD (CTS)
Signal without load	+/- 15 V
Signal with load	+/- 5 V
Permissible load	3 to 7 kΩ
input voltage	Permissible range +/- 15 V
input sensitivity	+/- 3 V
Electrical isolation	Between logic and transmission line
Test voltage	500 V AC / 3000 V DC for V.24-2
Power consumption	30 mA typically (at +Ub=24 V DC)
Operating temperature	0 to +50°C
Relative humidity	95% at 25°C without condensation (class F)



Mounting diagram

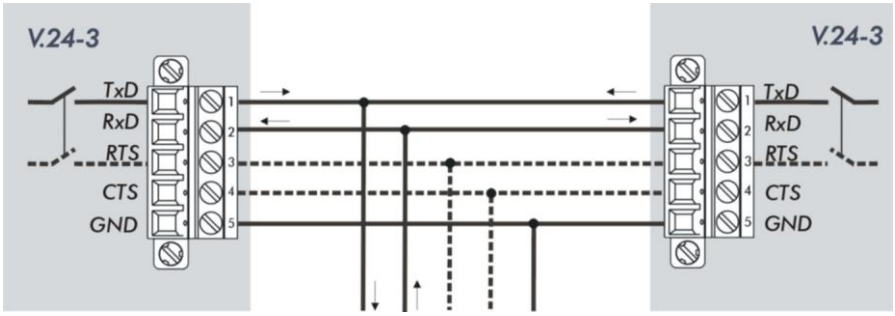


Selection of serial interface (COMx) via jumpers S11 - S14, see p. 98

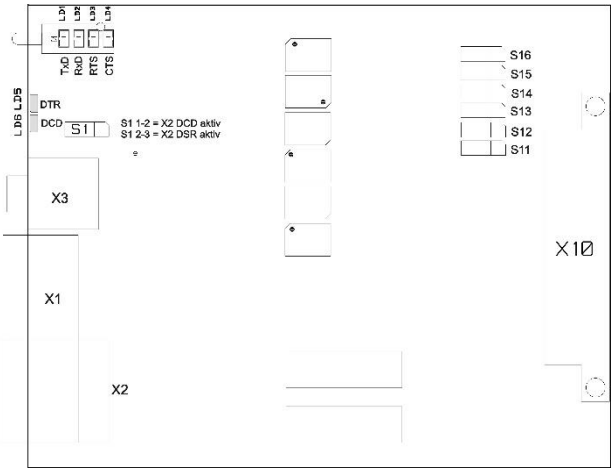
Interface card V.24-3

This card corresponds to a V.24-2 with switchable transmission data for the direct parallel activation on the duplicated heads. There is a pressed, party-line compatible interface where more than two V.24 interfaces can be interconnected. The TxD transmission line and the trigger signal are switched with high impedance via RTS. This prevents a complex cabling via the T-coupler or change over switch.

V24-3	V.24 (RS-232 , ANSI/EIA/TIA-232-F-1997) with monitoring interface
Operating methods	Full duplex, asymmetric, point-to-point and party-line via RTS keying
Line	Shielded cable, min. 3-wire
Baud rate	300 to 115 kbit/s
Range	Typically 20 m max. 100 m
Function indicator	Green LED in front TD, RD, RTS, CD (CTS)
Signal without load	+/- 7 V
Signal with load	+/- 5 V
Permissible load	3 to 7 kΩ
input voltage	Permissible range +/- 15 V
input sensitivity	+/- 3 V
Electrical isolation	Between logic and transmission line
Test voltage	3000 V DC
Power consumption	30 mA typically (at +Ub=24 V DC)
Operating temperature	0 to +70°C
Relative humidity	95% at 25°C without condensation (class F)



Mounting diagram V24-3 /V24-4



Selection of serial interface (COMx) via jumpers S11 - S14, see p. 98

Jumpers of the serial interfaces

The V24-3/V24-4 cards are equipped with 6 jumpers to select the interface. Both of the additional jumpers S15/S16 have been added to select the extended handshake signals DCD/DTR.

S11 - S14	COM of the serial Card	Slots	Comment
1-2	COM1	**X101** and **X102**	Default setting
2-3	COM2	X103 and X104	

S15 - S16	COM	Slots	Comment
Open			Open
Open			Open

Both of these jumpers must NOT be inserted into the existing racks of the FW-50 series.

Diagnostic interface (V.24)

see Diagnostic interface (V.24) p. 116

Attention

When changing a V.24-3 the module should **be supplied with a voltage before the data line is** inserted. The analogue switch of the card required energy to be activated; this would be retrieved from the data line and could result in brief communication interferences.

Interface card V.24-4

V24-4	**V.24 (RS-232 , ANSI/EIA/TIA-232-F-1997) with monitoring interface**
Operating methods	Asymmetric, full duplex, point-to-point
Line	RJ-45 PATCH cable, adapter cable e.g. VB213
Baud rate	300 to 115 kbit/s
Range	Typically 20 m max. 100 m
Plug	RJ-45 bushing according to ETSI EN 300-392-5 DEE
Function indicator	Green LED in front TD, RD, RTS, CD (CTS)
Signal without load	+/- 12 V
Signal with load	+/- 5 V
Permissible load	3 to 7 kΩ
Input voltage	Permissible range +/- 15 V
Input sensitivity	+/- 3 V
Electrical isolation	Between logic and transmission line
Test voltage	3000 V DC
Power consumption	30 mA typically (at +Ub=24 V DC)
Operating temperature	0 to +70°C
Relative humidity	95% at 25°C without condensation (class F)

RJ-45 connected according to EN ETSI 300 392-5 DEE

	Pin	*Name*		*To ETSI EN 300 392-5 DTE*
	1	DSR/PWR	◀	Data Set Ready
RxD	2	DCD	◀	Data·Carrier·Detect·
	3	DTR	▶	Data ·terminal· ready
	4	GND	-	Ground
	5	RxD	◀	Receive Data
TxD	6	TxD	▶	Transmit Data
	7	CTS	◀	Clear· to ·send·
	8	RTS	▶	Request To Send keying

The RJ-45 occupation is designed so that an external WT module (SWT-12, SWT-96), TETRA-1 or GPRS-1 can be connected 1:1 with a patch cable.

Mounting diagram

Corresponds to Mounting diagram V24-3 /V24-4 p. 110.
Selection of serial interface via jumpers S11-S16, see p. 110

Diagnostic interface (V.24)

see Diagnostic interface (V.24) p. 116

Interface card modem WT12

The WT12 modem is used in telecontrol systems, if independent current paths are used (fixed connection) as wire paths or if private copper-bound wire paths have to be bridged with distances of more than 1000 m.
For data transmission according to CCITT V.23, the WT12 can be used in the two-wire half duplex (WT12-2) as well as in a four wire full duplex operation (WT12-4).
It is compatible with MOD12-x and can be used point-to-point and party-line in the same line with Mod12-x (MOD12 keying times are used).
Due to the optional monitoring function on X2, it is possible carry out a data analysis with external auxiliary means on the transmission layer (layer 1 ISO model) without interfering or affecting the internal software.

Brief profile WT12

Function:	VFT dedicated line modem · upward compatible with MOD12-2 according to R&TTE guideline, CCITT V.23
WT12-2/WT12-3	2-wire half-duplex, party-line up to 15 participants
WT12-4,WT12-5	4-wire full duplex Line: Telecommunication line, public and private, control cable
Speed:	1200 bits/s, keying-on time 10 ms
Range:	Typically 20 to 30 km

Variants

Variant	*Item number*	*Function*
WT12-2	310000538100	2-wire FSK modem 1200 bps half-duplex
WT12-3	310000538110	2-wire FSK Modem 1200 bit/s half duplex with monitoring function in front panel * (X2)
WT12-4	310000538120	4-wire FSK modem 1200 bps full duplex
WT12-5	310000538130	4-wire FSK Modem 1200 bit/s half duplex with monitoring function in front panel * (X2)

* Accessories monitoring cable VB-212, item: 310000068500

Use on public current paths (fixed connection -SFV)

Capable of approval according to European R&TTE directive

- 2-wire 1200 bit/s half-duplex (point-to-point and multi-point mode)
- 4-wire 1200 bit/s full-duplex (point-to-point)

For usage on **private transmission routes**

- 2-wire 1200 bit/s half-duplex (point-to-point and multi-point mode)
- 4-wire 1200 bit/s full-duplex (point-to-point)

A faster link at 9600 bits/s is possible with the WT96 modem.

Technical data WT-12

WT-12	WT-dedicated line modem for public and private networks
Data transmission rate	1200 bit/s joint operation/party-line possible
Modulation	Frequency shift keying (FSK) Centre frequency 1700 Hz, frequency deviation ± 400 Hz, Modulation index 0.66666
Range	Up to 30 km with 2-wire Cu-line ∅ 0.8mm
Operating method	Half duplex (2-wire),frequency equation full duplex (4-wire)
Transmission line	2-wire Cu / 4-wire Cu
Galvanic isolation	Through 1:1 transformer
Surge protection	Varistor
Plug-in connection	5-pole terminal connection
input impedance	Selectable via jumper: seen from the line in the module open: high-impedance (Transmitter = current source) closed: Line impedance (600 Ω)
output level	-6 dBm (with line termination)
Channel predistorter	Signal with higher frequency can be selected with jumpers 0 %, 20 %, 40 %, 60 % amplification
Reduced transmission power	- 20 dB attenuation selectable
Turning on and off	With RTS signal
input sensitivity	Typically UEIN, Eff = 3 mV, max. UEIN, Eff = 10 mV
input amplification	Adjustable via jumpers to 0, 10, 20, 30 and 40 dB
Bridgeable attenuation	Typically 50 dB, min. 40 dB
Data interface	TTL level, control signals RTS and CTS with TTL levels
Signal propagation delay	1 ms between transmitter and receiver
Voltage limitation	150 V VDR via line interfaces
Insulation voltage	2500 V DC
Interference immunity:	3.0 kV between telecommunication circuit and control electronics
Immunity	According to EN 61000-6-2 (08/2002) in industrial environments
Transient emissions	According to EN 61000-6-4 (08/2002) in industrial environments,
Power supply	Max. 50 mA (from power supply 24 V DC) approx. 250 mA (at +5 V internally)
Temperature range	0°C to +70°C

Keying times for WT12-2 and WT12-3

- Pre-keying time Tv 15 ms (before keying wait for reception)
- Keying time Te 10 ms (before transmission wait for keying-in)
- Blanking time Ta 3 ms (before keying-out waiting for transmission)
- Reception delay Tev 20 ms (first reception after blanking)

Control and display elements

Interface selection

Jumpers S11 and S14 are used to set the serial channel on which the module should be operated.

S11 - S14	Interface selection COM of the serial card
1-2	**COM1 ***
2-3	COM2

Amplification of transmission level

The signal with the higher frequency can be increased by 20%, 40% or 60% compared to the signal with the lower frequency.

S100	S101	Amplification of transmission level in transmitter
Open	Open	No change (0%) / -6 dBm
Closed	**Open**	**20% amplified / -4 dBm ***
Open	Closed	40% amplified / -3 dBm
Closed	Closed	60 % amplified / -1.5 dBm

Reducing the transmission level

S102	Reducing the transmission level
Open	**No reduction ***
Closed	- 20 dB attenuation with centre nearby

Line termination, 2-wire, half-duplex

S200	Line termination for transmitter and receiver
Open	No termination Station located in the joint operation/party-line and not at the end of the cable
Closed	**Termination of line with 600 Ω ***

Line termination, 4-wire, full duplex

S200 / S201	S200 termination for transmitter, S201 termination for receiver
Open	No termination Station located in the joint operation/party-line and not at the end of the cable
Closed	**Termination of line with 600 Ω ***

Input amplification

Amplification factors of the input amplifier in the receiver are set via jumpers S301 - S304:

input amplification	Jumper	Amplification factor	Sensitivity of carrier detection
0 dB	--	&0	> -24 dBm
10 dB	**S301**	**+10%**	**> -34 dBm ***
20 dB	S302	+20%	> -44 dBm
30 dB	S303	+30%	> -54 dBm
40 dB	S304	+40%	> -60 dBm

Carrier detection (CD)

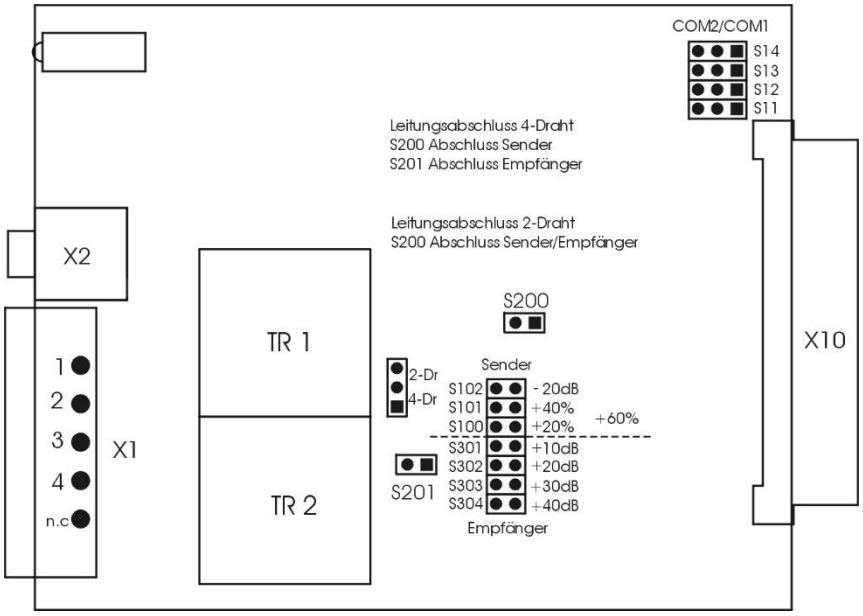
The input sensitivity data refers to the useful signals without injected interference signals.

* Default (factory setting)

Light-emitting diodes

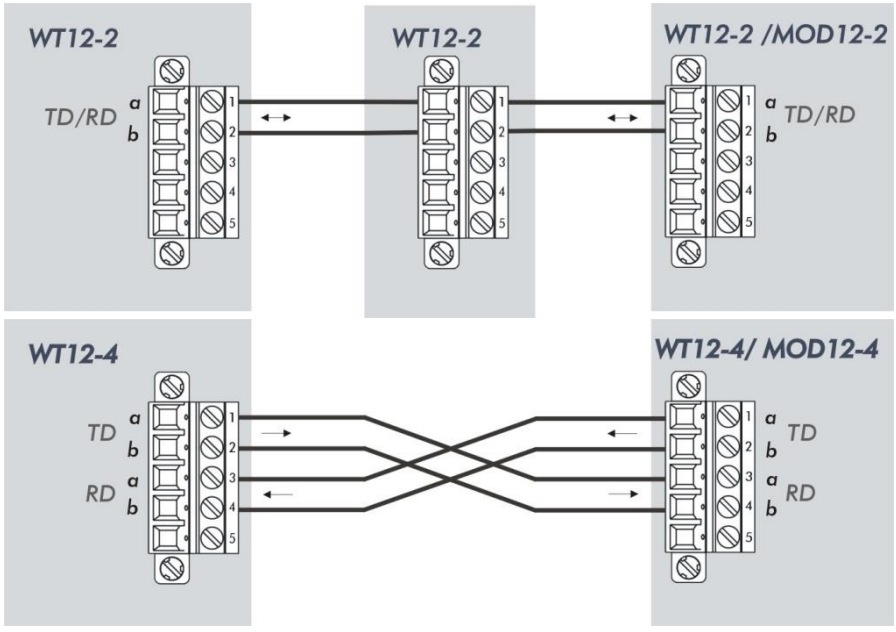
LED 1●●●●4	Colour	Function
1●	Green	"TD" Transmission signal
2●	Green	"RD" Received signal
3●	Green	"RTS" Request To Send signal
4●	Green	"CD" Received signal level, valid LW input signal

Component mounting plan



Selection of serial interface (COMx) via jumpers S11 - S14, see p. 98

Line interface



Diagnostic interface (V.24)

see Diagnostic interface (V.24) p. 116

Interface card modem WT96

The WT96 modem is used in telecontrol systems for point-to-point and multipoint operation, if private copper lines are used as wire paths to cover distances of more of 1000 m quickly. WT96 can be used in both the two-wire half duplex (WT96-2) as well as in the four-wire full duplex operation (WT96-4).
Due to the optional monitoring function on X2, it is possible carry out a data analysis with external auxiliary means on the transmission layer (layer 1 ISO model) without interfering or affecting the internal software.

Brief profile

WT96	VFT dedicated line modem for quick transmission (FSK)
WT96-2/WT96-3	2-wire half-duplex, party-line up to 15 units
WT96-4,WT96-5	4-wire full duplex line: private telecommunication line, control cable
Speed:	9600 bit/s, keying-in time 3 ms operation also possible with 4800 bit/s, 2400 bit/s
Range:	Typically 15 to 20 km

Variants

Variant	Item number	Function
WT96-2	310000538200	2-wire FSK modem 9600 bps half-duplex
WT96-3	310000538210	2-wire FSK Modem 9600 bit/s half duplex with monitoring function in front panel * (X2)
WT96-4	310000538220	4-wire FSK modem 9600 bps full duplex
WT96-5	310000538230	4-wire FSK Modem 9600 bit/s half duplex with monitoring function in front panel * (X2)

* Accessories monitoring cable VB-212, item: 310000068500

For usage on **private transmission routes**

- 2-wire 9600 bit/s half-duplex
  (point-to-point and multi-point mode)
- 4-wire 9600 bit/s full-duplex
  (point-to-point)

Diagnostic interface (V.24)

On the diagnostic interface the TxD and RxD signals are brought out at V.24 level as test signal/test tap for monitoring purposes. The signals are available via a 3.5 m ratchet coupling in the front panel, which are configured depending on the variant. By using the VB-212 accessory monitoring cable, these signals are available on two 9-pole D-SUB jumpers (bushings)

X2	Signal	Comment
R	Tx	Transmit signal
T	Rx	Receive signal
S	GND	Signal ground

Technical details

WT96	fast FVT dedicated line modem (FSK)
Data transmission rate	9600 bit/s joint operation/party-line possible
Modulation	Frequency shift keying (FSK), centre frequency 13600 Hz, frequency deviation ± 4400 Hz, modulation index 0.91666
Range	Up to 20 km with 2-wire Cu-line ∅ 0.8mm
Mode	Half duplex (2-wire),frequency equation full duplex (4-wire)
Transmission line	2-wire Cu / 4-wire Cu
Galvanic isolation	Through 1:1 transformer
Surge protection	Varistor
Plug-in connection	5-pole terminal connection
input impedance	Selectable via jumper: seen from the line in the module open: high-impedance (transmitter = current source) closed: line impedance (complex termination: 931 Ω parallel to RC unit with 130 Ω and 150 nF in series)
output level	-1 dBm (with line termination)
Channel predistorter	Signal with higher frequency can be selected with jumpers 0 %, 20 %, 40 %, 60 % amplification
Reduced transmission power	- 20 dB attenuation selectable
Turning on and off	With RTS signal
input sensitivity	Typically UEIN, Eff = 3 mV, max. UEIN, Eff = 10 mV
input amplification	Adjustable via jumpers to 0, 10, 20, 30 and 40 dB
Bridgeable attenuation	Typically 50 dB, min. 40 dB
Data interface	TTL level, RTS and CTS with TTL levels
Signal propagation delay	0.085 ms between transmitter and receiver
Voltage limitation	150 V VDR via line interfaces
Insulation voltage	2500 V DC
Interference immunity:	3.0 kV between telecommunication line and control electronics
EMC immunity	Acc. to EN 61000-6-2 (08/2002) in industrial environments
EMC emission	According to EN 61000-6-4 (08/2002) in industrial environments,
Power supply	Max. 50 mA (from power supply 24 V DC) approx. 250 mA (at +5 V internally)
Temperature range	-20°C to +70°C

Keying times for WT96-2 and WT96-3

- Pre-keying time Tv 6ms before keying wait for reception
- Keying time Te 3 ms before transmission wait for keying-in
- Blanking time Ta 3 ms before keying-out wait for transmission
- Reception delay Tev 10 ms first reception after blanking

Control and display elements

Interface selection

Jumpers S11 and S14 are used to set the serial channel on which the module should be operated.

S11 - S14	Selection of the serial card's COM interface
1-2	**COM1 ***
2-3	COM2

Amplification of transmission level

The signal with the higher frequency can be increased by 20%, 40% or 60% compared to the signal with the lower frequency.

S100	S101	Amplification of transmission level in transmitter
Open	Open	No change (0%) / -1 dBm
Closed	**Open**	**20 % amplified / +0.4 dBm***
Open	Closed	40% amplified / +1.8 dBm
Closed	Closed	60 % amplified / +3.0 dBm

Reduction of transmission level

S102	Reduction of transmission level
Open	**No reduction ***
Closed	- 20 dB attenuation with centre nearby

Line termination, 2-wire, half-duplex

S200	Line termination for transmitter and receiver
Open	No termination Station located in the joint operation/party-line and not at the end of the cable
Closed	**Termination of line with complex resistor ***

Line termination, 4-wire, full duplex

S200 / S201	S200 termination for transmitter, S201 termination for receiver
Open	No termination Station located in the joint operation/party-line and not at the end of the cable
Closed	**Termination of line with complex resistor ***

Input amplification

Amplification factors for the input amplifier in the receiver are set via jumper S301 - S304.

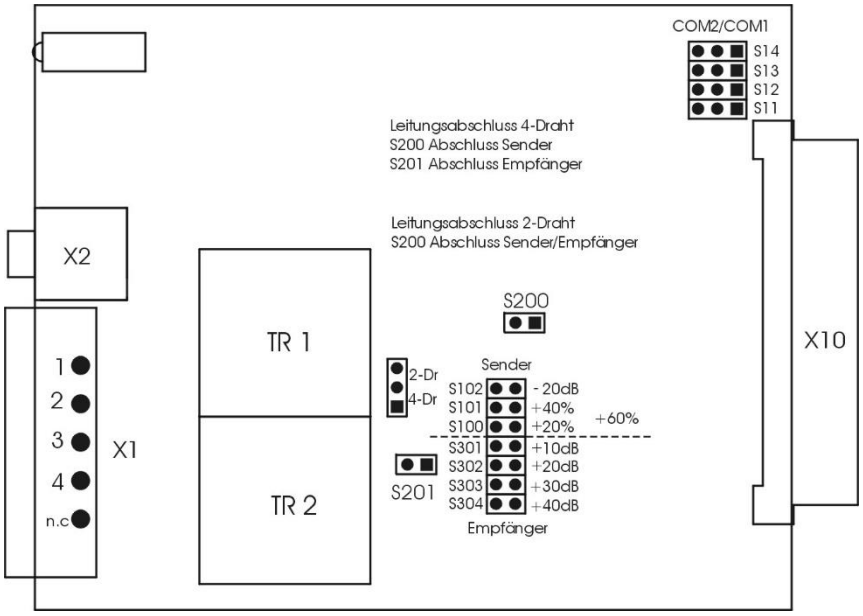
Input amplification	Jumper	Amplification factor
0 dB	--	&0
10 dB	**S301**	**+10% ***
20 dB	S302	+20%
30 dB	S303	+30%
40 dB	S304	+40%

* Default (factory setting)

Light-emitting diodes

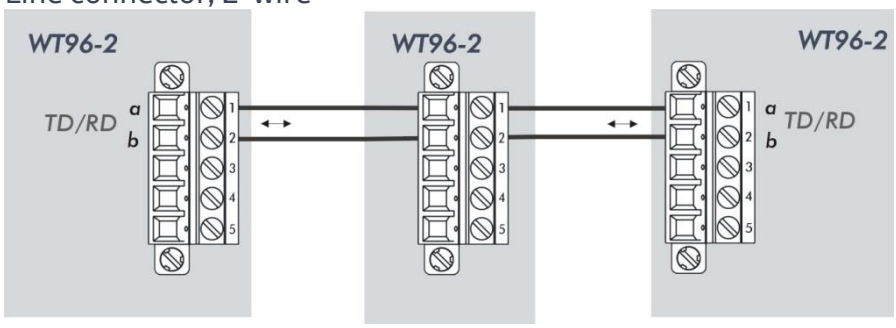
LED 1●●●●4	Colour	Function
1●	Green	"TD" Transmission signal
2●	Green	"RD" Received signal
3●	Green	"RTS" Request To Send signal
4●	Green	"CD" Received signal level valid AF input signal

Mounting diagram

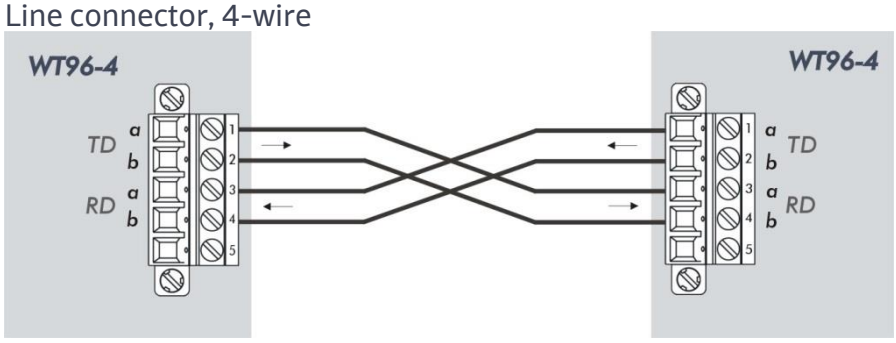


Selection of serial interface (COMx) via jumpers S11 - S14, see p. 98

Line connector, 2-wire



Line connector, 4-wire



Interfaces for dial-up lines (PSTN)

Dial-up modems WM144-1/WM336-1 /WM336-3

The dial-up modems

- WM144-1 (Dial-up modem max. 14.4 kbit/s)
- WM336-1 (Dial-up modem max. 33.6 kbit/s)
- WM336-3 (Dial-up modem max. 33.6 kbit/s)

are designed to be used in all expandable SAE telecontrol stations, data concentrators and telecontrol centres. The dial-up modems are designed as plug-in cards in 1/2 Euro-format and are integrated within the unit.

The modems are suited to be connected to the analogue dial-up connectors (PSTN) and based on industrial-suited socket modems. They have a serial interface with TTL levels (TxD, RxD, RTS, CTS). The connector to the switch network is established via a 6-pole Western connector at the front with a standard TAE connector cable.

The modems are designed for data transmissions up to 14.4 kbit/s and/or 33.6 kbit/s, depending on the version delivered. Control is based on an extensive AT command repertoire.

The dial-up modems have an EC-approval according to CTR21, whereby the dual-tone multi-frequency signalling (DTMF) is determined for the selection.

Function LEDS

At the front there are 4 green LEDs to indicate the operating states of the modems.

LED 1●●●●4	Colour	Function
1●	Green	"TD" Transmission signal
2●	Green	"RD" Received signal
3●	Green	"RTS" Request To Send signal
4●	Green	"CTS" Received signal level

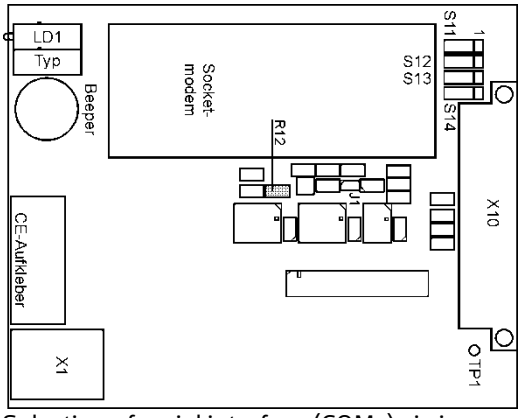
Technical data dial-up modem

WM144-1 **WM336-1** **WM336-3**	Analogue dial-up model for dial mode in public or private telephone networks (PTSN)
Data transmission:	300Bd, V.21 / 1200Bd, V.22 / 2400Bd, V.22bis / 9600Bd, V.32 / 14.4kbit/s, V.32bis 28.8kBit/s, V.34 depending on version 33.6kBit/s, V.34 depending on version 56kBit/s, V.90 depending on version
Fax operation	9600 bit/s, V.29, transmitting + receiving, 14.4 kbit/s, V.17, transmitting + receiving, fax class 2
Error correction/compression	V42.bis, MNP 5, MNP 10EC
Command repertoire	AT command, Hayes compatible
Dialling function	Frequency selection (DTMF), flash key
Line interface	According to CTR 21
Return loss	> 18 dB
Symmetry	> 55 dB
Direct current resistance	Approx. 300Ω
Max. loop current	60 mA
Flash duration	Approx. 80 ms
Level	Transmission level -4..-10dBm DTMF level -4..-6dBm
input sensitivity	-4..-43 dBm
Connection	Western socket (RJ12, 6-pole.).
Approval	EC approval CE 0506 X (CTR 21)
Electrical isolation	Between logic and transmission line
Test voltage	3000 VDC (at WM336-3 1500 V DC)
Serial interface to CPU	TTL level, TxD, RxD, RTS, CD
Baud rate to DTE	300 bit/s...57.6 kbit/s to CPU (DEE)
Power consumption	Supply with 24 VDC: typically 60 mA, max. 120 mA Internal power supply + 5V: typically 25 mA, max. 200 mA
Function indicator	4 green LEDs in front panel
Controls	4 internal jumpers, changeover COM1, COM2
Design	Board in half Euro-format , upright, 100 mm* 80 mm, plug connector according to DIN 41612 , structural shape C/2, plug assignment of interface cards
Ambient temperature	0..+50° C
Relative humidity	< 80%, without condensation

LED dial-up modem WM-xx

LED 1●●●●4	Colour	Function
1●	Green	"TD" Transmission signal
2●	Green	"RD" Received signal
3●	Green	"RTS" Request To Send signal
4●	Green	"CD" Carrier recognised

Mounting diagram



Selection of serial interface (COMx) via jumpers S11 - S14, see p. 98

Activation instructions

The dial-up modems

- WM144 (Dial-up modem max. 14.4 kbit/s)
- WM336 (Dial-up modem max. 33.6 kbit/s)

are connected with a 6 pole TAE connector cable to a TAE socket F coding. A western plug socket (RJ12, 6-pole) is located on the side of the unit.

Telephone connection

An external automatic telephone changeover switch is required if a telephone needs to be connected alongside the modem. The modem has an F-coded TAE socket and therefore, unable to **interconnect the telephone line directly to the telephone**.

Note: A filter to block the charge pulses must be switched between the modem and TAE connector when operating the dial-up modem on a connector with active charge pulses. This case is likely to be extremely rare, because these charge pulses have to be requested from the system operator and are subject to a charge.

Pin assignment

Signal name	TAE plug, F-coding	Modem connector RJ12
a	1	4
b	2	3

Connection cable

SAE dial-up modems must be connected with the supplied TAE cable because a correct function of the modems cannot be guaranteed with other cables.

Cable length: 3m
Cable colour: Black

Interfaces for GSM/GPRS/EDGE

GSM & GPRS modem GSM-2

The GSM-2 is a wireless module for cost-efficient mobile applications on public and private digital GSM-standard mobile networks (German networks) with low safety standards. It is inserted into the telecontrol station as an interface. It is powered and integrated into the communication processes via a plug-in connector.
The GSM-2 uses an MC75i embedded quad-band GSM module with integrated GPRS/EDGE functionality, embedded in a compact top-hat rail housing designed with high EMC resistance for industrial use.

The wireless module supports data services as a dial-up modem via GSM using the CSD service circuit switched data or GPRS/EDGE packet transmission linked to TCP/IP networks over a 'quasi'-dedicated line modem via wireless signals.
The control and initialising of the wireless module in the command mode is carried out via AT commands.

For the operation within GSM networks, you need a 3V SIM card with activated data services. This is inserted behind the front panel. You only need to add an external antenna. No other external components need to be installed. The SIM card and antenna are accessible via the front.

Product	Designation
310000070000	GSM-2 interface
Accessories	
310004050300	Dual-band rod antenna 2dB 1.5 m, SMA indoor
310004050400	GPRS Triband antenna set 2 dB, 5 m, SMA indoor
310000056400	Antenna set for GSM modems, Triband rod antenna

The GSM/GPRS module can be operated in different operating methods. These operating methods must be pre-set via the jumpers S3 & S4 that are located on the module.

Function LEDs

LED 1●●●●4	Function
1	TxD Transmit data
2	RxD Receive data
3	Level field strength of radio
4	Status of wireless network
LED 5●●6	**Function**
5	DTR control signal, release board
6	DCD control signal transparent data link in radio network

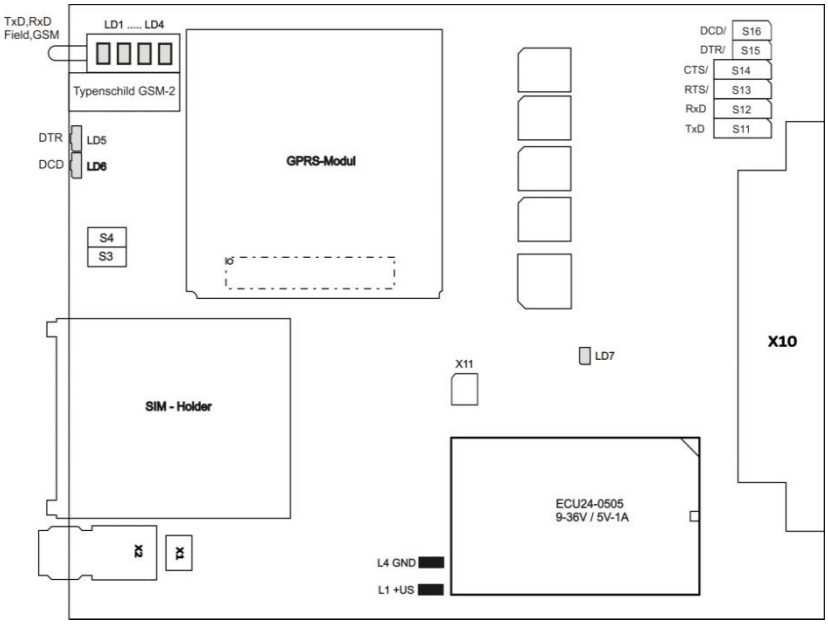
Field strength	LED 3	Function
Max field strength	●	static ON
sufficient field strength	✳	flashing, 1.5 s ON / 0.5 s OFF
low field strength other antenna needed	✳	flashing, 0.5 s O / 1.5 s OFF
field strength too low, no subscription to network available	○	static OFF

wireless status indication	LED 4	Function
Error: no data flow recognised by board processor	✳ 10 Hz	flashing, 10 Hz
missing data from wireless module, not subscirbed to mobile network	✳	flashing, 2 s ON / 0.1 s OFF
valid subscription to mobile network	✳ Flash	flashing, 0.1 s ON / 2 s OFF
Hook-up or call active	✳ 2 Hz	flashing, 2 Hz
transparent link	●	static ON

board status	LED 1	LED 2	LED 3	LED 4
subscribed to GSM network, max. field strength	○	○	●	✳ Flash
board in RESET (RTS/ or DTR/ active)	○	●	●	●
board released wireless module in reset	○	●	●	○
wireless module malfunction Reset requested	○	●	○	●
no available data stream between wireless-module and system CPU	○	○	✳ Flash	✳ Flash

operation status LD7	LED 7	Function
board inactive	○	board without function
normal operation mode	✳ 2 Hz	AT command & data transmission mode
board blocked via status signal RTS or DTR	✳ 4 Hz	The wireless module was inactivated via system driver
Initialisation phase of wireless module	✳ 10 Hz	The board initialises the wireless module according to jumper settings

Board layout



Interface selection

With jumpers S11 – S14 the interface COM1/COM2 of the internal bus is selected on which the board shall be operated. Please pay attention to the various interface assemblies of the desired product lines below.

S11 - S14	Function	Remark
S11	**BUS - TxD**	
S12	**BUS - RxD**	
S13	**BUS – RTS/**	In compatibility mode modem ON/OFF
S14	**BUS – CTS/**	In compatibility mode GSM-link (CSD data) active

All jumpers S11-S14 must be set to the same position.

S11 - S14	Interface FW-10, FW-40 , FW-50	Remark
1-2	COM1 ~ **X101**, **X102**	**Standard setting**
2-3	COM2 ~ **X103**, **X104**	

The additional control signals DTR & DCD via S15 – S16 are mandatory for a data transmission via GPRS/EDGE.

S15 - S16	Function	Remark
S15	**DTR/**	In compatibility mode GSM-1 without function
S16	**DCD/**	In compatibility mode GSM-1 without function

Control signals in telecontrol stations

S15 - S16	Interface in FW-50 BGT-USB	Remark
1-2	**X102, X104**	**Control signals active**
2-3		Control signals inactive

ATTENTION ! S15 & S16 shall only be used in racks of type BGT-x-USB.

Data format - setting the operation mode

The data format and the operation method are set with the S3 and S4 jumpers. The operating specifies the initialisation of the GSM/GPRS module and the system CPU bit rate.

In the GSM-1 interoperability mode (dial-up operation), the module is initialised to a fixed rate of 19.2 kbit/s.
GPRS requires a setting of 115 kbit/s. In addition, the control lines must be activated via S15-16.

Jumpers

If the data format is set incorrectly, the output of the operation states (LED strength and status) may be inaccurate, or the function of the module may be blocked in the system.

Jumpers up to Firmware/PIC V103

P3	P4	Data format	Remark
open	**open**	115 kbit/s, 8-1-N	GPRS mode
open	closed	19,2 kbit/s, 8-1-E	GSM-1 interoperability for setIT
closed	closed	19,2 kbit/s, 8-1-n	GSM-1 interoperability for createIT

Jumpers with Firmware/PIC V104

P3	P4	Data format	Remark
open	**open**	115 kbit/s, 8-1-N	GPRS mode
closed	closed	19,2 kbit/s, 8-1-E	GSM-1 interoperability for setIT
open	closed	19,2 kbit/s, 8-1-n	GSM-1 interoperability for createIT

Jumpers up to Firmware/PIC V105

P3	P4	Data format	Remark
closed	**open**	115 kbit/s, 8-1-N	GPRS mode
open	closed	19,2 kbit/s, 8-1-E	GSM-1 interoperability for setIT
closed	closed	19,2 kbit/s, 8-1-n	GSM-1 interoperability for createIT

GSM-2 technical data

GSM-2	**Wireless data modem for integration into GSM/GPRS infrastructures** for telecontrol and substation control, automation and telemetry
Communication	**1** System-internal COM1/COM2 interface 1 GPRS antenna connection, **SMA connector max. 2 W**
Protocols	AT command repertoire for control and link establishment IEC 60870-5-101 for dial-up links IEC 60870-5-104 via GPRS/EDGE with a PPP protocol
GSM/GPRS core	Cinterion MC75i quad-band wireless module + embedded controller Quad-band 850 / 900 / 1800 / 1900 MHz GPRS multi-slot class 12, full PBCCH support, mobile station class B, coding scheme 1 -4 EDGE multi-slot class 12, mobile station class B, modulation and coding scheme MCS 1-9 CSD V.110, RLP, 2.4/4.8 / 9.6 /14.4 kbit/s, USSD SMS Point-to-point MT and MO, text and PDU-mode Transmission power 1 W with GSM 1800 /1900 Transmission power 2 W with EGSM 850 /900
Antenna	GPRS antenna **50 Ω, SMA connector (f)** Recommended distance between antenna and device: 50 cm
SIM card	supports SIM cards with 3V and 1.8 V, data activation
Status indicators	LED in front plate for link and system status
Command repertoire	AT commands according to Hayes 3GPP TS 27.007, TS 27.005, Cinterion
Supply voltage	**internal** max. 12 W, (24 V DC 0.5 A / 60 V DC 0.3 A) max. in transmit mode
Dielectric strength	5 kV impulse supply & process E/A to PE, **in accordance with class VW3** 2,5 kV impulse supply to measured values, EIA/RS-232, USB
Standards	EMC: EN61000-6-2 , EN55022, Isolation: DIN EN 60870-2-1, IEC 60255-5 R&TTE: ETSI EN 300328, EN 301489, NSRL: DIN EN 60950
Housing	micro housing, Polyamide V0, IP 20
dimensions	45 x 105 x 115 mm (W x H x D)
Installation	**DIN top-hat rail,** DIN-EN 60715 TH35
Terminals	MSTB screw terminal, 0.2 to 2.5 mm² or Combicon spring terminal, 0.2 to 2.5 mm²
Ambient temperature	**-20° ... +60° C** (Threshold +70° C at a control voltage of < 60 V DC, recommended +55°C)
relative air humidity	< 80 %, without condensation

6 Input/output cards

Overview of modules

Signal inputs	
16OE-1✹	16 optocoupler inputs, 24 V DC
16OE-2-1✹ /-2✹	16 optocoupler inputs 48 V DC/60 V DC
16OE-3-W✹	16 transient inputs, S0-compatible
16OE-5-1	16 wide-range inputs, 18 - 72 V DC
16OE-5-2✹ /-3✹ ⚠*	16 wide-range inputs 60 ... 150 V DC / 220 V DC
16OE-6-1# /-2# /-3# ⚠*	16 wide-range inputs 18 ... 72 V DC/ 110 V DC/AC / 220 V DC/AC
8OE-4-110✹ ⚠*	8 optocoupler inputs 110 V AC/DC, isolated
8OE-4-230✹ ⚠*	8 optocoupler inputs 230 V AC/DC, isolated
16IE-5-1 /-2 ⚠*	16 quick wide range inputs 18 ... 72 V DC/48 ... 130 V DC
EVU-1✹	Special card EVU, 4 optocoupler inputs, 4 relay outputs
EVU2-I-1✹	Return information/command termination with EVU-2-O 24 V DC
EVU2-I-2# /-3# ⚠*	Command termination with EVU-2-O 60 to 130 V DC / 220 V DC
EVU2-I-5#	Return information/command termination with EVU-2-O 18 to 72 V DC
CNT1-1✹ /CNT1-2 ⚠*	8 counters 1 kHz, 8 optocoupler inputs 24 V DC /60 to 110 V DC
CNT1-3	8 counters 10 kHz, 8 optocoupler inputs 24 V DC
CNT1-5	8 counters 1 kHz, 8 optocoupler inputs 18 to 72 V DC

Command/relay outputs	
12RA-1# ⚠*	12 relay outputs, square root, 230 V AC 5 A
16RA-1 ⚠*	16 relay outputs
16RA-3#	16 relay outputs, 2-pole, isolated
6RA-4-AC✹ ⚠*	6 relay changeover contact, 230 V AC, 1 A, isolated
6RA-4-T✹	6 semiconductor outputs, changeover contact, isolated
16OA-1✹	16 optocoupler outputs, 30 V DC, 100 mA
16OA-3-1 ⚠*	16 optocoupler outputs, 250 V DC, 130 mA, 2-pole
16OA-3-2 ⚠*	16 optocoupler outputs, 100 V DC, 320 mA, 2-poleon request
EVU2-O-1# /-2#	Custom card EVU 1.5-pole / 2-pole 1/N monitoring, inductor measurement circuit 20 kΩCommand & permissive relay for 16 single commands / 8 double commands
EVU2-O-3# /-4# ⚠*	EVU-2-O-x 1.5 pole /2-pole Inductor measurement circuit 20 to 100 kΩ

8-bit measured value inputs	
8AE8-1-1✹ /-3✹	8 analogue inputs 0(4) to 20 mA/ 0 to 2.5 mA, 500 V DC
8AE8-1-2✹	8 analogue inputs, 0 to 10 V, 500 V DC
8AE8-2-1✹ /-2✹ /-3✹	8 analogue inputs 0(4) to 20 mA /10 V /2.5 mA, 3000 V DC
8AE8-3-1✹ /-2✹	8 analogue inputs 0(4) to 20 mA / 0 to 10 V, isolated

8-bit measured value outputs	
8AA8-1-1✹ /-2✹	8 analogue outputs 0(4) to 20 mA /0 to 10 V, 500 V DC
8AA8-2-1✹	8 analogue outputs, 0 to 20 mA, 3000 V DC

12-bit measured value inputs	
4AE12-1-1✹ /-2✹	4 analogue inputs, 12-bit, 0(4) to 20 mA / 10 V, isolated
4AE12-2-1✹ /-2✹ /-3✹	4 analogue inputs, 12-bit, bipolar, ±20 mA /±10 V /±2.5 mA

12-bit measured value outputs	
4AA12-1-1✹ /-2✹	4 analogue outputs, 12-bit, 0 to 20 mA / 10 V, isolated
4AA12-2-1✹ /-2✹	4 analogue outputs, 12-bit, bipolar, ±20 mA /±10 V
8AA12✹	8 analogue outputs, 12-bit, 0 to 20 mA

16-bit measured value inputs	
8AE16-1-1✹ /-2✹ /-3✹	8 analogue inputs, 12/16-bit, 0(4) to 20 mA / 10 V / 2.5 mA
8AE16-2-1 /-2 /-3	8 analogue inputs, 12/16-bit, 0(4) to 20 mA / 10 V / 2.5 mA, 3 kV
8AE16-3-1# /-2#	8 analogue inputs, 16-bit, multi-range mA /V

16-bit measured value outputs	
8AA16#	8 analogue outputs, 16-bit, mA /V, with individual channel switchover

Combination and special cards	
OERA-1✹	8 optocoupler inputs, 24 V DC, 8 relay outputs
OERA-5	8 optocoupler inputs, 18 to 72 V DC, 8 relay outputs
AOERA-1✹	4 analogue inputs, 8-bit, 20 mA, 4 optocoupler inputs, 24 V DC, 2 relay outputs

Meets the requirements in IEC 61850-3

✹ Older legacy component; has been replaced by compatible card and might not be available; It can be configured but is not part of this manual.
Also refer to https://sae-it.netexplorer.pro/dl/r1Mt6RltaDtawQRaUtBFTN5AWW_0YI

General information using I/O-cards

General technical specification

All I/O cards from systems FW-10, FW-40, FW-50 or BCU-50 are designed to be plug-in boards. Every I/O-card used as a spare-device will be delivered including its front panel, if the designated system is known. The placement in the slots and the definition of the terminal numbers may be given by the stickers, delivered aside the racks.

Valid general specification - if not noticed otherwise:

Format	**I/O -plug-in board for FW-10 /FW-40 /FW-50 /BCU-50**
Dimensions	21 * 160 * 100 mm (W x H x D) Europe board portrait
Terminals	2 detachable terminals 9-pole als: Spring terminal FKC 0.2 up to 2.5 mm² or Screw terminal MSTB 0.2 up to 2.5 mm² **green terminal** Tension < 75 V DC **black terminal** Tension > 75 V DC ⚠*
Accessories	Cable GST-9: Plug, 9-pole, 2.5m cable Item: 310000050700 Cable GST-9-ST: Plug 9-pole with housing, 2.5 m cable Item: 310000054400

Service-LEDs of I/O-card

Every I/O-card shows the opertion state in the front with is LED.

LED 1●○○○4	colour	Function	
1●	red	**off**	**Card valid and released**
		2 Hz	Error, Card wrong or misplaced
		on	Card inhibited /not released
○ ○ ○		if assembled , additional card specific states	

Using indication boards or binary inputs, every input with its signal "0" and "1" is assigned to a green LED in the front. At most types, the LED are arranged in blocks.

LED-Matrix of I/O-cards

LED ● ● ● ●				Colour	Function	
1	2	3	4	green/inputs	off	Signal OFF "0"
5	6	7	8	yellow/outputs	on	Signal ON "1"
9	10	11	12			
13	14	15	16			

Binary outputs/command relays are signalised with yellow LED.
Analogue boards may not be visualised with LED.

*Using tension > 75 V DC please consider!

DANGER

Before starting work, break all pole, pull plugs and deenergize!

Plugs have to carry a sign "Danger High Voltage" using tensions > 75 V.

Only use power signals with unique source.

Only use the given black terminals to prevent any swap with signals ≤ 75 V DC by different of colour.

Single braids have to be fixed mechanically to prevent a jump over of a energized braid to a neighboured board below 75 V DC.

WARNING

Inobservance may be harmful for the lives and health of personnel!

CAUTION

To fulfill the requirements for an electrical safety, the mounting and operation of the devices only is allowed in a case or a housing with protection class IP 56 or better!

Digital input card 16OE-5 (wide range)

Remark: This boards is discontinued , please use 16OE-6-x instead.

16OE-5	**16 wide range optocoupler inputs**
input ranges	18 - 72 V DC / 60 - 130 V DC / 150 - 240 V DC, see types
Electrical isolation	Optocoupler for logic
Root	Common reference potential per terminal for 8 channels each
Debouncing	Of the input circuit, max. 0.3 ms
Min. pulse width	10 ms
Power consumption	0.7 W | typ. 30 mA @ +Ub 24 V DC
Insulation	EN 60870-2-1 class VW3, Surge voltage 5 kV, power-frequency withstand voltage 2.5 kV eff./1 min.
EMC	CE, EN 61000-6-4: Emitted interference in industrial area EN 61000-6-2: Immunity industrial area, EN 60950
Temperature range	-20 to + 70° C system environment, Ø24h max. 55°C
Humidity	<95% at 25° C without condension (class F)
16OE-5-1	**Wide-range information inputs, 24 to 60 V DC ±20%**
input voltage	18 V DC ... 72 V DC
Switching point	Typically 17 V DC, 0.8 mA
input current	Signal "0" (Off) < 0.8 mA Signal "1" (On) > 1.0 mA, Typically + 1.2mA@24 V, 2.8 mA@48 V 3.7 mA@ 60 V DC
Compatibility	Replaces types 16OE-1, 16OE-2-1 (OE48) and 16OE-2-2 (OE60)
Item no.	310000036200
16OE-5-2	**Indication inputs, 110 V DC ±35%** ⚠*
input voltage	60 V DC ... 150 V DC
Switching point	Typically 37 V DC
input current	(On) max. 2 mA @ 150 V DC
Item no.	310000036300
16OE-5-3	**Indication inputs 220 V DC -30%/+10%** ⚠*
input voltage	150 V DC ... 240 V DC
Switching point	Typically 130 V DC
input current	(On) max. 1.2 mA @ 220 V DC
Item no.	310000036400

Terminals 16OE-5

Terminal X↑-up: Indication input 16OE-5

Terminal X↑	Signal name	Remarks
X↑.1	DE 1 des Moduls	Indication input 1
X↑.2	DE 2	Indication input 2
X↑.3	DE 3	Indication input 3
X↑.4	DE 4	Indication input 4
X↑.5	DE 5	Indication input 5
X↑.6	DE 6	Indication input 6
X↑.7	DE 7	Indication input 7
X↑.8	DE 8	Indication input 8
X↑.9	common 1-8	Ground 0 V

Terminal X↓-down: Indication input 16OE-5

Terminal X↓	Signal name	Remarks
X↓.1	DE 9 des Moduls	Indication input 9
X↓.2	DE 10	Indication input 10
X↓.3	DE 11	Indication input 11
X↓.4	DE 12	Indication input 12
X↓.5	DE 13	Indication input 13
X↓.6	DE 14	Indication input 14
X↓.7	DE 15	Indication input 15
X↓.8	DE 16	Indication input 16
X↓.9	common 9-16	Ground 0 V

Circuit of 16OE-5

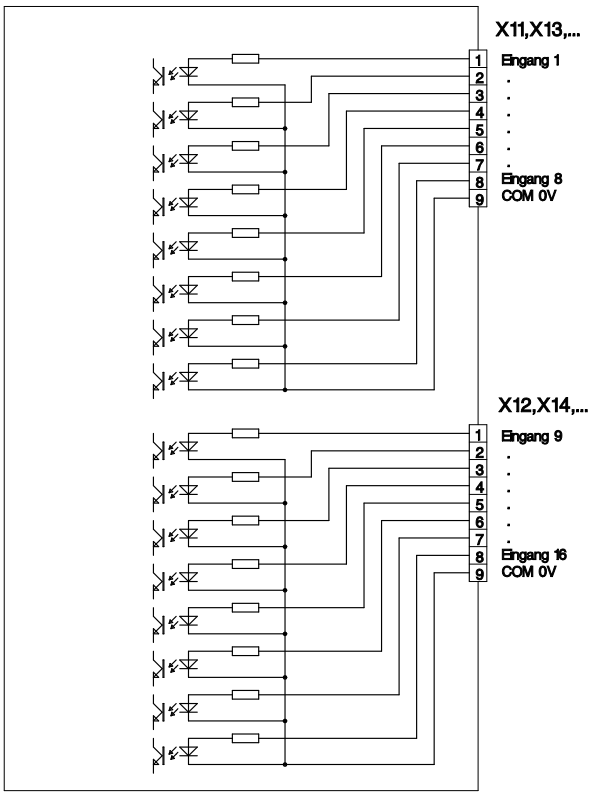


Figure 34: Input circuit of 16OE-5

*Using tension > 75 V DC please consider!

DANGER **Before starting work, break all pole, pull plugs and deenergize!**

Plugs have to carry a sign "Danger High Voltage" using tensions > 75 V.
Only use power signals with unique source.
Only use the given black terminals to prevent any swap with signals ≤ 75 V DC by different of colour.
Single braids have to be fixed mechanically to prevent a jump over of a energized braid to a neighboured board below 75 V DC.

WARNING **Inobservance may be harmful for the lives and health of personnel!**

CAUTION

To fulfill the requirements for an electrical safety, the mounting and operation of the devices only is allowed in a case or a housing with protection class IP 56 or better!

Digital input card 16OE-6 (wide range)

16OE-6	**16 wide range optocoupler inputs** permitted for connection to power switch gears
input ranges	18 - 72 V DC / 110 V DC / 220 V DC, see types
Electrical isolation	HV-Optocoupler for logic according to DIN EN 60747-5-5
Root	Common reference potential per terminal for 8 channels each may be connected to 0V/ground or processing supply
Debouncing	Of the input circuit, max. 0.5 ms
Min. pulse width	10 ms
Power consumption	Typically 20 mA, max. 25 mA supplying the overall system with 24 V DC
Insulation	EN 60870-2-1 class VW3, Surge voltage 5 kV, power-frequency withstand voltage 2.5 kV eff./1 min.
EMC	DIN EN 661850-3 (h), battery earth fault immunity 220 nF
Temperature range	-25 to + 70° C system environment, Ø24h max. 55°C
Humidity	<95% at 25° C without condensation (class F)
16OE-6-1	**Wide-range information inputs, 24 to 60 V DC ±20%**
input voltage	18 V DC ... 72 V DC
Switching point	Typically 17 V DC
input current	Signal "0" (Off) < 0.8 mA Signal "1" (On) > 1.0 mA, @24 V Typically + 1.9 mA
Compatibility	Replaces 16OE-1, 16OE-2-x (OE48/OE60) 16OE-5-x
Terminal.	**green** MSTB 2,5/9-STF-5,08
Item no.	FW-50: 310000037300 BCU-50: 310050505010
16OE-6-2	**Indication inputs, 110 V DC ±20%** ⚠*
input voltage	max. ±150 V DC
Switching point	Typically ±80 V DC
input current	(On) max. 1,9 mA
Terminal.	**black** MSTB 2,5/9-STF-5,08 BK
Item no.	W-50: 310000037310 BCU-50: 310050505020
16OE-6-3	**Indication inputs 220 V DC ±20%** ⚠*
input voltage	max. ±240 V DC
Switching point	Typically ±165 V DC
input current	(On) max. 1.9 mA
Terminal.	**black** MSTB 2,5/9-STF-5,08 BK
Item no.	FW-50: 310000037320 BCU-50: 310050505030

Terminals 16OE-6

Terminal X↑-up: Indication input 16OE-6

Terminal X↑	Signal name	Remarks
X↑.1	DE 1 des Moduls	Indication input 1 ±
X↑.2	DE 2	Indication input 2 ±
X↑.3	DE 3	Indication input 3 ±
X↑.4	DE 4	Indication input 4 ±
X↑.5	DE 5	Indication input 5 ±
X↑.6	DE 6	Indication input 6 ±
X↑.7	DE 7	Indication input 7 ±
X↑.8	DE 8	Indication input 8 ±
X↑.9	common 1-8	common 0 V

Terminal X↓-down: Indication input 16OE-6

Terminal X↓	Signal name	Remarks
X↓.1	DE 9 des Moduls	Indication input 9 ±
X↓.2	DE 10	Indication input 10±
X↓.3	DE 11	Indication input 11±
X↓.4	DE 12	Indication input 12±
X↓.5	DE 13	Indication input 13±
X↓.6	DE 14	Indication input 14±
X↓.7	DE 15	Indication input 15±
X↓.8	DE 16	Indication input 16±
X↓.9	common 9-16	common 0 V

Circuit of 16OE-6

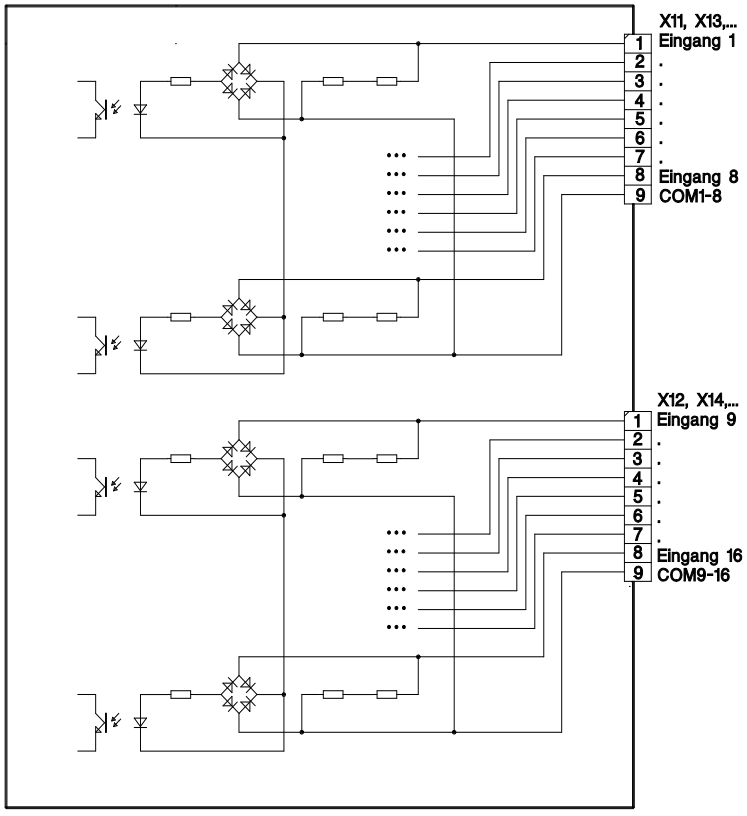


Figure 35: Input circuit of 16OE-6

*Using tension > 75 V DC please consider!

DANGER **Before starting work, break all pole, pull plugs and deenergize!**

Plugs have to carry a sign "Danger High Voltage" using tensions > 75 V.
Only use power signals with unique source.
Only use the given black terminals to prevent any swap with signals ≤ 75 V DC by different of colour.
Single braids have to be fixed mechanically to prevent a jump over of a energized braid to a neighboured board below 75 V DC.

WARNING **Inobservance may be harmful for the lives and health of personnel!**

CAUTION

To fulfill the requirements for an electrical safety, the mounting and operation of the devices only is allowed in a case or a housing with protection class IP 56 or better!

Fast binary Input card 16IE-5

16IE-5	Fast Indication inputs	
Indication inputs	16 inputs common root	
Scan cycle	250 µs	
16IE-5-1	input tension threshold current	18 ... 72 V DC ca. 17 V DC ca. 1,4 mA @ 24 V ca. 3,5 mA @ 60 V
16IE-5-2	input tension threshold current	60 ... 130 V DC ca. 37 V DC ca. 1,2 mA @ 60 V, ca. 2,4 mA @ 120 V
Isolation	Logic / inputs optional 3 kV	
Max current consumption	50 mA (@ + 5 V DC)	
Environment temperature	-20° up to +70° C	
Rel. humidity	80 % at 25° C without condension	

Circuitry of 16IE-5

Terminal	No	Remark
X11 X13 X15 ...	1	Input 1
	2	Input 2
	3	Input 3
	4	Input 4
	5	Input 5
	6	Input 6
	7	Input 7
	8	Input 8
	9	Common [-]
X12 X14 X16 ...	1	Input 9
	2	Input 10
	3	Input 11
	4	Input 12
	5	Input 13
	6	Input 14
	7	Input 15
	8	Input 16
	9	Common [-]

At voltages > 75 V the terminals have to be marked with the warning "Danger High Voltage".
Before maintenance, switch off all poles, remove terminals and discharge!

Integrated total card CNT-1

Acquisition of 8 fast integrated totals up to 1 kHz and 8 information inputs in the voltage ranges 24 V DC and 60 ... 110 V DC.
Support from setIT (from V 2.011) process data type 16-bit counter input

CNT-1	**Counter board and information card**
Counter inputs	8 pulse inputs for counters, 1 kHz, 8-bit cache,
Information inputs	8 digital inputs for information
Electrical isolation of measuring circuit	Via optocoupler according to root 1-8/9-16
Power-frequency withstand voltage	2500 V AC
Surge voltage	3 kV
Standards	EN 61000-6-2 (03/2000) EN 61000-6-4 (04/2002) DIN EN 60950 (12/2001)
Interrupt	Yellow LED at the front
Controls	6 internal jumpers
Max. power consumption	1 W | typ. 40 mA @ +Ub 24 V DC
Ambient temperature	20 to + 70° C
Relative humidity	80 % at 25°C without condensation
CNT-1-2	**Input voltage 60 ... 110 V DC**
Switching point	Approx. 35 V DC
input current	At 60 V approx. 1.2 mA, At 120 V approx. 2.4 mA
CNT-1-3	**Wide range 24 V DC acquisition 10 kHz**
input voltage	24 V DC
Switching point	Approx. 12 V DC
input current	Approx. 6 mA DC
Insulation	Process inputs against SELV circuit & process inputs against system earth
CNT-1-5	**Input voltage 18 ... 72 V DC**
Switching point	Approx. 15 V DC
Input current	At 24 V approx. 1.2 mA At 48 V approx. 2.8 mA At 60 V approx. 3.5 mA

Circuitry of CNT-1

Terminal	No.	Description
X11 X13 X15 ...	1	Counter 1
	2	Counter 2
	3	Counter 3
	4	Counter 4
	5	Counter 5
	6	Counter 6
	7	Counter 7
	8	Counter 8
	9	Common [-]
X12 X14 X16 ...	1	Input 1
	2	Input 2
	3	Input 3
	4	Input 4
	5	Input 5
	6	Input 6
	7	Input 7
	8	Input 8
	9	Common [-]

Relay output card 12RA-1

12RA-1	12 command outputs to switchgears
Process supply voltage	max. 250 V AC, max. 250 V DC ⚠*
Nominal load	8 A at 250 V AC ⚠* 5 A at 24 V DC resistive /0.7 A inductive 30 A DC for 500 ms
up time relay	typ. 8 ms
off time relay	typ. 2,5 ms
Inrush	1000 VA at L/R = 40 ms
Switch off capacity	0.5 A @ 110 V DC, 0.2 A@220 V DC at L/R = 50 ms ⚠* 8 A @ 230 V AC cosphi=1
Switching operations	100 ,000
Isolation	4000 Vrms coil/contact, 1000 Vrms open contacts 8 mm air gap coil/contact
Consumption	max. 265 mA (at 12 Relais ON +Ub=24V DC)
Operating temperature	-20° up to + 70° C ø24h max. +55°C
Relative humidity	<95% at 25° C without condensation (class F)

Relay output card 12RA-1 rev.1

12RA-1	12 command outputs to switchgears black relaiy AZDC110 with magnetic arc blow-out
Process supply voltage	max. 300 V AC, max. 253 V DC ⚠*
Nominal load	8 A 30 A DC for 500 ms
up time relay	typ. 10 ms
off time relay	typ. 5 ms
Inrush	1000 VA at L/R = 40 ms
Switch off capacity	0.5 A @ 220 V DC ⚠* relay 3000 W 8 A @ 230 V AC cosphi=1 relay 4200 VA
Switching operations load	30 ,000
Isolation	5000 Vrms coil/contact, 1000 Vrms open contacts 8 mm air gap coil/contact 10 kV surge 6 mm creepage distance PCB primary secundary
Consumption	5,5 W | typ. 230 mA @ +Ub 24 V DC
Operating temperature	-20° up to + 70° C
Relative humidity	<95% at 25° C without condensation (class F)

Terminals 12RA-1

Terminal X↑-upper: Command outputs12RA-1

Terminal X↑	Signal name	Remarks
X↑.1	RA 1 of module	14 Command output1
X↑.2	RA 2	24 Command output2
X↑.3	common 1-2	11/21 Process supply voltage
X↑.4	RA 3	34 Command output3
X↑.5	RA 4	44 Command output4
X↑.6	common 3-4	31/41 Process supply voltage
X↑.7	RA 5	54 Command output5
X↑.8	RA 6	64 Command output6
X↑.9	common 5-6	51/61 Process supply voltage

Terminal X↓-lower: Command outputs12RA-1

Terminal X↓	Signal name	Remarks
X↓.1	RA 7 of module	74 Command output7
X↓.2	RA 8	94 Command output8
X↓.3	common 7-8	71/81 Process supply voltage
X↓.4	RA 9	94 Command output9
X↓.5	RA 10	104 Command output10
X↓.6	common 9-10	91/101 Process supply voltage
X↓.7	RA 11	114 Command output11
X↓.8	RA 12	124 Command output12
X↓.9	common 11-12	111/121 Process supply voltage

*Note for signal voltages > 75 V DC:

Usage with a supply > 60 V is only approved for the BCU-50!

WARNING

Prior to working, switch off all poles, remove plug and discharge!

Nip voltages > 75 V terminals must be labelled with warning 'Danger High Voltage'.
Only use control signals with the same signal voltage.
To prevent confusion with DC signals ≤ 75 V by means of colour differentiation, only use the black terminals provided.
In addition, single braids must be connected to each other mechanically (with a cable tie for example) to prevent jump-over of a braid carrying hazardous voltage to an adjacent module with DC voltage ≤ 75 V.
Failing to comply can entail physical injury or material damage.

CAUTION

To satisfy the requirements for electrical safety, the module may only be installed and operated in a cabinet, a housing (having protection class IP 56 or higher) or an enclosed operating room.

Circuitry of 12RA-1

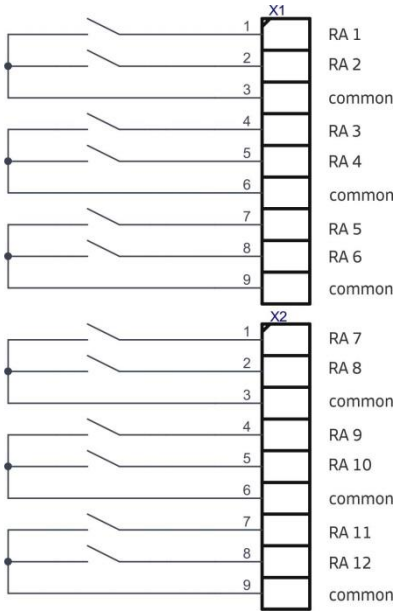


Figure 36: Circuitry 12RA-1

2-pole mode12RA-1

Activated in setIT the card may be operated in 2-pole mode to control external switchgear-motors using 2-pole power supply. The power up of supply voltage is done by 2 relays in grouping RA1/RA3, RA2/RA4, RA5/RA7, RA6/RA8, RA9/RA11, RA10/RA12. A checkback indication with automatic 1/N control or measuring circuit is only available with EVU2-O.

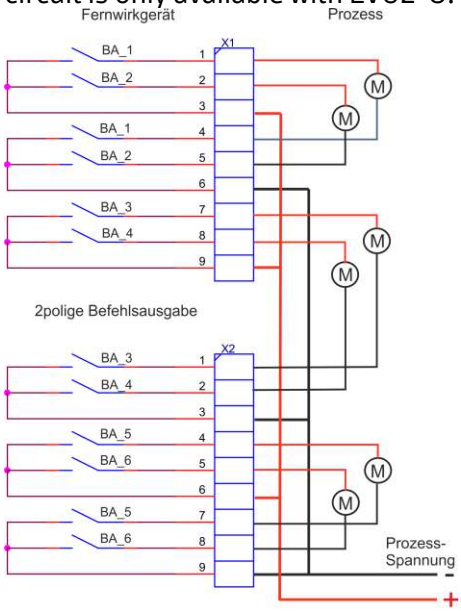
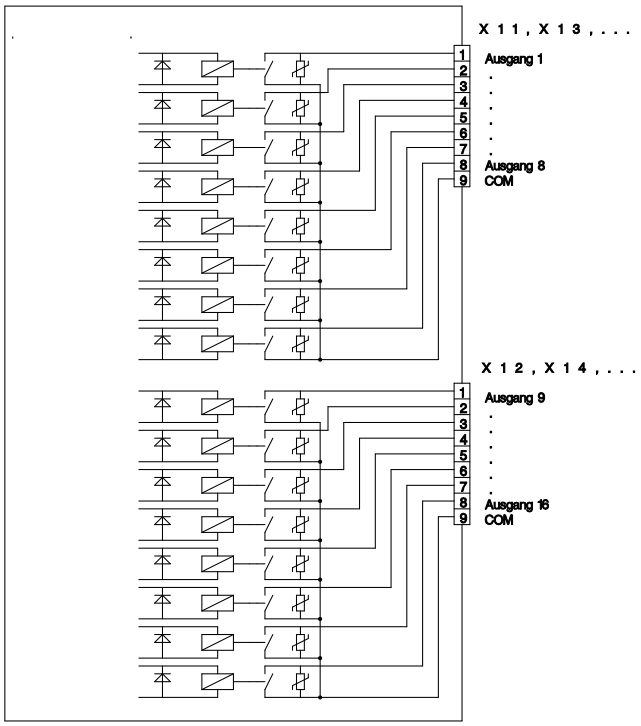


Figure 37: Cirtcuitry 12RA-1 2-pole

Relay output card 16RA-1

16RA-1	16 Relay outputs/commands
Nominal load	1 A at 230 V AC, 1 A at 24 V DC resistive/0.7 A inductive 0.5 A at 60 V DC resistive/0.4 A inductive 0.3 A at 220 V DC resistive However, max. 4.0 per group of 8, max. 125 VA / 50 W
Electrical isolation	via relay, according to root 1-8/9-16
Test voltage	2500 V
Nominal insulation voltage	250 V AC
Protective circuitry of contacts	Varistor 250 V VDR S07K250n
Switching voltage	Max. 210 V AC, max. 220 V DC
Reaction time relay	Approx. 6 ms
Switching operations	10,000,000
Maximum power consumption	220 mA typically (at +Ub=24V DC)
Operating temperature	0 to + 50° C
Relative humidity	95% at 25°C without condensation (class F)

Circuitry of 16RA-1

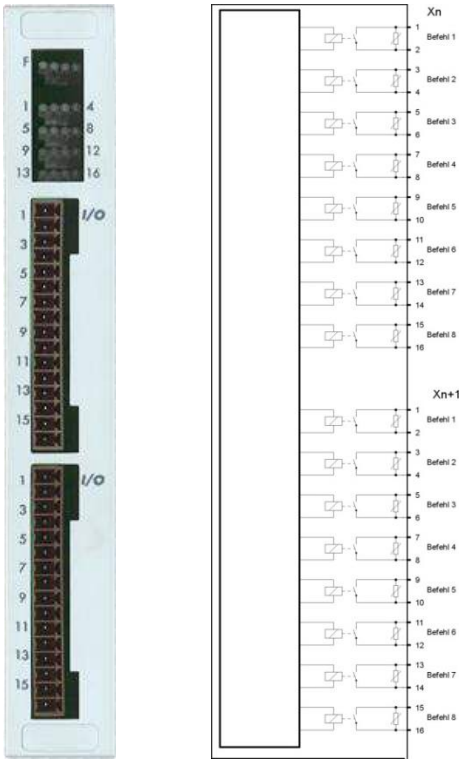


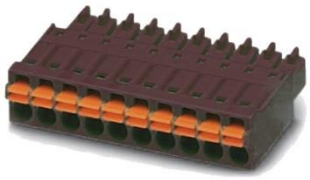
In case of nip voltages > 75 V, the terminals must be labelled with the warning "Caution high voltage".
Prior to working, switch of all poles, remove plug and discharge!

Relay output card 16RA-3

16RA-3	**16 relays/commands, make contact isolated** functional compatibility to 16RA-1 with setIT versions < V 4.8
Nominal load	1 A at 250 V AC, 1 A at 24 V DC resistive 0.7 A inductive 0.4 A at 60 V DC resistive 0.3 A inductive 0.25 A at 110 V DC resistive 0.2 A inductive 0.15 A at 220 V DC resistive. 0.1 A inductive
Electrical isolation	Yes, 2-pole connector for each channel
Test voltage	3000 V
Isolation relay	4000 Vrms AC/1 min, 6000 V Surge (1.2/250µs)
Protective circuitry of contacts	Varistor 250 V VDR S07K250n
Switching voltage	Max. 250 V DC/AC
Contacts	AgNi
Operate, dropout time	Max. 8 ms/4 ms
Switching operations	30,000,000 mechanical
Power consumption	160 mA typically (3.1 W at +Ub=24V DC)
Terminals	**2 * FMC 1.5/16-3.5 BK, 2* 16 pole black**
Operating temperature	0 to + 70° C
Relative humidity	95% at 25°C without condensation (class F)

Circuitry of 16RA-1





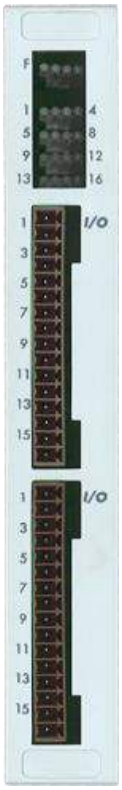
In case of nip voltages > 75 V, the terminals must be labelled with the warning "Caution high voltage". The terminals have been coloured black for visual purposes.

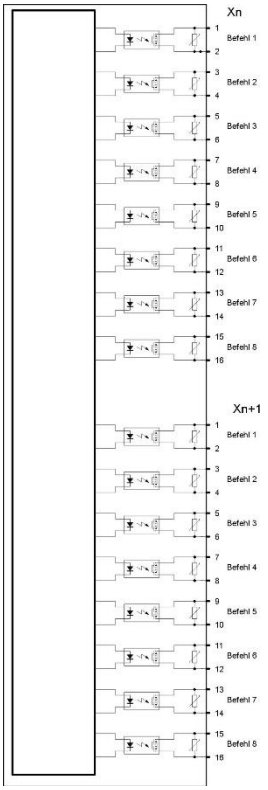
Prior to working, switch of all poles, remove plug and discharge!

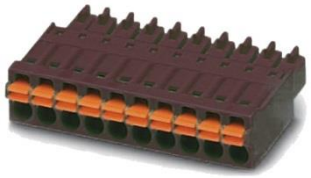
Output card 16OA-3

16OA-3	**16 optocoupler/transistor outputs** Isolation per channel Functional compatibility with 16OA-1 for setIT versions < V 4.8	
Switching voltage	16OA-3-1 16OA-3-2	max. 250 V DC/AC, max. 23 Ω max. 100 V DC/AC, max. 2.3 Ω
Electrical isolation	Yes, 2-pole connector for each channel	
Test voltage	3000 V	
Isolation relay	1500 Vrms AC/1 min	
Protective circuitry of contacts	Varistor 250 V VDR S07K250n	
Nominal load	16OA-3-1 16OA-3-2	130 mA AC/DC 320 mA AC/DC
Operate time/dropout time	< 1 ms/< 1 ms	
switching cycles	Electrically unrestricted	
Maximum power consumption	140 mA typically (0.8 W at +Ub=24V DC)	
Terminals	**2 * FMC 1.5/16-3.5 BK, 2* 16 pole black**	
Operating temperature	0 to + 70° C, Last derating 75% @60°, 50% @80°	
Relative humidity	95% at 25°C without condensation (class F)	

Circuitry of 16OA-3







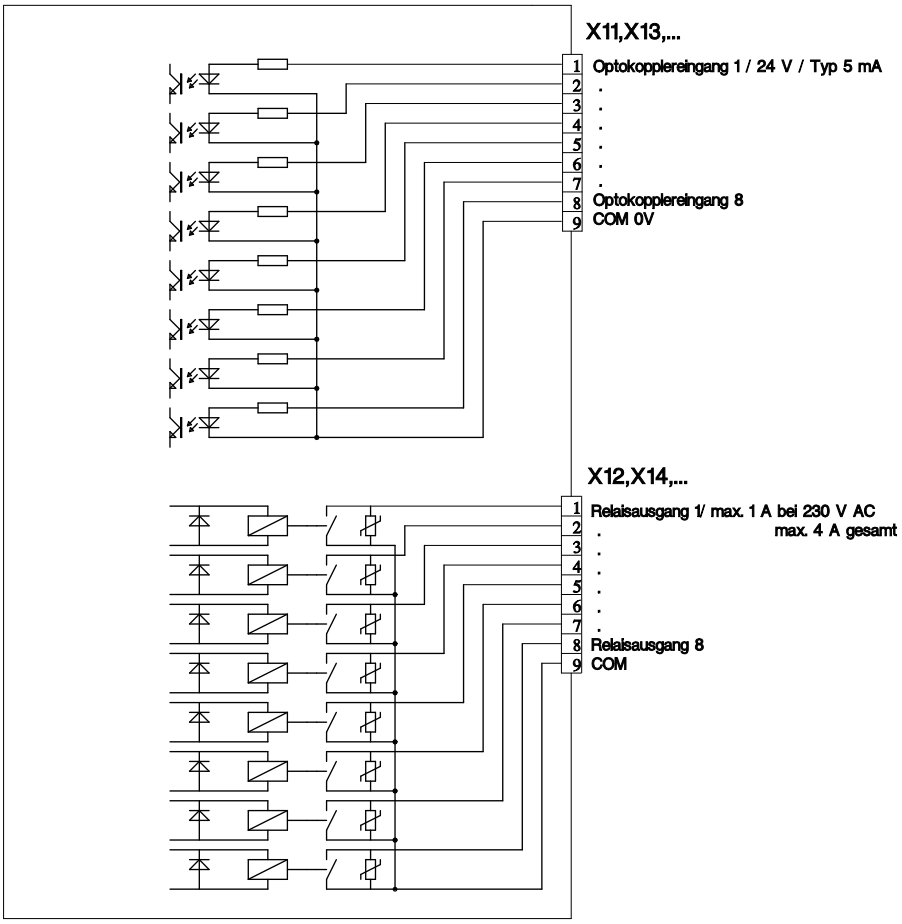
In case of nip voltages > 75 V, the terminals must be labelled with the warning "Caution high voltage".
The terminals have been coloured black for visual purposes.

Prior to working, switch of all poles, remove plug and discharge**!**

Digital input/output card OERA-5

OERA-5:	8 optocoupler inputs - 8 relay outputs
Optocoupler inputs	8 information inputs, wide range 18 to 72 V DC
Electrical isolation	Via optocoupler
Root	mutual reference potential for 8 channels
Input voltage	Wide range 18 to 72 V DC
Signal "0" off	0 to 16 V DC
Signal "1" on	> 17 V DC typically 0.8 mA
Input current signal "1"	Typically 1.2 mA (at 24 V DC)
Delay time	Approx. 0.3 ms
Test voltage	2500 V
Relay outputs	8 command relay make contact, according to root 1-8
Electrical isolation	Yes
Test voltage	2500 V
Nominal insulation voltage	250 V AC
Protective circuitry of contacts	Varistor 250 V, VDR S07K250
Nominal current contact	1 A at 230 V AC
Switching voltage	Max. 250 V AC, max. 30 V DC
Switched current	Max. 1.0 A/channel, however max. 4.0 A total max. 125 VA / 50 W
Operate time, dropout time	Approx. 6 ms
Switching operations, mechanical	30,000,000
Maximum power consumption	150 mA typically (at +Ub=24V DC)
EMC	CE, EN 61000-6-4: Emitted interference industry EN 61000-6-2: Immunity industry, EN 60950
Operating temperature	0 to + 60° C
Relative humidity	95% at 25°C without condensation (class F)

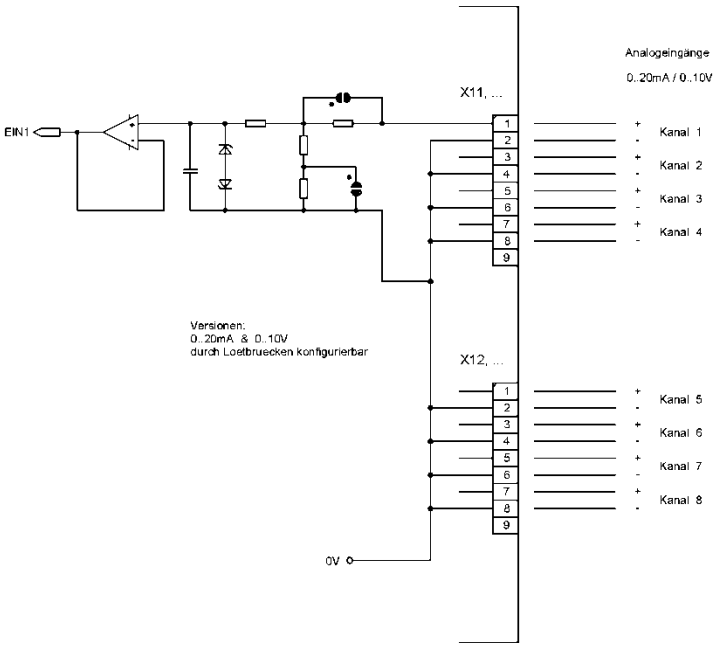
Circuitry of OERA-5



Analogue input card 8AE16-1

8AE16-1	8 analogue inputs 12/16 bit 0 - 20 mA /2.5 mA /10 V	
Input signal:	8AE16-1-1 8AE16-1-2 8AE16-1-3	0 (4) to 20 mA max. 30 mA 0 to 10 V max. 15 V 0 to 2.5 mA max. 5 mA
Resolution	12-bit/16-bit selectable via jumper	
Accuracy	+/-0.1% in the temperature range 0...50°C in relation to the measuring range end value	
Electrical isolation	Via optocoupler according to root 1-8	
Root	Common reference potential	
Insulation resistance	Surge voltage 3 kV 1.2/50 µs Power-frequency withstand voltage 2000 V eff. /1 min.	
Input impedance:	8AE16-1-1 8AE16-1-2 8AE16-1-3	62 Ω 100 kΩ 470 Ω
Maximum power consumption	100 mA typically (at +Ub = 24 V DC)	
Operating temperature	0 to + 50° C	
Relative humidity	95% at 25°C without condensation (class F)	

Circuitry of 8AE16-1



Jumpers		Mode
S3	**Closed**/inserted	**Averaging active** (8 measured values)
S4	**Closed**/inserted	**Unipolar acquisition***
S1, S2, S5-S8		No function

* *Standard S4 = inserted*

Analogue input card 8AE16-2

The 8AE16-2 card replaces the 8AE16-1 type and other sub-variants. Furthermore, it offers isolation per channel and analogue inputs one below the other and a ripple rejection which can be selected with jumpers.
In the compatibility mode the card behaves like 8AE16-1 on the outside. Therefore, it can also be used compatibly in older projects without changing the position on 8AE16-1.

8AE16-2	8 analogue inputs 12 bit, isolated per channel 0 to 20 mA /2.5 mA /10 mA /10 V
input signal:	8AE16-2-1 0 (4) to 20 mA Max. 30 mA 8AE16-2-2 0 to 10 V Max. 15 V upon request 8AE16-2-3 0 to 2.5 mA Max. 5 mA 8AE16-2-4 0 to 10 mA Max. 15 mA
Resolution	12 bit
Accuracy	± 0,15% in the range of -5°C to + 55° C, in addition 0.05% per 5 K in the range of -20°C to --5°C and +55°C to +70°C
Isolation	Via optocoupler isolation of the measured values per channel
Insulation resistance	Surge voltage 3 kV 1.2/50 µs power-frequency withstand voltage 2000 V eff. /1 min.
input impedance:	100 Ω
Max. power consumption	2 W | typ 80 mA @ +Ub 24 V DC
Operating temperature	20° to 70° C
Relative humidity	95% at 25°C without condensation (class F)

Circuitry of 8AE16-2

Terminal	No.	Description
X11 X13 X15 ...	1	Measured value 1 +
	2	Measured value 1-
	3	Measured value 2 +
	4	Measured value 2-
	5	Measured value 3 +
	6	Measured value 3-
	7	Measured value 4 +
	8	Measured value 4-
	9	n.c.· /unused
X12 X14 X16 ...	1	Measured value 5 +
	2	Measured value 5-
	3	Measured value 6 +
	4	Measured value 6-
	5	Measured value 7 +
	6	Measured value 7-
	7	Measured value 8 +
	8	Measured value 8-
	9	n.c.· /unused

Note: Unused voltage inputs (0 - 10 V) should be short-circuited in order to avoid negative effects on the high-impedance inputs.

Diagnostic LED and jumpers

Function LEDS

the front there are 4 LEDs to indicate the operating states.

LED 1●●●●4	Colour	Function
1●	Red	OFF Card OK and approved 2 Hz Error, card inserted incorrectly ON Card locked/not approved
2●	Yellow	OFF Valid measurement operation ON Calibration necessary, no measurement operation possible
3●	Green	OFF 8AE16-3 multi-range, uni-/bipolar on 8AE16-2 compatibility mode 8AE16-1
4●	Red	OFF fault-free operation ON internal transformer error

Operational LEDs

This module has 2 LEDs to indicate the card status.

LED 5● ●6	*Colour*	*Function*
5●	Green	2 Hz fault-free operation of the module
6●	Green	Free

Measuring range selection

The 8AE16-2 card is based on the hardware of the 8AE16-3 card which is used switch to 8AE16-1 by using the S9 jumper in the compatibility mode.

S9	S10	Mode	Card type
Closed/inserted	**Open**	**Compatibility mode**	**8AE16-2-x**
Closed/inserted	closed/inserted	Calibration	8AE16-2-x

The measuring range is preset using jumper depending on the type delivered. The setting is valid for all channels of 8AE16-2:

S1	S2	Mode	Card type
Open	Open	0 (4) to 20 mA	8AE16-2-1
Closed/inserted	Open	0 to 10 mA	8AE16-2-4
Open	Closed/inserted	0 to 2.5 mA	8AE16-2-3

Measuring range 0 to 10 V upon request

Ripple rejection

The filter setting is valid for all channels of 8AE16-2:

S3	S4	S5	Mode	Transformer rate f ADC
Open	Open	Open	50/60 Hz65 dB	16.6 Hz
Open	Open	Closed	50 Hz 80 dB	16.7 Hz
Closed	Open	Closed	50 Hz 25 dB	100 Hz
Open	Closed	Closed	60 Hz 80 dB	20 Hz
Closed	Closed	Closed	60 Hz 25 dB	120 Hz

S6/S7/S8 are reserved for calibration function..

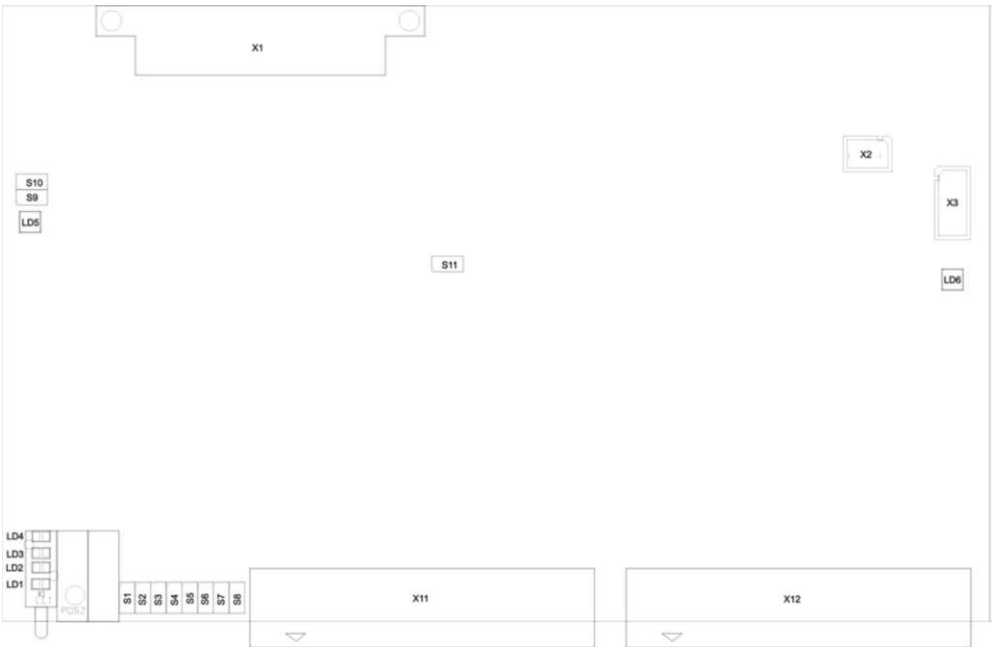


Figure 38: Jumpers and LED of 8ZE16-2

Analogue input card 8AE16-3

The 8AE16-3 card offers an optimal integration of different analogue inputs by carrying out adjustments per channel, multi-range selection of the measuring range, selectable ripple rejection and electrical isolation per channel. The overrun detection expands the measuring range to 100% and provides for better acquisition of transmitter errors. Furthermore, the card enables unipolar and bipolar measured value acquisition.

These functions are only available for the series5 systems from setIT V4.004.05.

- Measuring range multi-range
- Ripple rejection filter level
- Polarity unipolar/bipolar
- Overrun

The settings for each input can be carried out by right clicking the card image under 'Edit card parameters' or in the station configuration under 'Analogue transformer':

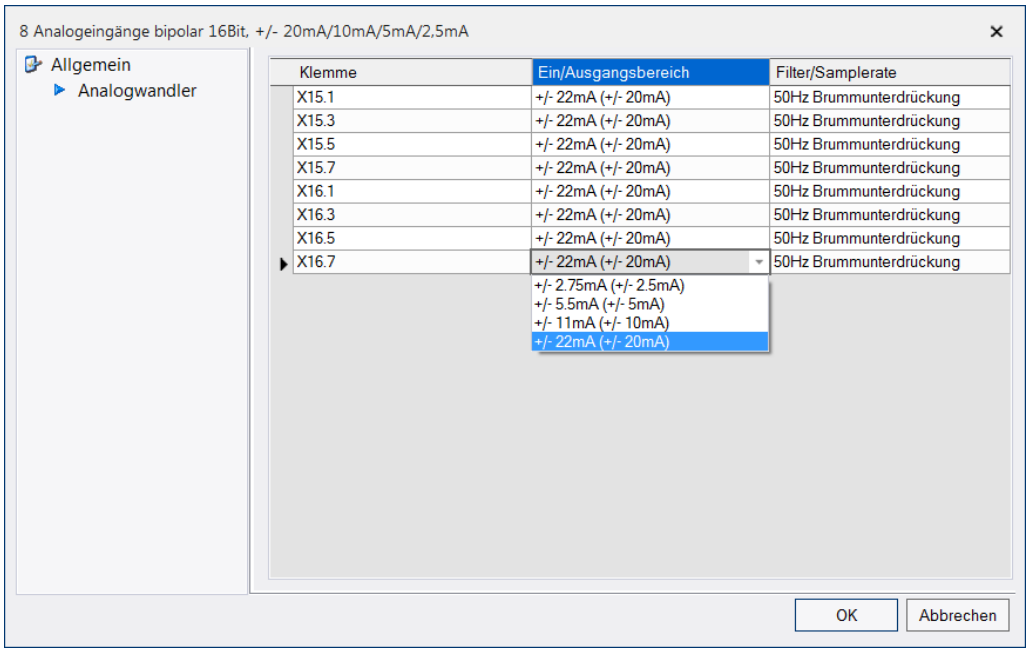


Figure 39: Multi-range selection of measuring ranges and ripple rejection per channel

The 8AE16-3 card can be moved into a compatibility mode which simulates cards 8AE16-1 and 8AE16-2. Through the improved output module, these older cards can be replaced in a compatible manner by an appropriately set 8AE16-3, see Compatibility mode & operating modes p. 159.

Technical details 8AE16-3

8AE16-3	8 analogue inputs 16 bit multi-range Isolated per channel
Input signal	Multi-range switchable per channel: 8AE16-3-1 ±20 / ±10 mA/ ±5 mA / ±2,5 mA 8AE16-3-2 ±10 V Nominal, upon request
Resolution	16 bit bipolar
Measuring range	Multi-range uni-/bipolar Overrun/underrun detection 110%
Accuracy	Core area: ± 0.1% at 5° to +55°C Expanded area: max. ±0,25% at -20 to +70°C
Ripple rejection	ON: 50Hz / 80dBm ; f_{ADC} = 16,7Hz OFF: 50Hz / 25dBm ; f_{ADC} = 120Hz
Electrical isolation	Isolation of the measured values per channel against and for logic via optocoupler
Insulation resistance	Surge voltage 3 kV 1.2/50 µs Power-frequency withstand voltage 2000 V eff. /1 min.
Input load	8AE16-3-1 100 Ω
Max. power consumption	2 W | typ 80 mA @ +Ub 24 V DC
Operating temperature	20° to 70° C
Relative humidity	95% at 25°C without condensation (class F)

Circuitry of 8AE16-3

Terminal	No.	Description
X11 *X13* *X15* ...	1	Measured value 1 +
	2	Measured value 1-
	3	Measured value 2 +
	4	Measured value 2-
	5	Measured value 3 +
	6	Measured value 3-
	7	Measured value 4 +
	8	Measured value 4-
	9	n.c.· /unused
X12 *X14* *X16* ...	1	Measured value 5 +
	2	Measured value 5-
	3	Measured value 6 +
	4	Measured value 6-
	5	Measured value 7 +
	6	Measured value 7-
	7	Measured value 8 +
	8	Measured value 8-
	9	n.c.· /unused

Note: **Unused voltage inputs (0 - 10 V) should be short-circuited in order to avoid negative effects on the high-impedance inputs.**

Diagnostic LED and jumpers

Function LEDS

There are 4 LEDs to indicate the operating states.

LED 1●●●●4	Colour	Function
1●	Red	**OFF** **Card OK and approved** 2 Hz Error, card inserted incorrectly ON Card locked/not approved
2●	Yellow	**OFF** **valid measurement operation** ON calibration necessary, no measurement operation possible
3●	Green	**OFF** **multi-range**, uni-/bipolar on compatibility mode 8AE16-1/8AE16-2
4●	Red	**OFF** **fault-free operation** ON internal transformer error

Operational LEDs

This module has 2 LEDs to indicate the card status.

LED 5● ●6	*Colour*	*Function*
5●	Green	2 Hz fault-free operation of the module
6●	Green	Free

Compatibility mode & operating modes

It is inserted with the S9 jumper and the card is moved into the compatibility mode which provides the replacement for 8AE16-1-1 or 8AE16-2-1 cards.

S9	S10	Mode
Open	**Open**	**Multi-range mode**
Open	Closed/inserted	Calibration
Inserted	Open	Compatibility mode 8AE16-3-1 => 8AE16-1-1 /8AE16-2-1 8AE16-3-2 => 8AE16-1-2 /8AE16-2-2

Measuring range multi-range

The measuring ranges of each analogue input can be set in the configuration. S9 and S10 must be open for the multi-range operation of 8AE16-3.

Input area 110 %	Measuring range	Comment
± 22 mA	20 mA	Basic setting
± 11 mA	10 mA	
± 5.5 mA	5 mA	from setIT V5.0
± 2.75 mA	2.5 mA	

Ripple rejection

Ripple rejection	Attenuation	Comment
50 Hz	80 dB	Basic setting
100 Hz		Max. sample rate

Range of values for PLC linking

Transmitting the data according to IEC 60870-5-10x takes places in the respectively configured range of values (normalised/scaled/IEEE); the raw values listed here are therefore not valid for a data transmission.
The values refer to the raw values of the analogue inputs in the internal memory of the system; when the codeIT-PLC is accessed 'statically', they must be observed during PLC applications.

A measuring range of e.g. ±22 mA displayed on 16 bit (65536 steps) is available:

Measured value/mA	Raw value/Hex	Raw value/decimal
-22	0000H	0
-20	**0BA2H**	2978
0	**8000H**	32768
20	**0F44AH**	62538
22	0FFFFH	65535

In the other measuring ranges, the raw values behave according to the measuring range end values (2.5 mA ~ 0F44AH, 2.75 mA ~ 0FFFFH).

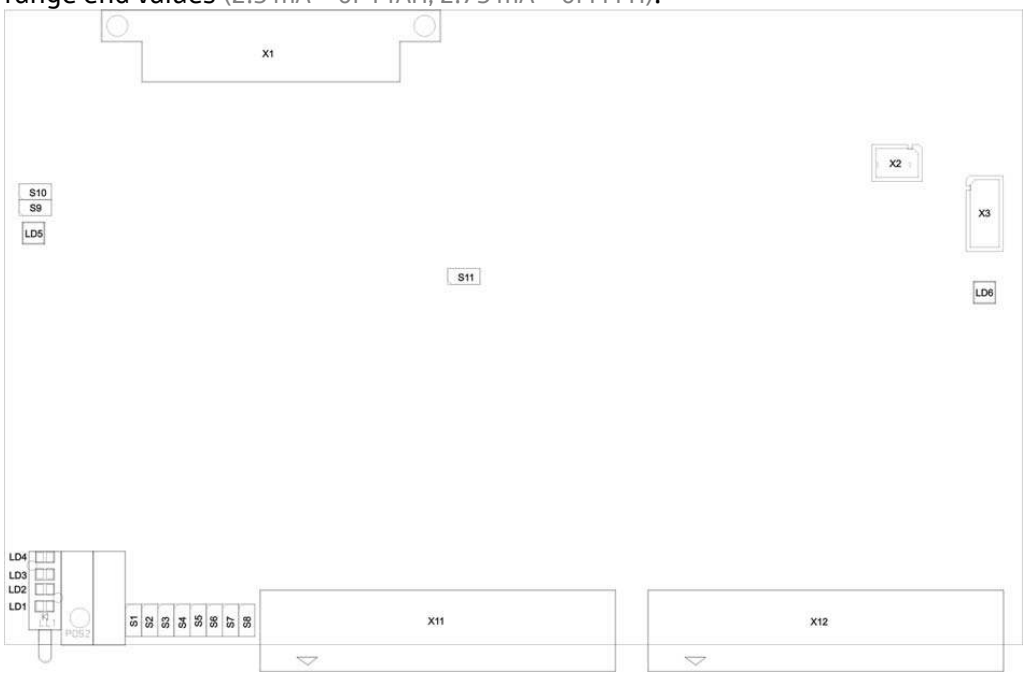
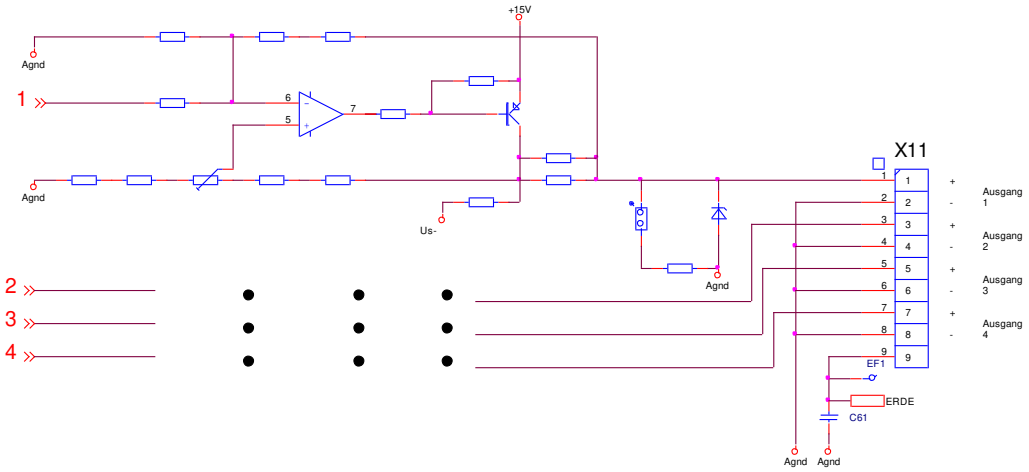


Figure 40: Jumpers and LED of 8ZE16-3

Analogue output card 8AA12-1

8AA12-1	**8 analogue outputs 12 bit, according to root**
output signal:	8AA12-1-1 0...20 mA 8AA12-1-2 0...10 V
Resolution	12 bit
Accuracy	+/- 0,1% / 10 K (at 25 °C related to total output range)
Electrical isolation	Via optocoupler, according to root
Insulation test voltage	Logic / outputs: 500 VDC (optional 3 kV)
Load	8AA12-1-1 300 Ω 8AA12-1-2 100 kΩ
additional status indicator	1 green SMD LED on the card
Controls	8 internal jumpers
Maximum power consumption	2.2 W | typ. 100 mA @ +Ub = 24 V DC
Operating temperature	0° to + 50° C
Relative humidity	95% at 25°C without condensation (class F)

Circuitry of 8AA12-1



Output mode

The card is in output mode when all channels have been completely calibrated (offset and full-scale) and there is no hardware error. This is the main operating mode of the card, this is where the cyclical output of analogue values on the DACs and the operation of the system bus takes place.

	LD1A red	LD1B green	LD1C green	LD1D green	LD2 green
Card disabled	●	●	●	○	○
Output mode	○	○	○	○	✳ 1 Hz
Rough calibration	○	✳ 2 Hz	✳ 2 Hz	✳ 2 Hz	✳ 2 Hz

Analogue output card 8AA16-1

Technical details

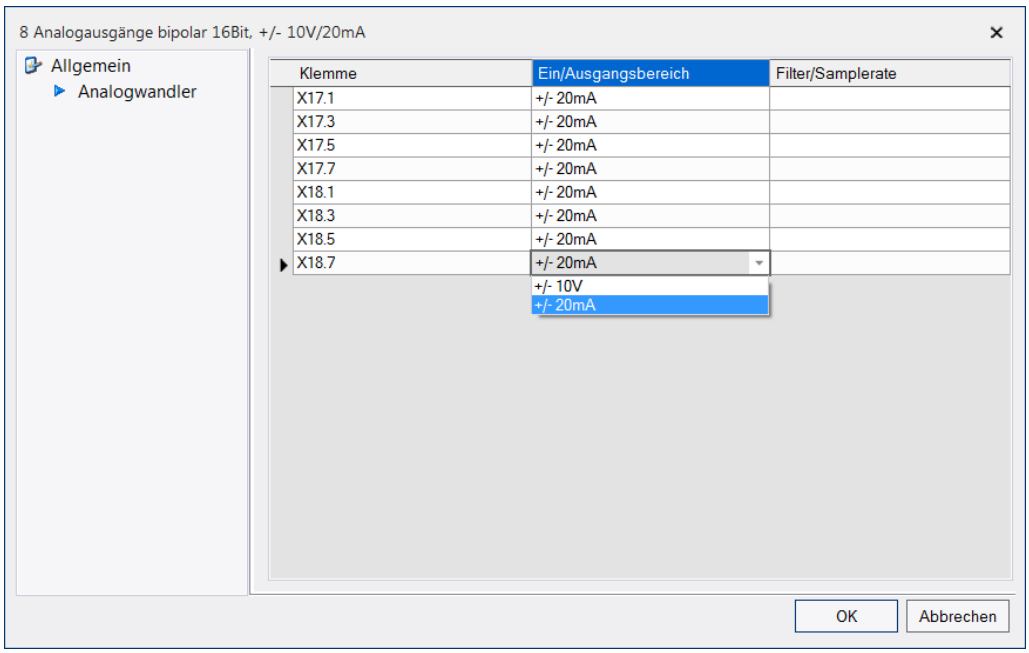
8AA16-1	8 analogue outputs 16 bit bipolar , isolated per channel, 0-20 m,A / 10 V switchable
Resolution	16 bit
output range	Uni-/bipolar ± 20 mA / ±10 V switchable per channel
Accuracy	±0.1% /10 K over entire range (2.5 mA: ± 0.25%)
Electrical isolation	Isolated per channel, 2-pole connector
Insulation test voltage	2500 VDC for power supply
Load	± 20 mA max. 500 Ω ± 10 V 100 kΩ
Max power consumption	6.7 W | typ. 280 mA @ +Ub 24 V DC
Operating temperature	20° to 70° C
Relative humidity	95% at 25°C without condensation (class F)

Circuitry of 8AA16-1

Terminal	No.	Description
X11 X13 X15 ...	1	Set point 1+
	2	Set point 1-
	3	Set point 2+
	4	Set point 2-
	5	Set point 3+
	6	Set point 3-
	7	Set point 4+
	8	Set point 4-
	9	n.c.· /unused
X12 X14 X16 ...	1	Set point 5+
	2	Set point 5-
	3	Set point 6+
	4	Set point 6-
	5	Set point 7+
	6	Set point 7-
	7	Set point 8+
	8	Set point 8-
	9	n.c.· /unused

Switching the output range per channel

The output/set point card 8AA16-1 can be separately switched for each set point/channel in the output range between ± 20 mA and ± 10 V. The setting is either carried out in the station view FW-50 in the card configuration or in the "Analogue transformer" menu of the station properties.
The bipolar/unipolar selection takes place in the output definition of the process data. Software carries out scaling process.



Check-back indication card EVU2-I

EVU-2-I	**Command check-back indication card** for EVU-2-O	
Check-back indication	16 inputs with common root	
Electrical isolation of measuring circuit	Via optocoupler	
EVU2-I-1	Input voltage Switching point Input current	24 V DC approx. 12 V DC at 20 V approx. 2.8 mA
EVU2-I-5	Input voltage Switching point Input current	18 ... 72 V DC approx. 17 V DC at 24 V approx. 1.4 mA at 60 V approx. 3.5 mA
EVU2-I-2	Input voltage Switching point Input current	60 ... 130 V DC approx. 37 V DC at 60 V approx. 1.2 mA, at 120 V approx. 2.4 mA
EVU2-I-3	Input voltage Switching point Input current	220 V DC approx. 135 V DC at 220 V approx. 1.3 mA
Insulation test voltage:	Logic/outputs optionally 3 kV	
Controls	6 internal jumpers	
Max. power consumption	0.4 W | typ. 20 mA @ +Ub 24 V DC	
Ambient temperature	-20° to +70° C	
Relative humidity	80 % at 25°C without condensation	

Circuitry of EVU2-I

Terminal	No.	Description
X11 *X13* *X15* ...	1	Input 1
	2	Input 2
	3	Input 3
	4	Input 4
	5	Input 5
	6	Input 6
	7	Input 7
	8	Input 8
	9	Common [-]
X12 *X14* *X16* ...	1	Input 9
	2	Input 10
	3	Input 11
	4	Input 12
	5	Input 13
	6	Input 14
	7	Input 15
	8	Input 16
	9	Common [-]

In case of nip voltages > 75 V, the terminals must be labelled with the warning "Caution high voltage".
Prior to working, switch of all poles, remove plug and discharge!

Command card EVU2-O

EVU2-O-1 / EVU2-O-3	Command termination 1.5-pole, max. 8 double commands or 16 single commands
EVU2-O-2 / EVU2-O-4	Command termination 2-pole, max. 4 double commands or 8 single commands
Command relay	16 relay outputs, 2 release relays
Monitoring times	0 .. 32000 ms in steps of 100 ms
Electrical isolation of measuring circuit	Via optocoupler
EVU2-O-**1**/ EVU2-O-**2**	Coupling relay < 20 kΩ control voltages to 60 V DC
External coil resistance	100 Ω ... 20 kΩ
Accuracy of measuring circuit	+/- 10 %
EVU2-O-**3**/ EVU2-O-**4** ⚠*	Coupling relay > 20 kΩ control voltages > 60 V DC
External coil resistance	**1 kΩ ... 100 kΩ**
Accuracy of measuring circuit	**+/- 15%**
Allowed switching voltage	**max. 220 V DC** ⚠*
Allowed switched current	**max. 2 A at 24 V DC** **60 V DC 0.4 A** **110 V DC 0.2 A** ⚠* **220 V DC 0.1 A** ⚠*
Maximum power consumption	**23 mA at +Ub 24 V DC (for 1.5-pole command output)**
Protective circuitry of contacts	**250 V varistors**
Terminals	2 pluggable 10-pole terminals as: FKC spring terminal strip 0.2 to 2.5 mm² or Screw terminal MSTB, 0.2 to 2.5 mm² EVU2-O-1/EVU2-O-2 **green** terminal EVU2-O-3/EVU2-O-4 **black** terminal ⚠*
Accessories	GST-10 connector cable: Connectors, housing, cables of various lengths GST-10-ST connector set: Plug, 10 pole with housing Item: 310000054700
Ambient temperature	-20° to +70° C recommended, max. 55°C
Relative air humidity	<95% at 25°C without condensation

Note

If 1.5 ½ pole (EVU2-O-1) and 2-pole (EVU2-O-2) commands are used simultaneously, it is necessary to use separate cards, which can however, be used in the same command group (rack). Single and double commands can be mixed on one card.

*Note for signal voltages > 75 V DC:

WARNING

Usage with a supply > 60 V is only approved for the BCU-50!

Prior to working, switch off all poles, remove plug and discharge!

Voltages > 75 V terminals must be labelled with warning 'Danger High Voltage'.

Only use control signals with the same signal voltage.

To prevent confusion with DC signals ≤ 75 V by means of colour differentiation, only use the black terminals provided.

In addition, single braids must be connected to each other mechanically (with a cable tie for example) to prevent jump-over of a braid carrying hazardous voltage to an adjacent module with DC voltage ≤ 75 V.

WARNING

Failing to comply can entail physical injury or material damage.

CAUTION

To satisfy the requirements for electrical safety, the module may only be installed and operated in a cabinet, a housing (having protection class IP 56 or higher) or an enclosed operating room.

Terminal allocation single commands EVU2-O-1 /EVU2-O-3

Terminal-top X↑: Command outputs EVU2-O-1 /EVU2-O-3

Terminal X↑	Signal name	Remarks
X↑.1	RO 1 of the module	14 command output 1
X↑.2	RO 2	24 command output 2
X↑.3	RO 3	34 command output 3
X↑.4	RO 4	44 command output 4
X↑.5	RO 5	54 command output 5
X↑.6	RO 6	64 command output 6
X↑.7	RO 7	74 command output 7
X↑.8	RO 8	84 command output 8
X↑.9	Uext +	Switching voltage +
X↑.10	Uext -	Switching voltage - ground

Terminal X↓ at bottom: Command outputs EVU2-O-1 /EVU2-O-3

Terminal X↓	Signal name	Remarks
X↓.1	RO 9 of the module	94 command output 9
X↓.2	RO 10	104 command output 10
X↓.3	RO 11	114 command output 11
X↓.4	RO 12	124 command output 12
X↓.5	RO 13	134 command output 13
X↓.6	RO 14	144 command output 14
X↓.7	RO 15	154 command output 15
X↓.8	RO 16	164 command output 16
X↓.9	common 1-16	x1 root
X↓.10	common 1-16	x1 root

Command termination 1.5-pole with single commands

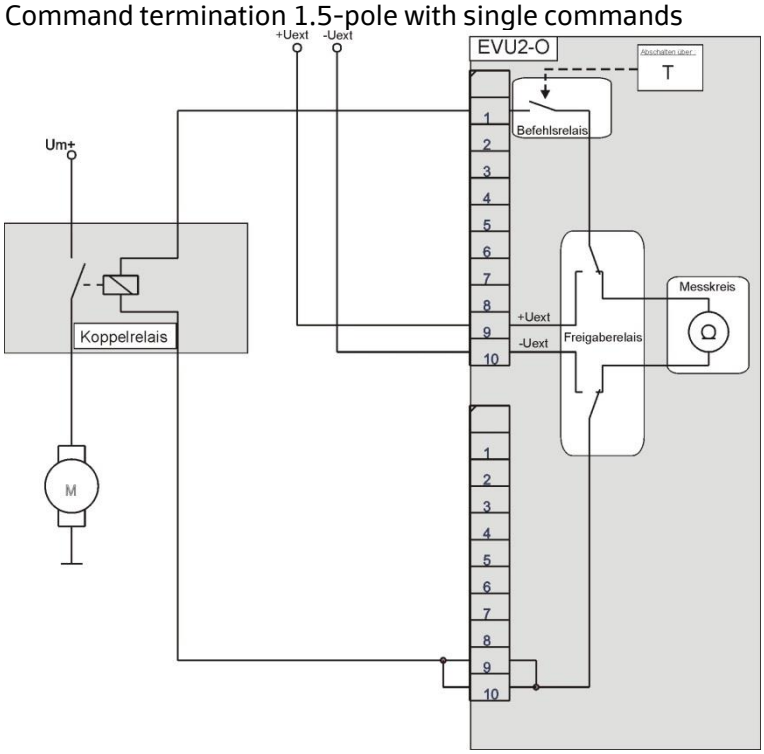


Figure 41: Command termination single command 1.5-pole of the EVU-2-O-1/-3 including measuring circuit test

Terminal allocation double commands EVU2-O-1 /EVU2-O-3

Terminal-top X↑: Command outputs EVU2-O-1 /EVU2-O-3

Terminal X↑	Signal name	Remarks
X↑.1	RO 1a of the module	Command output 1 OFF
X↑.2	RO 1b	Command output 1 ON
X↑.3	RO 2a	Command output 2 OFF
X↑.4	RO 2b	Command output 2 ON
X↑.5	RO 3a	Command output 3 OFF
X↑.6	RO 3b	Command output 3 ON
X↑.7	RO 4a	Command output 4 OFF
X↑.8	RO 4b	Command output 4 ON
X↑.9	Uext +	Switching voltage +
X↑.10	Uext -	Switching voltage - ground

Terminal X↓ at bottom: Command outputs EVU2-O-1 /EVU2-O-3

Terminal X↓	Signal name	Remarks
X↓.1	RO 5a of the module	Command output 5 OFF
X↓.2	RO 5b	Command output 5 ON
X↓.3	RO 6a	Command output 6 OFF
X↓.4	RO 6b	Command output 6 ON
X↓.5	RO 7a	Command output 7 OFF
X↓.6	RO 7b	Command output 7 ON
X↓.7	RO 8a	Command output 8 OFF
X↓.8	RO 8b	Command output 8 ON
X↓.9	common 1-8	x1 root
X↓.10	common 1-8	x1 root

histroy 8.2.19: The first relay output is an OFF command

Command termination 1.5-pole with double commands

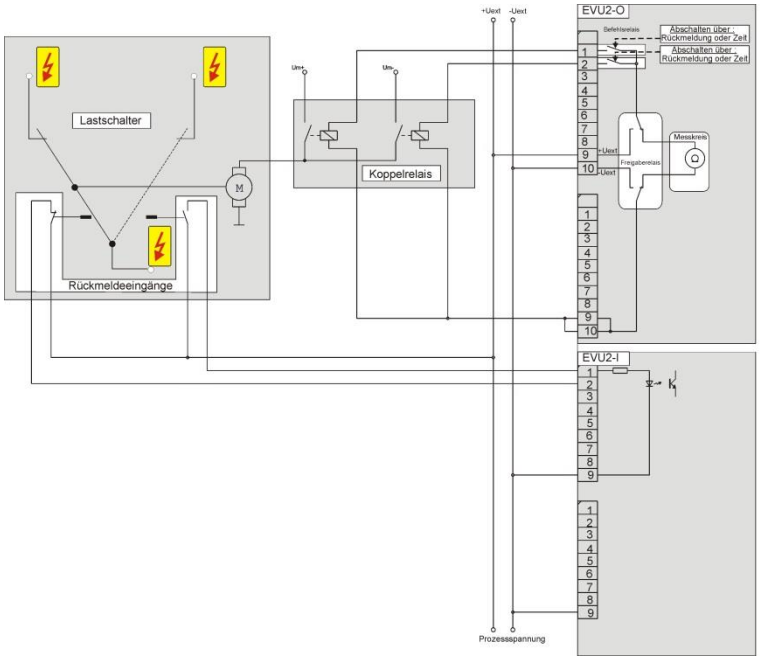


Figure 42: Command termination double command 1.5-pole of the EVU-2-O-1/-3 including measuring circuit test

Terminal allocation double commands EVU2-O-2 /EVU2-O-4

Terminal-top X↑: Command outputs EVU2-O-2 /EVU2-O-4

Terminal X↑	Signal name	Remarks
X↑.1	RO 1a+ of the module	Command output 1a OFF+
X↑.2	RO 1a-	Command output 1a OFF-
X↑.3	RO 1b+	Command output 1b ON+
X↑.4	RO 1b-	Command output 1b ON-
X↑.5	RO 2a+	Command output 2a OFF+
X↑.6	RO 2a-	Command output 2a OFF-
X↑.7	RO 2b+	Command output 2b ON+
X↑.8	RO 2b-	Command output 2b ON-
X↑.9	Uext +	Switching voltage +
X↑.10	Uext -	Switching voltage - ground

Terminal X↓ at bottom: Command outputs EVU2-O-2 /EVU2-O-4

Terminal X↓	Signal name	Remarks
X↓.1	RA 3a+ of the module	Command output 3a OFF+
X↓.2	RO 3a-	Command output 3a OFF-
X↓.3	RO 3b+	Command output 3b ON+
X↓.4	RO 3b-	Command output 3b ON-
X↓.5	RO 4a+	Command output 4a OFF+
X↓.6	RO 4a-	Command output 4a OFF-
X↓.7	RO 4b+	Command output 4b ON+
X↓.8	RO 4b-	Command output 4b ON-
X↓.9	n.c.	unused
X↓.10	n.c.	unused

histroy 8.2.19: The first relay output is an OFF command

Command termination 2-pole with double commands

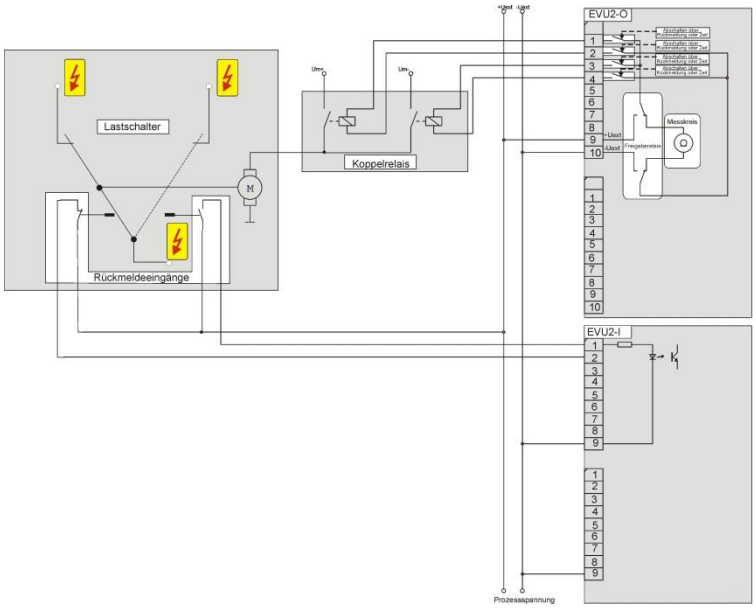


Figure 43: Command termination double command 2-pole of the EVU-2-O-2/-4 including measuring circuit test

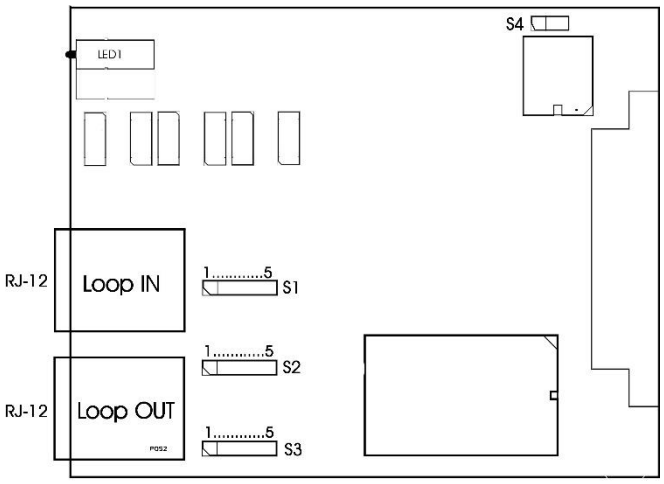
Coupling card EVU-X-1

Implementation of a rack overlapping command group for the joint use of EVU-cards in up to 7 racks. In this command group all commands are directly interconnected via hardware.

LED 1●●●●4		Function
1	Red	Card error / release
2	Green	Status signal "Command active"
3	Green	Status signal "Internal measuring circuit error"
4	Green	Reserved

Jumper	1-2 / 3-4 inserted	2-3 / 4-5 inserted
S1 = Loop for "Command active"	Active	Passive
S2 = Loop for "Internal measuring circuit error"	Active	Passive
S3 = Reserved for signal "End position reached"	Open	Open
S4 = Master / slave signalling	1-2 Master	2-3 Slave

Interface to DTE	3x TTL level, tri-state, Bi-directional transmission per current loop
Signals	Command active; internal measuring circuit error; end position reached (INT/)
DCE interface	3 current loops, 20mA. EVU-signalling line inactive (+5V) = 20mA, Active (Command active/interference) = 0mA
Load.	Approx. 3V / EVU-X card
DCE plug-in connection	2 6-pole Western connectors for loop-out and loop-in
Status indicator	3 green LEDs, status of 20 mA loops, 1 red LED card status
Controls	3 jumper for active/passive – adjustment of the respective current loops
Design	Board in 100 mm x 80 mm
Plug-in connector	2x 6-pole western connector (RJ12)
Insulation	3000 V surge for EVU applications 2000 V AC
Ambient temperature	0° ... +50° C
Relative humidity	80% at 25°C without condensation



Cable and connection of EVU-X cards

The closed current loop (LED lights up) indicates the inactive state of the respective bus signals in the interconnected command groups. An active command/error immediately interrupts the current loop.
If one current loop is faulty the EVU command output of all modules will be blocked.
The card is designed as an interface card and **must only be inserted in the "upper" bus**. Any slot position can be chosen on the upper bus.

A connection cable is provided with a "module ribbon cable for western connectors" with RJ12 plugs.

Figure 44: Cable EVU-X

The cable length is specified by the design.

A short connection of approx. 23 cm (17.7 cm + 2 * 3 cm) is anticipated because the racks are mounted below one another (~ 4HE). The exact dimensions need to be checked at the mounted rack frames.

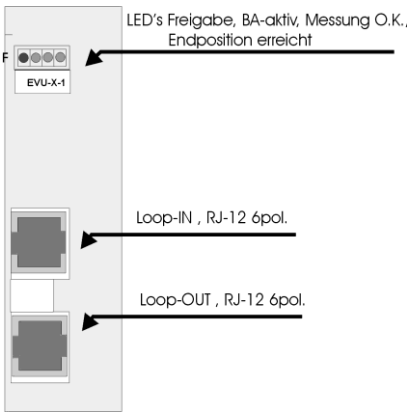
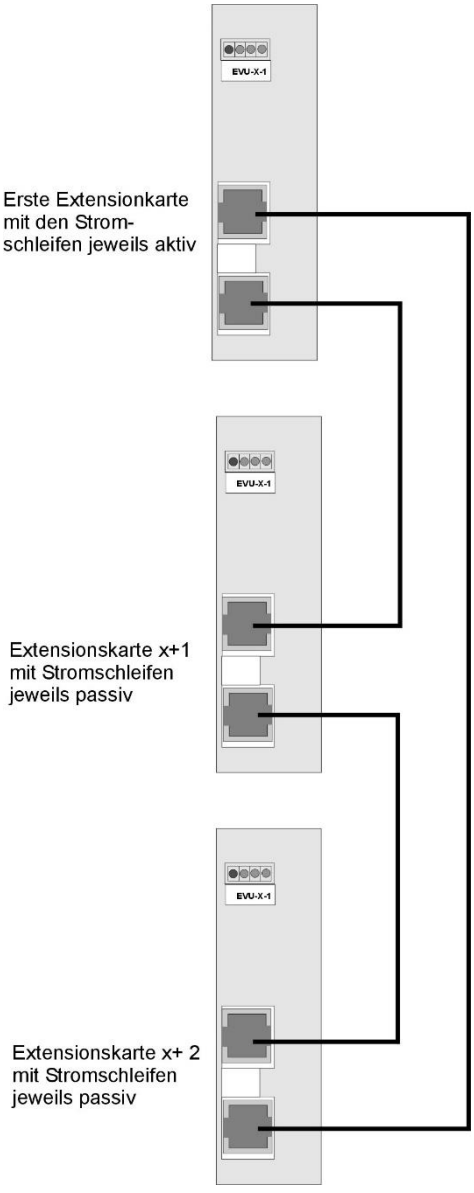


Figure 45: Circuitry EVU-X

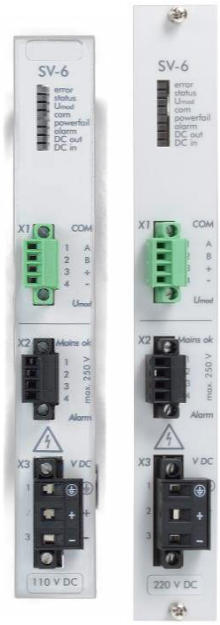


The maximum cable length must not exceed **3m** due to EMC safety reasons.
Further information can be derived from the short description of EVU-X.

7 Power supplies

Internal power supplies

Intelligent Power Supply SV-6



The power supply SV-6 was developed for substation automation applications in medium high voltage grids for systems:

- net-line BCU-50
- net-line FW-50

To meet the requirements, several tensions for supply have been realised. Additionally it may be operated redundantly.

As an intelligent power supply it fulfils relevant requirements. For support of intelligent power down concept the primariy voltage, temperature and load of the board will be supervised with fixed thresholds. The board meets the high requirements to environment, shock-, vibration- and isolation of IEC 61850-3 for the range of application (h/H).

Itemlist

Itemno.	Name	Function
310050040400	SV-6-24-LC	Stromversorgung 24 V DC for FW-50
310050040421	SV-6-60-LC	Power supply 48 /60V DC for FW-50
310050040410	SV-6-48#~	Power supply 24 /48 V DC for FW-50
310050040412	SV-6-48-2#	Power supply 24 /48 V DC for FW-50
310050040420	SV-6-60#~	Power supply 24 /60V DC for FW-50
310050040422	SV-6-60-2#	Power supply 24 /60V DC for FW-50
310050503400	SV-6-24-LC BCU	Power supply 24 /48 V DC for BCU
310050503421	SV-6-60-LC BCU	Power supply 48 /60 V DC for BCU
310050503410	SV-6-48 BCU#~	Power supply 24 /48 V DC for BCU
310050503412	SV-6-48-2 BCU#	Power supply 24 /48 V DC for BCU
310050503420	SV-6-60 BCU#~	Power supply 24 /60 V DC for BCU
310050503422	SV-6-60-2 BCU#	Power supply 24 /60 V DC for BCU
310050503430	SV-6-110 BCU# ⚠*	Power supply 110 V DC for BCU
310050503440	SV-6-220 BCU# ⚠*	Power supply 220 V DC for BCU

Board meets requirements according to IEC 61850-3 (h) | ~ withdrawn
Remark: Low cost variants -LC in BCU-50 reduce the range of regular application.
*Using tensions > 75 V DC please obey:

Before starting work, break all pole, pull plugs and deenergize!

Plugs have to carry a sign "Danger High Voltage" using tensions > 75 V.
Only use power signals with unique source.
Only use the given black terminals to prevent any swap with signals ≤ 75 V DC by different of colour.
Single braids have to be fixed mechanically to prevent a jump over of a energized braid to a neighboured board below 75 V DC.

Inobservance may be harmful for the lives and health of personnel!

To fulfill the requirements for an electrical safety, the mounting and operation of the devices only is allowed in a case or a housing with protection class IP 56 or better!

Supervision of primary voltage

A powerful and innovative installation engineering requires an intelligent power management for optimized supply of its components. Thus not only a stable supply of power is essential but a correct behaviour in the limit ranges concerning undervoltage, overvoltage and overload.
SV-6 is equipped with an intelligent supervision of the primary tension, load and temperature of the board. The board supports appropriate signals such as release and power failure to the RTU and thus allows defined operation.

To avoid an uncontrolled charging/decharging of the UPS-batteries in the field, an intelligent, multiple layer voltage concept was realised which supports a release and control of the CPU-tension. Detecting undervoltage an alarm relay will be activated, which may be used as a inhibiting signal for the secondary power supply of controls as well; the load of battery may not be strong enough to power commands to switchgears.

The thresholds are preinstalled acccording to the supplied voltage range.

Intelligent warning and power off at unsufficient supply

- ≥115% (≥119% at 110V DC) critical overload
- ≥110% of operation tension detected
- ≥86% Start-up / Restart
- ≤85%, critical undervoltage (powerfail alarm)
- ≤80% power down threshold

Front-LED SV-6

LED	colour			Function
error ●	red		on	Temperature > 100°C, Primary voltage >115% of operation voltage, Board error
			off	normal operation, board active
			flashing	Internal error, no or invalid measurands of primary voltage/temperature
status ●	yellow	●	on	Reserved for operation with setIT*
			off	Operation
			Flashing	Internal communication error, no supply
Umod ●	green	●	on	auxiliary voltage 24 V DC active*
			off	auxiliary voltage down
com ●	green	✳	flashing	serial communication active (RS-485) *
		-	off	no communication
powerfail ●	yellow	●	on	Primary voltage <85% % of operation voltage
		-	off	Primary voltage valid range
alarm ●	yellow	●	on	Temperature > 90°C, Primary voltage >110% of operation voltage*
		-	off	no alarm
DC out ●	green	●	on	Secondary voltage active
		-	off	Secondary voltage switched off
DC in ●	green	●	on	Primary voltage in valid range
		-	off	Primary voltage too low

* not available at -LC variants; valid operation, malfunction

If only the LED powerfail is on, the SV-6 signalises an regular measurement, but the primary voltage is below the minimal level.
This state may be recognized as well in redundant mode with power down of second source supply.

SV-6-24-LC 24 V DC power supply

The SV-6-24 is a low-cost variant of the SV-6 series. To be able to provide a low-cost voltage supply, some of the functions on other SV-6-x variants have been left out:

- No galvanic isolation of the primary and secondary voltages
- No current or temperature measurements
- No alarm outputs
- No auxiliary voltage U_{mod}

The corresponding front LEDs therefore have no meaning.

SV-6-24-LC	**Power supply 24 V DC 48 W**
Nominal voltage	24 V DC -15%/+20%
Operating voltage	21.2 ... 28.2 V DC
Power consumption	max. 2.1 A @ 24 V DC, 50 W
Internal output voltage	System supply voltages 24 V DC, 5 V DC regulated
Secondary power	max. 48 W | 2 A @ 5 V, 2,5 A @ 24 V
Efficiency	> 90%
Thermal dissipation loss	typical 3 W
Redundant operation	Yes
Power failure protection	20 ms
Alarm outputs	None
Isolation	5 kV DC primary/ground, EMC Level 3 primary / secondary none
Protection class	None (extra-low voltage)
Connection terminals	X_1, X_2: MC 1.5/4-STF-3.5 X_3: GMSTB 2.5/3-STF-7,62
dimensions	FW system card 20 x 160 x 100 mm (W x H x D)
Ambient conditions	-25° ... + 60°C

Voltage connector X3: SV-6-24-LC

	Protective earth / functional earth
+	24 V DC
-	GND

SV-6-60-LC 60 V DC power supply

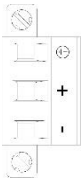
The SV-6-60-LC is a low-cost variant of the SV-6 series. To be able to provide a low-cost voltage supply, some of the functions on other SV-6-x variants have been left out:

- No galvanic isolation of the primary and secondary voltages
- No current or temperature measurements
- No alarm outputs
- No auxiliary voltage U_{mod}

The corresponding front LEDs therefore have no meaning.

SV-6-60-LC	**Power supply 60 V DC 50 W**
Nominal voltage	60 V DC -30%/+20%
Operating voltage	40 ... 72 V DC
Power consumption	max. 0.9 A @ 60 V DC, 54 W
Internal output voltage	System supply voltages 24 V DC, 5 V DC regulated
Secondary power	max. 48 W 1 A @ 5 V, 1.8 A @ 24 V
Efficiency	> 90%
Thermal dissipation loss	typical 5.8 W
Redundant operation	Yes
Power failure protection	20 ms @ 50% load
Alarm outputs	None
Isolation	5 kV DC primary/ground, EMC Level 3 primary / secondary none
Protection	No class (extra-low voltage) Reversal protection, varistor overvoltage protection
Connection terminals	X_1, X_2: MC 1.5/4-STF-3.5 X_3: GMSTB 2.5/3-STF-7,62
dimensions	FW system card 20 x 160 x 100 mm (W x H x D)
Ambient conditions	-25° ... + 60°C

Voltage connector X3: SV-6-60-LC



	Protective earth / functional earth
+	**60** V DC
-	GND

SV-6-48 wide range power supply

~Card withdrawn due to lacking efficiency~.
The SV-6-48 variant features 24 and 48 V DC with all the monitoring functions of the SV-6.
Note: In order to bridge the 50 ms Power failure protection, several DC/DC converters were connected in series. These generate high heat loss and poor efficiency. This must be taken into account when dimensioning a station with SV-6-48.
As an alternative the SV-6-48-2 is available.

SV-6-48	**Internal power supply 24 / 48 V DC 50 W**
Nominal voltage	24 / 48 V DC ±20%
Operating voltage	21 ... 28 VDC / 41 ...55 VDC
Power consumption	max. 2.5 A @ 24 VDC, max. 1.25 A @ 48 VDC
Internal output voltage	System supply voltages 24 V DC, 5 V DC regulated
Secondary power	Max. 36 W
Redundant operation	Yes
Power failure protection	50 ms
Voltage measurement	Primary & secondary voltages, resolution 1 V
Current measurement	Monitoring of the secondary Current load (including auxiliary voltage U_{mod})
Temperature measurement	Monitoring of the module temperature, resolution 1°C
Alarm outputs / relays	Powerfail: max. 240 V DC 10µA ... 40 mA, break contact Alarm: max. 240 V DC 10µA..40 mA, make contact
Auxiliary voltage U_{mod}	0.4 A @ 24 VDC
Diagnostic interface RS-485	available on front
Isolation / EMC	5 kV DC primary/ground, 1.5 kV DC primary/secondary, EMC Level 4
Protection class	None (extra-low voltage)
Connection terminals	X_1, X_2: MC 1.5/4-STF-3.5 X_3: GMSTB 2.5/3-STF-7,62
dimensions	FW system card 20 x 160 x 100 mm (W x H x D)
Ambient conditions	-25° ... + 60°C (> 40°C derating)

SV-6-48-2 48 V DC power supply

The variant SV-6-48-2 offers a 48 V DC supply with all monitoring functions of the SV-6 and a higher efficiency than the SV-6-48. The power failure protection time of 20 ms reflects the loss of higher intermediate voltage.

SV-6-48-2	**Internal power supply 48 V DC 50 W**
Nominal voltage	48 V DC ±20%
Operating voltage	41 ...55 VDC
Power consumption	max. 58 W | 1.2 A @ 48 VDC
Secondary power	max. 48 W | max. 2 A @ 5 V, max 1,8 A @ 24 V internal
Internal output voltage	System supply voltages 24 V DC, 5 V DC regulated
Efficiency	84 %
Heat loss	min. 6 W max. 9,4 W full load
Redundant operation	Yes
Power failure protection	20 ms
Voltage measurement	Primary & secondary voltages, resolution 1 V
Current measurement	Monitoring of the secondary Current load (including auxiliary voltage U_{mod})
Temperature measurement	Monitoring of the module temperature, resolution 1°C
Alarm outputs / relays	Powerfail: max. 240 V DC 10µA ... 40 mA, break contact Alarm: max. 240 V DC 10µA..40 mA, make contact
Auxiliary voltage U_{mod}	0.4 A @ 24 VDC
Diagnostic interface RS-485	available on front
Isolation / EMC	5 kV DC primary/ground, 1.5 kV DC primary/secondary, EMC Level 4
Protection class	None (extra-low voltage)
Connection terminals	X_1, X_2: MC 1.5/4-STF-3.5 X_3: GMSTB 2.5/3-STF-7,62
dimensions	FW system card 20 x 160 x 100 mm (W x H x D)
Ambient conditions	-25° ... + 60°C (> 40°C derating)

Switching thresholds 24 V operation for SV-6-48/SV-6-60

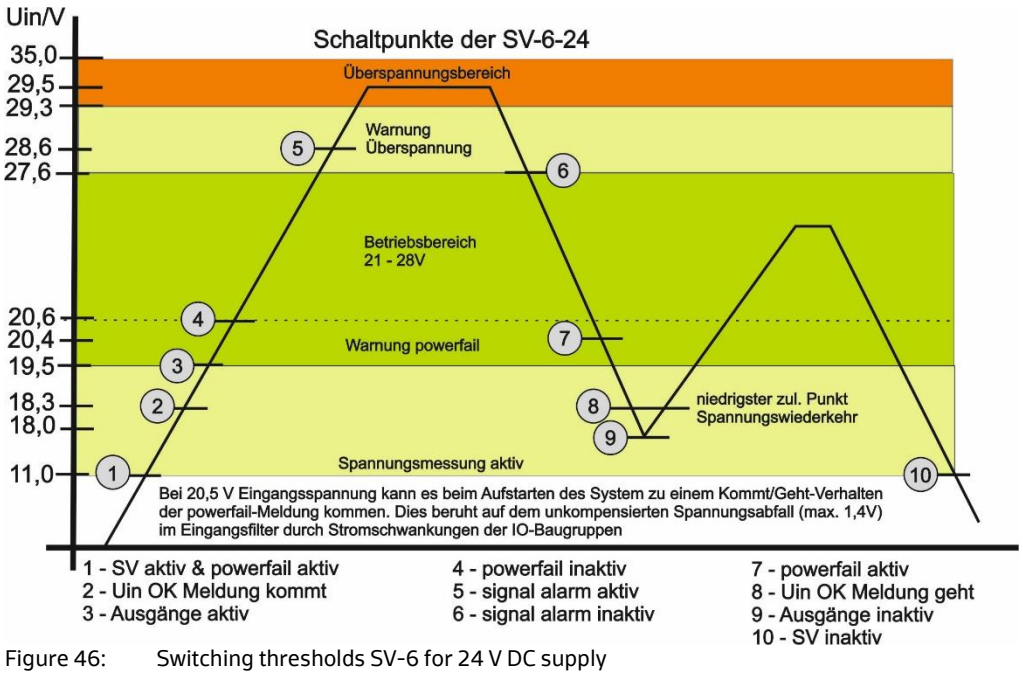


Figure 46: Switching thresholds SV-6 for 24 V DC supply

- Powerfail signal output OFF: 86% U_B >20.6 V, the station starts
- Powerfail signal output ON: 85% U_B <20.4 V
- Output voltage ON: 81% U_B >19.5 V
- Output voltage OFF:75% U_B < 18.0 V, the station is off

Switching thresholds SV-6-48

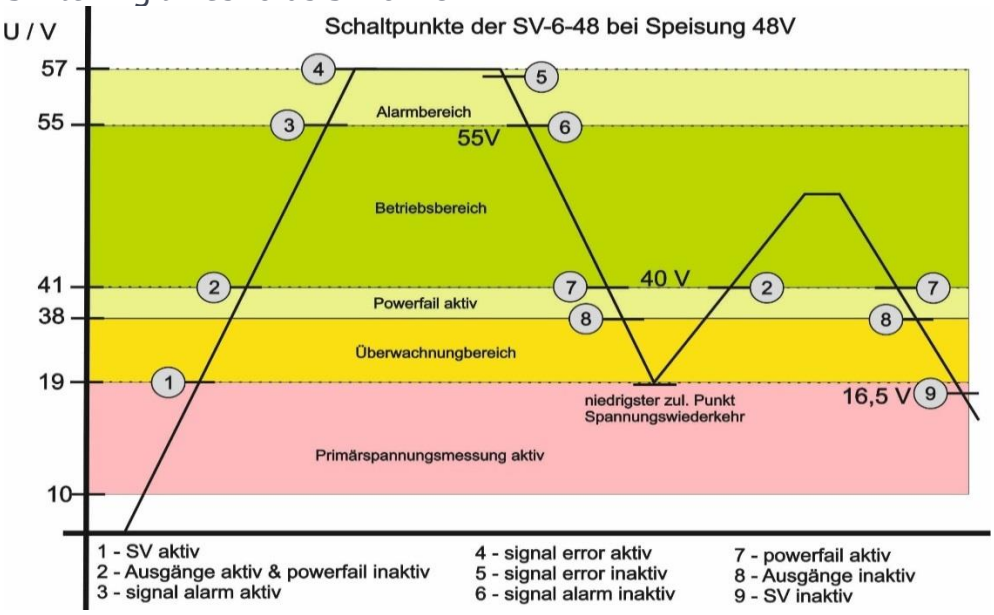


Figure 47: Switching thresholds for SV-6-48, supply 48 V DC

- Powerfail signal output OFF: 86% U_B > 41 V, the station starts
- Powerfail signal output ON: 85% U_B < 41 V
- Output voltage ON: 80% U_B > 38 V

- Output voltage OFF:40% U_B < 19 V, the station is off

Connection terminals SV-6-48

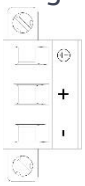
Service X1

	COM A RS-485
	COM B RS-485
	Umod + 24 V DC 0.4 A max.
	Umod -

Signal relay X2

	Powerfail signal Relay 1 Break contact
	Powerfail signal Relay 2
	Alarm relay Contact 1 make contact
	Alarm relay Contact 2

Voltage connector X3:



	Protective earth / functional earth
+	24/48 V DC
-	GND

Block diagram for SV-6-48

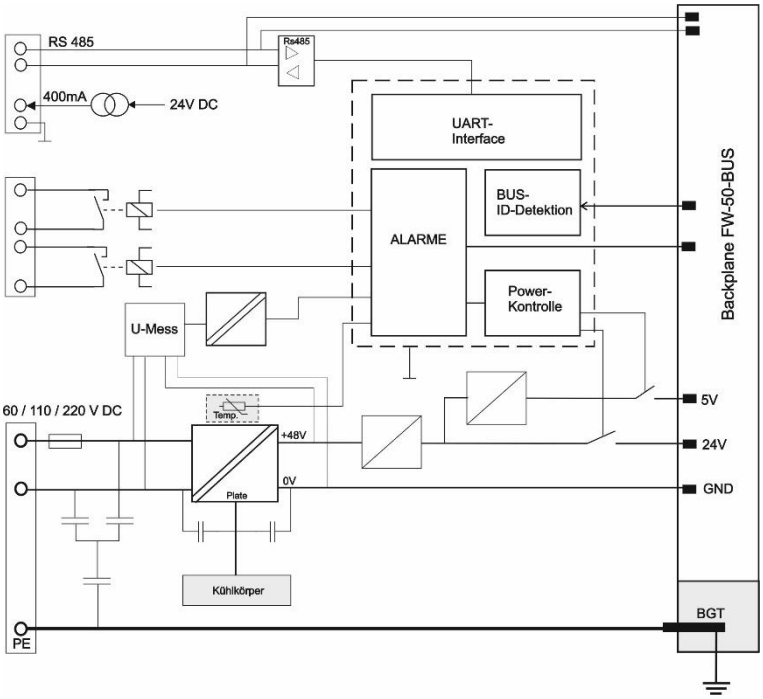


Figure 48: Block diagram for SV-6-48

SV-6-60 wide range power supply

~Card withdrawn due to lacking efficiency~.

This variant features 24 and 60 V DC with all the monitoring functions of the SV-6.

SV-6-60	**Internal power supply 24 / 60 V DC 50 W**
Nominal voltage	24 / 60 V DC ±20%
Operating voltage	21 ... 28 VDC / 52 ...69 VDC
Power consumption	max. 2.5 A @ 24 VDC, max. 1 A @ 60 VDC
Internal output voltage	System supply voltages 24 V DC, 5 V DC regulated
Secondary power	Max. 36 W
Redundant operation	Yes
Power failure protection	50 ms
Voltage measurement	Primary & secondary voltages, resolution 1 V
Current measurement	Monitoring of the secondary Current load (including auxiliary voltage U_{mod})
Temperature measurement	Monitoring of the module temperature, resolution 1°C
Alarm outputs / relays	Powerfail: max. 240 V DC 10µA ... 40 mA, break contact Alarm: max. 240 V DC 10µA..40 mA, make contact
Auxiliary voltage U_{mod}	0.4 A @ 24 VDC
Diagnostic interface RS-485	available on front
Isolation / EMC	5 kV DC primary/ground, 1.5 kV DC primary/secondary, EMC Level 4
Protection class	None (extra-low voltage)
Connection terminals	X_1, X_2: MC 1.5/4-STF-3.5 X_3: GMSTB 2.5/3-STF-7,62
dimensions	FW system card 20 x 160 x 100 mm (W x H x D)
Ambient conditions	-25° ... + 60°C (> 40°C derating)

Switching thresholds SV-6-60S

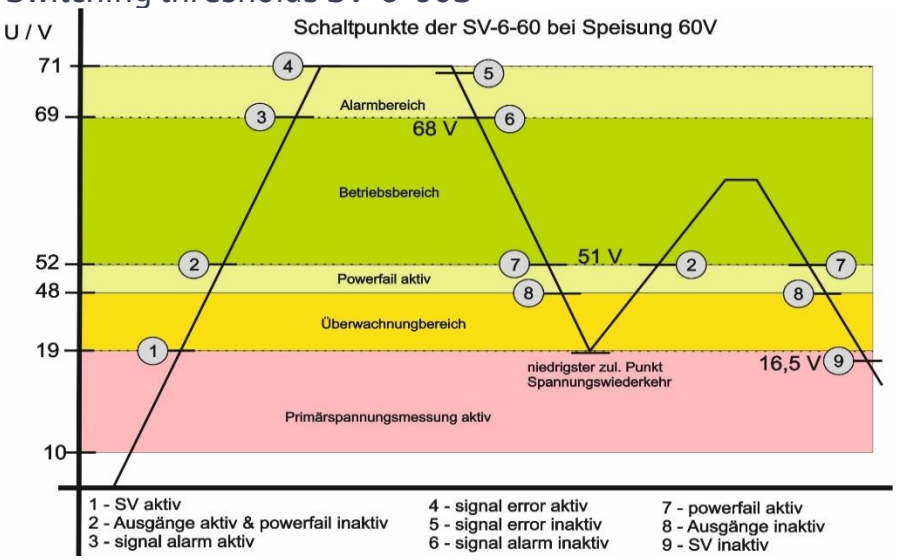


Figure 49: Switching thresholds for SV-6-60, supply 60 V DC

for 24 V DC supply, see SV-6-48

Connection terminals for SV-6-60

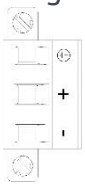
Service X1

	COM A RS-485
	COM B RS-485
	Umod + 24 V DC 0.4 A max.
	Umod -

Signal relay X2

	Powerfail signal Relay 1 Break contact
	Powerfail signal Relay 2
	Alarm relay Contact 1 make contact
	Alarm relay Contact 2

Voltage connector X3:



	Protective earth / functional earth
+	24/60 V DC
-	GND

Block diagram for SV-6-60

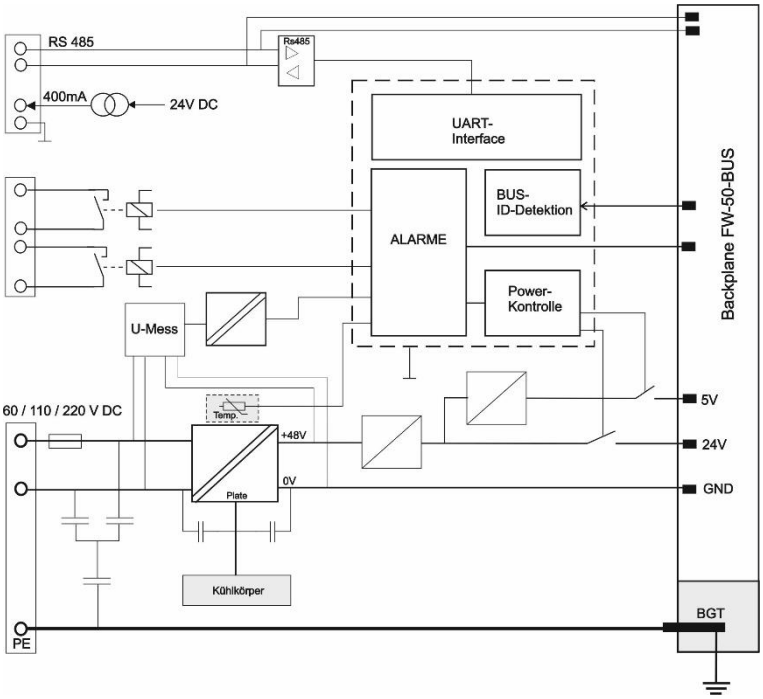


Figure 50: Block diagram for SV-6-60

SV-6-60-2 60 V Power Supply

The SV-6-60-2 variant offers 60 V DC supply with all monitoring functions of the SV-6. Compared to the SV-6-60, it allows a higher secondary power of 48 W with low heat loss power by reducing the internal system voltage to 24 V DC; with a 20 ms power failure bypass.

SV-6-60-2	**Internal power supply 60 V DC**
Nominal voltage	60 V DC ±20%
Operating voltage	52 ...69 V DC
Power consumption	max. 57 W, 1,2 A @48 V DC, 0,95 A @60 VDC
Internal output voltage	System supply voltages 24 V DC, 5 V DC regulated
Secondary power	max. 48 W, max. 2 A @5 V, max. 1,8 A @24 V DC
Efficiency	84 %
Power loss	min. 6 W max. 9,7 W Full load
Redundant operation	Yes
Power failure protection	20 ms @50% Last
Voltage measurement	Primary- & Secondary voltages, accuracy 1 V
Current measurement	Monitoring of the secondary Current load including auxiliary voltage Umod
Temperature measurement	Monitoring of the module temperature, resolution 1°C
Alarm outputs / relays	powerfail: max. 240 V DC 10µA ... 40 mA, break contact alarm: max. 240 V DC 10µA..40 mA, make contact
Auxiliary voltage U_{mod}	0,4 A @24 VDC
Diagnostic interface RS-485	available on front
Fuse	2 AT TR5 intern
Isolation / EMV	5 kV DC primary/ground, 1.5 kV DC primary/secondary, EMC Level 4
Protection class	None (extra-low voltage)
Connection terminals	X_1, X_2: MC 1,5/4-STF-3,5 X_3: GMSTB 2,5/3-STF-7,62
Dimensions	FW system card 20 x 160 x 100 mm (W x H x D)
Ambient conditions	-25° ... + 60°C from 50°C derating 50°C @48 W | 55°C @42 W | 60°C @36 W

Switching thresholds SV-6-60-2

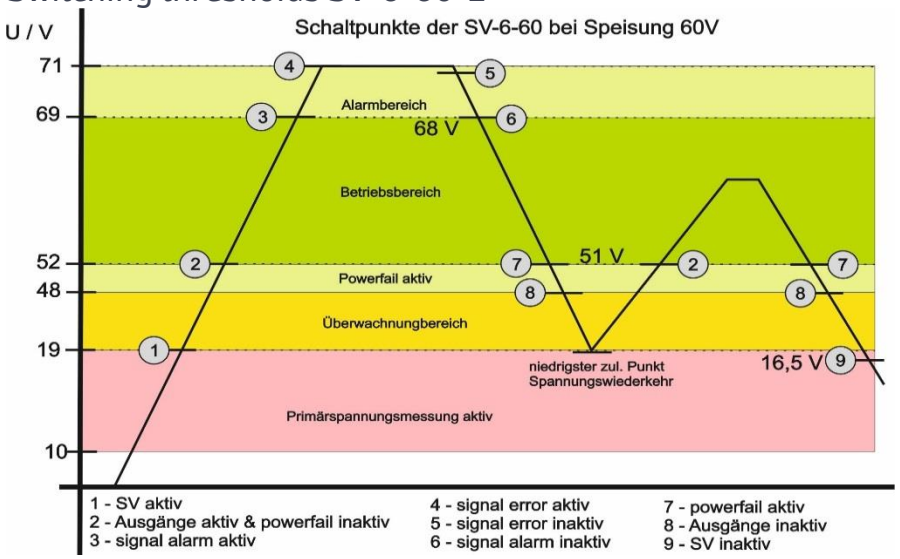


Abbildung 51: Switching thresholds for SV-6-60-2, Speisung 60 V DC
at 48 V DC supply s. SV-6-48

Connection terminals for SV-6-60

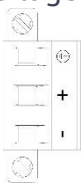
Service X1

1	**COM** A RS-485
2	COM B RS-485
3	**Umod** + 24 V DC 0.4 A max.
4	Umod -

Signal relay X2

1	**Powerfail** signal Relay 1 Break contact
2	Powerfail signal Relay 2
3	**Alarm** relay Contact 1 make contact
4	Alarm relay Contact 2

Voltage connector X3:



⏚	**Protective earth** / functional earth
+	60 V DC
-	GND

Block diagram for SV-6-60-2

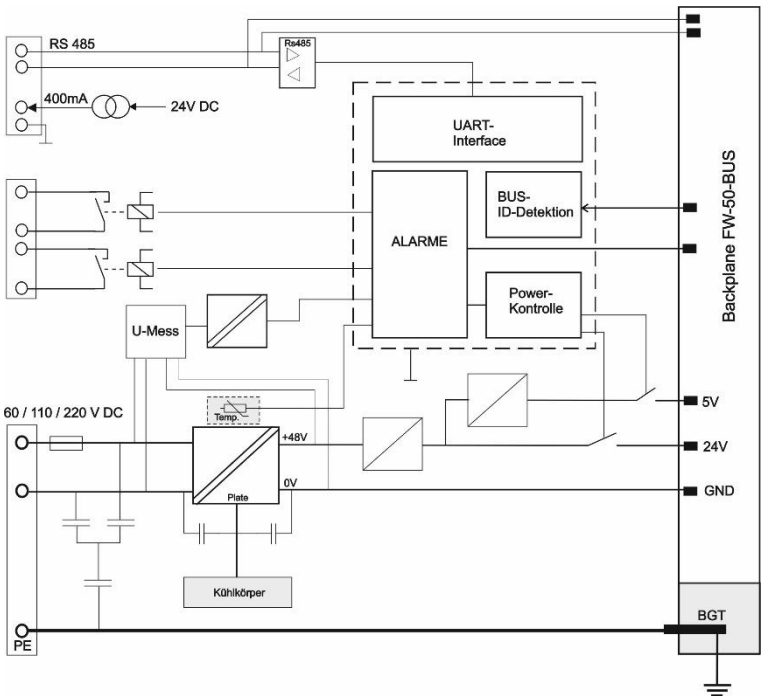


Figure 52: Block diagram for SV-6-60-2; internal voltage is 24 V DC

SV-6-110 110 V DC voltage supply

SV-6-110	Internal power supply 110 V DC 50 W
Input voltage	110 V DC ±20% ⚠*
Operating voltage	93 ... 121 VDC
Power consumption	Max. 1 A
Internal output voltage	System supply voltages 24 V DC, 5 V DC regulated
Secondary power	Max. 36 W
Redundant operation	Yes
Power failure protection	50 ms
Voltage measurement	Primary & secondary voltages, resolution 1 V
Current measurement	Monitoring of the secondary current load (including auxiliary voltage U_{mod})
Temperature measurement	Monitoring of the module temperature, resolution 1°C
Alarm outputs / relays	Powerfail: max. 240 V DC 10µA ... 40 mA, break contact Alarm: max. 240 V DC 10µA..40 mA, make contact
Auxiliary voltage U_{mod}	0.4 A @ 24 VDC
Diagnostic interface RS-485	available on front
Isolation / EMC	5 kV DC primary/ground, 2.5 kV DC primary/secondary, EMC Level 4
Protection class	1
Connection terminals	X1, X2: MC 1.5/4-STF-3.5; X3: GMSTB 2.5/3-STF-7,62
dimensions	FW system card 20 x 160 x 100 mm (W x H x D)
Ambient conditions	-25° ... + 60°C (> 40°C derating)

*Note for signal voltages > 75 V DC:

Usage with a supply > 60 V is only approved for the BCU-50!

WARNING

Prior to working, switch off all poles, remove plug and discharge!

Nip voltages > 75 V terminals must be labelled with warning 'Danger High Voltage'.
Only use control signals with the same signal voltage.
To prevent confusion with DC signals ≤ 75 V by means of colour differentiation, only use the black terminals provided.
In addition, single braids must be connected to each other mechanically (with a cable tie for example) to prevent jump-over of a braid carrying hazardous voltage to an adjacent module with DC voltage ≤ 75 V.
Failing to comply can entail physical injury or material damage.

CAUTION

To satisfy the requirements for electrical safety, the module may only be installed and operated in a cabinet, a housing (having protection class IP 56 or higher) or an enclosed operating room.

Switching thresholds SV-6-110

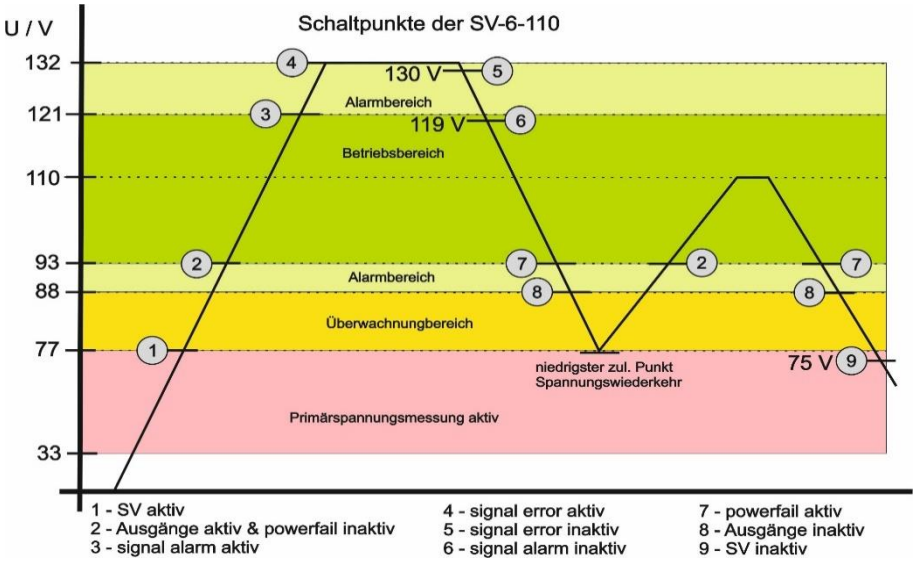


Figure 53: Switching thresholds SV-6-110

Block diagram of SV-6-110

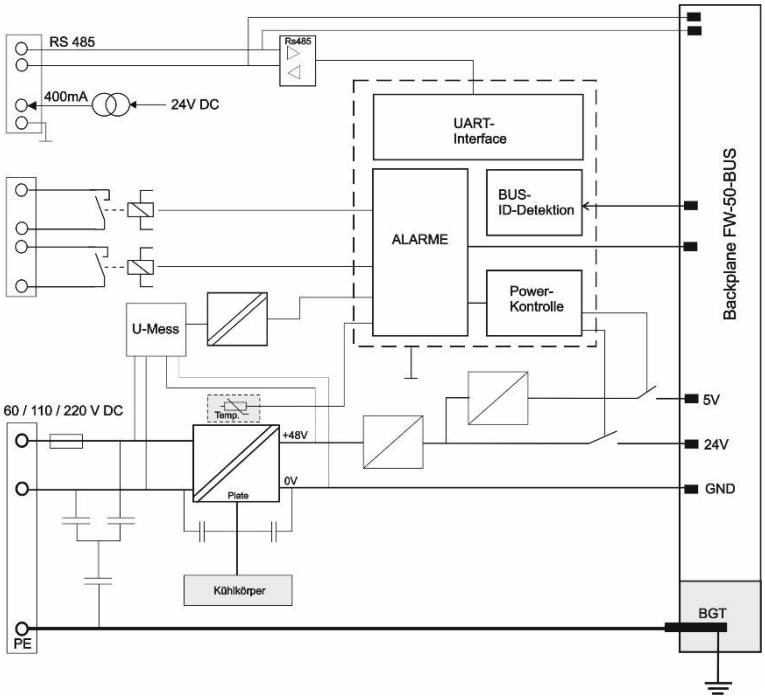


Figure 54: Block diagram of SV-6-110

Connection terminals SV-6-110

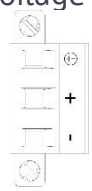
Service X1

COM A RS-485	
COM B RS-485	
Umod + 24 V DC 0.4 A max.	
Umod -	

Signal relay X2

Powerfail signal Relay 1 Break contact	
Powerfail signal Relay 2	
Alarm relay Contact 1 make contact	
Alarm relay Contact 2	

Voltage connector X3:



Protective earth / functional earth	
+	110 V DC
-	GND

SV-6-220 220 V DC voltage supply

SV-6-220	Internal power supply 220 V DC 50 W
Input voltage	220 V DC -20% / +15% ⚠*
Operating voltage	187 ... 242 VDC
Power consumption	Max. 0.45 A
Internal output voltage	System supply voltages 24 V DC, 5 V DC regulated
Secondary power	Max. 36 W
Redundant operation	Yes
Power failure protection	50 ms
Voltage measurement	Primary & secondary voltages, resolution 1 V
Current measurement	Monitoring of the secondary current load (including auxiliary voltage U_{mod})
Temperature measurement	Monitoring of the module temperature, resolution 1°C
Alarm outputs	Powerfail: max. 240 V DC 10µA ... 40 mA, break contact Alarm: max. 240 V DC 10µA..40 mA, make contact
Auxiliary voltage U_{mod}	0.4 A @ 24 VDC
Diagnostic interface RS-485	available on front
Isolation / EMC	5 kV DC primary/ground, 2.5 kV DC primary/secondary, EMC Level 4
Protection class	1
Connection terminals	X_1, X_2: MC 1.5/4-STF-3.5; X_3: GMSTB 2.5/3-STF-7,62
dimensions	FW system card 20 x 160 x 100 mm (W x H x D)
Ambient conditions	-25° ... + 60°C (> 40°C derating)

*Note for signal voltages > 75 V DC:

Usage with a supply > 60 V is only approved for the BCU-50!

Prior to working, switch off all poles, remove plug and discharge!

WARNING

Nip voltages > 75 V terminals must be labelled with warning 'Danger High Voltage'.
Only use control signals with the same signal voltage.
To prevent confusion with DC signals ≤ 75 V by means of colour differentiation, only use the black terminals provided.
In addition, single braids must be connected to each other mechanically (with a cable tie for example) to prevent jump-over of a braid carrying hazardous voltage to an adjacent module with DC voltage ≤ 75 V.
Failing to comply can entail physical injury or material damage.

CAUTION

To satisfy the requirements for electrical safety, the module may only be installed and operated in a cabinet, a housing (having protection class IP 56 or higher) or an enclosed operating room.

Switching thresholds SV-6-220

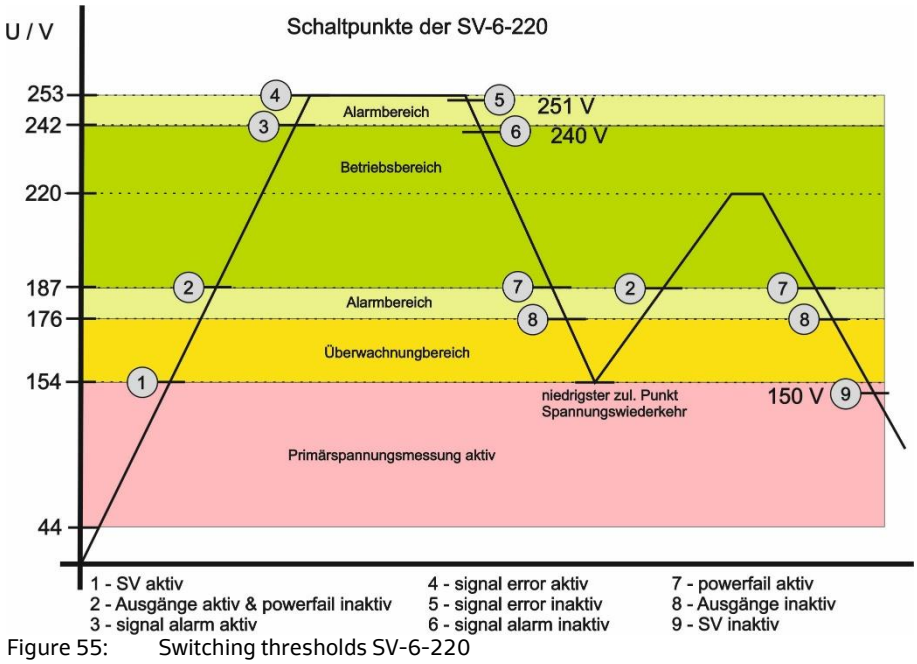


Figure 55: Switching thresholds SV-6-220

Block diagram for SV-6-220

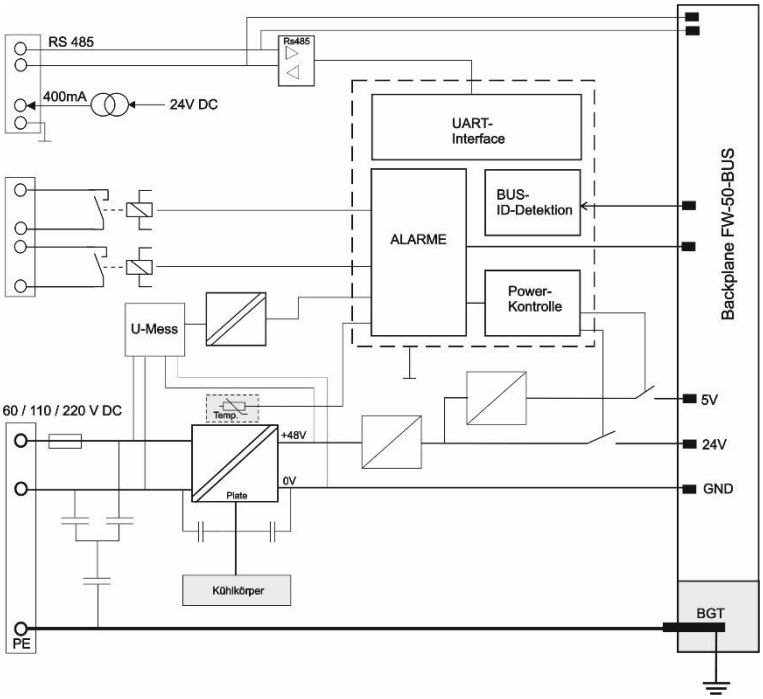


Figure 56: Block diagram for SV-6-220

Connection terminals SV-6-220

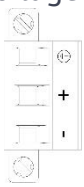
Service X1

COM A RS-485	
COM B RS-485	
Umod + 24 V DC 0.4 A max.	
Umod -	

Signal relay X2

Powerfail signal Relay 1 Break contact	
Powerfail signal Relay 2	
Alarm relay Contact 1 make contact	
Alarm relay Contact 2	

Voltage connector X3:



Protective earth / functional earth	
+	220 V DC
-	GND

Heat dissipation at BCU-50 series5e

The dimensioning of the control cabinet and the selection of a suitable climatisation depends directly on the heat loss capacity Q installed in the cabinet. To calculate this, the power loss of all components, power supply (SV-x), CPU and all other cards (serial & extension modules) must be added together.

$$Q = \Sigma n^* Q_{SV/CPU/EWB}$$

Power supply	Q_{max}	P_{sek}
SV5-24	3 W	75 W
SV5-60	8 W	75 W
SV6-24-LC	2 W	48W
SV6-48	24 W	36 W
SV6-60	24 W	36 W
SV6-60-2	9 W	48 W
SV6-60-LC	6 W	48 W
SV6-110	24 W	36 W
SV6-220	24 W	36 W

CPU	Q_{max}	$I_{5V\ intern}$	$I_{24V\ intern}$
CPU-5	3,8 W	5 mA	155 mA
CPU-5	3,8 W	5 mA	155 mA
CPU-5B	2,9 W	1 mA	120 mA
CPU-5B+	1,5 W	1 mA	90 mA
CPU-5B+	1,5 W	1 mA	90 mA
CPU-5B+G46	1,5 W	1 mA	90 mA
CPU-5B-BT	2,9 W	1 mA	120 mA
CPU-5B-BT+	2,5 W	1 mA	100 mA
CPU-5B-eco	2,0 W	1 mA	80 mA
CPU-5B+eco	1,7 W	1 mA	70 mA
CPU-5C	2,3 W	1 mA	95 mA
CPU-5C	2,3 W	1 mA	95 mA
CPU-5C-BT	2,5 W	1 mA	100 mA
CPU-5E	3,4 W	1 mA	140 mA
CPU-5Es	3,4 W	1 mA	140 mA

Interfaces	Q_{max}	$I_{5V\ intern}$	$I_{24V\ intern}$
com5C-RS485	0,2 W	2 mA	5 mA
com5C-RS485i	0,2 W	2 mA	5 mA
BBM-1	1,4 W	62 mA	42 mA
DPM-1	2,8 W	46 mA	105 mA
DPS-1	2,8 W	48 mA	105 mA
ENET-1	1,2 W	239 mA	0 mA
ENET-2	1,4 W	270 mA	0 mA
EVU-X-1	2,1W	85 mA	69 mA
GSM-1	3,8 W	30 mA	150 mA
GSM-2	2,4 W	18 mA	95 mA
ISDN-1	0,8 W	155 mA	0 mA
MOD12-6	1,2 W	230 mA	0 mA
RS422-2	0,4 W	70 mA	0 mA
RS485-2	0,4 W	70 mA	0 mA
RS485-2	0,3 W	45 mA	0 mA
SWI1-1	1,6 W	0 mA	64 mA
SWI1-2	2,2 W	0 mA	90 mA
SWI1-3	2,1 W	0 mA	87 mA
SWI1-4	2,5 W	0 mA	102 mA
SWI1-5	1,6 W	69 mA	51 mA
SWI1-6	2,9 W	70 mA	105 mA
SWI1-6ST	2,9 W	70 mA	105 mA
SWI1-7	2,3 W	70 mA	81 mA
SWI1-7ST	2,3 W	70 mA	81 mA
SWI2-1	2,1 W	69 mA	70 mA
SWI2-2	2,1 W	69 mA	70 mA
SWI2-2ST	2,1 W	69 mA	70 mA
SWI2-3	2,7 W	69 mA	98 mA
SWI2-3ST	2,7 W	69 mA	98 mA
SWI-3	2,9 W	0 mA	120 mA
V24-1	0,3 W	55 mA	0 mA
V24-2	0,3 W	50 mA	0 mA
V24-3	0,4 W	63 mA	0 mA
V24-4	0,4 W	74 mA	0 mA
WM336-3	0,4 W	65 mA	0 mA
WM336-4	1,1 W	214 mA	0 mA
WT12-2	1,1 W	205 mA	0 mA
WT12-3	1,1 W	205 mA	0 mA
WT12-4	1,2 W	230 mA	0 mA
WT12-5	1,2 W	230 mA	0 mA
WT96-2	1,1 W	212 mA	0 mA
WT96-3	1,1 W	212 mA	0 mA
WT96-4	1,3 W	260 mA	0 mA
WT96-5	1,3 W	260 mA	0 mA

I/O-boards	Q_{max}	$I_{5V\ intern}$	$I_{24V\ intern}$	$P_{relais\ max.}$
12RA-1*[1]	3,4 W	76 mA	124 mA	4,80 W
16IE5	0,8 W	150 mA	0 mA	
16IE5-2	0,6 W	115 mA	0 mA	
16OA-1	1,7 W	49 mA	60 mA	
16OA-3-1	0,8 W	141 mA	0 mA	
16OA-3-2	0,6 W	110 mA	0 mA	
16OE-1	0,3 W	58 mA	0 mA	
16OE-5-1	0,6 W	120 mA	0 mA	
16OE-5-2	0,7 W	121 mA	0 mA	
16OE-5-3	0,7 W	122 mA	0 mA	
16OE-6-1	0,6 W	120 mA	0 mA	
16OE-6-2	0,7 W	121 mA	0 mA	
16OE-6-3	0,7 W	123 mA	0 mA	
16RA-1*[1]	4,9 W	44 mA	195 mA	3,52 W
16RA-2*[1]	8,8 W	44 mA	356 mA	7,20 W
16RA-3*[1]	3,1 W	85 mA	110 mA	2,72 W
16OE-3-D	0,1 W	15 mA	0 mA	
16OE-3-W	0,2 W	36 mA	0 mA	
4AA12-1	5,4 W	32 mA	218 mA	
4AA12-1-2	4,8 W	0 mA	200 mA	
4AE12-1	3,6 W	0 mA	150 mA	
4AE12-1-2	4,0 W	59 mA	153 mA	
4AE12-2	2,8 W	80 mA	100 mA	
4AE12-2	2,4 W	0 mA	100 mA	
4AE12-2	2,4 W	0 mA	100 mA	
4AE12-2	2,4 W	0 mA	100 mA	
4AE12-2	2,4 W	0 mA	100 mA	
6RA4-AC*[1]	2,4 W	45 mA	88 mA	
6RA4-T	2,6 W	35 mA	100 mA	
8AA16-1	6,0 W	104 mA	228 mA	
8AA8-1	3,6 W	67 mA	135 mA	
8AA8-1	4,0 W	65 mA	150 mA	
8AE16-1	1,0 W	183 mA	0 mA	
8AE16-1	2,4 W	0 mA	100 mA	
8AE16-1	2,4 W	0 mA	100 mA	
8AE16-1	1,7 W	94 mA	50 mA	
8AE16-2	2,4 W	0 mA	100 mA	
8AE16-2-2	2,4 W	0 mA	100 mA	
8AE16-2	1,7 W	99 mA	50 mA	
8AE16-2	1,7 W	99 mA	50 mA	
8AE16-3	1,7 W	99 mA	50 mA	
8AE16-3-2	2,4 W	0 mA	100 mA	
8AE8-1-3	1,6 W	0 mA	65 mA	
8AE8-1	0,6 W	112 mA	0 mA	
8AE8-1	0,8 W	155 mA	0 mA	
8AE8-2	0,7 W	121 mA	0 mA	
8AE8-2-2	1,6 W	0 mA	65 mA	

8AE8-2-3	1,6 W	0 mA	65 mA	
8AE8-3	0,8 W	150 mA	0 mA	
8AE8-3	0,8 W	150 mA	0 mA	
8OE4-110	0,3 W	50 mA	0 mA	
8OE4-230	0,4 W	63 mA	0 mA	
8OE4-D	0,3 W	60 mA	0 mA	
8OE4-WA	3,9 W	75 mA	145 mA	
8OE4-WP	0,4 W	70 mA	0 mA	
AOERA-1*[1]	1,4 W	123 mA	31 mA	0,44 W
CNT-1-1	0,8 W	148 mA	0 mA	
CNT-1-2	0,8 W	156 mA	0 mA	
CNT-1-3	0,9 W	177 mA	0 mA	
CNT1-5	0,8 W	143 mA	0 mA	
EVU2-I1	0,4 W	70 mA	0 mA	
EVU2-I2	0,4 W	63 mA	0 mA	
EVU2-I3	0,4 W	66 mA	0 mA	
EVU2-I5	0,4 W	68 mA	0 mA	
EVU2-O1	0,8 W	160 mA	0 mA	0 mA
EVU2-O2	0,8 W	160 mA	0 mA	0 mA
EVU2-O3	0,8 W	160 mA	0 mA	0 mA
EVU2-O4	0,8 W	146 mA	0 mA	0 mA
OE2-48	0,6 W	120 mA	0 mA	
OE2-60	0,2 W	32 mA	0 mA	
OERA-1*[1]	2,9 W	58 mA	108 mA	1,76 W
OERA-5*[1]	2,4 W	116 mA	75 mA	1,76 W

Table 1: Internal load and heat loss of the components
*[1] incl. Load at 100% activated relays PRelais, *[2] with additional supply

Dimensioning of supply BCU-50 series5e

For complete consideration, the power consumption of the individual boards in the rack must be taken into account. Depending on the performance of the power supply via the CPU or the SV-x card, only limited equipment may be available here. In the module rack, the cards are operated via two voltages 5 V and 24 V DC. The sum of the currents in the respective string must not exceed the maximum value of the power supply. As of setIT V6, a current calculator helps with the compilation.

Versorgung	P_{prim}	P_{sek}	Wirkungsgrad	Speisung	$I_{5Vmax.sek}$	$I_{24Vmax.sek}$
CPU-5B				24 V DC	1 A	1,8 A
CPU-5B+				24 V DC	1 A	1,8 A
CPU-5C	50 W			24 V DC	1 A	1,8 A
CPU-5E	50 W			24 V DC	1 A	1,8 A
CPU-5Es	50 W			24 V DC	1 A	1,8 A
SV-5-24	100 W	75 W	75 %	24 V DC	3 A	2,5 A
SV-5-60	100 W	75 W	75 %	24 V DC	3 A	2,5 A
SV-6-24-LC	50 W	48 W	95%	24 V DC	2,0 A	2,5 A
SV-6-48	60 W	36 W	60%Volllast	24 V DC	2,0 A	1,3 A
SV-6-48	60 W	36 W	60%Volllast	48 V DC	2,0 A	1,3 A
SV-6-60-LC	54 W	48 W	88 %	60 V DC	2,0 A	1,8 A
SV-6-60	60 W	36 W	60%Volllast	24 V DC	2,0 A	1,3 A
SV-6-60	60 W	36 W	60%Volllast	60 V DC	2,0 A	1,3 A
SV-6-60-2	57 W	48 W	84%	60 V DC	2,0 A	1,8 A
SV-6-110	60 W	36 W	60%Volllast	110 V DC	2,0 A	1,3 A
SV-6-220	60 W	36 W	60%Volllast	220 V DC	2,0 A	1,3 A

Table 2: max. external load, Efficiency and max. internal power feed of the power supplies

The load of a subrack on a supply can be determined with Table 2. The consumption values of the individual components on the respective internal supply line are added and multiplied by the voltage of the supply line to P_{sek}. The efficiency η of the SV or CPU power supply results in the load P_{prim} of the primary supply.

$$P_{prim} = 5\,V * \Sigma I_{5V} + 24\,V * \Sigma I_{24V} * \frac{1}{\eta_{SV}}$$

The calculation is based on the worst-case assumption with 100 % relay switched on. As a rule, however, not all relays are energized at the same time. This can be corrected by a simultaneity factor G_{Faktor}, which indicates as a percentage how many relays are closed at the same time. Add the loads resulting from the assembly P_{Relais} from table 2 and multiply this by the simultaneity factor. This power can be subtracted from the general power calculated above to arrive at the real maximum value P_{eff}.

$$P_{eff} = P_{prim} - n * \Sigma P_{Relais(n)} * G_{Faktor}$$

The supply voltage U_e can be used to calculate the current I_e to be fed in from the power supply unit or battery.

$$I_e = \frac{P_{eff}}{U_e}$$

The calculated current results in the dimensioning of the power supply unit or battery.

Supply security BCU-50 series5e

The fuse of the respective supply circuit must be provided externally. The fuse value is determined by a factor of 2.1 of the maximum input current I_e.

1. PLC programming information using codeIT

For the integrated use of the codeIT PLC programming tool under IEC 61131-3 programming, a dipswitch is available on the front that enables simple and "PLC-standard" operating mode selection.

IEC 61131-3 programming

Switch S1 with two operating methods: STOP / RUN
The access to programming mode was changed to a system command due to security issues; it may be performed remotely - thus the switch position PROG was omitted.

Switch position **RUN**

All programs running
The test functions are not active
When a test function is called that is only available in PROG mode, "wrong operating method" is displayed.

Switch position **STOP**

PLC program has stopped
Communication programs continue
No output on the output modules

Function of the LED codeIT /PLC

		Colour	Function
codeIT	●	green	OFF = PLC stop; ON = PLC RUN; flashing = PLC- loading program
Stop	●	red	OFF = OK; ON = error; flashing = operating method PROG

Programming interface

Programming is only supported via LAN interface.

Memory accesses and addressing

The options of static and selective process data assignment between setIT and codeIT are available depending on the target system settings in codeIT. Up to series5, the static mode was still supported but newer systems only support the selective mode.

Targets and their run-time systems (target systems)

Since series5+ only the selective mode will be supported; it is easier and multifunctional.

- SAE_IT-systems_series5_static no longer supported
  series5 target system with static address assignment series5
- **SAE_IT-systems_series5_selective**
  target system with selective address assignment

Selective process data coupling of codeIT PLC

The selective process data assignment for a PLC link is supported in series5 since setIT V4.005.x. In a codeIT project the target **SAE_IT-systems_series5_selective** has to be **installed and selected.**

In setIT the activation is done via the codeIT settings **selective** in the stations properties:

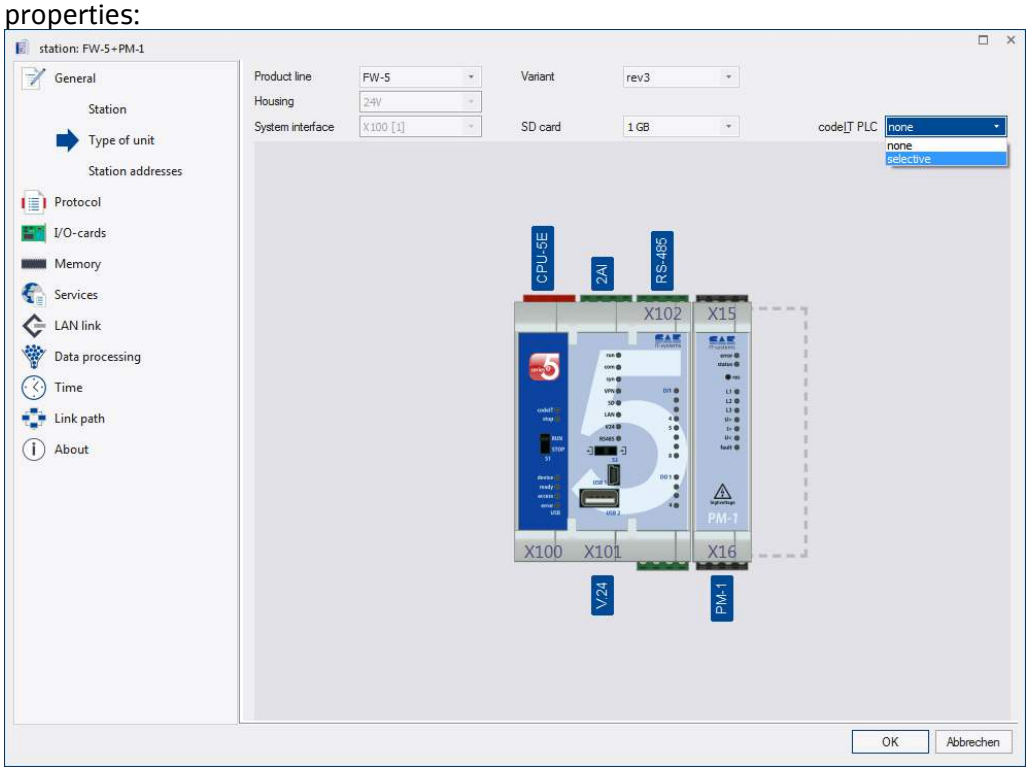


Figure 57: Selection of selective process data assignment to codeIT-PLC in sample station

The effective IO assignment is selected in the property page **codeIT-PLC/ Coupling to process module**. Only the marked process data will be launched to the PLC-shell, assigned to the memory area for codeIT and integrated in the list of variables for easy import in codeIT. All other values will be operated by the telecontrol device immediately.

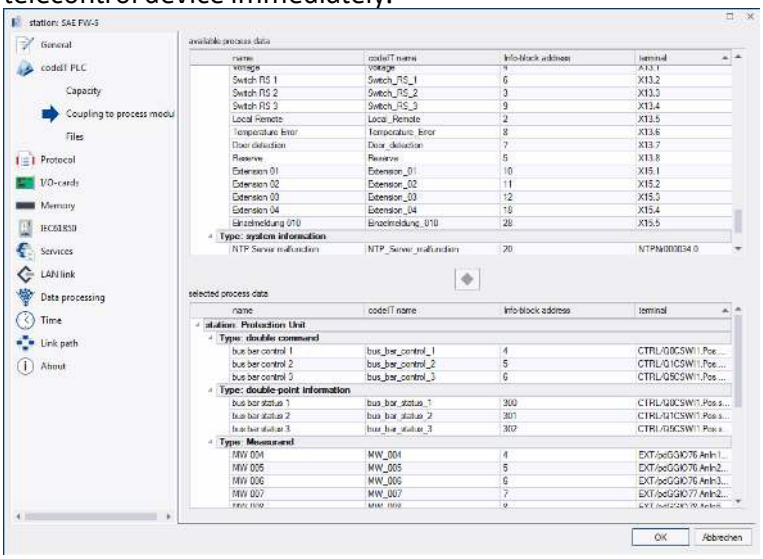
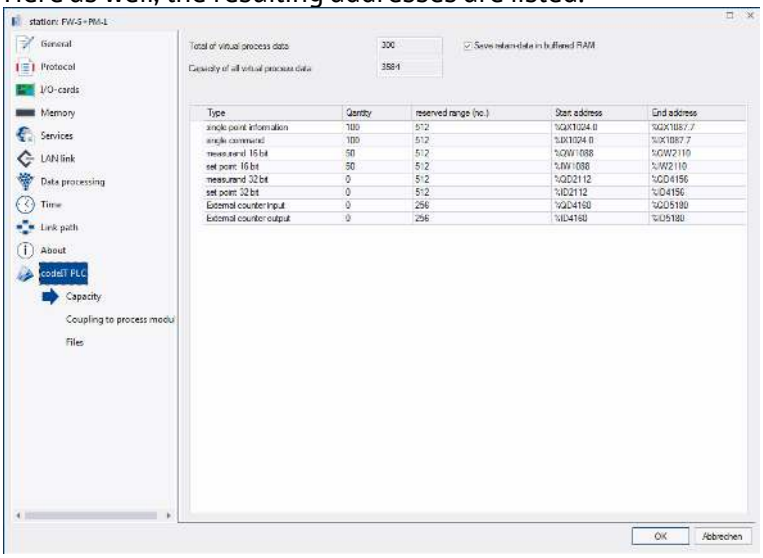


Figure 58: Selection of process data from existing I/O

The capacity may be supervised and modified in limits in **codeIT-PLC/Capacity**. Here as well, the resulting addresses are listed.



More information is available in the documentation Manual_codeIT_V23_GB.pdf.

8 Security relevant settings

This section provides a summary of the measures that must be taken to implement rapid setup and verification according to the BDEW whitepaper. In order to achieve this, it takes a closer look at the general properties.

Application-specific settings for particular user profiles and execution instructions are contained in separate appendices.

In order to achieve the highest security level according to the BDEW whitepaper, it is generally recommended to use the new technology series5e and the newest release of setIT. A free update service informs you about new releases and features.

Default parameters for project set up

For compatibility reasons, setIT presets a default of security settings, which apply when a project is created:

- IP address monitoring is enabled for network communication
  - Communication only takes place between known addresses
- User management is disabled.
  - The "sae" and "root" default users are enabled for the WEB page. These are disabled or overwritten when user roles and super-admin roles are created.
- FTP/http access is enabled until release V5.003.07 by default.
  - The FTPs/https protocol is recommended for security reasons.
- The default Bluetooth selection is "activatable"
  at CPU cards that have a Bluetooth module
  - Access can be activated locally by switch.
- USB Ethernet is enabled by default
  - Local access via USB cable is enabled and is accessible via DHCP server in the address space 192.168.59.81/29
- The firewall is not enabled.
  - Only configured ports are enabled on the station.
  - Users can also determine at the socket level which service/port (e.g. for diagnostic access) will be allowed on the corresponding socket via the enabled firewall. Moreover, the system runs more stably, even in the event of a brute force attack (traffic).

Minimum settings of safety-relevant functions

As of version setITV7, the minimum settings for IT security are requested for each new project. Settings activated here are already checked during project planning and an adjustment is requested in the event of deviation.

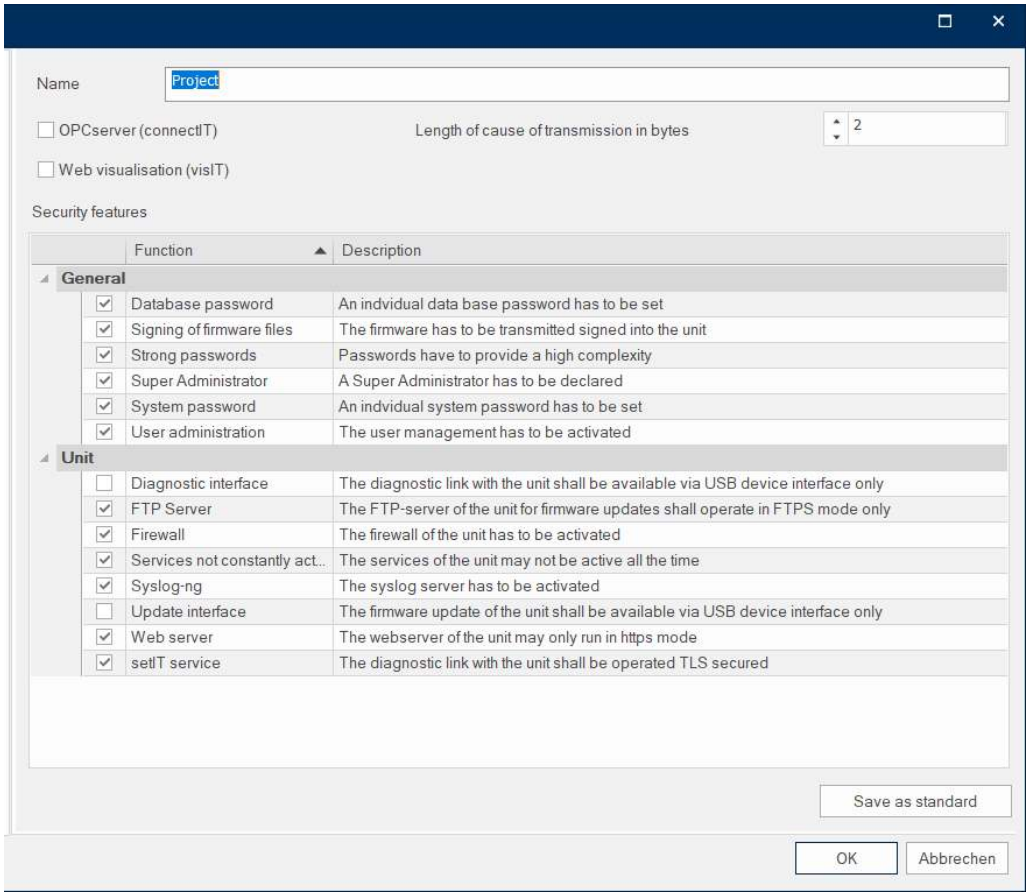


Figure 59: Minimum settings of safety-related functions as of setITV7

These settings should be set to the required values at the first project station. The inheritance of properties when additional stations are created simplifies subsequent configuration.
The settings can be made using the following checklist as a reference.

Security related issues of the series

The essential features and their potential applications are listed in the product series:

	System4	series5	series5+	series5e	series5X
User management from setIT V4.008	-	●	●	●e	●x
LDAP/Radius from setIT V6	-	-	-	●e	●x
Firewall from setIT V5.0	-	-	●	●e	●x
FTPs/https from setIT V5.0	-	●	●	●e	●x
IP address verification	●	●	●	●e	●x
Port limitation on enabled communication	○	●	●	●e	●x
Disabling unused interfaces from setIT V7.0	-	-	-	-	●x
Enabling PLC programming from setIT V5.0	-	●	●	●e	●x
Disabled USB device from setIT V5.0	-	●	●	●e	●x
VPN (end-ende) from setIT V5.0	-	-	●	●e	●x
IPsec IKEv2 from setIT V5.2	-	-	●	●e	●x
TLS (IEC 870-5-104, DNP3) from setIT V7.0	-	-	-	●e	●x
Encrypted database from setIT V5.3	-	-	-	●e	●x
Signed firmware from setIT V5.3	-	-	●	●e	●x
Syslog from setIT V5.3	-	-	●	●e	●x
Disabled remote download	-	-	●	●e	●x
Disabled Bluetooth #1	-	●	●	-	-
Control commands for services from V5.3 webserver, USB-host/-device, FTP, diagnostic,	-	-	●	●e	●x
Defence of brute-force attacks	-	-	○	●e	●x
Separated LAN segments, no routing	●	●	●	●e	●x
EST key exchange IEC 62351-9	-	-	-	●e	●x
Secure boot	-	-	-	-	●x
Unique device certificate in Secure-Element	-	-	-	-	●x
Encrypted file system for configuration	-	-	-	-	●x

- not possible ○ partially available ● available

[e]The technology series5e will be supported from setIT V5.004, [x]series5X from setITV7.002, #1 if available

Separated network segments

Any function of routing of IP-frames is inhibited, thus **a direct access via TCP/IP from one network port to another is blocked in the device with an active firewall**. A gateway functionality from one interface to another is only available using cross connection of process data operated by self-sustaining protocols according to the specific configuration.

Checklist

This checklist is intended to facilitate the establishment of a project with specifications according to the BDEW whitepaper. It in no way replaces requirements profiles and execution instructions, as required by the customer in the BDEW whitepaper. Essential standards can nevertheless be realised in a few steps. Your selection may deviate from this checklist provided that the deviations meet your security requirements.

Definitions at the project start

- ☐ Define the name and storage location of the project database
- ☐ Organise a backup system for the project database
- ☐ Define components (PCs, laptops, control systems, etc.) that may be used in the project.
- ☐ Align current malware test programs to these components (if possible) and check the components against infection.
- ☐ Define the updating cycle of the operating system and malware of the components.

Network and communication

- ☐ Define the project topology. When doing so, avoid public networks and switched telephone lines if possible.
- ☐ Define the protection of all communication paths;
  in series5 devices from setIT V5.0, VPN end-to-end encryption is available from the inside of the telecontrol station.
- ☐ Define remote maintenance access and their protection level
- ☐ Obtain/determine the IP addresses of the network and the planned stations with TCP-IP access.

User administration

- ☐ Define the **users** that should have access to the project, configuration or station.
- ☐ Define **responsibilities** internally and externally.
- ☐ Define responsibilities and **access rights** for each user.
- ☐ Define the **password quality**.
- ☐ Set the users profiles and responsibilities in the user management in setIT. Use individual profiles an avoid group declarations.
- ☐ Set a **database password**.
- ☐ Set a **system password**.
- ☐ Activate **signed firmware**.
- ☐ Set the '**super admin**' role for the main coordinator. Only this coordinator can set the system password and users globally.

Start of project

- ☐ Find out about new version releases and patches for the components used.
- ☐ Conduct IT security information sessions with the project participants and present the specifications.
- ☐ From setITV7: Define your minimum requirements of security-related settings.
- ☐ Set the project with the first station/head and make the following settings. The properties set here are automatically inherited to new stations, where they can be modified.

Settings in the dialogue station/services

- ☐ Lock the service **Memorystick-Transfer** if no update shall be available on site via stick or set to activatable via control command.
- ☐ Lock the **USB Ethernet** service if the device must not be accessed via USB cable or set to activatable via control command.
- ☐ Lock the **FTP server/ firmware update** if no remote downloads are allowed or set to activatable via control command.
- ☐ Enable **https** and **FTPs** in the 'Services' station dialogue.
  by default from setITV6.003
- ☐ Lock the service **setIT diagnostic** if no service shall be available or set to activatable via control command.
- ☐ Using service setIT diagnostic, select **TCP(TLS secured)** for communication.
- ☐ Lock the **web server** if no network access may be used via browsers or set to activatable via control command.
- ☐ If available, disable Bluetooth® if no wireless access must be used or select to activatable.
- ☐ Lock the **console** for series5 devices (series5 only)
- ☐ Enable the **firewall** from series5+ devices and restrict the services in the connections/sockets to the desired minimum.
  by default from setITV6.003
- ☐ Enable **IPsec (IKEv1/IKEv2)** or select a TLS-link if VPN end-to- end encryption is to be established.
- ☐ Enable **Syslog-ng** if a centralised server shall collect system indications.
- ☐ Set your own **user certificates** if your IT policy requires this.

Settings in the station/LAN connection dialogue

- ☐ Enter the **IP addresses** and **subnet mask** of the station and the gateway according to the topology.
- ☐ With the firewall enabled, disable **unwanted services** on the link layers and accesses according to the specifications. This process must be repeated after configuration of the station has been completed, since the connections and services only be selected after the station has been set-up. When doing so, please also remember the **expanded firewall rules** for each activated service and link.
- ☐ Using a release < V5.002, please take care to use only automatically generated routing commands and no additional entries in section routing are declared will be set automatically from setIT V5.002.

During the project

- ☐ If possible, DO NOT make configuration changes or download the operating system and firmware using the "send configuration" function – instead, use the USB memory stick or the firmware download via FTPs. (Doing so could compromise the communication process described as UNIP/UDP or service)
- ☐ Ensure that changes made as part of the project are properly documented.
- ☐ Always store the documents in a safe place.
- ☐ Check the components used in the project cyclically for malware and approval as part of the project.
- ☐ Avoid using of untested components, particularly USB memory sticks.
- ☐ Using Syslog, ensure to check the indications periodically, if no automatic alarming is guaranteed.

Recommendations and specifications

- Use of safe and/or **closed networks**
  - Operating an information technology (IT) system in a public or inadequately closed network potentially allows attackers to access the network and enables spying, manipulation and sabotage.
- Using technology in **closed, non-accessible areas**
  - A local open access to rooms or cabinets during installation provides possibilities of manipulation
- **Do not use switched telephone lines**
  - According to the BDEW whitepaper, switched telephone lines represent an open access point and must be avoided.
- Use services only if the security concept allows this, e.g.
  - Bluetooth®, where available, set to "can be enabled" as standard
  - Web server use of https and user management is recommended
  - USB Ethernet DHCP service enabled – assignment of an IP address on service laptop
- **Enabling FTPs/https secure services** for firmware update and web server
  - the secure services encrypt the information that is sent and make access much more difficult.
- **Only allow firmware update on secure networks and only with https/FTPs**
  - The firmware update via FTP or UNIP (UDP) must be activated only in networks that are sufficiently secure, if possible without public access.
  - FTPs secures the data transport and prevents content and access information from being eavesdropped.
- Use the newest **technology** as far as possible
  - On the series5 platform, not all the security features can be provided without affecting the overall concept, and with it the basic function of the system.
  - series5+ units are well equipped but newer series grant more efficient protection s. Security related issues of the series page 205.
- Use **the latest update** if possible.
  - From version setIT V4.008, essential components were upgraded to a higher security level according to the BDEW whitepaper security concept.
  - In Version setIT V5.000 additional characteristics have been added.
  - The role concept has been refined.
  - The system password is disabled by editable super admin.
  - New patches have been introduced and certificates renewed.
  - Starting with setIT V5.002 IPsec is supported with IKEv2.
  - From setIT V5.003 Syslog, database encryption and signed firmware are supported.
  - In setIT V5.004.09 and V6.003.06b27 a set of leaks have been closed. Please refer to the current releasenotes..
    We highly recommend to update to setIT from V7.000.

- **Enable user management** and set roles as personally as possible
  - without user management and role allocation, the system is open and can be used in the same way by everyone
  - without user management, no user-dependent activity logging is possible
  - with impersonal group assignment it is not possible to track the actions of an individual user
  - without user management, the web service is also available to all users in the same way using the default password
- Set users with **secure passwords**
  - Secure passwords consist of a minimum of 10 characters.
  - The longer and more cryptic the password, the safer its classification.
  - - Avoid family or company names, sequences such as 123, abc and known words possibly listed in dictionaries or rainbow password lists. Special characters and upper/lower case add complexity.
- **Set a super admin** in the user management
  - if the super admin is not set up, the general system user remains active and allows access to the system using the default password.
- **Set a database password** in user administration
  - With a database password and *.sdbx files, the projects settings will be stored encrypted in the database file. Any access to the information will only be available with the valid database password.
- **Set the system password** in the user management
  - A new system password overwrites the default passwords used by SAE. The firmware download is protected by this password; loading by an external project is prevented.
- **Activate sign firmware** in user administration
  - An update to the station will only be valid with a signed firmware file. No other source will be accepted.
- **Disable potentially unsecure services** and approaches such as FTP (firmware update), http (web server) by activating https/FTPs
  - FTP and HTTP allow eavesdropping, and information providing access and manipulation options can be disclosed in this way
  - The access to the system with UNIP/UDP listed under the "service" designation in the firewall can be monitored via a network connection. Select TCP(TLS secured) to avoid external access. Default as of setITV6.003
- **Change the SNMP Default Community Name**
  - The default community name 'public' is well known. With link to this service, an attacker may read out settings and perform modifications which may lead to unsecure conditions.

- **Create securely-related system messages** for alerting and archiving, as proposed in the system messages wizard, such as:
  - Redundancy messages
  - Time server fault
  - Station fault detection
  - Data overflow interface
  - Interface error detection
  - Card error detection
  - Expansion slot error detection
  - Time server error detection
  - SD card malfunction
  - Archive errors and overflows
  - Command output interlock indications
  - Change control group indication
  - PLC software status
- **Use IP address verification** and record fixed IP addresses everywhere
  - When checking is disabled and the IP address 0.0.0.0 is assigned, all connections are accepted and the origins of these connections cannot be checked.
- Store the setIT database and **project files securely**
  - Project databases must be securely protected against unauthorised access, since they contain essential access information.
- **Set up a multi-level backup**
  - A potential malfunction or incorrect operation may require a roll-back to an older version in order to maintain operations.

Specifications for series5 components

- **Lock the console**
  - When the console is enabled, a user can access the core system.
- If possible, limit the bandwidth of data connections via networks with public access to 1 MBit/s
  - This limitation will ensure that DOS attacks no longer have any significant sabotaging effect. Any load over this rate can lead to a system restart in extreme cases.

Additional specifications for series5+ /series5e

- **Enable the firewall**
  - The firewall detects attack situations outside normal operation and can filter/disconnect ports on individual paths.
- **Setting the firewall**
  - Limiting services to accesses that are actually being used reduces the potential attack target
- Setting up an **end-to-end encryption** VPN client from setIT V5.0
  - When public or insufficiently protected paths are used, information transfers could be read and manipulated
- While using series5+ devices and if possible, limit the bandwidth of data connections via networks with public access to 3 Mbit/s
  - This limitation will ensure that DOS attacks no longer have any significant sabotaging effect. Any load over this rate can lead to a system restart in extreme cases.

Recommendation for active web servers

- **Setting the session timeout** for enabled web servers
  - If the selected timeout session is too large or is disconnected, an open web session may be taken over by another service PC user without renewed authentication.
- **Enabling the https protocol**
  - prevents access and values from being eavesdropped
- **Enabling the user profile with secure passwords**
  - prevents unwanted access to the system
  - regulates access and functions via role profiles/settings
- **Only enable the webserver via system command when needed**
  - A disabled webserver simply offers no target area.

Recommendation on active Bluetooth® interface

- **Activate the Bluetooth interface during the session only**
  - The "activatable" setting, which allows temporary Bluetooth activation, is set by default
  - In the setting"active", the Bluetooth interface cannot be disabled due to customer demand.

Recommendation on enabled PLC programming

- When using the PLC programming with codeIT or the setIT workbench, access to the programming interface should be disconnected or activatable via a system command.
  - If the programming interface and access to the network are open, access to the programming level cannot be excluded.
  - With series5+ systems, access can be disabled individually if the firewall is enabled.

Delivery status

Stations from stock are usually cold-started and have no configuration. On customer demand, e.g. in preconfigured projects or works tests, configured stations can be supplied on request. A cold-started station can be identified by the (flashing) chasing light of the "run/com/IO/data" status LED or "run/com/sys/VPN" at series5e devices.

Default values in delivery status

No configuration operation does not yet have any telecontrol communication relationship and is therefore not accessible via the protocols; it has no valid function, and represents only a minimal attack target.

IP addresses after cold start

The Ethernet socket standard addresses are set to the following values:

1. Ethernet Controller X100	192.168.1.111/24
2. Ethernet-Controller X102	10.0.6.177/16 if available
3. Ethernet-Controller X400	192.168.178.1/24 if available
3. Ethernet-Controller X101	192.168.179.1/24 if available
4. Ethernet-Controller X103	192.168.180.1/24 if available
5. Ethernet-Controller X105	192.168.181.1/24 if available
6. Ethernet-Controller X107	192.168.182.1/24 if available
USB-device	192.168.59.81/29

Ports after cold start

In this state, the station can be loaded via a firmware update from setIT via FTP. A station configuration can be used to disconnect any of these ports. After a valid configuration acquisition, the system starts at the defined security level. The selected communication drivers and services are started, the function of the configured I/O cards is checked and the process modules are started.
The default output state of commands and setpoints is 0 = off. A current target state "refresh" must be set via the communication.

Passwords after cold start

In the cold-started state, default passwords are enabled, thus allowing initial access to the system (FTP, web server). These passwords are overwritten automatically when the super admin authorisation concept is activated or are overwritten by FTPs and are no longer available after configuration. Starting with series5+ it is possible to enable your own system password in the project.

Services (port List and function)

After a cold start, i.e. in delivery status, a station does not yet have a current configuration. The following ports are accessible as standard:

Port	Protocol	Remarks
23	telnet	Console with password request (series5 only)
20/21	FTP	Access with password request
67	DHCP	only at USB-Ethernet from series5+
80	http	Port only provides FTP download

The Telnet console via ports 23 and 992 is not accessible from series5+ systems. The root password is overwritten after loading a project with activated FTPS or System password with an unknown, random 19-byte password.

Station configuration allows any port to be disabled or enabled by selecting/deselecting the function. In a complete project, the following ports can also be enabled:

Port	Protocol	Remark
102	IEC 61850	Access control for client IP possible
123	NTP	Client time synchronisation
161/162	SNMP/v3 UDP/Traps	SNMP status interrogations
389/1812	LDAPTCP/Radius UDP	User management from series5e V6.0
443	https	Port only provides FTP/FTPs download
500/4500	IPsec IKEv2	series5+ from V5.2
502	Modbus-TCP	Access control for client IP possible
514/1470	Syslog UDP/TCP	series5+ from V5.3
1194	OpenVPN	VPN-Tunnel ab series5e V6.0
1200	3S	Proprietary (3S) for connection to codeIT
1293	IPsec IKEv1	series5+ from V5.0
1883/8883	MQTT/MQTTS	Data server broker+ ab V7.0
2404	IEC 60870-5-104	Access control for client IP possible
5980	UNIP	Proprietary (SAE) for connection to setIT
7259	SML	UDP/TCP access control for client IP possible
8000	IEC 62051-21 overIP	Access control for client IP possible
16725/17725	http/https	visIT Datenkommunikation
20000	DNP3	TCP Port
40000/40001	FTPs	Access with password request

A further limitation of the ports on the respective network segments/sockets is possible via the firewall from series5+ technology.

The IP messages routing function is disabled. **Direct TCP access from one network card to another within a station is blocked with an active firewall**. This also applies to network segments that are set up via PPP communication via serial interfaces, for example. A gateway function is only enabled via implementation of the protocols from one interface to another according to the configuration in ISO/OSI application level 7.

Decommissioning

The stations described here are loaded with security features that represent secrets in various forms. Some of these secrets have a considerable protection potential. If such a station - for whatever reason - is taken out of service, appropriate protective measures must be taken in order not to reveal these secrets or to leave them unprotected.
Decommissioning only means the return of a product to a safe stock, not disposal according to WEEE Directive 2002/96/EC.

Deleting the project by cold start

A project created with a security level described here carries secrets that must be deleted when it is taken out of service. This information must be removed by a cold start.
The execution of the cold start is described in the respective manuals; it is usually associated with a restart of the station or is triggered by a command to the station via the parameterisation tool.

The cold start removes the project and its settings and resets the system memory. If the flash memory also needs to be cleaned, this can be done by a basic system update. This also resets the entire flash memory.
If the station can no longer be started and repaired, the CPU module or the SoC system on chip can be removed and destroyed accordingly. The SoC is usually located as a plug-in module on the CPU board. It carries all relevant memories of the basic system.

SD card

If an SD card was inserted, it must be removed and safely deleted. This is particularly necessary if system backups were also saved on the card.
Secure deletion is not achieved by formatting, as only administrative areas are overwritten. Similarly, the standard erase function only marks the files as deleted but does not remove the information stored in the sectors. Use an appropriate tool that actually overwrites the storage area with any content to bring it to a state that is considered securely erased.

9 Appendix

System comparison

Function	series5	series5+	series5e
CPU	ARM®9 ARM920T	ARM®9 SAM9G45	Cortex® A8 TI3552
MHz	180	400	800
MIPS	200	400	1200
RAM /MB	32	128/256	512
ROM /MB	64	128/256	512
SD card max.	1 GB	1 GB	1 GB
Real-time clock buffer	SuperCap 5 days	Li-Ion 30 days	Li-Ion 60 days
codeIT IEC61131-3	O	O	O
visIT *3.5	-	O	O
IEC 60870-5-101	•1	•1	•
IEC 60870-5-103	O	O	•
IEC 60870-5-104	•1	•1	•
IEC 61850 client *0	-	O	O
IEC 61850 server *4	-	-	O
IEC 62056-21	-	O	O
SYM²/SML	-	O	O
DNP3 outstation*3	-	O	O
DNP3 master*7	-	-	O
DSfG *0	-	O	O
Modbus RTU/TCP	•1	•1	•
3964R/RK512	•1	•1	•
Profibus-DP	O	O	O
NTP/DCF	•	•	•
Firewall	-	•	•
brute-force Firewall *4	-	-	•
http/FTP	•	•	•
https/FTPs/IPsec	-	•	•
SNMP *1	-	•	•
SNMPv3 *3.5	-	•	•
SNMP-agent *7	-	-	•
VPN IKEv1/ IKEv2 *3	-	•	•
SYSLOG *3	-	•	•
openVPN *6	-	-	•
RADIUS/LDAP *6	-	-	•

+ = series5+, e = series5e

• = included in standard, •1 = standard from 2017, O = expansion/option/licence, - = not available
from: *0 setIT V5.0, *1 setIT V5.1, *3 setIT V5.3, *3.5 setIT V5.3.05, *3.7 setIT V5.3.07, *4 setIT V5.004, , *6 setIT V6, *7 setIT V7, *7.2 setIT V7.002, -m5 not with m5

Information on using relays

Assemblies with relay outputs have been written with their core values in the technical data of the assembly. In order to give clearly more information about the

possible uses, but to avoid multiple nomination, we have compiled additional information.

Glossary - switching with relays

AgNi	silver nickel is the standard material under MSR applications with good powers under resistive and weakly-inductive loads for average and higher switch operations (typical 2 A @24 V DC, 2 A @250 v AC).
$AgSiO_2$	silver tin oxide is a good choice for high switch operations, especially in network voltage applications under larger start-up currents. They feature low material creep under DC loads, good burn-off resistance with very low tendency for welding failures.
AgNi+Au	silver nickel meshed with a layer of gold the special contact for very small power values in the region of a few mA. The contacts remain fresh for the lowest loads due to their corrosion resistance and negligible material loss under low currents. However: once switched at high load, the gold layer will burn off and the normal AgNi contact remains. This contact can no longer switch the low power values cleanly.
Switching capacity	The switching capacity of a relay assembly is for the most part determined by the relay contact, number, mechanics, and the material of the relays. The entire switching capacity can be limited by the terminals and connections on the PCB of the assembly. The endurance load is rarely the same as the maximum load of the relay but the thermal load capacity of the conductor paths. The maximum load on this root applies when using common terminals.
Making capacity	The make/operate procedure for the relay is not as critical under a greater FC load as the contact material is barely affected. During the rebounding of the contacts, a melting loss may also arise here due to arcing.
Breaking capability	Under the breaking capability (brake/reset), the contacts are separated using mechanical movement; light arcs arise which damage the material and which can lead to a material displacement and even a change to the shape of the contact. When using AC, these light arcs are erased by the phase change. Under high DC load, considerable damage to the contact may arise, this may result in the minimization of the life of the contact to contact adhesives. The switching capacity is also dependent on the switching voltage; this non-linear switching curve is specified in the relay data in separate graphs, e.g. as 'max. load breaking capacity'. These values usually relate to purely resistive loads unless indicated otherwise.
Resistive loads	do not have a phase displacement and no pulse-like side effects through asymmetric load displacement.
Inductive loads	such as engines and coils generate a high back voltage during the switching operation and an increasing phase displacement with the L/R factor. These counter-voltages are often limited by protective circuitry. These extend the break process however.
max. switching voltage	As well as the max. switching voltage of the relay, the maximum switchable voltage is specified by the switching voltage of the assembly. These response values of these switching operations are usually much smaller than the relay data and are therefore important for the field of application. Depending on the version, protection circuits can delay the breaking procedure.
Life	The life of a relay is often only specified as a mechanical life in switching cycles without load. Since the life of the contacts strongly depends on the switching capacity (voltage, current, L/R factor), the expected duration in the field of application can usually be read from separate graphs.

Technical data for relays

APF	monostable NO contact used on **FW-5, FW-5-230, 8DO, RES-1,DSO-1,DSO-2**
Contacts *	Contact AgNi
Switching voltage *	250 V AC, max. 300 V DC, max. 400 V AC
Making capacity	6.0 A, min. 100 mA > 5 V DC
Steady-state current *	6.0 A AC
Breaking capability	1500 VA, resistiv: 6,0 A @24 V DC/ 0,4 A @60 V DC / 0,2 A @110 V DC/ 0,17 A @220 V DC induktiv: 2 A @ 24 V DC, 3 A @ 250 V AC
Switching times ON/OFF	8 ms / 4 ms
switching cycles	> 5*106 mechanical EN 60947-5-1: 6000 under 24 V DC, 2 A, 25° C
Switching frequency	72000 h-1 without load /360 h-1 with load
Isolation	6000 V surge contact/coils, 4000 V rms 1 min
Safety *	EN IEC 61810-1: 8A 250 V AC (cosφ = 1) 25° C N.O. side / 6 A 250 V AC (cosφ = 1) 85° C UL508/ UL1604: 6A 24 V DC, general use B300, R300 (Pilot duty)
Environment *	- 40° + 85°C

* All information relate to the relay- the assembly data are important

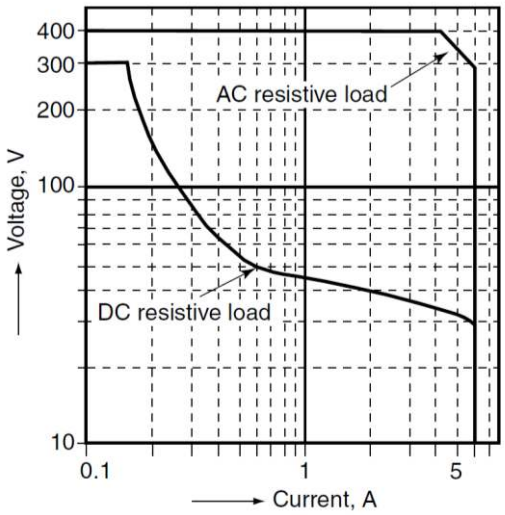
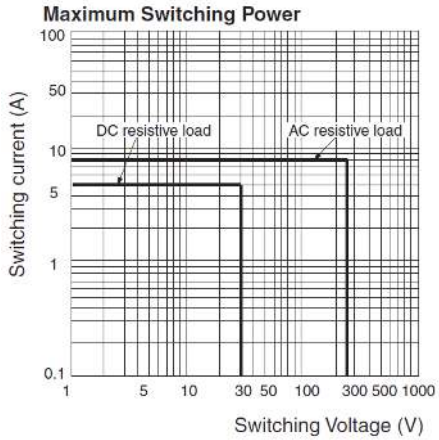
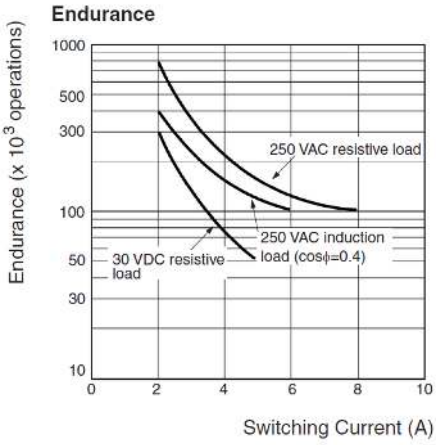


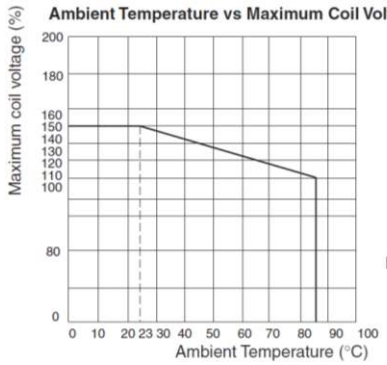
Figure 60: Switching capacity APF 30224
Source: Panasonic APF

G6RN	monostable NO contact used on 16RA-1, OERA-5, AOERA-1
Contacts *	1 contact AgAlloy+Au 0.35µ
Switching voltage *	250 V AC, max. 30 V DC, max. 400 V AC
Making capacity *	8.0 A AC, 5 A DC min 10 mA > 5 V DC
Steady-state current *	8.0 A
Breaking capability	2000 VA, 150 W 8.0 A @250 V AC/ 5.0 A @30 V DC
Switching times ON/OFF	15 ms typ. 6 ms / 5 ms typ. 3 ms
Switching cycles	> $10*10^6$ mechanical $50*10^3$ max. load, typ. $100*10^3$
Switching frequency	36000 h^{-1} without load / 360 h^{-1} with load
Isolation	10000 V surge 1.2 * 50 µs 4000 V AC contact/coil 1 min, > 8 mm 1000 V AC contact/contact 1 min, > 3 mm
Safety *	Protection class II to VDE 0106 Part 1 Isolation class C/250, B/360 to VDE 0110
Environment	- 40° + 85°C

* All information relate to the relay- the assembly data are important







Note: The maximum coil voltage refers to the maximum value in a varying range of operating power voltage, not a continuous voltage.

Figure 61: Switching capacity, service life and working area G6RN
Source: Omron

AZ696	monostable NO contact used on old 16RA-1, OERA-1,AOERA-1
Contacts *	1 contact AgCdO
Switching voltage *	440 V AC, max. 240 V DC
Making capacity *	10 A @250 V AC, 10 A @30 V DC resistive UL B300 Min. 10 W
Steady-state current *	10 A
Breaking capability	2500 VA, 300 W
Switching times ON/OFF	typical 10 ms / typ. 5 ms
Switching cycles	> $10*10^6$ mechanical $10*10^3$ 10 A @250 V AC, resistive, 85° C VDE
Switching frequency	max. 10 min^{-1} with load
Isolation	4000 V eff contact/coil, > 8 mm 1000 V eff contact/contact C250, Overvoltage category III, Pollution 3
Approvals *	VDE 0435, 0631, 0700UL E 44211, CSA LR 85 091 IP67
Environment	- 40° + 85°C

* All information relate to the relay- the assembly data are important

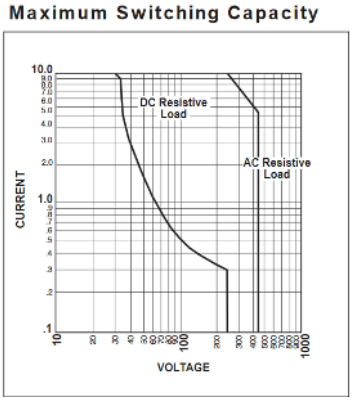


Figure 62: Switching capacity, service life and working area AZ696
Source: Zettler

MSR V23061	monostable NO contact used on 12RA-1
Contacts *	Contact AgNi
Switching voltage *	250 V AC, max. 300 V DC, max. 400 V AC
Making capacity	6.0 A, min. 100 mA > 5 V DC
Steady-state current *	6.0 A AC
Breaking capability	1500 VA, 6.0 A @24 V DC/ 0.4 A @60 V DC / 0.2 A @110 V DC/ 0.17 A @220 V DC
Switching times ON/OFF	8 ms / 4 ms
switching cycles	> 5*10^6 mechanical EN 60947-5-1: 6000 under 24 V DC, 2 A, 25° C
Switching frequency	72000 h^{-1} without load /360 h^{-1} with load
Isolation	6000 V surge contact/coils, 4000 V rms 1 min
Safety *	EN IEC 61810-1: 8A 250 V AC (cosφ = 1) 25° C N.O. side / 6 A 250 V AC (cosφ = 1) 85° C UL508/ UL1604: 6A 24 V DC, general use B300, R300 (Pilot duty)
Environment *	- 40° + 85°C

* All information relate to the relay- the assembly data are important

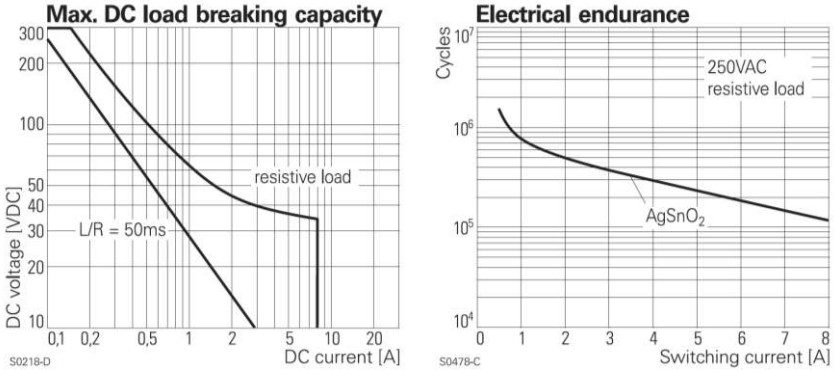


Figure 63: Switching capacity, service life and working area MSR V23061

Figures

Literature

[1] **Online Help / manual for setIT**, SAE IT-systems GmbH & Co. KG, 2019
[2] **Interoperability list for IEC 60870-5-101**; SAE IT-systems GmbH & Co. KG; 2016
[3] **Interoperability list for IEC 60870-5-104**; SAE IT-systems GmbH & Co. KG; 2018
[4] **IEC61850 Conformance statements ACSI-PIXIT-PICS-TICS**; SAE IT-systems GmbH & Co. KG; 2018
[5] **setIT configuration**; SAE IT-systems GmbH & Co. KG; 2018
[6] **codeIT manual**V 2.3, SAE IT-systems GmbH & Co. KG, 2015
[7] **Integration and update for codeIT**, SAE IT-systems GmbH & Co. KG, 2010
[8] **codeIT library**, SAE IT-systems GmbH & Co. KG, 2005
[9] **IT security checklist**; SAE IT-systems GmbH & Co. KG; 2018

Change log

19.04.16	Initial version from FW-50 manual
30.05.17	Additions and corrections
28.07.17	Formatting and technical details aligned
30.08.17	Updating of technical details, SV-6-x-LC added
09.01.18	Missing references . links corrected
09.02.18	FO-2 star coupler added
09.11.18	SV-6 corrections
01.03.19	localisation from current German manual
23.05.19	SWI-3 added
01.07.18	SFP as items, CPU-5Es and BGT-Ls added
18.08.22	new logo, updates and new links, IEC61850 cert.

Outstanding additions

None

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Typically, the 1st digit of the license number e.g. 6.xxx.yy denotes a major version - a license is required for permanent operation. The 2nd number x.000.yyy refers to functional extensions; the 3rd number x.yyy.01 refers to a bug fix - the build-nr.is used to manage the generator runs.
The purchase of a license includes 12 months update service from the date of issue of the license letter. The update of licensed software within the third version number group e.g. V 6.01.xxx is free of charge only in the maintenance contract or on goodwill. The replacement of a licence to another licence model (upgrade) or a higher release (update) is available by agreement and surcharge at any time. On update in between the main release number (first character) the licence key remains valid. On update or skip of the main release number, a new licence key has to be granted. By installation of a new software/licence, you voluntarily release the former licence and rights. The handling will be proceeded like a new delivery.

With the release of a new major version, functional extensions of the previous version are discontinued (EOD: end of development). Maintenance (service) of the previous version through bug fixes and security-relevant corrections remains. The maintenance prior to the previous version major version-2 is discontinued (EOS: end of service); security-relevant corrections remain reserved here.

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Certificates

Declarations of conformity - DOC

Erklärung der EG/EU - Konformität
Declaration of EC/EU- Conformity • *Déclaration CE/UE de Conformité*

SAE IT-systems GmbH & Co. KG
Im Gewerbegebiet Pesch 14
50767 Köln GERMANY

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BCU-50

• Anwendungsbereich Stationsleittechnik /Fernwirktechnik
Area Substation automation /Telecontrol
Champ d'application Contrôle-commande de la station/ Télé-conduite

Richtlinie • Directive • *Directive*			Norm • Standards • *Normes*
Bis/*jusqu'à* 19.04.2016		ab/*à partir de* 20.04.2016	
2004/108/EG 2004/108/EC *2004/108/CE*	EMV Richtlinie EMC Directive *Directive CEM*	2014/30/EU 2014/30/EU *2014/30/UE*	IEC 61850-3:2013 IEC 61000-6-2:2005 CISPR22:2008-05 Device class A
2014/35/EG 2014/35/EC *2014/35/CE*	Niederspannungsrichtlinie Directive Low Voltage *Directive Basse Tension*		IEC/EN 61010-1:2011-06
2011/65/EU 2011/65/EU *2011/65/UE*	RoHS RoHS *RoHS*		DIN EN 50581:2012

Die aufgeführten Normen gelten als Grundlage für eine Risikoanalyse nach 2014/30/EU, die gesondert angefordert werden kann.
The standards listed shall be the basis for a risk analysis after 2014/30 / EU, which can be requested separately.
Les normes citées sont la base d'une analyse des risques après 2014/30 / UE, qui peut être demandé séparément.

SAE IT-systems GmbH & Co. KG
Im Gewerbegebiet Pesch 14 • 50767 Köln
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Köln, 19.4.2016
Ort und Datum
Place and date
lieu et date

i.V. Jürgen Venhaus
Product Manager
SAE IT-systems GmbH & Co. KG

i.V. Ulrich Werner
Quality Manager
SAE IT-systems GmbH & Co. KG

IEC 60870-5-104

DNV

ATTESTATION OF CONFORMITY

No. 10377377-DSO 23-2971

Issued to:
SAE IT-Systems GmbH & Co. KG
Im Gewerbegebiet Pesch 14
50767 Köln
Germany

For the server product:
BCU-50-M
Bay Control Unit
Software version: Release 07.003.02B Build 017-16.05.2023 13:13 Rev 59212
S/N: 310050502310

The server product has not been shown to be non-conforming to:

IEC 61850 Edition 2 with Amendment 1 Parts 6, 7-1, 7-2, 7-3, 7-4, 8-1

Communication networks and systems in substations

The conformance test has been performed according to IEC 61850-10 and the UCAIug Edition 2 with Amendment 1 Server Conformance Test Procedures version 1.1 with product's protocol and model implementation conformance statements and product's extra information for testing: "IEC 61850 Interoperability Telecontrol Substation Automation starting with setIT V7.0 from series5e devices, date 28-7-2022".

The following IEC 61850 conformance blocks have been verified with a positive result:

1a	Basic Exchange	12a	Direct Control
2	Data Sets	12b	SBO Control
2+	Data Set Definition	12c	Enhanced Direct Control
5	Unbuffered Reporting	12d	Enhanced SBO Control
6	Buffered Reporting	13a	Time Synchronization with SNTP

This attestation includes a summary of the test results as carried out at DNV in The Netherlands with UniGrid SA Simulator 2.0.2 with test suite 20230307.1 and UniCA 61850 Analyzer 6.40.01. This document has been issued for information purposes only, and the archived DNV verification report No. 10377377-DSO 23-2969 rev 2 will prevail.

The test has been carried out on one single specimen of the server product as referred above and submitted to DNV by SAE IT-systems GmbH & Co. KG. The manufacturer's production process has not been assessed. This attestation does not imply that DNV has verified any server product other than the specimen tested.

Arnhem, July 28, 2023

Issued by:

G. Akse
Business Development Manager
Interoperability of Smart Power Systems

DNV

R. Schimmel
Verification Manager

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Applicable Server Test Procedures from the UCA International Users Group Edition 2 with Amendment 1 Server Test Procedures version 1.1

Conformance Block	Mandatory	Conditional
1a: Basic Exchange	sAss1, sAss2, sAss3, sAss4, sAssN2, sAssN3, sAssN4, sAssN5, sSrv1, sSrv2, sSrv3, sSrv4, sSrv5, sSrv8, sSrvN1abcdf, sSrvN4	sAssN6, sSrv9, sSrv12
2: Data Sets	sDs1, sDs10a, sDsN1ae	sDs15
2+: Data Set Definition	sDs2, sDs3, sDs4, sDs5, sDs6, sDs7, sDs8, sDs9, sDs13, sDs14, sDsN1cd, sDsN2, sDsN3, sDsN4, sDsN5, sDsN6, sDsN7, sDsN8, sDsN9, sDsN10	sDs11, sDs12, sDsN11, sDsN12
5: Unbuffered Reporting	sRp1, sRp2, sRp3, sRp4, sRp5, sRp9, sRp14, sRp16, sRp23, sRpN1, sRpN2, sRpN3, sRpN4, sRpN5, sRpN7, sRpN8, sRpN9	sRp6, sRp7, sRp8, sRp10, sRp11, sRp12, sRp13, sRp15
6: Buffered Reporting	sBr1, sBr2, sBr3, sBr4, sBr5, sBr9, sBr14, sBr16, sBr20, sBr21, sBr22, sBr23, sBr24, sBr25, sBr26, sBr27, sBr28, sBr29, sBrN1, sBrN2, sBrN3, sBrN4, sBrN5, sBrN7, sBrN8, sBrN9, sBrN10	sBr6, sBr7, sBr8, sBr10, sBr11, sBr12, sBr13, sBr15
12a: Direct control	sCtl5, sCtl10, sDOns1, sDOns2	sCtl13, sCtl15, sCtl16, sCtl17
12b: SBO control	sCtl5, sCtl8, sCtl9, sCtl10, sCtl11, sCtl25, sSBOns1, sSBOns2, sSBOns6	sCtl4, sCtl6, sCtl15, sCtl16, sCtl17, sCtl27
12c: Enhanced Direct Control	sCtl5, sCtl10, sDOes1, sDOes2	sCtl13, sCtl14, sCtl15, sCtl16, sCtl17, sCtl26
12d: Enhanced SBO Control	sCtl5, sCtl8, sCtl9, sCtl10, sCtl11, sCtl25, sSBOes1, sSBOes2, sSBOes6, sSBOes8	sCtl4, sCtl6, sCtl15, sCtl16, sCtl17, sCtl26
13a: Time sync SNTP	sTm1, sTm2, sTm7, sTmN1	sTm5

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IEC 615850 ed2

No. 10377377-DSO 23-2970

IEC 61850 Certificate Level A[1]

Issued to:
SAE IT-Systems GmbH & Co. KG
Im Gewerbegebiet Pesch 14
50767 Köln
Germany

For the server product:
BCU-50-M
Bay Control Unit
Software version: Release 07.003.02B Build 017-16.05.2023 13:13 Rev 59212
S/N: 310050502310

The server product has not been shown to be non-conforming to:

IEC 61850 Edition 2 with Amendment 1 Parts 6, 7-1, 7-2, 7-3, 7-4, 8-1

Communication networks and systems for power utility automation

The conformance test has been performed according to IEC 61850-10 and the UCA International Users Group Edition 2 with Amendment 1 Server Test Procedures version 1.1 with product's protocol and model issue implementation conformance statements and the extra information for testing: "IEC 61850 Interoperability Telecontrol Substation Automation starting with setIT V7.0 from series5e devices, date 28-7-2022".

The following IEC 61850 conformance blocks have been tested with a positive result (number of relevant and executed test cases / total number of test cases):

1a Basic Exchange (19/29)	12a Direct Control (8/18)
2 Data Sets (4/7)	12b SBO Control (15/27)
2+ Data Set Definition (24/24)	12c Enhanced Direct Control (10/20)
5 Unbuffered Reporting (25/26)	12d Enhanced SBO Control (16/28)
6 Buffered Reporting (35/36)	13a Time Synchronization with SNTP (5/8)

This certificate includes a summary of the test results as carried out at DNV in The Netherlands with UniGrid SA Simulator 2.0.2 with test suite 20230307.1 and UniCA 61850 Analyzer 6.40.01. This document has been issued for information purposes only, and the archived DNV verification report No. 10377377-DSO 23-2969 rev 2 will prevail.

The test has been carried out on one single specimen of the product as referred above and submitted to DNV by SAE IT-systems GmbH & Co. KG. The manufacturer's production process has not been assessed. This certificate does not imply that DNV has approved any product other than the specimen tested.

Arnhem, July 28, 2023

G. Akse
Business Development Manager
Interoperability of Smart Power Systems

Issued by:

R. Schimmel
Verification Manager

[1] Level A - Independent test lab with certified ISO 9001 Quality System
UCA International Users Group P.O. Box 315, Shell Knob, MO 65747 USA

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No. 10377377-DSO 23-2970

IEC 61850 Certificate Level A

Applicable Server Test Procedures from the UCA International Users Group Edition 2 with Amendment 1 Server Test Procedures version 1.1

Conformance Block	Mandatory	Conditional
1a: Basic Exchange	sAss1, sAss2, sAss3, sAss4, sAssN2, sAssN3, sAssN4, sAssN5, sSrv1, sSrv2, sSrv3, sSrv4, sSrv5, sSrv8, sSrvN1abcdf, sSrvN4	sAssN6, sSrv9, sSrv12
2: Data Sets	sDs1, sDs10a, sDsN1ae	sDs15
2+: Data Set Definition	sDs2, sDs3, sDs4, sDs5, sDs6, sDs7, sDs8, sDs9, sDs13, sDs14, sDsN1cd, sDsN2, sDsN3, sDsN4, sDsN5, sDsN6, sDsN7, sDsN8, sDsN9, sDsN10	sDs11, sDs12, sDsN11, sDsN12
5: Unbuffered Reporting	sRp1, sRp2, sRp3, sRp4, sRp5, sRp9, sRp14, sRp16, sRp23, sRpN1, sRpN2, sRpN3, sRpN4, sRpN5, sRpN7, sRpN8, sRpN9	sRp6, sRp7, sRp8, sRp10, sRp11, sRp12, sRp13, sRp15
6: Buffered Reporting	sBr1, sBr2, sBr3, sBr4, sBr5, sBr9, sBr14, sBr16, sBr20, sBr21, sBr22, sBr23, sBr24, sBr25, sBr26, sBr27, sBr28, sBr29, sBrN1, sBrN2, sBrN3, sBrN4, sBrN5, sBrN7, sBrN8, sBrN9, sBrN10	sBr6, sBr7, sBr8, sBr10, sBr11, sBr12, sBr13, sBr15
12a: Direct control	sCtl5, sCtl10, sDOns1, sDOns2	sCtl13, sCtl15, sCtl16, sCtl17
12b: SBO control	sCtl5, sCtl8, sCtl9, sCtl10, sCtl11, sCtl25, sSBOns1, sSBOns2, sSBOns6	sCtl4, sCtl6, sCtl15, sCtl16, sCtl17, sCtl27
12c: Enhanced Direct Control	sCtl5, sCtl10, sDOes1, sDOes2	sCtl13, sCtl14, sCtl15, sCtl16, sCtl17, sCtl26
12d: Enhanced SBO Control	sCtl5, sCtl8, sCtl9, sCtl10, sCtl11, sCtl25, sSBOes1, sSBOes2, sSBOes6, sSBOes8	sCtl4, sCtl6, sCtl15, sCtl16, sCtl17, sCtl26
13a: Time sync SNTP	sTm1, sTm2, sTm7, sTmN1	sTm5

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