



Telecontrol-Interface-Module

Type TK102



1. Application

The TK102 operates as a coupling-device or protocol bridge between field devices – IEDs, Voltage regulators etc. and a local RTU or directly to a control centre. The TK102 also operates as a communications processor that supports almost all important telecontrol protocols.

1.1 Features

The TK102 ...

- is conform to BDEW-Whitepaper and supports full Cybersecurity
- supports RBAC and RADIUS
- is able to process Sampled Values according to IEC 61850-9-2
- supports many serial & Ethernet Telecontrol Protocols including:
 - IEC 61850 Ed. 1 & 2, MMS, GOOSE & Sampled Values (= 61850-8 and 61850-9)
 - IEC 870-5-101, 103 and 104
 - DNP 3:00
 - SPABUS
 - MODBUS
 - C37.113
 - ELAN-Extension via Ethernet
 - NTP/PTP to DCF Time Synch Feature
 - SNMPv3
- Multiple choices for connection such as copper, RS 485 and RS 232 or fibre-optics, (ST and SMA Connectors), Ethernet ports can be:
 - Fiber ST (via optional adapter) and LC (100Mbit and 1Gbit per Software-Switch)
 - Copper RJ45 (10/100/1000 Mbit autoswitching)

- Supports multiple Serial Ports Coordinates the telegram traffic between one or more substation units, and with all possible connection types to central stations or substations
- Settings may be changed online at any time

1.2 Specification

The TK102-board is equipped with a high performance dual-core microcontroller with PowerQUICC – engine driven serial communication ports and operates as a standalone computer with an address-range of 17,6 TByte and supports „Cache Coherent Interconnect“ (CCI400) as well as QorIQ™-Network-Technology.

The CPU runs up to a speed of 1 GHz. The board has a maximum capacity of 1 GB RAM, 64 MB NOR Flash and a micro-SD-card with up to 256 GByte capacity.

This may be used for logging and system configuration storage as well as for storing A. Eberle device manuals. All 16 hardware-timers are required for the real-time operating system.

One timer is used for the system cycle. All of the processor included UART - modules control the 5 asynchronous V.24-interfaces. Three of these interfaces have their own baud rate timers.

The PARAM interface used for maintenance purposes via micro-USB. For serial interfaces using pulse-width-modulation an add-on board is necessary.

All interfaces can be used either in PWM or in PCM (pulse-code-modulation) -mode or as control lines for modems serving up to 4 coupling partners.

Despite the functions running by different software branches on TK102, there are supervisory and monitoring functions that protect the TK102 module against malfunctions. These functions are implemented both in hardware and in software.

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1.3 Interfaces

The TK102 module offers the following interface for communication with a PC for programming and set up and for connection with serial devices depending on the physical connection regime:

- 2x10/100/1000 Mbit Ethernet RJ45 or 100/1000 Mbit fibre-optic (ST via optional adapter/LC)
- up to 4 serial interfaces (COMs)
- 2 of those 3 serial interfaces can be RS485
- up to 3 serial fibre-optic interfaces (optional)
- up to 4 COM interfaces have transmitters and receivers with galvanic isolation
- all COM ports are able to work as V.24 interfaces for serial communication and are connected via rack mount or SUB-D connector that include control and data lines.

With the help of parameter driven onboard functions you can adjust the inversion of the specific signals. The status of each channel is shown by the 3 LEDs on the front panel indicating sending activity (green), receive activity (yellow) and an error condition (red).

1.4 Socket Connections on the Front

On the left hand side of the front panel is a micro-SD-connector intended for maintenance purpose.

Also using one of the Ethernet connectors is possible for maintenance.

You can easily adjust the settings of the TK102 online at any time.

In case of special application, you can use the USB 2 Micro B connector of front to access the inside located micro-USB-Card.

2. General Functions

In addition to the functions run by different software applications, there are also functions which protect against malfunctions of the device. These functions are realised by hardware implementation and by software routines (watchdog)

2.1 Contact Positions for COMs and Power

A) DIN-C-Connector B1 Release

| Pin | d | b | Z |
|-----|----------|------------|------------|
| 2 | COM1 TxD | COM1 RTS | COM1 RxD |
| 4 | COM1 CTS | COM1 485-P | COM1 485-N |
| 6 | COM2 TxD | COM2 RxD | COM2 GND |
| 8 | COM4 TxD | COM4 RTS | COM4 RxD |
| 10 | COM4 CTS | COM4 485-P | COM4 485-N |
| 12 | COM4 GND | COM1 GND | COM3 GND |
| 14 | COM3 TxD | COM3 RTS | COM3 RxD |
| 16 | COM3 CTS | COM3 485-P | COM3 485-N |
| 28 | | | P |
| 30 | | N | |
| 32 | PE | | |

B) DIN-C-Connector B2 release

| Pin | d | b | z |
|-----|----------|------------|------------|
| 6 | COM2 TxD | COM2 RxD | COM2 GND |
| 12 | | | COM3 GND |
| 14 | COM3 TxD | COM3 RTS | COM3 RxD |
| 16 | COM3 CTS | COM3 485-P | COM3 485-N |
| 28 | | | P |
| 30 | | N | |
| 32 | PE | | |

C) Connector B2 Release Param/COM1

| Pin | Signal | Pin | z |
|-----|------------|-----|-----------|
| 1 | COM1 485-P | 7 | Param GND |
| 2 | COM1 485-N | 8 | PE |
| 3 | COM1 TxD | 9 | Param RxD |
| 4 | COM1 RxD | 10 | Param TxD |
| 5 | COM1 RTS | 11 | Param GND |
| 6 | COM1 CTS | 12 | + 5 V |

D) Sub-D-Connectors B3 Release

| Pin | Signal | Pin | z |
|-----|------------|-----|------------|
| 1 | COM1 485-P | 5 | COM1 485-N |
| 2 | COM1 RxD | 6 | COM1 GND |
| 3 | COM1 TxD | 7 | COM1 RTS |
| 4 | COM1 485-N | 8 | COM1 CTS |



At the B1 type COM1/DB-9 is paralleled with a SUB-D-Connector. N.B.: COM1 may only be connected at one time via DIN-F-Connector or via SUB-D-Connector.

The B3 type has got 4 COM ports (COM3 and 4 under the COM1 of the middle Slot and COM2 at the aux. power slot on right side), which also have the same pinning like COM 1

2.2 Reset

There are four possibilities to trigger the reset on a TK102. A proper restart of TK102 is guaranteed for each of the following:

- by pressing "RESET" on the front panel
- watchdog runs up
- reconnection and return of power supply
- reset by monitoring software module

2.3 Watchdog

Watchdog is a hardware supplement to monitor the smooth process of the software. It consists of a timer that has to be triggered continuously by a background software program. Lack of retriggering leads to a hardware-reset. The correct status of watchdog is displayed by a LED on the front panel, near the Reset-button at B1 and B2 release. B3 has the Reset-button under the Ethernet connectors.



3. Technical Data

| | |
|----------------------|-------------------------|
| Processor | NXP |
| Processor technology | Dual Cortex A7 |
| Memory | 1 GB SDRAM |
| Operating system | Linux |
| Serial interfaces | max. 5 |
| Input-resistance | 1000 Ohm |
| Output-resistance | 120 Ohm |
| Input-voltage | ± 3 ... 12 V |
| Power supply | + 5 V ± 10 % 2,5 A max. |

Reference conditions during operation in a 19" rack or wall mount rack:

| | |
|---------------------|--------------------|
| Temperature: | - 20... + 55 °C |
| Relative humidity : | max. 85 % at 25 °C |

Reference conditions during storage:

| | |
|--------------------|--------------------|
| Temperature: | - 25... + 65 °C |
| Relative humidity: | max. 80 % at 25 °C |

3.1 Setting up TK102

A generated file is transferred via micro-SD or Ethernet interface from a standard PC into TK102. Data is kept in flash memory.

3.2 Applied Rules ad Standards

- IEC 61010-1 / EN61010-1
- IEC 60255-22-1 / EN 60255-22-1
- IEC 60529 / EN 60529
- ICE 60068-1 / EN 60068-1
- ICE 61000-6-2 / EN 61000-6-2
- ICE 61000-6-4 / EN 61000-6-4



3.3 Mechanical Construction Release B3

| | |
|---|---|
| Front panel | Stainless steel, Wst. 1,4301; 0,1 mm |
| Height, width, depth | 3U, 6T (147 mm, 90,36 mm, 127 mm (incl. lugs on front panel)) |
| Weight | ≤ 0,4 kg |
| Protection class | |
| Plug-in device | IP 00 |
| Terminal block | IP 00 |
| Mounting according to standard DIN rail at version B3 | |

3.4 Operating Modes

The telecontrol board TK102 has not got any jumpers on board. In order to switch between the operating modes RS485 and RS232 (fibre optic mode is done via RS232 mode and additional piggy back module), a software parameter has to be set accordingly.

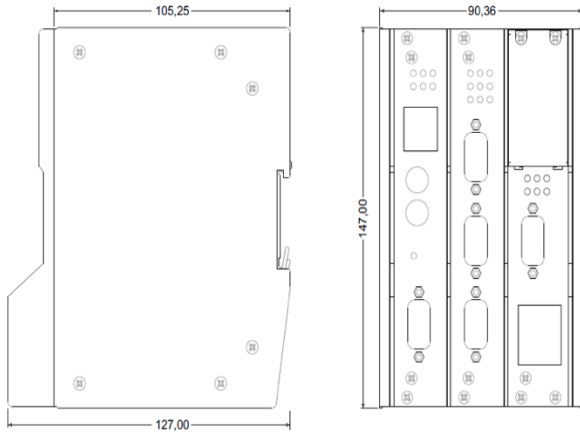
3.5 Fibre optic Connectors for COM 1 - 4

The TK102 has got jumper free settings via software. COM 1-4 may be extended by an additional fibre optic board. This board allows you to switch the idle level via jumpers.

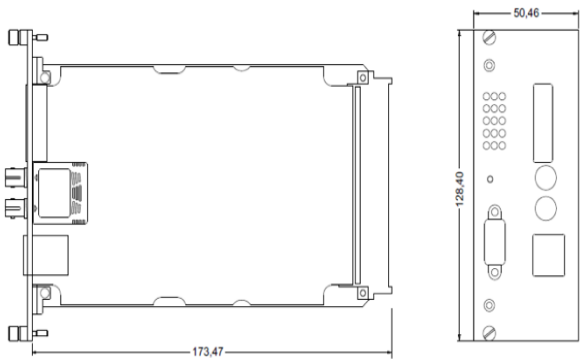
Jumper settings fibre optic board at B1-B2 release

| Jumper | Bedeutung |
|--------|------------|
| X5-1 | Invert RxD |
| X6-1 | Invert TxD |

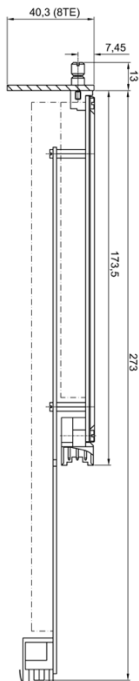
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Picture 1: Dimensions rack at B3 release



Picture 2: Dimensions plug-in module at B2 release



Picture 3: Dimensions plug-in module at B1 release

4. Electrical Connection

Terminal screws with self-locking protection; clip on connector block.

4.1 Ethernet Connection

The TK102 is available with either RJ45 or fibre-optic (LC) connectors. The RJ45 connector provides Ethernet at 10/100/1000 Mbit (auto switching) whereas the fibre connectors are only available at 100 and 1000 Mbit speed. With additional add-on-board up to 4 NICs are available.

You can order the board with:

- 2 RJ45 or
- 1 RJ45 and 1 LC or
- 2 LC connectors.

4.2 RS485-Processing

In order to terminate the RS485-bus you can connect a termination resistor by soldering according jumpers, depending on the type used on the mainboard.

It can be ordered with preinstalled active termination resistors.

4.3 Electrical Safety

Protection class I

Grade of pollution 2

Overtoltage category, rated isolation voltage

| Name | Overtoltage | Max. Over-voltage |
|-------------------|-------------|-------------------|
| Serial interfaces | II | 50 V front |
| Serial interfaces | II | 350 V back |

Transient voltage 5 kV, 1,2/50 ms, 0,5 Ws

Strength immunity

Electrostatic discharge Air load 8 kV
Contact load 4 kV

Electromagnetic fields 80 MHz...1000 MHz 10 V/m
900 MHz ± 5 MHz 10 V/m
pulse modulated

Rapid transient disturbance quantities(Bursts)

Power supply AC 230 V: 2 kV

Contacted RF- 0,15 MHz...80 MHz

disturbance factors $U_{eff} = 10 V$

50 Hz-magnetic field 30 A / m

Interference emissions Limit Class A according to IEC 61000-3-2



4.4 Commissioning of the Board

For commissioning purposes, a quick guide and user manual with setting guide is provided with the board, and also downloadable on our home page. The parameterizing is done via web browser or a Windows-based application.

4.5 Data Programming Cable

Cable has to be shielded and may not be longer than 3 m.

| PC-Sub-D-Connector 9 pol. | Meaning | TK860D Sub-D-Connector 9 pol. |
|---------------------------|----------|-------------------------------|
| 1 | n.a. | – |
| 2 | TXD SMC1 | 3 |
| 3 | RXD SMC1 | 2 |
| 4 | n.a. | – |
| 5 | GND | 5 |
| 6 | n.a. | – |
| 7 | n.a. | – |
| 8 | n.a. | – |
| 9 | n.a. | – |

4.6 Fields of Application

The telecontrol board TK102 processes the following telecontrol protocols together with A-Eberle or other manufacturer devices:

- IEC 60870-5-101
- IEC 60870-5-103
- IEC 60870-5-104
- IEC 61850
- DNP 3.0
- Routers:
 - IEC 60870-5-101 to IEC 60870-5-104
 - IEC 60870-5-103 to IEC 60870-5-101
 - IEC 61850 to IEC 60870-5-104
 - IEC 60870-5-103 to IEC 61850
 - Modbus TCP to IEC 61850
- Modbus RTU
- C37.118
- ELAN-Extension via Ethernet
- NTP/PTP to DCF Time Synch Feature
- SPABUS
- Other protocols on demand.

The telecontrol connection can be made via RS232 and RS485, via copper or fibre optics. Settings are done via web browser or a Windows-based application, which is

divided in two main sections:

- common part, where only baud rate and device name or address have to be entered and
- Advanced part, where specialist can adjust specifics.

This allows specific parameters such as: timeouts and making protocol requirements in the telecontrol profile.

4.7 Example Applications:

A) COM Server

a) COM Server Only Application: Up to 4 COM ports serve both Ethernet connections, assuming that the 2 Ethernet addresses are different. Example: IP address of Port 1 is set to 192.168.1.214 and IP address of Port 2 is set to 10.0.0.215, or “bonding” in “active backup mode” or RSTP was selected, then both Ethernet interfaces have same IP and MAC address.

b) ELAN-Extension (CSE, COM Server Ethernet): Extension of ELAN via serial port of TK102 over Ethernet in order to connect to another REG-PE(D) via Ethernet in order to achieve wide area ELAN.

B) Dedicated Protocol Application

a) Working as a telecontrol board for customer specific devices starting with IEC 60870-5-103 or 104 telecontrol protocols e.g.: for the substation connection of A. Eberle devices, you can easily update later to IEC 61850 by firmware update, no hardware change is needed.

b) Working as a protocol router

0 IEC 60870-5-101 to IEC 60870-5-104

Up to 4 COM ports may be used to connect the Router to IEC 60870-5-101 lines of several substations, to multiple control centres via IEC 60870-5-104. The only settings required for this application is to simply entering addresses and baud rate.

- IEC 60870-5-103 to IEC 60870-5-101
With the help of fibre-optic star couplers of you may connect up to 8 IEC 103 devices to one COM port of a TK102 board, and route information to another COM port with IEC 101 protocol.
- IEC 61850 to IEC 60870-5-104
One ethernet port may be connected to IEC 61850 and the other Ethernet port to IEC 60870-5-101, or both protocols may be operated from the same ethernet port.
- IEC 61850 to IEC 60870-5-103
Router works as slave for IEC 60870-5-103 master and client for IEC 61850.

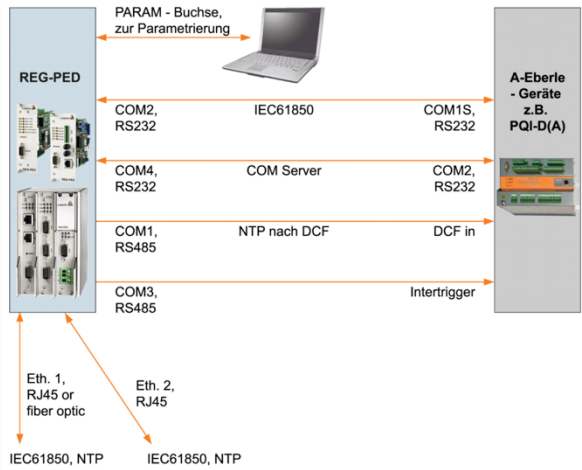
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C) Mixed Ethernet Operation

If you order one Ethernet port with electrical RJ45 connector, and the other Ethernet port with fibre-optic connector, you are free to choose the connector type. Even combined use of both ports is possible.

D) Optimal Use of all Interfaces

The following scheme shows the one of the optimal use cases of a TK102 card:



Picture 4: Example application

General Information concerning Dual Ethernet Connectors

Both Ethernet connectors may be merged to one logically interface using so called “bonding feature” in “broadcast mode” or RSTP, where both Ethernet interfaces have same IP and MAC address. Additionally they can be set in PRP as well as RSTP mode.

„Modbus Collector“ for TK102 - a real highlight:

Using Modbus-Master functionality, the device will collect sensor data from arbitrary Modbus-slaves. Use this data for example to support regulation function by sending it to regulating devices or in fact to any receiver via IEC 61850. This functionality is a replacement for the „COM3-Extension“.

IEC61850 support for REG-DGA via Modbus Collector - collect data from up to 32 Modbus devices and make them available via one virtual IEC 61850 device.

Data acquisition according to IEC61850-9-2 (“Process-Bus”)

With the help of the available add-on board with 2 Ethernet Interfaces you can listen to Sampled Values and use them for data acquisition e.g. for the voltage regulator REG-D.



Picture 5: Fibre optic (LC) version of B1 release



Ordering Details

- Only one code of the same capital letter is possible
- When the capital letter is followed by number 9, further details are necessary
- The code can be omitted when the capital letter is followed by zero
- An X code e.g. XP1 cannot be combined freely with other codes

| Telecontrol Interface Module REG-PED ^{SV} | |
|---|---|
| Characteristic | TK102 |
| Protocol Interface Unit For connection of A. Eberle devices to a SCADA system with 3x RS232 or with 3x RS485, one of them may be used as SCADA interface for the protocols IEC 60870-5-101/103/104, 61850, DNP 3.0 or Modbus; incl. parametrization software TeleRoute | TK102 Sampled Values acc. to IEC61850-9-2 and Cyber Security |
| Design 19" plug-in unit (8TE, 3HE) for racks (long version) 19" plug-in unit (10TE, 3HE) integrated into a wall mounting case (short version) DIN-Rail version installation with other REGSys™-components | B01 B02 B03 B09 |
| IT-Security Without With | – I1 |
| Power Supply Wall mounting version (20TE, 3HE) wired; incl.wiring for power supply AC 85V...110V...264V / DC 100V...220V...280V DC 18V...60V...72V | H1 H2 |
| SNMPv3 Without With | SN0 SN1 |
| Protocol option: Needing a connection for "old" protocols like DNP 3.0 serial please add "V" and "Z" features 2x RJ45 1x RJ45, 1x LWL (100 MBit, Multimode, LC, ST via optional adapter) 1x RJ45, 1x LWL (1000 MBit, Multimode, LC, SX, ST via optional adapter) 1x RJ45, 1x LWL (1000 MBit, Multimode, LC, LX, ST via optional adapter) 2x LWL (100 MBit, Multimode, LC, ST via optional adapter) 2x LWL (1000 MBit, Multimode, LC, SX, ST via optional adapter) 2x LWL (1000 MBit, Multimode, LC, LX, ST via optional adapter) | D4 D11 D11.1 D11.2 D12 D12.1 D12.2 |

| | |
|--|---|
| <p>Process bus IEC 61850-9-2:</p> <p>Without Process bus with Process bus, 2x RJ45 (100/1000 Mbit) with Process bus, 1x RJ45, 1x LWL (100MBit, Multimode, LC, adapter to ST available) with Process bus, 1x RJ45, 1x LWL (1000MBit, Multimode, SX, LC, adapter to ST available) with Process bus, 1x RJ45, 1x LWL (1000MBit, Multimode, SX, LC, adapter to ST available) with Process bus, 2x LWL (100MBit, Multimode, LC, adapter to ST available) with Process bus, 1x RJ45, 1x LWL (1000 MBit, Multimode, LC) with Process bus, 2x LWL (1000 MBit, Multimode, LC)</p> | <p>T0 T1 T2 T2.1 T2.2 T3 T4 T5</p> |
| <p>Type of connection for serial protocols up to 115200bd</p> <p>Copper: 1 x RS 232 RS 485; two-wire operation only</p> <p>Fibre optic connection with FSMA Glass (wavelength 800...900 nm, distance < 2000 m) Plastic (wavelength 620...680 nm, distance < 50 m)</p> <p>Fibre optic connection with ST Glass (wavelength 800...900 nm, distance 2000 m) Plastic (wavelength 620...680 nm, distance 50 m)</p> <p>Fibre optic connection with VL Plastic (wavelength 620...680 nm, distance 50 m)</p> | <p>V10 V11 V13 V15 V17 V19 V22</p> |
| <p>Telecontrol Protocol</p> <p>IEC 60870-5-103 IEC 60870-5-101 DNP 3.00 MODBUS RTU SPABUS COM Server DNP 3.00 via Ethernet MODBUS TCP/IP IEC 61850 IEC 60870-5-104</p> <p>NB: All other protocols on demand!</p> | <p>Z01 Z02 Z20 Z23 Z22 Z09 Z21 Z24 Z31 Z92</p> |



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