Application

The fiber optic coupler FOSM10 is intended for the use in the Remote Terminal Unit PKS RTU513 or in other foreign devices. The module is used to transmit data via two independent optical links (Receive and Transmit). Optical fiber cables are not sensitive to inductive and capacitive interferences, as well for potential differences between the two data communication equipments. Fiber optic cables will be used to bridge over distances in critical environments, or if a potential isolation is required. The maximum distance can be up to 2600 m. The board can be used for signal conversion of the received and transmitted data for the following electrical interface standards:

- PKS RTU513 I/O-Bus
- RS485 Bus
- RS232 C

Hence it follows the following applications:

- Substitution of the PKS RTU513 electrical serial peripheral bus between the subracks of a station
- Coupling of digital protection relays with fiber optic interfaces according to IEC60870-5-103
    - With point to point connection
    - In a multi-drop link connection
    - In a bus link
- Optical booster to extend a fiber optic link
- Connection to any other unit with optical interface

The board FOSM10 occupies one slot in a PKS RTU513 rack. It couples itself via the backplane direct with the RTU513 peripheral bus. The board is available for 820 nm glass fiber optic cable with bayonet lock socket

Application

type BFOC/2.5 according to IEC 874-10. The fiber optic cable connection is done by the four lock sockets on the front plate. The maximum distance between two FOSM10 depends on:

- the fiber optic cable type
- the number of fiber slices

The maximum transfer rate is only limited by the transmission rate of the electrical interface. Interface standard and output optical power can be selected and configured by jumper.

The marking condition is defined to ‚Light ON' or ‚Light OFF'.

Selectable time supervision (TSV) switches the receiver off, if the receive signal is active longer than 16 msec. The electrical RTU513 peripheral bus can be substituted by the FOSM10 board either between groups of sub-racks or as well completely. The real configuration can be adapted very easy to the actual local facts. The FOSM10 connects the subracks either in a star-configuration or in a multipoint-T configuration.

The FOSM10 board allows direct connecting the digital protection relays either in a point-to-point link, in a multi-drop link or in a bus link. One FOSM10 board can be used also as optical amplifier without additional wiring. Six light-emitting diodes on the front panel indicate the following operation states:

- Tx 1/2 Transmit data active
- Rx 1/2 Receive data active

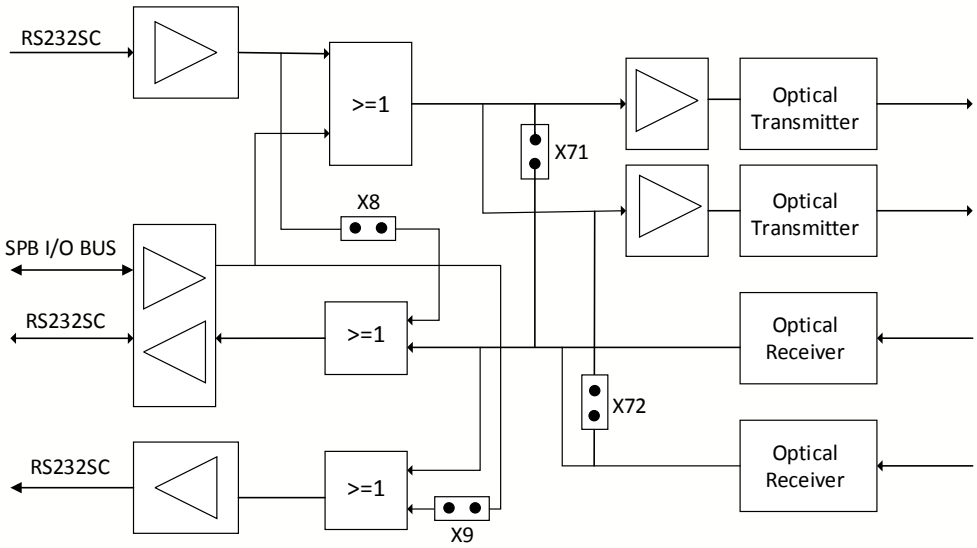

Fig.1:Principle block diagram

Operation

The FOSM10 board is used to convert electrical serial interface signals to / from optical-fiber signals. The FOSM10 board is available in one version:

- 820 nm glass optical fiber with bayonet lock connector BFOC/2.5 (IEC874-10) The FOSM10 board can convert
- PKS RTU513 serial peripheral bus (SPB)
- External RS485 bus
- RS232C serial interface

The board FOSM10 is functional and pin-compatible to the FOSM10.

Processing functions

The FOSM10 board allows the following processing functions:

- Universal Fiber Optic Coupler
- Replacement of serial RTU peripheral bus
- Optical star coupler with RS485-Bus
- Optical repeater

Serial peripheral bus

Fig. 4, 5 shows the possible configurations to substitute the electrical RTU513 serial peripheral bus (SPB) by an optical fiber connection. The optical link is possible between each subrack or between groups of subracks. It depends on the physical distribution which solution is taken. By using the star configuration the maximum expansion is defined by the distance between the basic subrack and the extension subrack. By using the Multipoint-T-configuration the optical-fiber signals are reconditioned in the extension subracks, thus allowing significant enlargement of the geographical arrangement of the RTU's I/O subracks.

Serial peripheral bus

The total distance is calculated as the sum of the distances between the extension subracks.FOSM10 boards should be used if the serial bus is routed through an area with electrical noise and critical EMC conditions or if the grounding voltage differences between two subrack groups may increase the allowed value for RS485 signals. The FOSM10 board access to the system internal peripheral bus (SPB) directly via the DIN-F connector on the subrack.

Coupling of digital protection relays with optical-fiber connection

Star-Configuration RS485-Bus

The electrical RS485 bus is connected to all FOSM10 boards (half duplex operation). Only two lines have to be wired. If one FOSM10 board is faulty in this operation mode (e. g. LED'ST'='ON') or one board is not connected to the subrack the RS485 bus will not be blocked. Therefore in optical-star configurations theRS485 bus should be used instead of cascaded receive signals.

Optical Ring with RS485 Bus

The optical ring will be configured by the jumper X71/X72. All devices are connected in series. If one device fails, the whole system will fail.

Party line with cascaded receive signals (Recommended only for FOSM10 replacement)

The received data of the digital protection relays are combined in cascades with each other by means of OR elements and routed to the communication unit. For easier wiring the terminals for transmit data are available in duplicate. In this arrangement RS485 or RS232C signals can be used by corresponding wiring alternatively. The selection must be coordinated with the settings of the connected communication unit.

Coupling of digital protection relays with optical-fiber connection

RS232C to RS485 Converter

The first board FOSM10 is used as a converter from RS232C to RS485. All other boards in the configuration are connected via the RS485 bus. If the first board in the configuration fails, the whole system will fail. A failure on a board connected to the bus, will not influence the rest of the system.

Optical Repeater

If the direct distance between two FOSM10 boards is too long, an optical repeater can be created by inserting one FOSM10 boards in the optical link (refer to Fig.10). Each FOSM10 board used as optical repeater enlarges the total length of the fiber optic link by one times of the maximum length of one direct link. Table 8 shows the jumper settings to configure the FOSM10 board for this operation mode. The received signal RX1 is switched directly to the transmitter TX2, and the received signal RX2 to the transmitter TX1 via the jumper X71/X72. No additional external wiring is necessary.

Settings

Adaptation to optical-fiber cable

Optical overload of the input must be avoided. Otherwise the lifetime and the dynamic characteristic of the optical receiver will decrease. The adaptation attenuation for the existing fiber optic lines is set in 8 steps between 0 and -14dB (for settings refer to table 1). The overall attenuation can be measured and corresponds to the real relations or it can be calculated by means of the formula in Fig.2. The attainable cable lengths depend on the used type of fiber optic cable. Fig.2 shows the association between the different types of power output and attenuation.

Bus Termination for PKSRTU513 I/O-Bus

The jumpers X2 and X3 define that the serial peripheral bus (SPB) is used as electrical interface (X2 = TA,X3 = TB). The jumpers X4 and X5 connect terminating resistors, which are necessary as terminators of the RS485 bus. The PKS RTU513 subracks provide these terminating resistors already.

Settings

Bus Termination for RS485

If the RS485 bus is used as electrical interface (setting X2 = RxA (2-3), X3 = RxB (2-3)) the terminating resistors must be set according to the configuration (only at the electrical line's end). The bus termination for the RS485 bus is needed for the first and last board of a configuration according to Fig.9. The jumpers X4 and X5 connect terminating resistors to the RS485 bus. The valid settings are: X4=T1 (1-2), X5 = T2(1-2).

Light position Receiver / Transmitter

The light position of both receivers and transmitters can be set by the jumper X201/X202 (Transmitter) and X211/ X212 (Receiver). In position 1-2 the light position of the fiber-optical Transmitter/Receiver corresponds to the LED, in position 2-3 the light position is opposite to the LED.

Supervision on long active signal

The data received at RX are monitored against continuous signal level. If TSV = 'ON' is selected (Jumper X221/ X222) and the fiber optic input 'RX' is longer than approx. 16 ms on active signal level a malfunction is signalized with LED 'ST' ='ON'. The electrical output signal of the fiber optic receiver 'RX' is turned off and cannot block the electrical receive signal (RxD). The status of the malfunction is indicated by:

- LED 'ST' = ON and LED 'R' = ON

Settings

	System power [dBm]²	Overload Capability [dBm]	Typical connect-or attenuation [dB]	Typical cable attenuation [dB / km]	Attainable fiber-optic length [m]
50 / 125 µm	1.3	0	0.3	3.0	447
62.5/125¹ µm	5.1	2.4		3.5	1469
100/140¹ µm	10.6	7.9		5.0	2128
200 µm	15.6	13.9	1.8	6.0	2607

1) Recommended fiber-optic cable types

2) Includes 3 dB system reserve and attenuation of the two connectors

Table 1: Attainable fiber-optic cable length

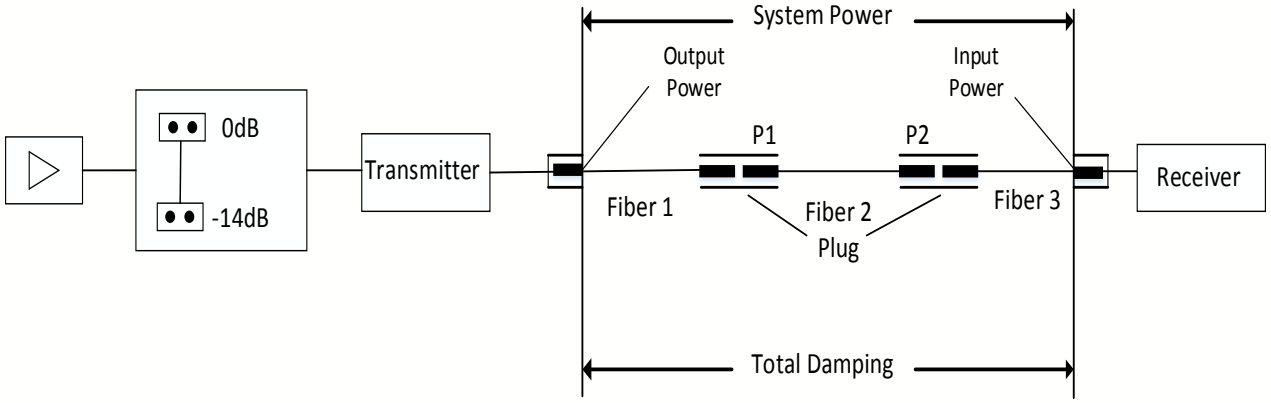

Fig.2: Kinds of power and attenuation by using fiber-optic cables

Overall attenuation = Fiber1 [dB] + P1 [dB] + Fiber2 [dB] + P2 [dB] + Fiber3 [dB]

System power must be ≥ Overall attenuation

Adaption attenuation = Overall attenuation []–overload capability []

e.g. 0.5 dB set jumper x301/x302 to 0 dB

e.g.-0.5 dB set jumper x301/x302 to-2 dB

Settings

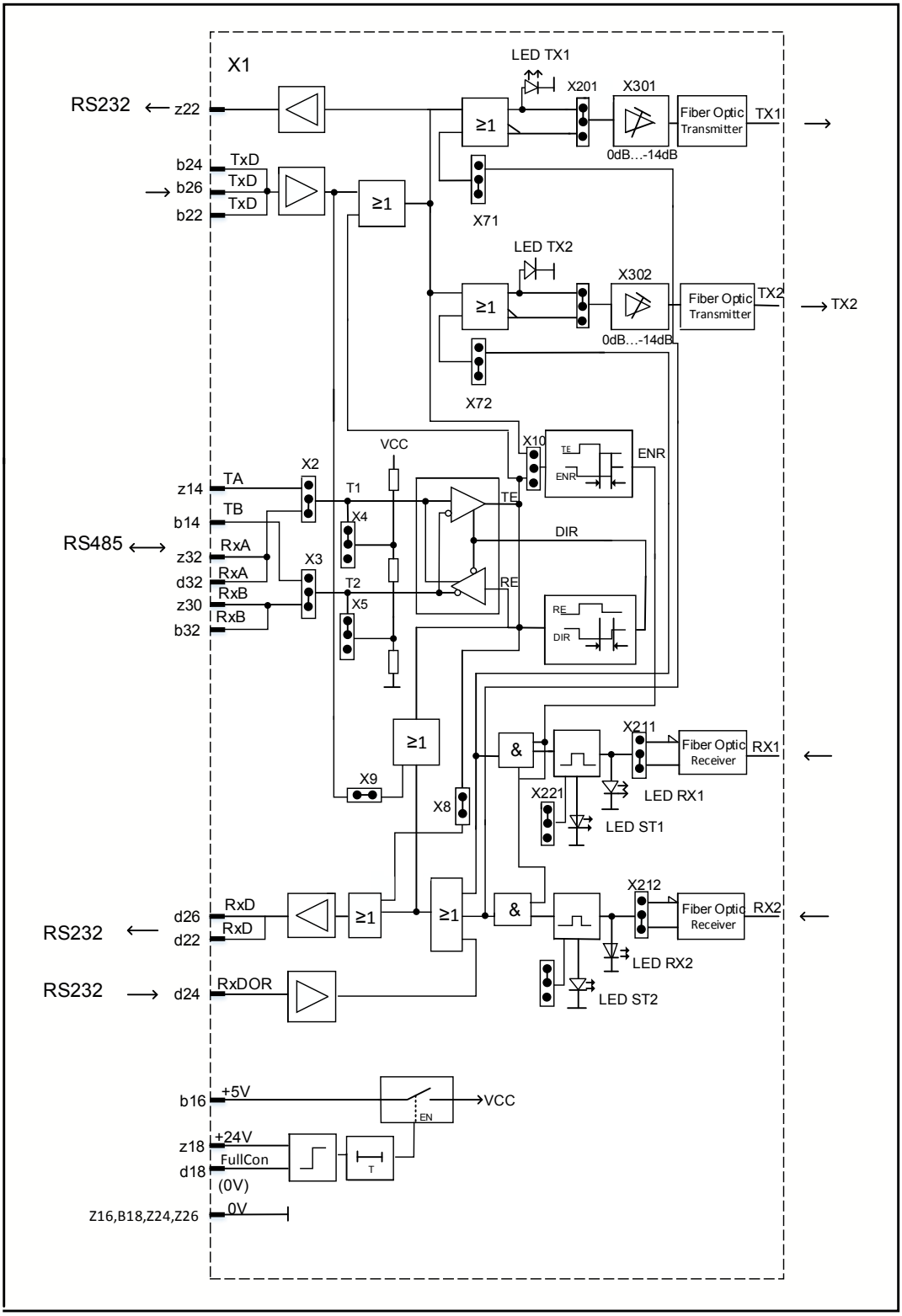

Fig.3: Logic block diagram FOSM10

Settings

Jumper	Position	Definition	Remark
X2,X3		External RS485 Bus	Default
		Serial Peripheral Bus-RTU513	
		Optical Repeater	
X4,X5		Terminating resistors(for A/B) are connected	Default
		No termination resistor	
X8,X9		RS232-RS485 are connected	Default
		RS485 Mode	
X10		Normal operation mode	Default
		Optical ring configuration	
X71,X72		No optical repeater	Default
		Optical repeater mode	
X201(forTX1) X202(for TX2)		Light position at fiber optic transmitter correspond to LED TX	Default
		Light position at fiber optic transmitter opposite to LED TX	
X211(forRX1) X212 (for RX2)		Light position at fiber optic receiver correspond to LED RX	Default
		Light position at fiber optic receiver opposite to LED RX	
X221 (for RX1) X222 (for RX2)		No supervision on long active signal state	Default
		Supervision on long active signal state	
X301 (for TX1) X302 (for TX2)			Default

Table. 2: Setting elements of FOSM10

Settings

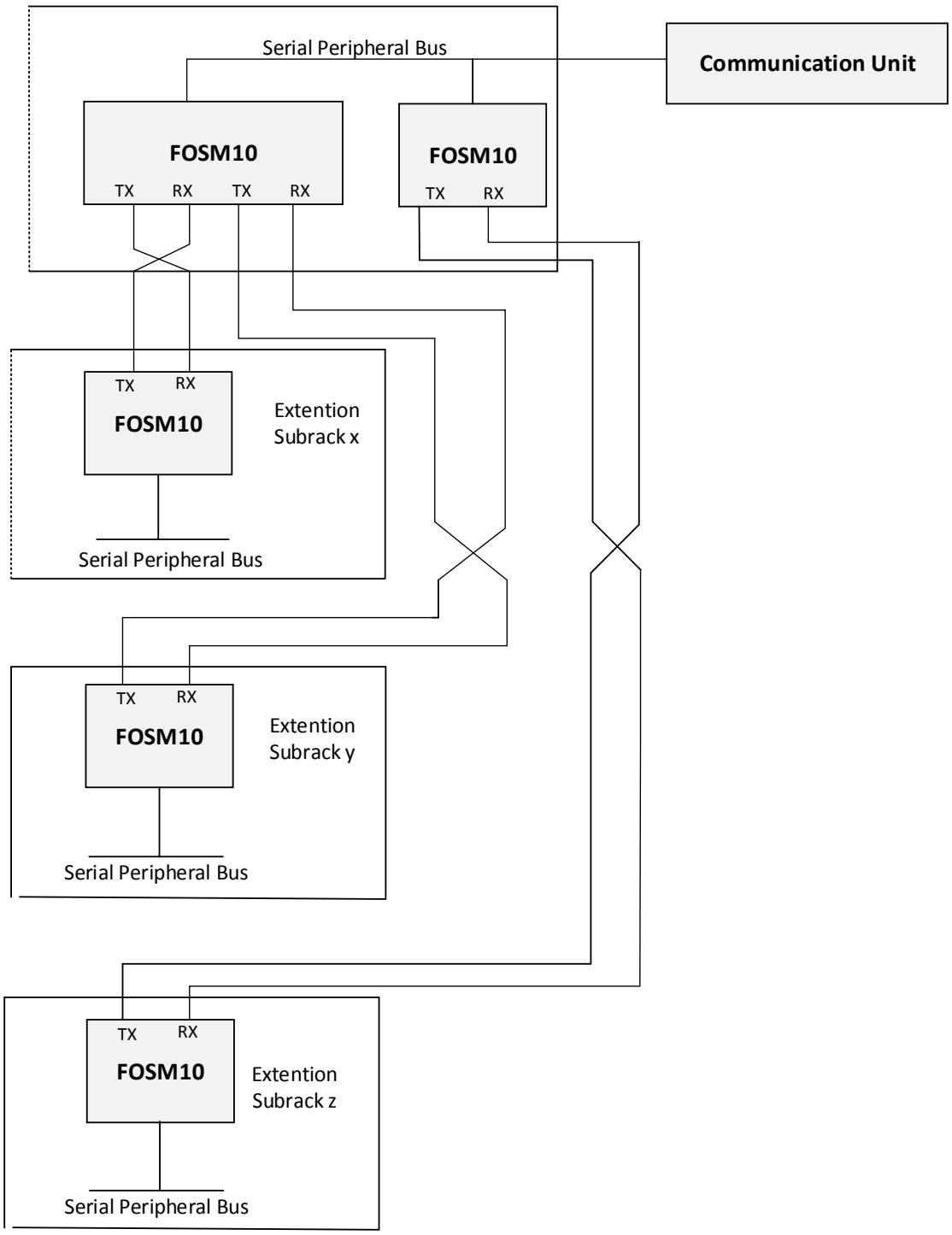

Fig.4: Replacement of electrical RTU513 peripheral bus by means of optical fiber connection (star configuration)

Settings

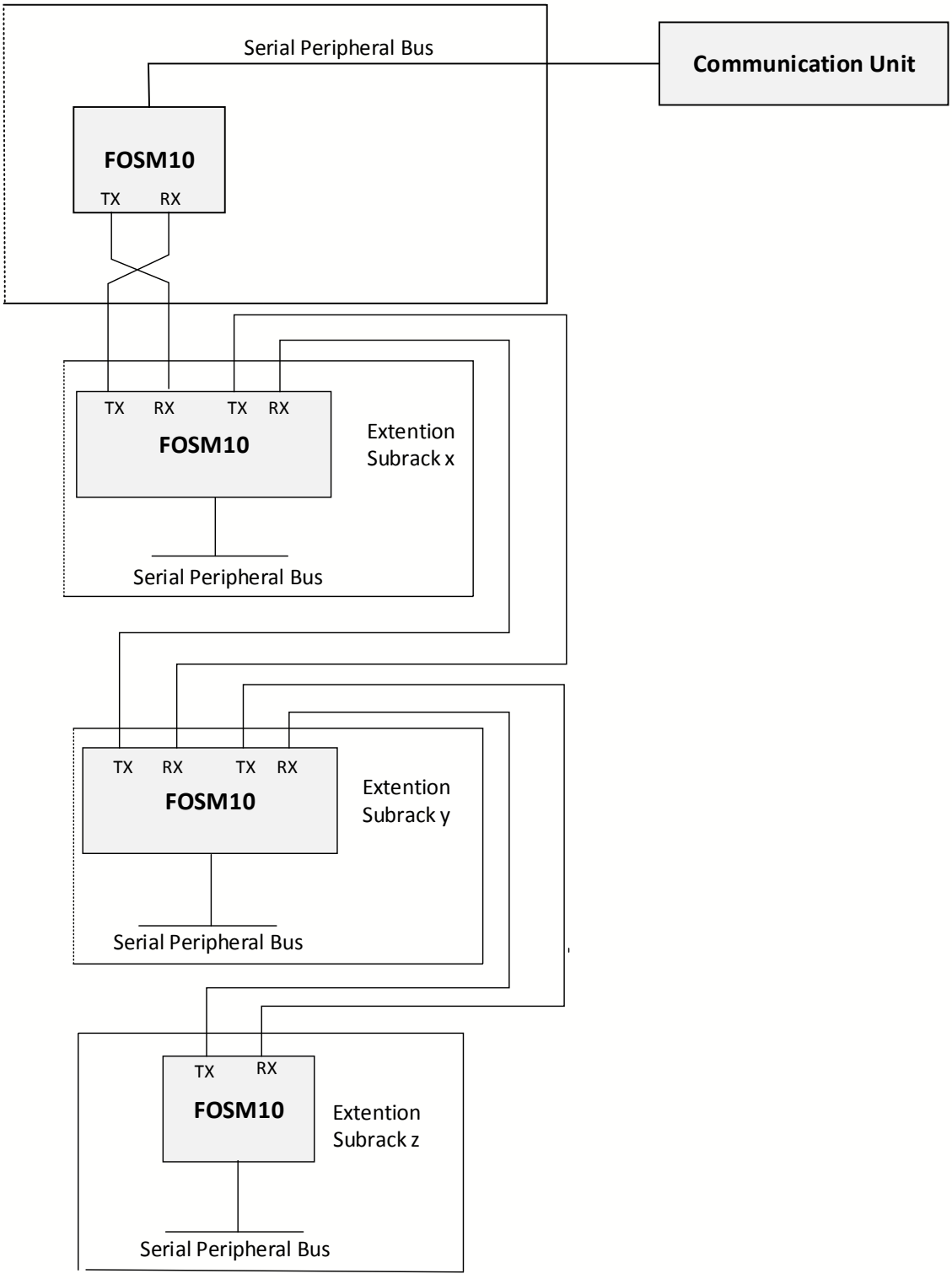

Fig.5: Replacement of electrical RTU513 peripheral bus by means of optical fiber connection (Multipoint-T configuration)

Settings

Jumper	Position	Remark
X2,X3		Serial peripheral bus of RTU513
X4,X5		Terminate the last device only! (if not already terminated in the subrack)
X8,X9		RS485 Mode
X10		Normal operation
X71,X72		No optical repeater
X201, X202, X211, X212, X221,X222, X301 and **X302** depending on local requirements		

Table3: Settings for operation mode ,RTU513 peripheral bus

Settings

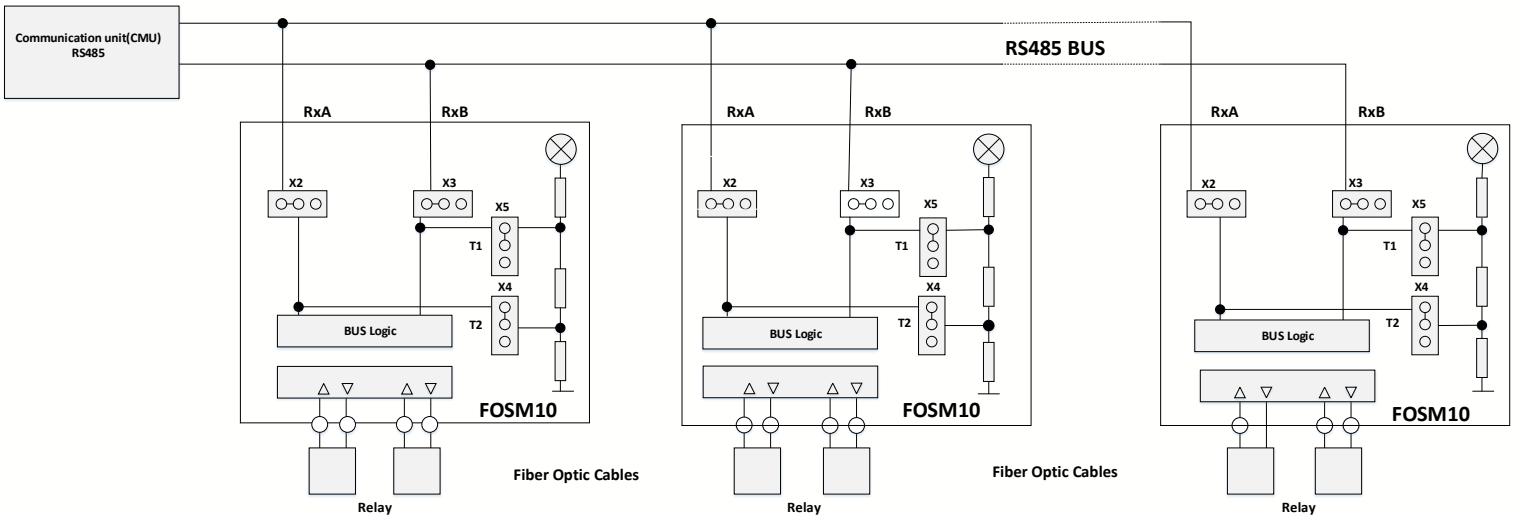

Fig.6: Connection of digital protection relay, star configuration with RS485 bus

Jumper	Position	Remark
X2,X3		External RS485 Bus
X2,X3		Serial peripheral bus
X4,X5		Terminate the first and the last device only
X8,X9		RS485 Mode
X10		Normal operation
X71,X72		No optical repeater
X201, X202, X211, X212, X221,X222, X301 and **X302** depending on local requirements		

Table4: Settings for star configuration with RS485

Settings

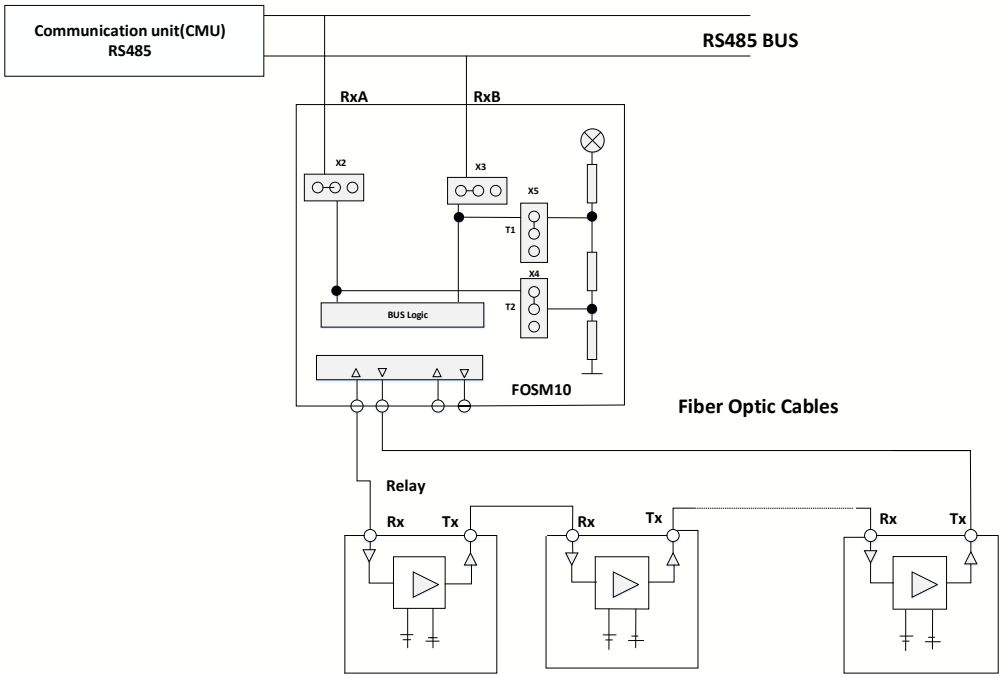

Fig.7: Connection of digital protection relays, optical ring configuration

Jumper	Position	Remark
X2,X3		External RS485 Bus
X2,X3		Serial peripheral bus
X4,X5		Termination active
X8,X9		RS485 Mode
X10		No ring configuration (Master)
X10		Ring configuration (at Protection relays)
X71,X72		No optical repeater
X201, X202, X211, X212, X221,X222, X301 and **X302** depending on local requirements		

Table5: Settings for optical ring configuration

Settings

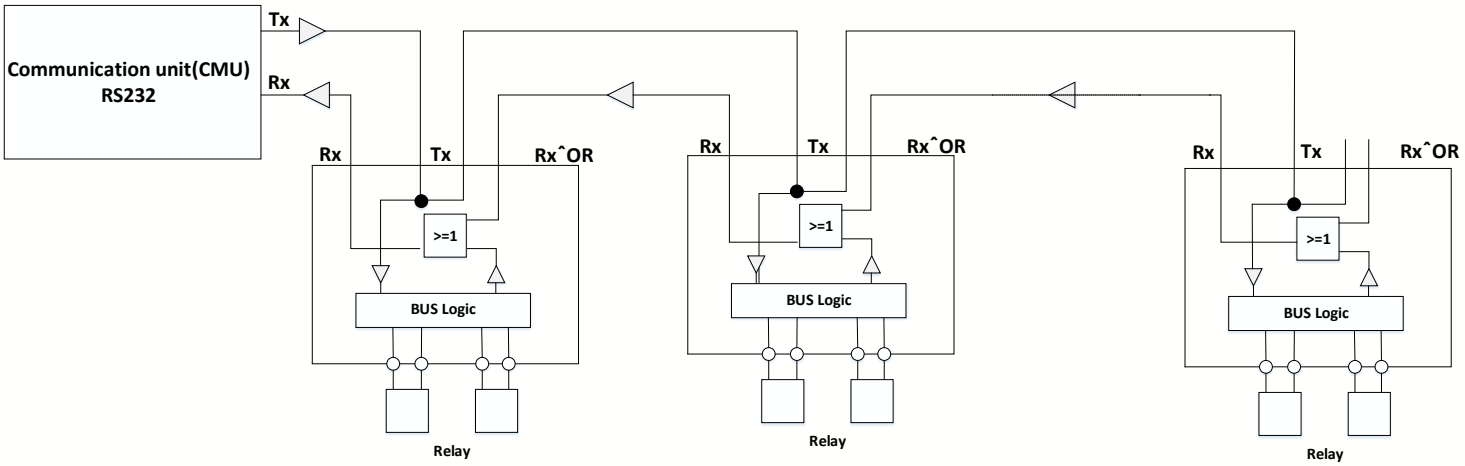

Fig.8: Party line with cascaded received signal

Jumper	Position	Remark
X2,X3		No bus operation
X4,X5		No bus operation
X8,X9		RS485 Mode
X10		No ring configuration
X71,X72		No optical repeater
X201, X202, X211, X212, X221,X222, X301 and **X302** depending on local requirements		

Table 6: Settings for party line with cascaded received signal

Settings

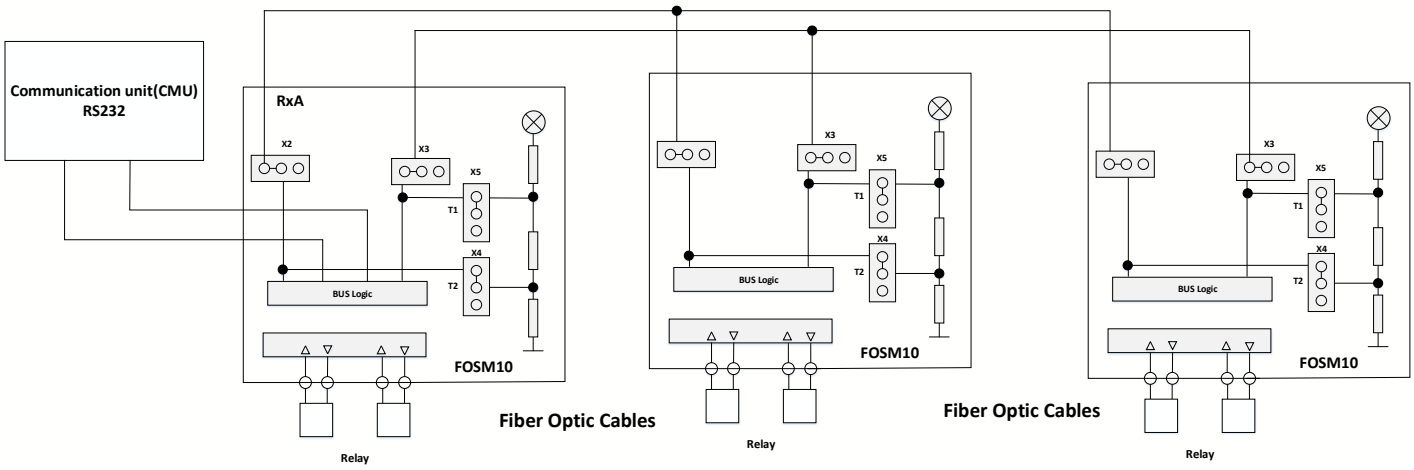

Fig. 9: RS232C to RS485 converter

Jumper	Position	Remark
X2,X3		External RS485 Bus
X4,X5		Terminated
X8,X9		RS232C and RS485 connected
X10		No ring configuration
X71,X72		No optical repeater

First device with RS232 to RS485 conversion

Settings

Jumper	Position	Remark
X2,X3		No bus operation
X4,X5		No bus operation
X8,X9		RS485 Mode
X10		No ring configuration
X71,X72		No optical repeater

All other devices connected to the RS485 bus

Table7: Settings RS232C-> RS485 converter

Settings

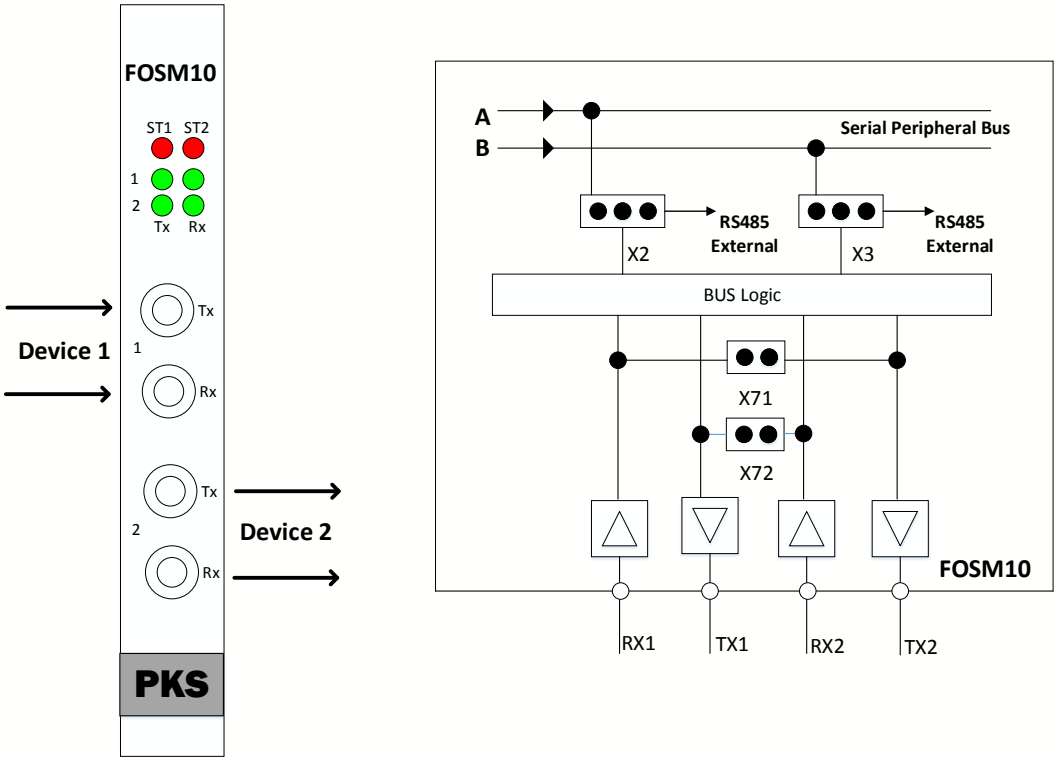

Fig. 10: Optical repeater

Jumper	Position	Remark
X2,X3		Disconnected fromRS485-Bus
X4,X5		Terminated (Always necessary to terminate the FOSM10)
X8,X9		RS485 Mode
X10		No ring configuration
X71,X72		Optical repeater
X201, **X202**, **X211**, **X212**, **X221**,**X222**, **X301** and **X302** depending on local requirements		

Table 8: Settings for optical repeater

Settings

WMS10	SMS10			Signal identification	
	Sub-connector			Abbrev	Definition
1			z32	RxA	External RS485-Bus A
2		b32		RxB	External RS485-Bus B
3	d32			RxA	External RS485-Bus A
4			z30	RxB	External RS485-Bus B
5		b30			<not used>
6	d30				<not used>
7			z28		<not used>
8		b28			<not used>
9	d28				<not used>
10			z26	0V	Signal Ground RS232 C
11		b26		TxD	Transmit data RS232 C
12	d26			RxD	Receive data RS232 C
13			z24	0V	Signal Ground RS232 C
14		b24		TxD	Transmit data RS232 C
15	d24			RxDOR	Receive data OR input RS232 C
16			z22	TxDT	Transmit data test-line / RS232 C
17	6,3Faston			A	
18		b22		TxD	Receive data RS232 C
19	d22			RxD	Transmit data RS232 C

Table9: Subrack terminal connection FOSM10

Please note:

The serial peripheral bus is connected in parallel to both Fiber-optic receiver of the FOSM10. The following states may result in disturbances of the serial peripheral bus:

- Open fiber-optic input with inverted light position
- Faulty fiber-optic connection with permanent light ON

That is way the supervision on long active signal (X221, X222) should always be activated.

Settings

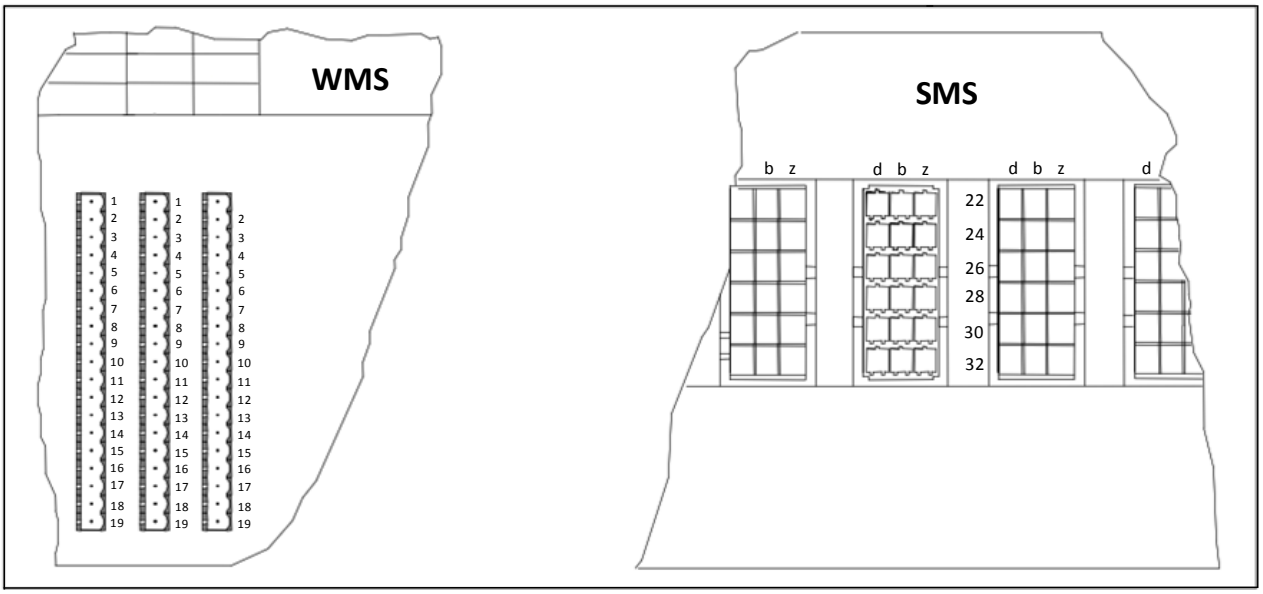

Fig.11: Placement of signal terminal connectors on subracks

Technical Data

In addition to the PKS RTU513 general technical data, the following applies:

Optical Interface

Fiber optic cable length with consideration of a 3 dB reserve:

Fiber optic cable type	Output optical power (dBm)	Input optical power (dBm)	System power (dBm)
50/125µm	-19.7	-24	1.3
*62.5/125µm	-15.9		5.1
*100/140µm	-10.4		10.6
200 µm	-5.4		15.6
Attenuation through two plugs included			
* : Recommended cable types			

Fiber optic coupler

Emission wave length	820 nm
Input optical power	Min.–24.0 dBm Max.–10.0 dBm
Transmission rate	1 Mbit/s max. (max. rate of serial interface)
Marking condition	adjustable

Available fiber optic cable length

Fiber optic cable length with consideration of a 3 dBm reserve, in dependence of the output power and typical fiber optic cable attenuations:

Fiber optic cable type	System power (dBm)	Plug attenuation (dB)	Cable attenuation (dB/km)	Fiber optic cable length (m)
50 µm	1.3	0.3	3.0	447
*62.5µm	5.1		3.5	1469
*100 µm	10.6		5.0	2128
200 µm	15.6	1.8	6.0	2607
* : Recommended cable types				

Technical Data

Electrical serial interfaces

RTU513I/O and RS485 Bus

Signals	TA / TB; RxA / RxB
Input Voltage	-12 V bis + 15 V
Output voltage (at 54Ω load)	5.0 V max.1.5 V min
Input impedance	>12 kΩ
Transmission rate	19.2 Kbit/s
Ready to receive after send	<10 µsec.
No optical echo	Approx...10 µsec.

Interface RS232C

Output Signals	RxD / TxDT
Input Signals	TxD
Input voltage	±30 V max.
Output voltage	±5 V min.
Input impedance	>3000Ω
Transmission rate	=230Kbit/s

Power Supply

Supply	5 V /260 mA max. 24 V /4mA

Mechanical Layout

PCB	3HE, Euro card format (160 x 100)
Weight	App. 0.2 kg
Front plate	4R, 1 slot (20 mm)

Connection types

Connector	Indirect, 48-pole Type F DIN 41612
Fiber Optic Cable	Bayonet lock socket Type BFOC/2,5 (IEC874-10)

Environmental conditions

Temperature	0...70°C
Relative humidity	5 ... 95 % (noncondensing)