

Serial interfaces

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Introduction

Apart from applications in the field of telecommunications, fibre optic technology is of great importance in the industrial market sector.

In telecommunications there are requirements for:

- High transmission capacity
- Low cable attenuation
- No crosstalk

The features are also required in the industrial sector along with the following major considerations:

- Zero susceptibility to electromagnetic interference
- Electrical insulation between transmitter and receiver
- Small cable diameter

Fibre optic communication works by pulses of light. When feeding them in at one end of the fibre optic cable, the pulses are passed to the other end by total internal reflection.

Total internal reflection occurs at the boundary layer between core and cladding by virtue of the different values of optical refractive index (n) between the two materials (n cladding less than n core).

There are three different types of optical fibres:

	Typical Dimensions Core/Cladding ϕ	Attenuation
Step index (SI) fibre HCS ^{®2)} / POF ¹⁾	200 / 230 μm 980 / 1000 μm	5 ... 8 dB/km 0.2 dB/m
Gradient index (GI) fibre	50 / 125 μm 62.5 / 125 μm	2.6 dB/km 3.2 dB/km
Single mode fibre	9 / 125 μm	< 0.3 dB/km

optical refractive index profile

The single-mode fibre is mainly used in telecommunications because of its low attenuation and wide bandwidth.

The gradient index fibre and the step fibre with their large core diameters are chiefly used as communication cables in industrial applications due to their easy handling and relatively low costs. The link length ranges from several meters to several kilometers.

Mounting of connectors for gradient fibres is achieved by the use of adhesive.

For POF¹⁾ or HCS^{®2)} fibres, the crimping technique eases the connector attachment. With the advanced HARTING quick assembly components, POF¹⁾-cables can be mounted without the need of special tools.

HARTING F.O. systems are designed for gradient index fibres with a core diameter of 50 and 62.5 μm as well as for 200 μm (HCS^{®2)}) and 1 mm (POF¹⁾) step index fibres.

The typical operating wavelengths are 660 nm (POF¹⁾, HCS^{®2)}), 850 nm (GI; HSC^{®2)}) and 1300 nm (GI).

¹⁾ POF = Polymer-Optical Fibre

²⁾ HCS[®] = Hard Clad Silica is registered trademark of SpecTran Corporation

System Technique

Electrical signals to be transmitted by fibre optic cable must be converted into pulses of light and vice versa. For this purpose there are electro-optic converters available as transmitter (T) and receiver (R) modules.

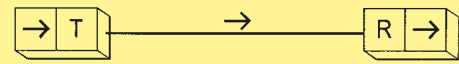
A simplex link is defined by the signal transmission in a single direction. Data transmission in two directions is performed in a duplex link. With these configurations, point-to-point links can be realized. Usually separate fibres for each direction are used.

The interconnection of multiple units in a communication system can be done in different configurations. At the optical line signals are passed through each participant only in one direction. Each participant transmits the received optical signal to the next station (repeater functionality). If the optical line is closed to a ring-structure, bi-directional communication between the participants, is possible.

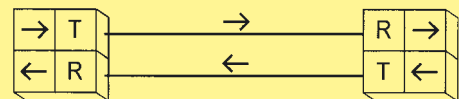
The linear duplex bus is the combination of two contrary lines. Each participant has two transmitting and receiving modules passing received optical signals to the opposite direction and vice versa (repeater functionality).

In a star configuration a central point is the connection mode for each participant. A transceiver module for each participant is equipped at this point. Each star shaped split can be enlarged with the a.m. configurations.

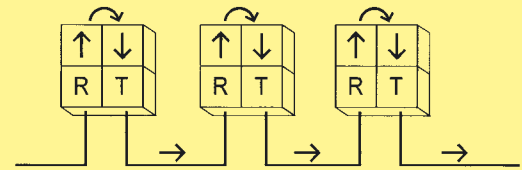
Simplex



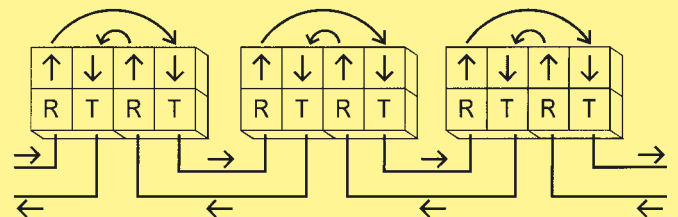
Duplex



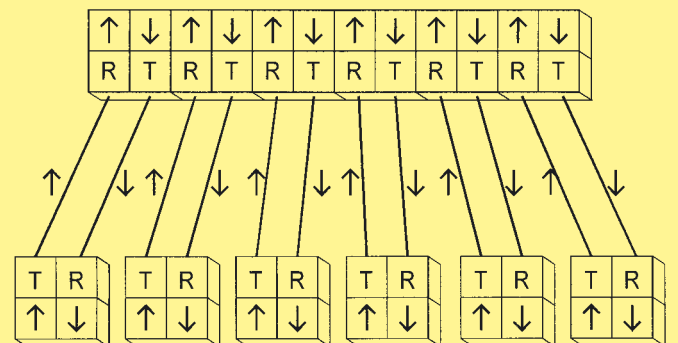
Optical line, optical ring



Linear duplex bus



Star configuration (star coupler)



Dimensioning of F.O. Transmission Systems

For reliable operation of a F.O. data transmission system it is essential that the transmitted optical signals arrive at the receiver with sufficient amplitude. The incident power should at least exceed twice (+ 3 dB) the value of the minimum sensitivity of the receiver. Otherwise, the inherent noise of the system may result in increasing randomly distributed transmission errors in the data transfer. Therefore, in system design the power budget of the optical path has to be checked. The following aspects have to be considered:

● Optical power output of the transmitter

The optical power generated by the LED does mainly depend on the applied forward current.

Typical power levels coupled into the core are

50/ 125 μm GI fibre:	80 μW	} at	850 nm
200/ 230 μm Si fibre:	250 μW		
980/1000 μm Polymer fibre:	600 μW		660 nm

● Specific attenuation-coefficient of the fibre

The specific attenuation of optical fibres depends on the wavelength applied and is specified in dB/km.

Typical values for glass-fibres are

50/ 125 μm GI fibre:	--- 3 dB/km	} at	$\lambda = 850 \text{ nm}$
200/ 230 μm HCS:	--- 5 dB/km		

for Polymer fibre:
980/1000 μm : (PMMA) -- 0.2 dB/m $\lambda = 660 \text{ nm}$.

The fibre loss usually contributes to the highest amount to the overall transmission index of the optical link.

● Additional interconnections in the cable system

Interconnections in the optical link create some further attenuation for the travelling optical signals.

Typical insertion loss is

for a spliced connection	$\leq 0.3 \text{ dB}$
for a connector-set	0.8 ... 1.5 dB,

depending on the type of fibre and the connectors applied.

● Sensitivity of the optical receiver

DC-coupled optical receivers, commonly used, with Si-diodes as receiving elements show typical minimum sensitivities of

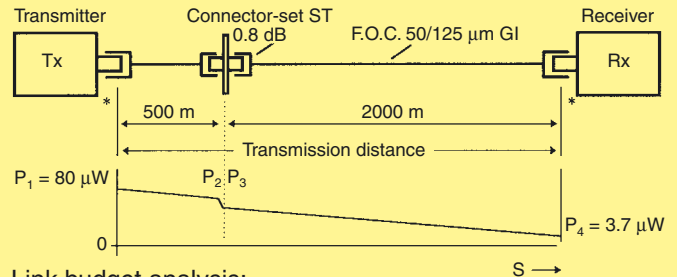
$\leq 3 \mu\text{W}$ at 850 nm (glass fibre systems)
$\leq 5 \mu\text{W}$ at 660 nm (Polymer fibre systems).

● Temperature dependence and ageing of LED, thermal influence on cable loss

These items should be taken into account with an amount of 2 dB. Thus, in total a system reserve of 5 dB has to be considered in the link power budget.

Examples

a) Glass fibre system ($\lambda = 850 \text{ nm}$)



Link budget analysis:

Transmitter

$P_1 = 80 \mu\text{W} \triangleq -11 \text{ dBm}$
power coupled into fibre core

Cable Loss: 2.5 km x 3 dB/km = 7.5 dB

Loss per connector set ST = 0.8 dB

System reserve (3 dB + 2 dB) = 5.0 dB

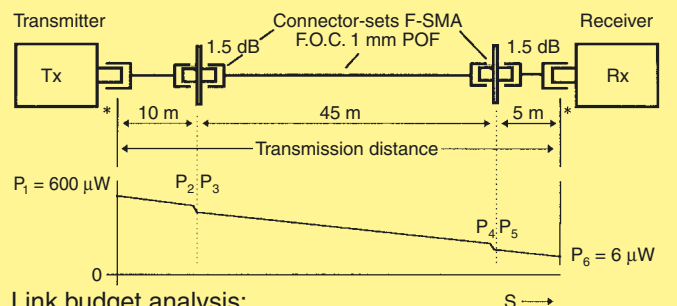
Total system losses: 13.3 dB

Incident power at receiver: $P_4 = -24.3 \text{ dBm} \triangleq 3.7 \mu\text{W}$

This satisfies the required minimum-conditions $\geq 3 \mu\text{W}$

* The injection- and decoupling-loss at the transmitter- and receiver-ends of the fibre has not additionally to be taken into account as they are already included in the given power ratings of these elements.

b) Polymer fibre system ($\lambda = 660 \text{ nm}$)



Link budget analysis:

Transmitter

$P_1 = 600 \mu\text{W} \triangleq -2.2 \text{ dBm}$
power coupled into fibre core

Cable loss: 60 m x 0.2 dB/m = 12.0 dB

2 connector-sets F-SMA (2 x 1.5 dB) = 3.0 dB

System reserve (3 dB + 2 dB) = 5.0 dB

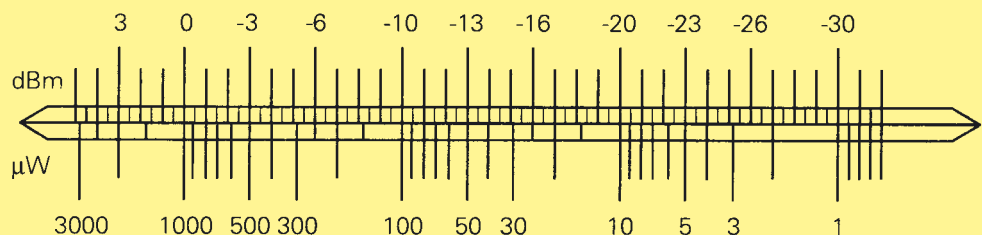
Total system losses: 20.0 dB

Incident power at receiver: $P_6 = -22.2 \text{ dBm} \triangleq 6.0 \mu\text{W}$

This satisfies the required minimum-conditions $\geq 5 \mu\text{W}$

Omitting the additional interconnections in the cable (here e.g. the 2 F-SMA connector sets) results in larger maximum transmission distances.

Conversion-Diagram



Tables of Interface Standards and Fieldbus Systems

For the most well-known electrical interface standards HARTING offers suitable connection systems and converters, especially designed for the conversion of electrical signals into optical signals.

Table of electrical interface standards

	TTL	RS 232	RS 422	RS 485
Interface logic	voltage level	voltage level	differential voltage	differential voltage
Transmission principle	application specific	bi-directional full duplex on min. 3 ¹⁾ bis 9 ²⁾ wires	fullduplex, bi-directional on two twisted pair cables	halfduplex, bi-directional on one twisted pair cable
Logic level "high" Logic level "low"	2.4 ... 5 V 0 ... 0.8 V	- 15 V ... - 3 V + 3 V ... + 15 V	$\Delta U > 0.2 V$ $\Delta U < - 0.2 V$	$\Delta U > 0.2 V$ $\Delta U < - 0.2 V$
Max. data rate	application specific	19.2 kBit/s 115 kBit/s	12 MBit/s (20 m) 100 kBit/s (1.2 km)	12 MBit/s (100 m) 100 kBit/s (1.2 km)
Max. link length with Cu-wires	application specific	20 m	20 m – 1.2 km	100 m – 1.2 km

HARTING media converters for fieldbus systems

Fieldbus system	HARTING product	Page
Suconet K	RS 485 Converter	F30.01
CS 31 (ABB)		
Modbus Plus	RS 485 MB + Converter	F30.04
Suconet S	RS 422 Converter	F20.01
ARCNET ^{®3)}	Arcnet Converter	F40.01

Concerning electro-magnetic compatibility HARTING Media Converter comply with the relevant specifications

¹⁾ Hardware-handshake

²⁾ Software-handshake

³⁾ ARCNET[®] is registered trademark of Datapoint Corporation

Description

The components offered by HARTING in the field of fibre optical data transmission are suitable in combination with different types of FOC. With view to the optical transmission characteristics we differentiate between the following types of fibre:

Cables with Multimode-Gradient-Fibres (GI-Fibres)

- Suitable for transmission distances up to approx. 2 km (850 nm), approx. 5 km (1300 nm)
- Typical F.O. connector termination: adhesive technique
- Typical wave length: 850/1300 nm

Cable with HCS^{®1}-Step-Index-Fibres (HCS^{®1}-Fibres)

- Suitable for transmission distances up to approx. 2 km (850 nm), approx. 400 m (660 nm)
- Typical F.O. connector termination: Crimp termination
- Typical wave length: 660/850 nm

Cable with Plastic-Optical-Fibres (POF²)

- Suitable for transmission distances up to approx. 100 m
- Typical F.O. connector termination: Crimp termination, or HARTING quick assembly technique, no special too necessary
- Typical wave length: 660 nm

Fibre types (typical characteristics)

	Plastic-Optical Fibre	HCS-Optical Fibre	Glass-Optical Fibre	
Fibre type	SI	SI	GI	GI
Core / jacket Ø (µm)	980/1000	200/230	62.5/125	50/125
Attenuation coefficient (dB / km)				
at 660 nm	200	10	–	–
at 850 nm	2000	8	≤ 3.5	≤ 3.0
at 1300 nm	–	–	≤ 0.80	≤ 0.70
typ. wave length	660 nm	660/850 nm	850/1300 nm	850/1300 nm
Bandwidth (MHz*km)				
at 660 nm	10	–	–	–
at 850 nm	–	≥ 17	≥ 200	≥ 400

Cable plastic materials

Material designation		Polymers (Low Smoke Zero Halogen)	Polyvenylchloride	Polyethylene	Polyurethane	Polyamide
Abbreviation		LSOH	PVC	PE	PUR	PA
Halogen free		yes	no	yes	no	yes
Fire behaviour		self-extinguishing	self-extinguishing	combustible	self-extinguishing	combustible
Resistance	to UV radiation	fair - good	fair	good	fair - good	good
	to oil	poor	fair	fair	fair - good	good
	with hydrolysis	fair	good	good	poor - fair	fair
Abrasion resistance		good	fair	good	excellent	good
Mechanical resistance		good	fair	good	good	good

¹) HCS[®] = Hard Clad Silica (registered trademark of SpecTran Corporation)

²) POF = Polymer-Optical Fibre



RS 232 self-powered

Description

This self-powered FO-interface is suitable for the interconnection of PSc and all peripheral devices equipped with RS 232 interface.

The benefits are

- no additional power supply required, the necessary power is directly extracted from the data signal
- connector-less FOC mounting
- small dimensions
- no special tools for mounting required

Identification

Part No.

Drawing

Dimensions in mm

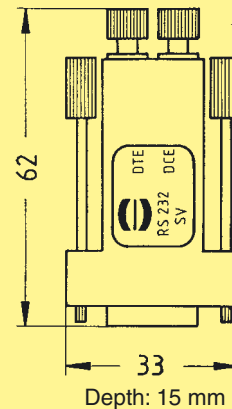
Media Converter
RS 232
self-powered

9-pin D-Sub female

20 40 002 3448

male adaptor

20 80 000 3052



Pin-configuration:

9way D-Sub females

	DCE / DTE selectable by switch
Pin 2:	TxD / RxD
Pin 3:	RxD / TxD
Pin 7/8:	connected
Pin 1/4/6:	connected
Pin 5:	Gnd

Note:

This interface only transmits the signals of RxD- and TxD-lines (no handshake signals). A proper function of this device requires a permanent spacing-level according to RS 232 standard.

Transmission rate*:	50 m incl. 3dB power margin
Suitable fibre:	POF 980/1000 µm

* Signal source with an internal resistance of 100 Ω. Lower (higher) source resistance may result in an increased (decreased) transmission range.



RS 232-1-channel
RS 232-8-channel

Description

RS 232-1-channel

- Suitable for systems with software handshake
- 25-pin version is designed for point-to-point links
- 9-pin version is designed for point-to-point and linear duplex bus structures (see page F00.03 and F30.01)
- Switch-over facility from DTE to DCE mode
- Possibility for change of interface between RS 422 and RS 232
- 9-pin and 25-pin versions are not compatible

RS 232-8-channel

- Suitable for the data transmission at interfaces according to EIA RS 232 / V 24 with all handshakesignals
- Pin configuration of the 25-pin D-Sub connectors corresponds to DCE according to CCITT standard for modems
- Transmission of 8 RS 232 channels via one fibre optic duplex link due to time multiplexing with synchronisation

Technical characteristics

Technical details	RS 232-1-channel	RS 232-8-channel
Electrical interface	RS 232-C / V 24 1-channel duplex	RS 232-C / V 24 8-channel duplex
Operating wave-length	$\lambda = 660 \text{ nm}$ for plastic fibre, $\lambda = 850 \text{ nm}$ for glass fibre	
Mode of operation	full duplex, asynchron	
Data rate	0 ... 120 kBit/s	0 ... 19.2 kBit/s
Bit error rate	$< 10^{-9}$	
Link length	max. 2500 m for glass fibre, max. 80 m for plastic fibre	
Power supply	9 ... 30 V DC / 170 mA via screw terminal	9 ... 30 V DC / 150 mA via screw terminal
Temperature range	0 ... + 60 °C	
Mounting	standard rail mounting (35 mm) acc. to DIN 50 022	



RS 232-1-channel

Identification	Part No.	Drawing	Dimensions in mm
Media Converter 1-channel duplex RS 232-C/V 24		RS 232-C / V 24 25-pin	
Standard: electrical link: 25-pin D-Sub female			
optical link: F-SMA for POF ¹⁾ 660 nm	20 40 002 3411		
optical link: F-ST for GI 850 nm	20 50 002 3421		
Media Converter 1-channel duplex RS 232-C/V 24		RS 232-C / V 24 9-pin	
Standard: electrical link: 9-pin D-Sub female			
optical link: F-SMA for POF ¹⁾ 660 nm	20 40 002 3412		
optical link: F-ST for GI 850 nm	20 50 002 3422		
Media Converter 1-channel duplex RS 232-C/V 24 MDR		RS 232-C / V 24 MDR 9-pin	
Standard: electrical link: 9-pin D-Sub females.			
optical link: F-SMA for POF ¹⁾ 660 nm	20 40 004 3411		
optical link: F-ST for GI 850 nm	20 50 004 3421		
Power supply	see page F90.04	Block diagramm RS 232, 25-pin	RS 232 MDR, 9-pin
		Contacts: 6, 8, 20 (DSR, DCD, DTR) connected 4, 5 (RTS, CTS) connected	Contacts: 1, 4, 6 (DCD, DTR, DSR) con. 7, 8 (RTS, CTS) connected

Serial Interfaces

¹⁾ POF = Polymer-Optical Fibre



RS 232-8-channel Multiplexer

Identification Part No. Drawing Dimensions in mm

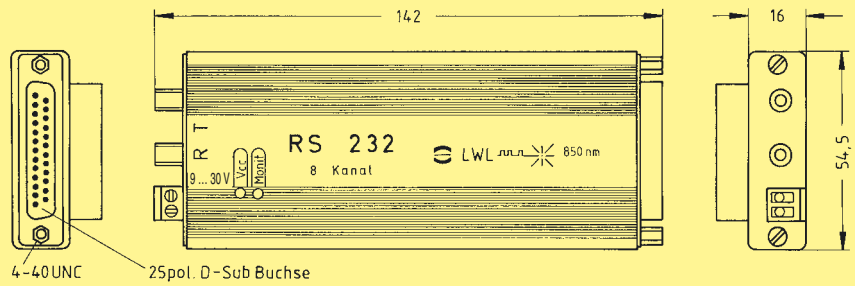
**Multiplexer
8-channel duplex
RS 232-C/V 24**

optical link: F-SMA
for POF¹⁾ 660 nm

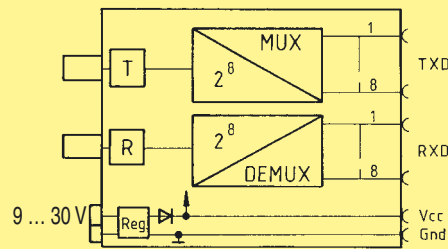
20 40 016 3411

optical link: F-ST
for GI 850 nm

20 50 016 3421



Block diagram of the 8-channel multiplexer



Power supply

see page
F90.04

Pin loading of the RS 232 interface for DCE-mode

Symbol acc. to DIN 66 020 part 1	Description	Data line	Control line	Timing	Pin loading	Direction of data
E 2 S-Ground	System ground				7	
D 1 TxD	Data transmitted	x			2	Input
D 2 RxD	Data received	x			3	Output
S 1.1 DTR	Switch on transmission line		x		20	Input
S 1.2 D/L system ready for operation						
M 1 DSR	Readiness for operation		x		6	Output
S 2 RTS	Switch on transmitter		x		4	Input
M 2 CTS	Readiness to transmit		x		5	Output
T 1 T-Set DTE	Timing of transmission pulses to the D/L end unit			x	24	Input
T 2 TC	Timing of transmission pulses from the D/L end unit			x	15	Output
S 4 DSRS	Switch on high data transmission rate		x		23	Input
M 4 RLSD	High data transmission rate		x		12	Output
	STF		x		11	Input
M 6 SQ	Legibility of reception from D/L end unit		x		21	Output
T 4 Timing of reception from the D/L end unit				x	17	Output
T 3 Timing of reception to the D/L end unit				x	14	Input
M 5 DCD	Level of reception signal		x		8	Output
S 11 Switch on receiver			x		19	Input

Serial Interfaces

F 10 04

¹⁾ POF = Polymer-Optical Fibre

RS 422

- Optical point-to-point interconnections or ring bus systems with units equipped with electrical interfaces acc. to EN RS 422 A / CCITT V.11 (“4-wire”)
- Protocol transparent data transmission
- Repeater functionality can be manually and electrically controlled

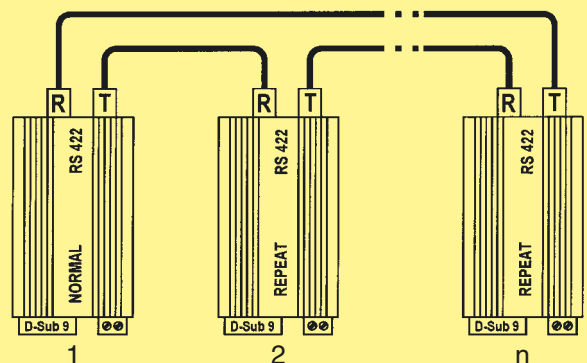
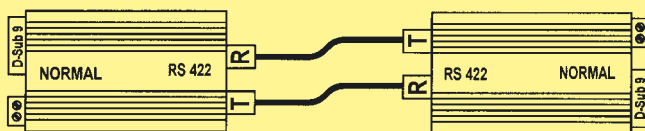
Technical characteristics

Electrical interface	: EIA RS 422, CCITT V.11
Data transmission rate	: 0 ... 10 MBit/s
Optical interface	: for FOC onnectors type F-SMA or FH-ST
Wave-length	: $\lambda = 850$ nm for glass fibre $\lambda = 660$ nm for plastic fibre
Mode of operation	: fullduplex anasynchronous
Bit error rate	: $< 10^{-9}$ over the entire range of data transmission
Operational check	: internal monitoring, LED lamps
Supply voltage	: 9 ... 30 V DC via screw termination
Temperature range	: 0 ... 60 °C during operation
Transmission distance	: max. 2000 m for glass fibre max. 80 m for plastic fibre
Mounting	: Standard rail (35 mm) mounting acc. to DIN 50 022

Variants of optical links

In point-to-point applications the wiper switches have to be in the “NORMAL” position at both interface units.

Ring bus systems require a “NORMAL” selection at one single device. All the other units work in the “REPEAT” mode, thus preventing optical oscillation.



Permissible tolerances in signal distortion and delay determine the number of subscribers in a ring bus system. Notes for dimensioning are available on request.



RS 422

Identification Part No. Drawing Dimensions in mm

Media Converter RS 422

full duplex
4 wire transmission

External power supply:
9 ... 30 V DC

optical link: F-SMA 660 nm
for POF¹⁾

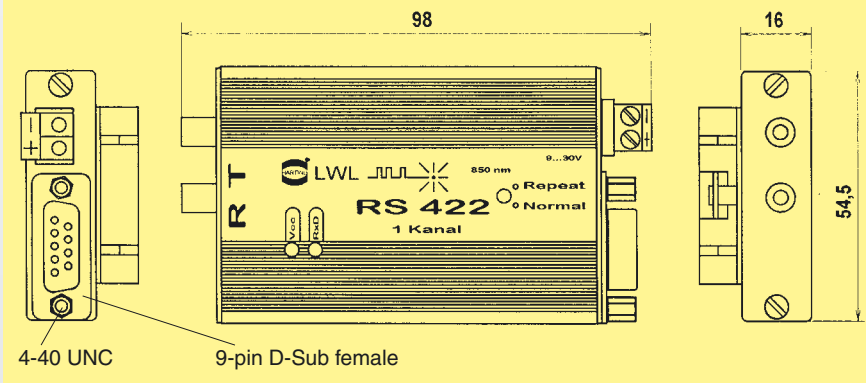
optical link: F-ST 850 nm
for GI

Part No. Drawing

20 40 002 3511

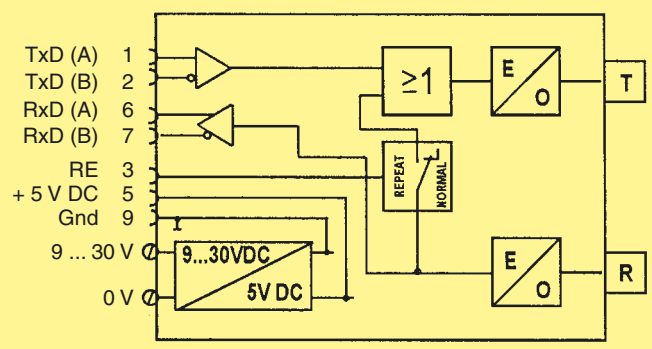
20 50 002 3521

The devices provide a mode selection for bus-applications (repeater).



Serial Interfaces

Block diagram RS 422



Pin loading 9way D-Sub female

Function	Pin-No.
Electrical input TxD A (+)	1
Electrical input TxD B (-)	2
Electrical input repeat enable	3
Power supply + 5 V DC 200 mA max.	5
Electrical output RxD A (+)	6
Electrical output RxD A (-)	7
GND	9

Power supply for RS 422

see page F90.04

F 20 02

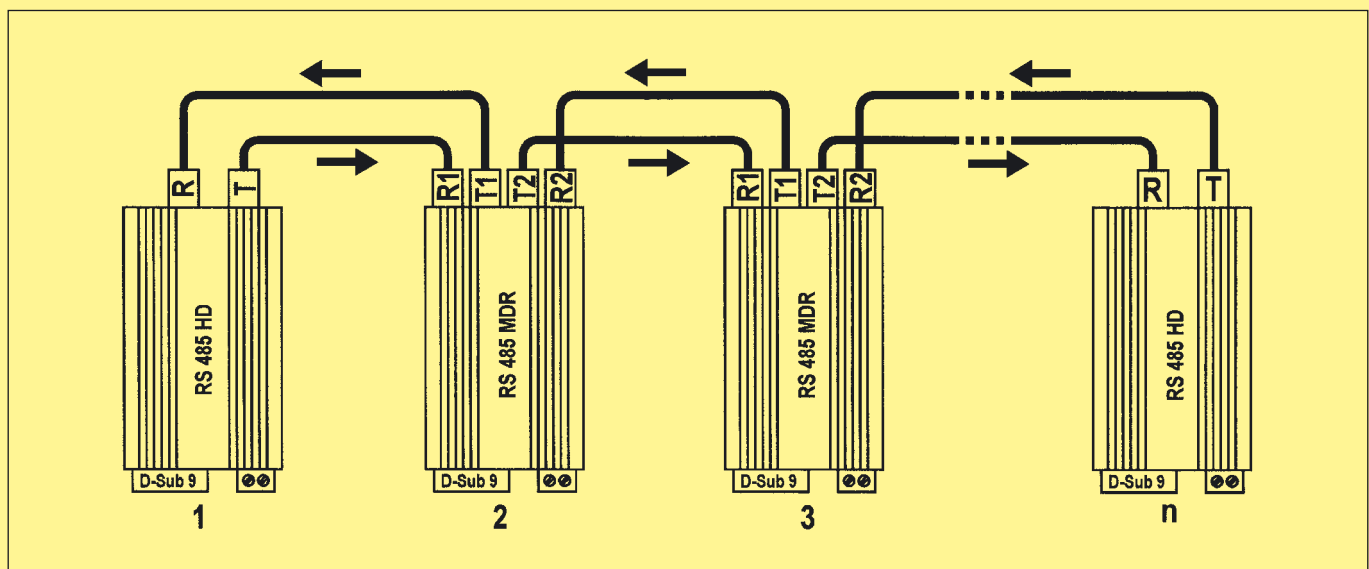
¹⁾ POF = Polymer-Optical Fibre

Converter for RS 485-based bus systems

The HARTING media converter RS 485 and RS 485 MB+ are suitable for point-to-point links or linear duplex bus systems between units with an electrical interface according to the EIA RS 485 Standard. Typical applications can be found in data acquisition and process automation via fieldbus systems.

For point-to-point links converters with one electrical and one optical port are used (version HD).

For optical bus systems with several participants at the beginning and the end of the bus structure HD converters are used. As optical intermediate devices converters with two optical transceiver ports (MDR-version) are installed. Several optical linear duplex bus systems can be connected to each other by the link of the electrical ports of the converter. Thus complex bus structures can be realized.



Application for an optical linear duplex bus system.

Each participant in this bus system can communicate with each other. This bus structure is capable of multi-master operation. The link length between two converters depends on the converter and fibre used. Distances of several kilometers are possible. The total system's extension can be realized depending on the number of converters used.

Functional principle of the converter: received electrical data is directly transmitted from the optical ports. Similarly, received optical data is converted into electrical signals and with MDR-versions, reconverted into optical signals to be transmitted from the opposite optical port. Due to physical effects of the electro-optical conversion, the signal is distorted. The maximum number of units in a bus system is limited by the maximum tolerable puls-width distortion in the system. These converters are normally protocol transparent.

Media Converter for RS 485-Interfaces

- Point-to-point links or bus-structures between units with electrical interfaces according to EIA RS 485
- Data rate up to 2 MBit/s
- Protocol transparent conversion
- Multi-master capability
- Variants with different pin-outs
- Special versions for Modbus Plus-systems (MB +) with galvanically separated electrical interface

Technical characteristics

	RS 485 Standard	RS 485 MB +
Electrical interface	EIA RS 485	Modbus Plus - Bus termination
Data rate	max. 2 MBit/s	1 MBit/s Biphase S
opt. port	F-SMA, F-ST	F-ST
opt. wave-length	660 nm / 850 nm	850 nm
Mode of operation	halfduplex	
Bit-error rate	< 10 ⁻⁹	
Diagnostics	LED's for VCC, RxD	LED's for VCC, RxD electr. diagnostics output
Power supply	9 ... 30 V DC via screw terminals	
Link length	POF ¹⁾ : max. 80 m, GI: max. 2000 m	max. 2000 m
Temperature range	Operation: 0 ... 60 °C	
Mounting	Standard rail 35 mm acc. to DIN 50 022	

Pin-out of the electrical connector D-Sub 9ways female:

Pin-No	RS 485 Standard	RS 485 MB +
1	(shield / earth) ²⁾	(shield / earth) ²⁾
2	Data A	Data
3		Data
5	+ 5 V out	+ 5 V out
6		Gnd
8	Gnd	
9	Data B	

¹⁾ POF = Polymer-Optical Fibre

²⁾ optional, shield / earth preferred via D-Sub-shell



RS 485, RS 485 Profibus

Identification Part No. Drawing Dimensions in mm

Media Converter RS 485

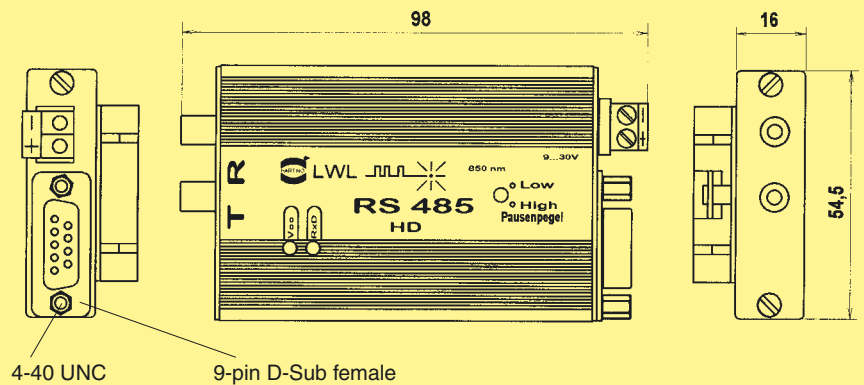
optical link: F-SMA
for POF¹⁾ 660 nm

20 40 002 3612

optical link: F-ST
for GI 850 nm

20 50 002 3622

The devices provide a selectable recessive bus-level "high" or "low"



Media Converter RS 485 MDR

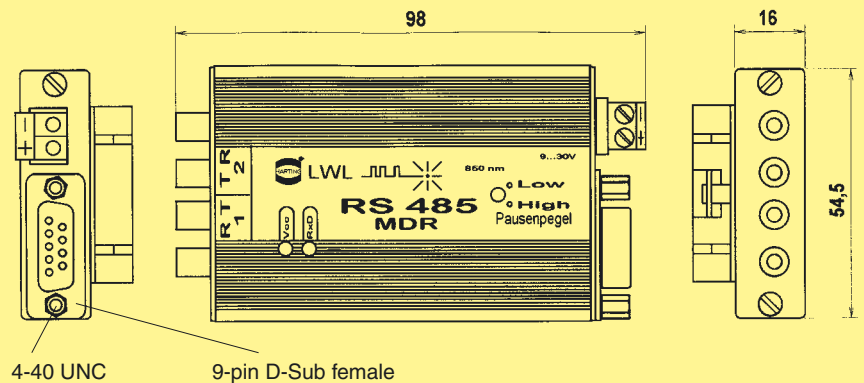
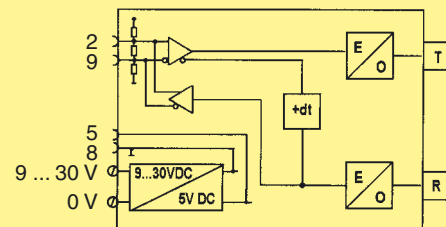
optical link: F-SMA
for POF¹⁾ 660 nm

20 40 004 3611

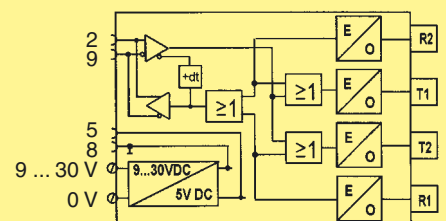
optical link: F-ST
for GI 850 nm

20 50 004 3621

Block diagram



Block diagram RS 485 Multidrop



Power supply

see page
F90.04

¹⁾ POF = Polymer-Optical Fibre



Modbus Plus

Description

- System diagnostics are given by a Rx-data signal via the screw terminals
- Rotary switch for the adaption of the optical output power

Identification

Part No.

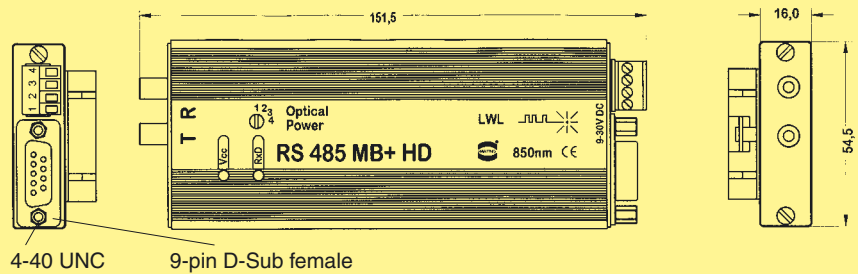
Drawing

Dimensions in mm

Media Converter RS 485 MB +

optical link: F-ST
for GI 850 nm

20 50 002 3625



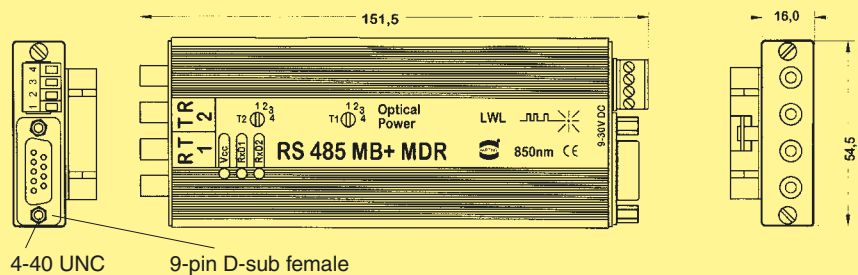
4-40 UNC

9-pin D-Sub female

Media Converter RS 485 MB + MDR

optical link: F-ST
for GI 850 nm

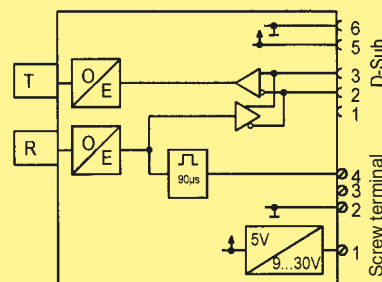
20 50 004 3625



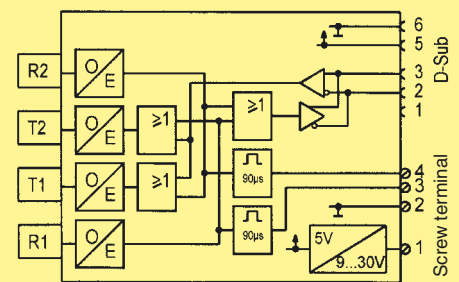
4-40 UNC

9-pin D-sub female

Block diagram RS 485 MB+



Block diagram RS 485 MB+ MDR



Power supply

see page F90.04



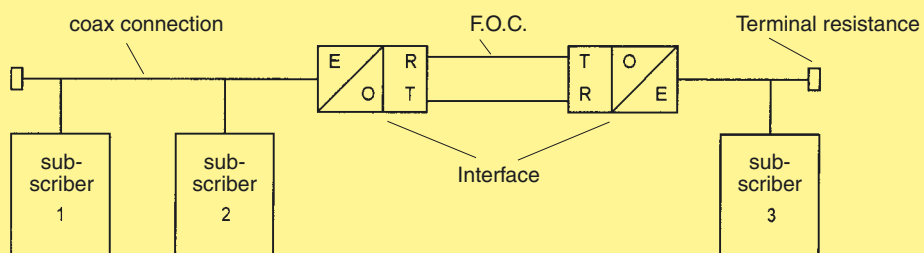
ARCNET®¹⁾

Technical characteristics

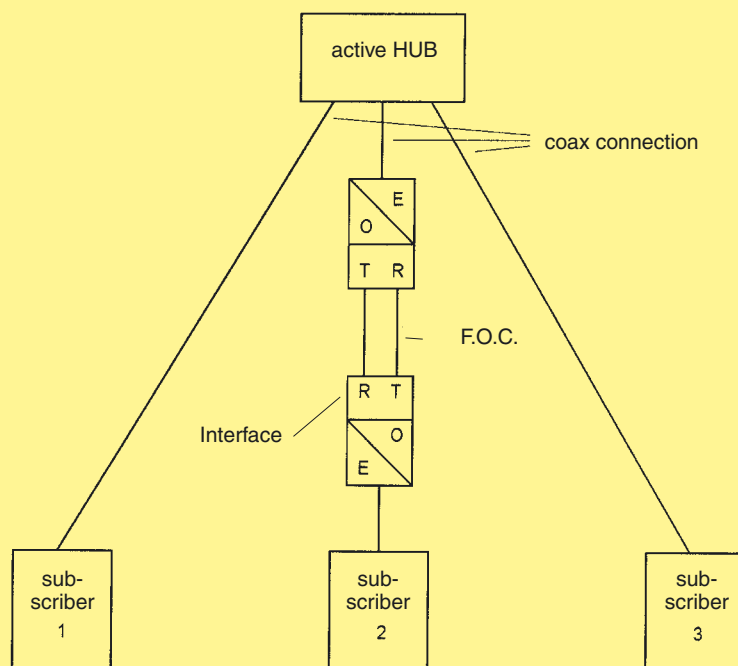
Supply voltage	: 9 ... 30 V DC (screw terminal)
Power consumption	: 300 mA max.
Data rate	: 2.5 MBit/s
Transmission range	: max. 2500 m with glass fibre ($\lambda = 850$ nm) max. 80 m with plastic fibre (POF ²⁾ , $\lambda = 660$ nm)
Temperatrue range	: 0 ... 60 °C
Mounting	: standard rail mounting (35 mm) acc. to DIN 50 022

Application

Bus topology



Star topology



¹⁾ ARCNET® is registered trademark of Datapoint Corporation
²⁾ POF = Polymer-Optical Fibre



ARCNET®¹⁾

Description

- Media Converter for the use in ARCNET®¹⁾-networks
- Waveforms and data rate in accordance with ARCNET®¹⁾ standards
- Optical point-to-point connections over distances up to 2.5 km possible
- Applications in networks with bus or star
- No external termination resistor at the converter

Identification Part No. Drawing Dimensions in mm

Media Converter ARCNET®¹⁾

optical link: F-SMA 660 nm
for POF²⁾

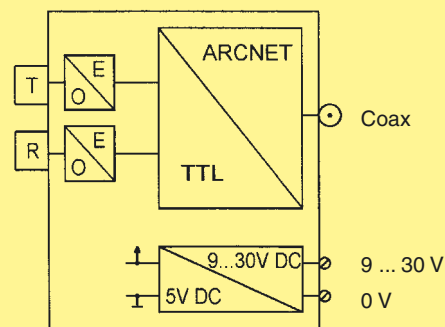
optical link: F-ST 850 nm
for GI

20 40 002 3711

20 50 002 3721



Block diagram



Power supply for ARCNET®¹⁾

see page F90.04

Serial Interfaces

F 40 02

¹⁾ ARCNET® is registered trademark of Diatapoint Corporation
²⁾ POF = Polymer-Optical Fibre

Description

The components offered by HARTING in the field of fibre optical data transmission are suitable in combination with different types of FOC. With view to the optical transmission characteristics we differentiate between the following types of fibre:

Cables with Multimode-Gradient-Fibres (GI-Fibres)

- Suitable for transmission distances up to approx. 2 km (850 nm), approx. 5 km (1300 nm)
- Typical F.O. connector termination: adhesive technique
- Typical wave length: 850/1300 nm

Cable with HCS^{®1}-Step-Index-Fibres (HCS^{®1}-Fibres)

- Suitable for transmission distances up to approx. 2 km (850 nm), approx. 400 m (660 nm)
- Typical F.O. connector termination: Crimp termination
- Typical wave length: 660/850 nm

Cable with Plastic-Optical-Fibres (POF²)

- Suitable for transmission distances up to approx. 100 m
- Typical F.O. connector termination: Crimp termination, or HARTING quick assembly technique, no special too necessary
- Typical wave length: 660 nm

Fibre types (typical characteristics)

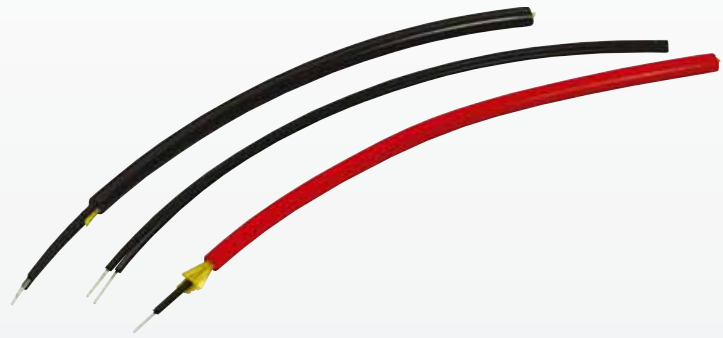
	Plastic-Optical Fibre	HCS ^{®1} -Optical Fibre	Glass-Optical Fibre	
Fibre type	SI	SI	GI	GI
Core / jacket Ø (µm)	980/1000	200/230	62.5/125	50/125
Attenuation coefficient (dB / km)				
at 660 nm	200	10	–	–
at 850 nm	2000	8	≤ 3.5	≤ 3.0
at 1300 nm	–	–	≤ 0.80	≤ 0.70
typ. wave length	660 nm	660/850 nm	850/1300 nm	850/1300 nm
Bandwidth (MHz*km)				
at 660 nm	10	–	–	–
at 850 nm	–	≥ 17	≥ 200	≥ 400

Cable plastic materials

Material designation		Polymers (Low Smoke Zero Halogen)	Polyvinyl-chloride	Poly-ethylene	Poly-urethane	Polyamide
Abbreviation		LSOH	PVC	PE	PUR	PA
Halogen free		yes	no	yes	yes	yes
Fire behaviour		self-extinguishing	self-extinguishing	combustible	self-extinguishing	combustible
Re-sistance	to UV radiation	fair - good	fair	good	fair - good	good
	to oil	poor	fair	fair	fair - good	good
	with hydrolysis	fair	good	good	poor - fair	fair
Abrasion resistance		good	fair	good	excellent	good
Mechanical resistance		good	fair	good	good	good

¹) HCS[®] = Hard Clad Silica, registered trademark of SpecTran Corporation

²) POF = Polymer-Optical Fibre



for internal and external applications with polymer fibres (POF¹⁾)

Description

- Robust and cost-effective alternative to standard glass fibres
- SI-fibre with 980 µm PMMA-core
- For short distance transmission up to 100 m
- Operating wave length 660 nm
- Easy mechanical crimp technology

Identification	Part No.	Drawing	Dimensions in mm
F.O.-cable POF¹⁾ Standard cable Simplex ø 2.2 mm PE fibre coating Duplex ø 2.2 x 4.4 mm PE fibre coating	20 20 001 1011 20 20 001 1021		Technical Details: PMMA-Fibre: 980/1000 µm Temperature range: -40 °C ... + 85 °C Bending radius min.: 30 mm
Special cable with strain relief suitable for SERCOS ²⁾ -applications Simplex ø 6.0 mm PE fibre coating PUR cable coating Simplex ø 3.6 mm PE fibre coating PUR cable coating Duplex round ø 5.5 mm PE fibre coating PUR cable coating	20 21 001 1011 20 21 001 1012 20 21 001 1021		When ordering please specify cable length in metres.
Hybrid-cable suitable for DESINA [®] -applications PUR cable coating 2 x POF PA fibre coating 4 x 1.5 mm ² 300/300 V ø 10.6 mm	20 23 041 1023		

¹⁾ POF = Polymer-Optical Fibre

²⁾ SERCOS = **SE**riell **R**ealtime **CO**munication **S**ystem

for fibre optic transmission

Identification	Part No.	Drawing	Dimensions in mm
F.O. transmitter for PBC mounting receptacle (metall) LED 850 nm in F-SMA housing in F-ST housing LED 660 nm in F-SMA housing in F-ST housing	20 50 000 1111 20 50 000 1121 20 40 000 1111 20 40 000 1121		F-SMA F-ST
F-SMA fixing nut	20 80 000 1072		

Technical characteristics

General data at T = 25°C

		LED 850 nm	LED 660 nm
Analog band-width	BWE	: 80 MHz (I _F = 100 mA DC)	7 MHz (I _F = 30 mA)
Optical wave-length	λ	: 850 nm	660 nm
Spektral band-width	Δλ	: 50 nm	30 nm
Drive current	I _{Fmax.}	: 100 mA	70 mA
Forward voltage	U _V	: 1.6 ... 1.8 V typ.	1.7 ... 2.0 V
Derating at 25 °C	I _F	: 0.8 mA/°C	0.93 mA/°C
Reverse voltage	U _{Rmax.}	: 4 V	4 V
Storage temperature	T _{Str}	: -40 °C ... + 100 °C	-35 °C ... + 100 °C
Operating temperature	T _{Opr}	: -40 °C ... + 100 °C	-30 °C ... + 85 °C

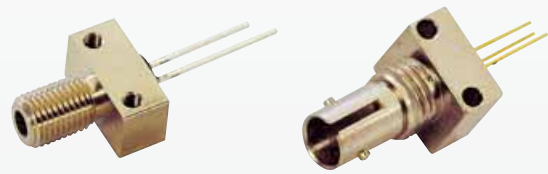
Power coupled into fibre (at I_F = max.)

in 50/125 GI	P _S	: 12 μW min.
in 200/230 SI	P _S	: 120 μW min.
in 980/1000 POF ¹⁾	P _S	: 600 μW min.

The technical specifications for the **SERCOS²⁾-Interface** are fulfilled by the LED 660 nm.

¹⁾ POF = Polymer-Optical Fibre

²⁾ SERCOS = **SE**riell **R**ealtime **CO**munication **S**ystem



Identification	Part No.	Drawing	Dimensions in mm
F.O. receiver for PBC mounting receptacle (metall) TTL 5 Mbit/s in F-SMA housing in F-ST housing Si-PIN Fotodiode* in F-SMA housing in F-ST housing	 20 50 000 2112 20 50 000 2222 20 50 000 2119 20 50 000 2229		The mounted, integrated receivers are suitable for applications in combination with glass fibre as well as polymer fibre. Dimensions of housing see page F70.01.
* Technical data on request			

Serial Interfaces

Technical characteristics

General data at T = 25 °C

Receiver type		0 ... 5 MBit/s (DC coupled)
Supply voltage	V _{CC} :	4.5 ... 5.5 V DC
Supply current	I _{CC} :	15 mA max.
Opt. power input (minimum value)	:	3 µW min. 5 µW min.
Fan out	:	4
Storage temperature	T _{Str} :	-65 °C ... + 100 °C
Operating temperature	T _{Opr} :	-55 °C ... + 70 °C

The technical specifications for the **SERCOS¹⁾-Interface** are fulfilled by the LED 660 nm and the receiver 5 MBit/s.

F 70 02

¹⁾ SERCOS = **SE**riell **R**ealtime **CO**munication **S**ystem

Stock items in bold type



in duplex style for short range transmission with optical fibres ($\lambda = 660 \text{ nm}$)

Description

- Electro-optical converters integrated into D-Sub connector shell housings
- Cost-effective solution for fibre optic duplex links
- Transmission distance up to 60 m
- Standard accessories for D-Sub can be applied
- Suitable for 1 mm \varnothing polymer optical fibres ($\lambda = 660 \text{ nm}$)
- Special housing for heavy duty applications is available

Technical characteristics

General data at $T = 25 \text{ }^\circ\text{C}$

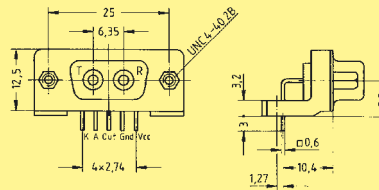
	LED	Receiver
Operating voltage		5 V DC $\pm 5 \%$
Drive current (max.)	70 mA	
Optical power	300 μW (at 20 mA) 600 μW (at 50 mA)	
Dynamic range		4 μW ... 80 μW
Wave-length	660 nm	
Transmission rate		TTL, 5 MBit/s
Storage temp.	-35 ... +100 $^\circ\text{C}$	-55 ... +100 $^\circ\text{C}$
Operating temp.	-30 ... +85 $^\circ\text{C}$	-40 ... +85 $^\circ\text{C}$

Identification Part No. Drawing Dimensions in mm

F.O. D-Sub T/E female connector

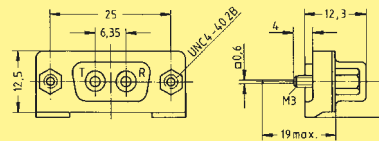
angled

20 66 009 3811



straight

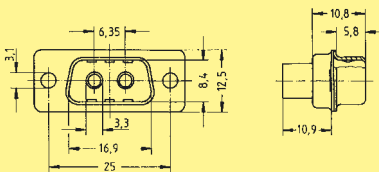
20 66 009 3812



(Outer dimensions like 9-pin D-Sub female)

F.O. D-Sub male connector

20 67 009 3811



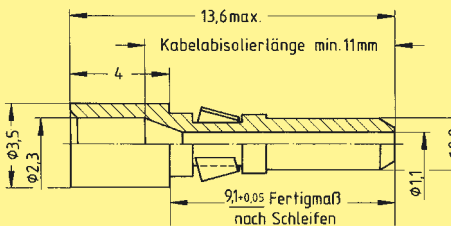
(Outer dimensions like 9-pin D-Sub male)

Cavities are designed for HARTING POF¹⁾ ferrules.

Ferrule

1 mm POF¹⁾ with cladding gauge 2.2 mm

20 10 001 3232



The mounting/enface-preparation of the ferrule can be achieved by crimping, hot-plate technique or by using adhesive.

The ferrules are snap-mounted into the male connector and can be released with aid of removal tool 09 99 000 0052 (see catalogue "Heavy Duty Connectors Han[®]").

¹⁾ POF = Polymer-Optical Fibre



for short range data transmission with polymer optical fibres ($\lambda = 660 \text{ nm}$)
 Multipole versions

Description

- Electro-optic converters integrated in multi-mode connectors
- Up to 16 optical lines via one connections
- Cost-effective alternative to conventional connectors
- Compact type
- Suitable for circuit board mounting
- Suitable for 1 mm \varnothing polymer fibres ($\lambda = 660 \text{ nm}$)
- Transmission distance up to 60 m
- Configuration in custom-made application possible

Identification	Part No.	Drawing	Dimensions in mm
Mounting device 16 cables for 1 mm POF ¹⁾ -fibres with HARTING POF ¹⁾ ferrules	20 10 016 3211		
Mounting device 16 diodes solder straight with 8 x SFH 756 8 x SFH 551	20 40 016 3823		
Mounting device 7 cables for 1 mm POF ¹⁾ -fibres with HARTING POF ¹⁾ ferrules	20 10 007 3211		
Mounting device 7 diodes angled with 3 x SFH 756 3 x SFH 250	20 40 007 3821		

Serial Interfaces

F 70 04

¹⁾ POF = Polymer-Optical Fibre



for short range data transmission with polymer optical fibres ($\lambda = 660 \text{ nm}$)
 Multipole versions

Identification	Part No.	Drawing	Dimensions in mm
Mounting device 3 cables for 1 mm POF ¹⁾ -fibres with POF ¹⁾ ferrules	20 10 003 3211		
Mounting device 3 diodes angled with 1 x SFH 756 2 x SFH 551	20 40 003 3821		
with 2 x SFH 756 1 x SFH 551	20 40 003 3822		
Ferrule 1 mm POF ¹⁾	20 10 001 3232	see page F70.03	

Serial Interfaces

Technical characteristics

Transmitter (LED): SFH 756	Wave-length: 660 nm Switching times: 100 ns Output power (I = 10 mA): 200 μW (typ) 100 μW (min.) Drive current max.: 50 mA Forward voltage: 2.1 V Operating temperature: -40 ... 80 °C
Receiver (digital): SFH 551	Wave-length: 600 ... 780 nm Data rate: 5 MBit/s Optical input power: 6 ... 400 μW Electrical output: TTL, open collector Operating voltage: 3 ... 15 V Operating temperature: -55 ... 100 °C
Receiver (photo diode): SFH 250	Wave-length: 400 ... 1100 nm Switching times: 10 ns Photo current: 3 μA (at $\lambda = 660 \text{ nm}$, input power 10 μW , reserve voltage 5 V) Operating temperature: -40 ... 80 °C

¹⁾ POF = Polymer-Optical Fibre

General description

Power supply and TTL compatible signals for transmitted and received data represents the electrical device interface for the optical module. The electrical connection is realized by means of flat cables and IDCs (insulation displacement connector) or by means of a board stacker.

The devices are suitable for multimode fibre cables (980/1000 μ POF¹⁾ SI, 200/230 μ HCS^{®2)} SI). The maximum transmission distance is 50 m for POF¹⁾ and 300 m for HCS^{®2)}. Data rates of 12 MBit/s NRZ are supported without having to consider the minimum link length. If requested, it is possible to realize versions with data rates up to 125 MBit/s.

Elements

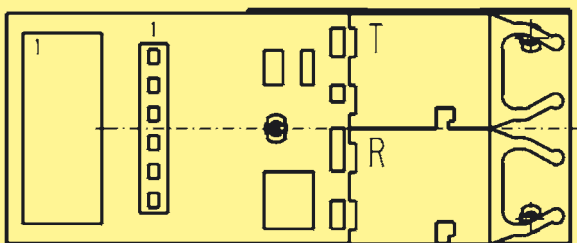
Electrical Elements

- Insert for 5 Han D[®] male or female contacts, possibility to combine with FOC transmitter and receiver or with FOC male contacts
- Han D[®] male and female are standard crimp contacts
- Rated current: 10 A
- Rated voltage: 24 V
- Termination range: 0.14 - 2.5 mm²

Optical Elements

- Han-Brid[®] offers the possibility to use all HP Versatile Link (Horizontal package) transmitters and receivers
 - data rates up to 125 MBit/s
 - suitable for all common field bus systems
- Insert offers the possibility to use HP crimp contacts, suitable for POF¹⁾ (HCS^{®2)} in preparation)

Optical module: Wiring plan



	Pin Out			
	/R	GND	- 5 V DC	/T
Board stacker	5	4, 6	1, 3	2
IDC	8, 9	1, 4, 7, 10	2, 3	5, 6

Technical data

Signal assignment:

- /R Optical reception data (electrical output), TTL-compatible, negative logic , $I_{out\ max} \leq 16\ mA$
- GND Ground, Power supply, data
- +5 V DC Power supply +5 V DC $\pm 5\ \%$
- /T Optical transmission data (electrical input), TTL compatible, negative logic

Optical Elements: Laser classification I

Serial Interfaces

F 70 06

¹⁾ POF = Polymer-Optical Fibre
²⁾ HCS[®] = Hard Clad Silica is registered trademark of SpecTran Corporation

DESINA® conforming product
 For more information conc. DESINA: www.desina.de



Hybrid fieldbus connector
 with FOC transmitter and receiver
 + 4 electrical contacts 10 A
 + option für PE

Insert

Part No.

Drawing

Dimensions in mm

Possible combinations

FOC female
 + Han D® male

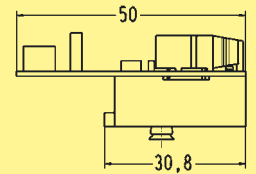
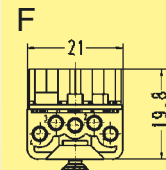
FOC male
 + Han D® female



09 12 004 2611

09 12 004 2711

View
 termination side

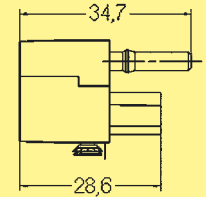
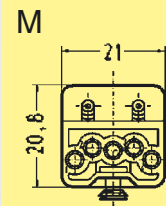


also available without FOC devices



09 12 004 3011

09 12 004 3111



Serial
 Interfaces

FOC female
 + Han D® female

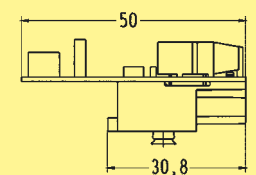
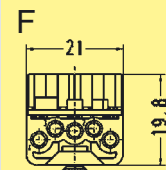
FOC male
 + Han D® male



09 12 004 2701

09 12 004 2601

View
 termination side

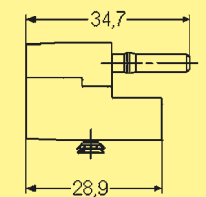
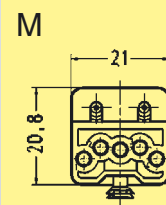


also available without FOC devices

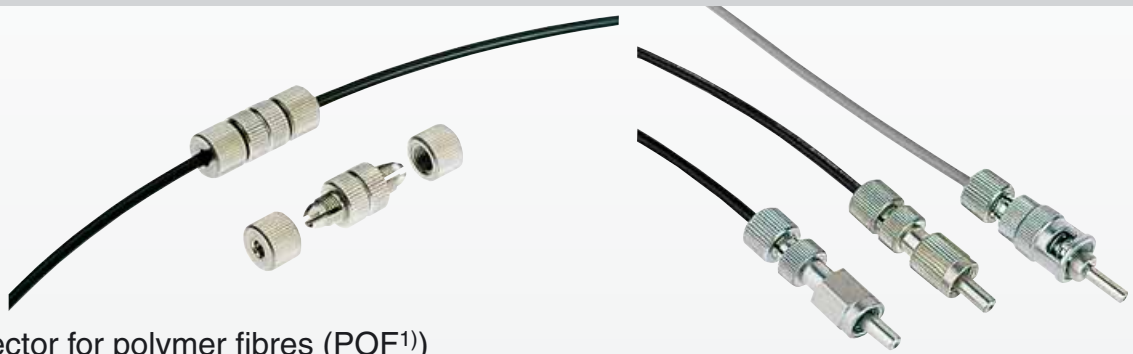


09 12 004 3101

09 12 004 3001



F
 70
 07



Single connector for polymer fibres (POF¹⁾)

Description

Advantages of the HARTING quick-assembly technique:

- No special tools necessary
- Quick, cost-effective assembly
- No crimping, no glueing
- Fixed connection due to metallic type
- Suitable for 1 mm polymer fibre (2.2 mm jacket)

Assembly of the single connectors:

- Cut the cable, strip the jacket, insert of the fibre, tighten the sleeve nut and polish the connector's tip

Assembly of the coupling sleeve:

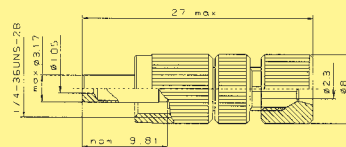
- Cut the cable's ends, insert in the coupling sleeve and tighten the sleeve nut

Identification Part No. Drawing Dimensions in mm

Quick-assembly connector for 1 mm polymer fibre cable \varnothing 2.2 mm

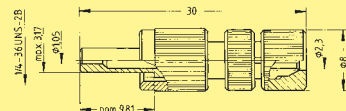
F-SMA type with hexagonal nut bending – without protection

20 10 001 1212



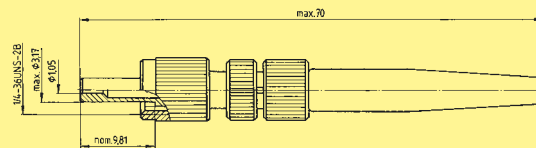
with knurled nut bending – without protection

20 10 001 1215



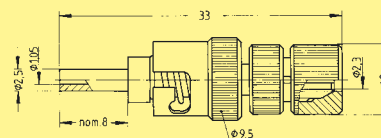
– with bend protection sleeve

20 10 001 1217



F-ST – without protection

20 10 001 2212



Coupling sleeve for 1 mm polymer fibre cable \varnothing 2.2 mm

Standard-Set

20 80 000 1065

Delivery range:

4 x quick assembly cable couple
1 x cutter

Set consisting of 10 pcs

20 80 000 1066

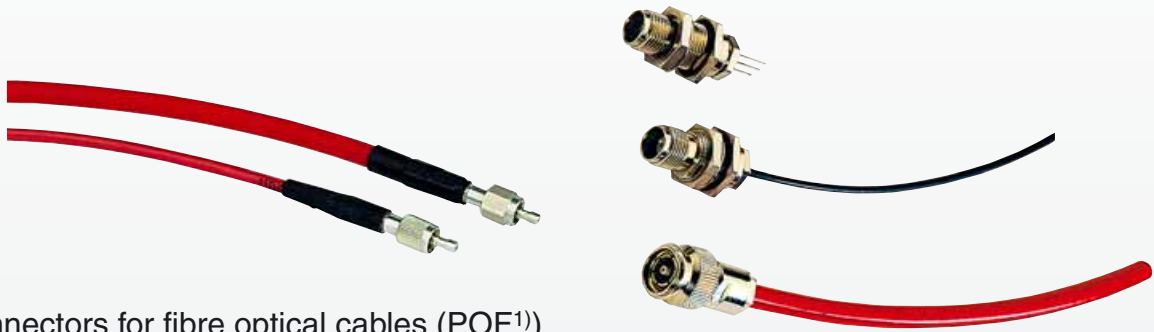
10 x quick assembly cable coupler



SAerial Interfaces

F 70 08

¹⁾ POF = Polymer-Optical Fibre



Single connectors for fibre optical cables (POF¹⁾)

Identification	Part No.	Drawing	Dimensions in mm
F.O. connectors for 1 mm polymer fibre cable \varnothing 2.2 mm F-SMA type with hexagonal nut	20 10 001 1211		The connector for 1 mm POF ¹⁾ may be directly attached to the fibre by crimping, glueing or by using a "hot plate". Insertion loss: POF ¹⁾ < 2.5 dB
F-ST type	20 10 001 2211		
Versatile Link type			
Crimp	20 10 001 7111		
Crimpleless	20 10 001 7112		
for 1 mm polymer fibre cable 3.6 mm SERCOS ²⁾ F-SMA type with hexagonal nut	20 10 001 1241		
for 1 mm polymer fibre cable 6 mm SERCOS ²⁾ F-SMA type with hexagonal nut	20 10 001 1221		
F-TNC (IP 65) Male cable connector for 1 mm polymer fibre cable-type SERCOS ²⁾ \varnothing 6 mm	20 10 001 6211		
Female cable connector for 1 mm polymer fibre cable-type \varnothing 2.2 mm	20 10 001 6233		

¹⁾ POF = Polymer-Optical Fibre
²⁾ SERCOS = SEriell REaltime COmmunication System



F.O. single connectors with glass fibres

Identification Part No. Drawing Dimensions in mm

F.O. connectors

for GI-fibre
50-62.5/125 µm

F-SMA type
for cable ø 2.8 mm

20 10 125 1212

F-ST type
for cable ø 2.8 mm

20 10 125 2212

for SI-fibre(HCS)¹⁾
200/230 µm

F-SMA type
for cable ø 2.8 mm

20 10 230 1212

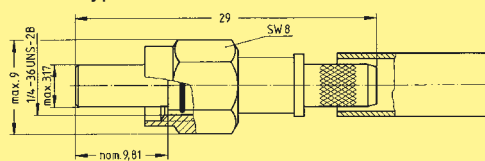
F-ST type
for cable ø 2.8 mm

20 10 230 2212

Versatile Link type
for cable ø 2.2 mm

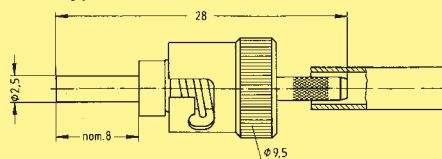
20 10 230 7111

F-SMA type



The ferrule of the FO connector for GI-fibre is ceramic

F-ST type

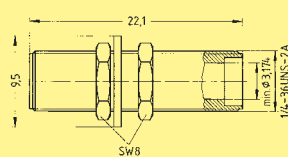


Insertion loss:
F-SMA GI/SI < 1.0 dB
F-ST GI/SI < 0.5 dB

Coupling sleeve

F-SMA type

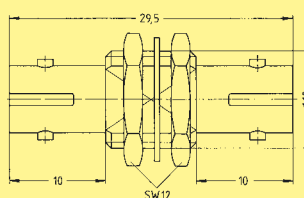
20 80 000 1071



F-SMA connector and coupling sleeve acc. to IEC 874-2

F-ST type

20 80 000 1021



F-ST connector and coupling sleeve acc. to IEC 874-10 CECC 86123-801

¹⁾ HCS® = Hard Clad Silica is registered trademark of SpecTran Corporation



Description

- Field of application: optical, passive networks
- Large temperature range (-25 °C ... +75 °C)
- Robust design
- Small size
- Low attenuation
- Low crosstalk
- Especially suitable for applications in the field of automotive and sensors
- Light weight

Identification	Part No.	Drawing	Dimensions in mm
1 x 2 coupler	20 30 001 1121	<p>2x 1m 36 transmission loss. < 6 dB</p>	

Technical characteristics

Fibre:	980/1000 µm POF ¹⁾ , 2.2 mm PE-jacket	Additional versions are available on request in different fibre lengths, in alternative fibres and pre-assembled with connectors.
Total length:	2 m	
Face:	polished, without connector	
Dimensions:	36 x 12 x 7.5 mm	

¹⁾ POF = Polymer-Optical Fibre




for assembly and control of cables

Description


The tools of the HARTING F.O. tool kit are suitable for the installation of F.O. connectors in site conditions.

Detailed instructions for assembling the different connector-types are included.


Identification	Part No.	Drawing	Dimensions in mm
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Tool kit POF ¹⁾ without optical measuring device	20 99 000 3016		Height : 170 mm Width : 470 mm Depth : 360 mm Tool kit for F.O. connector assembly to all POF ¹⁾ cables, without optical measuring instruments.
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Tool kit POF ¹⁾ with optical measuring device	20 99 000 3013		Height : 170 mm Width : 470 mm Depth : 360 mm Tool kit for F.O. connector assembly and control of the F.O. transmission links for 1 mm polymer-optical fibres (POF ¹⁾). When applying these tools, F.O. connector types F-SMA, F-ST and other F.O. contacts can be assembled without adhesive and grinding. The measuring instruments are easy to handle and suitable for service and maintenance. The tool kit contains a complete set of tools and test equipment.
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F.O. kit measuring instruments	20 99 000 3014		Suitable cables are included in the delivery range: 50/125 µm GI-fibre, 1 m 200/230 µm SI-fibre, 1 m 1 mm Plastic fibre 2 m When ordering, please give the following information: Measuring instruments: • standard with F-SMA link • on request with F-ST link
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¹⁾ POF = Polymer-Optical Fibre

Identification	Part No.	Drawing								
Tool kit GI-fibre	20 99 000 3015	 <p>Height : 170 mm Width : 470 mm Depth : 360 mm</p> <p>Tool kit for connector mounting of glass fibres, using adhesive e.g.: GI 50/125 µm.</p>								
HARTING Crimping tool for F.O. connector (glass fibre) SW 4.3 and 3.8 mm	20 99 000 1031	 <p>For crimping the strain relief to the connector</p> <p>... 1031 F.O. cable for glass fibre</p> <p>... 1033 POF¹⁾ and SERCOS²⁾ cable ø 6.0; ø 3.6</p>								
HARTING Crimping tool for F.O. connector (glass fibre) SW 6.5, 4.95 and 3.0 mm	20 99 000 1033									
Crimping tool Han-Brid® for electrical and optical crimp contacts	09 99 000 0362									
Cutting tool 2.2 mm POF ¹⁾	20 99 000 1049	Delivery range: 10 pieces / set								
Fibre stripper 1 mm POF ¹⁾	20 99 000 1041 20 99 000 1045 20 99 000 1046	0.3 mm 1 mm 0.18/0.3 mm 								
BUCHANAN Crimping tool for crimping installations of F.O. connectors to POF ¹⁾ 1 mm ø	20 99 000 1035	 <p>Adjustable crimping tool setting:</p> <table border="0"> <tr> <td>FOC R 15</td> <td>ø 1.45 mm</td> </tr> <tr> <td>POF¹⁾ DIN 41 626</td> <td>ø 1.8 mm</td> </tr> <tr> <td>POF¹⁾ Ferrule</td> <td>ø 1.8 mm</td> </tr> <tr> <td>POF¹⁾ F-SMA, -ST</td> <td>ø 2.0 mm</td> </tr> </table> <p>This tool is suitable only for F.O. contacts. Crimping tool for electrical contacts see catalogue "Heavy Duty Connectors Han®"</p> <p>Suitable plug gauges and positioning devices to be ordered separately.</p>	FOC R 15	ø 1.45 mm	POF ¹⁾ DIN 41 626	ø 1.8 mm	POF ¹⁾ Ferrule	ø 1.8 mm	POF ¹⁾ F-SMA, -ST	ø 2.0 mm
FOC R 15	ø 1.45 mm									
POF ¹⁾ DIN 41 626	ø 1.8 mm									
POF ¹⁾ Ferrule	ø 1.8 mm									
POF ¹⁾ F-SMA, -ST	ø 2.0 mm									
Positioning device POF ¹⁾ -R 15, Han® E male	20 99 000 0036									
POF ¹⁾ -F-SMA/ST/DIN Ferrule Han® E female	20 99 000 0037 20 99 000 0038									
Plug gauge Ø 1.45 mm Ø 1.8 mm Ø 2.0 mm	20 99 001 1032 20 99 002 1032 20 99 003 1032									

Serial Interfaces

F 90 02

¹⁾ POF = Polymer Optische Faser
²⁾ SERCOS = SEriell Realtime COmmunication System

Stock items in bold type

Identification	Part No.	Drawing	Dimensions in mm
Polishing tool for F.O. connectors: F-SMA	20 99 000 1091		
DIN 41 626	20 99 000 1092		
POF ¹⁾ cable ø 2.2	20 99 000 1093		
F-TNC	20 99 000 1094		
F-ST	20 99 000 1095		
Ferrule	20 99 000 1096		
Polishing kit Versatile Link	20 80 001 9914	Delivery range: Duplex polishing tool 2 x polish paper	
Epoxy adhesive glass fibre	20 80 001 9902	2 ml EPO-TEK 360 with hardener (10:1), 4g foil pack	
Polishing paper		Delivery range: Each part number ordered comprises 5 pieces	
for POF ¹⁾ -grain size 1000	20 80 001 9911		
for GI 9µ-grain size	20 80 001 9912		
for GI 1µ-grain size	20 80 001 9913		

¹⁾ POF = Polymer-Optical Fibre

Part No.		Description	Tools for assembling HARTING FO. contacts										
			Fibre stripper	HARTING crimping tool	BUCHANAN crimping tool	Locator	Adjustment gauge	Polishing tool	Epoxy adhesive	Polishing paper			
20 10 001 1211	F-SMA connector 1 mm / 2.2 mm POF ¹⁾ with hexagonal nut		20 99 000 1045	20 99 000 1033	20 99 000 1032	20 99 000 0037	20 99 003 1032			20 80 001 9911			
20 10 001 1212	F-SMA quick assembly connector 1 mm / 2.2 mm POF ¹⁾ with hexagonal nut		20 99 000 1045					20 99 000 1091		20 80 001 9911			
20 10 001 1213	F-SMA connector 1 mm / 2.2 mm POF ¹⁾ with knurled nut		20 99 000 1045	20 99 000 1033	20 99 000 1032	20 99 000 0037	20 99 003 1032	20 99 000 1091		20 80 001 9911			
20 10 001 1215	F-SMA quick assembly connector 1 mm / 2.2 mm POF ¹⁾ with knurled nut		20 99 000 1045					20 99 000 1091		20 80 001 9911			
20 10 001 1217	F-SMA quick assembly connector 1 mm / 2.2 mm POF ¹⁾ with knurled nut and bending protection		20 99 000 1045					20 99 000 1091		20 80 001 9911			
20 10 001 1221	F-SMA connector POF ¹⁾ / SERCOS ²⁾ 6.0 with hexagonal nut		20 99 000 1045	20 99 000 1033	20 99 000 1032	20 99 000 0037	20 99 003 1032	20 99 000 1091		20 80 001 9911			
20 10 001 1223	F-SMA connector POF ¹⁾ / SERCOS ²⁾ 6.0 with knurled nut		20 99 000 1045	20 99 000 1033	20 99 000 1032	20 99 000 0037	20 99 003 1032	20 99 000 1091		20 80 001 9911			
20 10 001 1241	F-SMA connector POF ¹⁾ / SERCOS ²⁾ 3.6 with hexagonal nut		20 99 000 1045	20 99 000 1033	20 99 000 1032	20 99 000 0037	20 99 003 1032	20 99 000 1091		20 80 001 9911			
20 10 001 1243	F-SMA connector POF ¹⁾ / SERCOS ²⁾ 3.6 with knurled nut		20 99 000 1045	20 99 000 1033	20 99 000 1032	20 99 000 0037	20 99 003 1032	20 99 000 1091		20 80 001 9911			
20 10 001 2211	F-ST connector 1 mm / 2.2 mm POF ¹⁾		20 99 000 1045					20 99 000 1095		20 80 001 9911			
20 10 001 2212	F-ST quick assembly connector 1 mm / 2.2 mm POF ¹⁾		20 99 000 1045					20 99 000 1095		20 80 001 9911			
20 10 001 3211	FO. male insert 1 mm / 2.2 mm POF ¹⁾ for Han DD [®] , Han [®] K		20 99 000 1045			20 99 000 1032	20 99 001 1032	20 99 000 1093		20 80 001 9911			
20 10 001 3212	FO. male insert 1 mm / 2.2 mm POF ¹⁾ for Han D [®] , Han [®] U		20 99 000 1045			20 99 000 1032	20 99 001 1032	20 99 000 1093		20 80 001 9911			
20 10 001 3213	FO. male insert 1 mm / 2.2 mm POF ¹⁾ for Han 15 D		20 99 000 1045			20 99 000 1032	20 99 001 1032	20 99 000 1093		20 80 001 9911			
20 10 001 3221	FO. female insert 1 mm / 2.2 mm POF ¹⁾ for Han DD [®] , Han [®] K		20 99 000 1045			20 99 000 1032	20 99 001 1032	20 99 000 1093		20 80 001 9911			
20 10 001 3222	FO. female insert 1 mm / 2.2 mm POF ¹⁾ for Han D [®] , Han [®] U		20 99 000 1045			20 99 000 1032	20 99 001 1032	20 99 000 1093		20 80 001 9911			
20 10 001 3232	FO. ferrule 1 mm / 2.2 mm POF ¹⁾		20 99 000 1045			20 99 000 1032	20 99 002 1032	20 99 000 1096		20 80 001 9911			
20 10 001 3311	FO. male insert 1 mm / 2.2 mm POF ¹⁾ for Han E [®]		20 99 000 1045			20 99 000 1032	20 99 001 1032	20 99 000 1093		20 80 001 9911			
20 10 001 3321	FO. female insert 1 mm / 2.2 mm POF ¹⁾ for Han E [®]		20 99 000 1045			20 99 000 1032	20 99 001 1032	20 99 000 1093		20 80 001 9911			
20 10 001 4211	FO. male insert 1 mm / 2.2 mm POF ¹⁾ for Han [®] Multicontact module		20 99 000 1045	20 99 000 1033	20 99 000 1032	20 99 000 0037	20 99 002 1032	20 99 000 1092		20 80 001 9911			
20 10 001 4221	FO. female insert 1 mm / 2.2 mm POF ¹⁾ for Han [®] Multicontact module		20 99 000 1045	20 99 000 1033	20 99 000 1032	20 99 000 0037	20 99 002 1032	20 99 000 1092		20 80 001 9911			
20 10 001 6211	F-TNC male contact 1 mm / 2.2 mm POF ¹⁾		20 99 000 1045					20 99 000 1094		20 80 001 9911			
20 10 001 6233	F-TNC female contact 1 mm / 2.2 mm POF ¹⁾		20 99 000 1045					20 99 000 1094		20 80 001 9911			
20 10 001 7111	Versatile Link connector 1 mm / 2.2 mm POF ¹⁾		20 99 000 1045					20 80 001 9914					
20 10 001 7112	Versatile Link connector 1 mm / 2.2 mm POF ¹⁾ , crimpless		20 99 000 1045					20 80 001 9914					
20 10 125 1212	F-SMA connector 125 Gi		20 99 000 1046	20 99 000 1031				20 99 000 1091	20 80 001 9902	20 80 001 9912/13			
20 10 125 2212	F-ST connector 125 Gi		20 99 000 1046	20 99 000 1031				20 99 000 1095	20 80 001 9902	20 80 001 9912/13			
20 10 125 4211	FO. male insert (metal) 125 Gi for Han [®] Multicontact module		20 99 000 1046					20 99 000 1092	20 80 001 9902	20 80 001 9912/13			
20 10 125 4212	FO. male insert (ceramic) 125 Gi for Han [®] Multicontact module		20 99 000 1046					20 99 000 1092	20 80 001 9902	20 80 001 9912/13			
20 10 125 4221	FO. female insert (metal) 125 Gi for Han [®] Multicontact module		20 99 000 1046					20 99 000 1092	20 80 001 9902	20 80 001 9912/13			
20 10 125 4222	FO. female insert (ceramic) 125 Gi for Han [®] Multicontact module		20 99 000 1046					20 99 000 1092	20 80 001 9902	20 80 001 9912/13			
20 10 230 1212	F-SMA connector HCS ^{®3)} , Crimp		20 99 000 1041	20 99 000 1031				20 99 000 1091		20 80 001 9912/13			
20 10 230 2212	F-ST connector HCS ^{®3)}		20 99 000 1041	20 99 000 1031				20 99 000 1095	20 80 001 9902	20 80 001 9912/13			
20 10 230 4211	FO. male insert HCS ^{®3)} for Han [®] Multicontact module		20 99 000 1041					20 99 000 1092	20 80 001 9902	20 80 001 9912/13			
20 10 230 4221	FO. female insert HCS ^{®3)} for Han [®] Multicontact module		20 99 000 1041					20 99 000 1092	20 80 001 9902	20 80 001 9912/13			

Serial Interfaces

1) POF = Polymer Optische Faser
 2) SERCOS = SEriell REaltime COmmunication System
 3) HCS[®] = Hard Clad Silica, registered trademark of SpecTran Corporation

