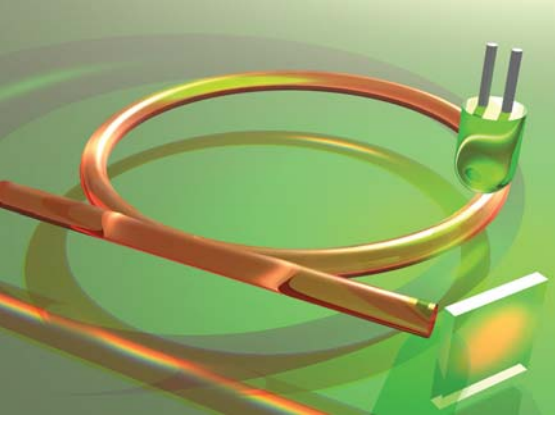


SCHLEIFRING



optical transmission of analog & digital signals

: FIBER OPTICAL ROTARY JOINTS



TRANSMISSION PRINCIPLES

Plastic Optical Fiber (POF):

Due to the lower costs, technical features and the larger core diameter, which allows easy handling and installation, Plastic Optical Fiber is mainly used for industrial applications. For the transmission of data rates up to 125 MBit/s at a fiber length of up to 25 m.

Single-Mode (SM) Fiber:

A small-core optical fiber through which only one mode will propagate. The typical core diameter is 9 microns. SM Fibers are the best choice for long-haul links up to 120 km and high data rates >10 GBit/s. Standard wavelengths are 1310 nm and 1550 nm. SM Fibers offer best signal quality but require tight mechanical tolerances and dust free fiber end surfaces.

Multi-Mode (MM) Fiber:

An optical fiber with a core large enough to propagate more than one mode of light. The high number of modes limits the max. link length at high data rates. Typical core diameters are 62.5 or 50 microns. MM Fibers are commonly used for short-haul links at moderate data rates, e. g. 300 m with 1 GBit/s. Typical wavelengths are 850 nm or 1300 nm. MM Fibers are more robust against mechanical tolerances and dust on connectors.

Fluorescent Fiber (FF):

A ring of polymer optical fiber doped with fluorescent dye. Light pulses are guided inside of the fiber. This process is uni-directional. For bi-directional applications two of these fluorescent fiber rings are combined to one system. The unit is immune to exposure of ambient light. Typical wavelengths are 650 nm, 850 nm and 1300 nm.

Holographic Optical Transmission: (HOT):

Uses a stationary optical element for image derotation, a computer generated diffractive optical element (DOE). Each channel has a fiber optical input collimating the light of a standard Multi-Mode or Single-Mode fiber. The collimated beam is focused on a stationary focus by a synthetic hologram. Advantage: Light beams can cross each other without interference or shadowing.

Capacitive Transmission: (GigaCAP®):

The data transmission is based on a differential capacitive coupling between a rotating and a stationary interface. The non contacting transmission allows a large free inner diameter. The data transmission is transparent to protocols, electrically insulated and immune against EMC. An off-axis capacitive Data Communication System for data rates from 50 MBit/s up to >10 GBit/s.

Optical Transmission: (GigaFOS®):

An off-axis optical Data Communication System for large free inner diameters. The GigaFOS® is a passive, non-contacting fiber optical slip ring for high data rates >10 GBit/s per channel through rotating interfaces up to 300 rpm. The system is protocol transparent, electrically isolated and immune against EMC.

OPTICAL DATA COMMUNICATION



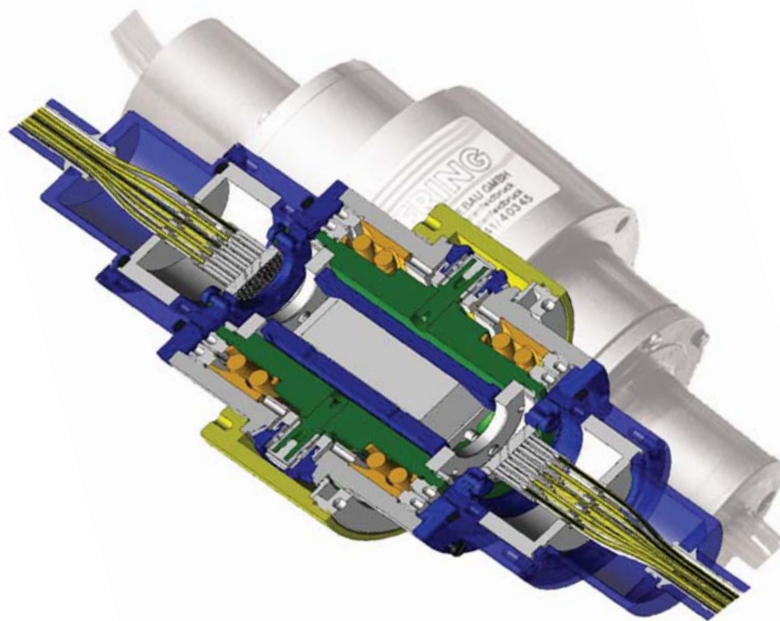
Today the increasing volume of data transmission requires advanced technical solutions. The technical features of fiber optical rotary joints – passive, bi-directional and immune against EMI, EMP and ESD – allow the transfer of highest data rates >10 GBit/s per channel even under extreme environmental conditions or in explosive atmosphere.

These rotary joints support communication using Single-Mode or Multi-Mode fibers and micro-optic technology. Available variations of SCHLEIFRING FORJs include units for submersion in water, for high pressure, for miniature systems, for high RPM, for multi-fiber cables and for use in broad spectral ranges.

All versions are resistant to water and dust ingress and feature stainless steel design with stainless steel ball bearings.

Highly compact on-axis fiber optic rotary joints are available as well as complex customer specific systems for multi-pass applications with a free inner bore.

SCHLEIFRING is also providing Hybrid Units. These sub-systems can be combined with SCHLEIFRING's electrical slip rings, media rotary joints and any kind of optical transfer technology.



Innovative achievements are always a result of decades of experience.



ON-AXIS

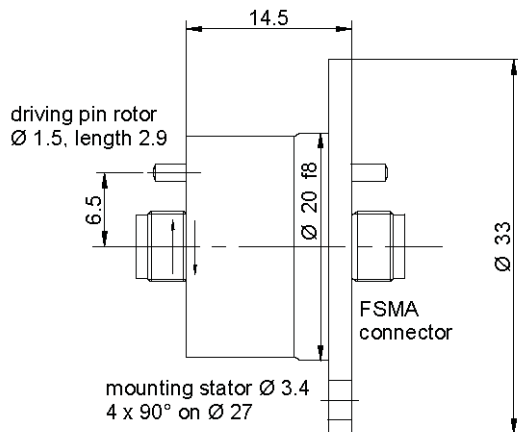
PLASTIC OPTICAL FIBER

Single-pass

The single-pass plastic optical fiber rotary joint is the smallest and lightest in this category which allows a rotational speed of up to 1000 rpm for the transmission of low data rates. The large fiber core makes this rotary joint easy to handle and to install.

The robust industrial design and its compact size allow the integration into conventional slip rings. This fiber optical rotary joint can be delivered with mounting flange to ensure a quick and easy installation.

- Options:**
- Customer specific cables and connectors
 - Housings for special applications
 - Specific mounting parts



- Typical Applications:**
- Industrial applications
 - Automation
 - Robot Handling
 - Special Machinery

PLASTIC OPTICAL FIBER

ON-AXIS



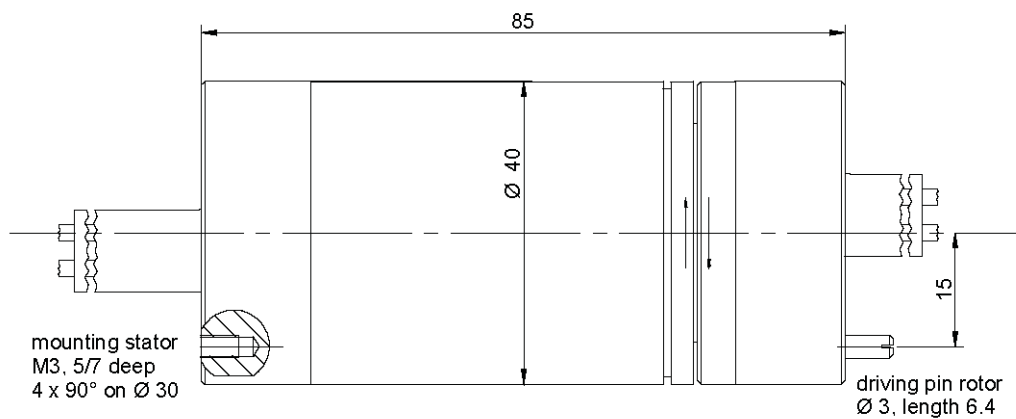
Dual-pass

The dual-pass fiber optical rotary joint has optimum features in terms of electromagnetic compatibility, interference resistance and life. It allows a bi-directional transmission of two isolated optical channels. The rotary joint is optimized for the use of plastic optical fibers and can be connected into an optical transmission network easily – especially for industrial applications. Basically this unit will be delivered with a standard cable length of 1 m and 4 FSMA connectors. Other cable lengths, cable types or customer specific cables are available upon request.

Because of the passive design the dual-pass POF is best suited for every data protocol and data format and allows a combination with electrical slip rings as well.

Options:

customized cables
and connectors



Typical applications:

- Video Surveillance Systems
- Wind energy
- Robots and Material Handling Systems
- Remote I/O in Industrial Machinery



ON-AXIS

MULTI-MODE FIBER

Single-pass

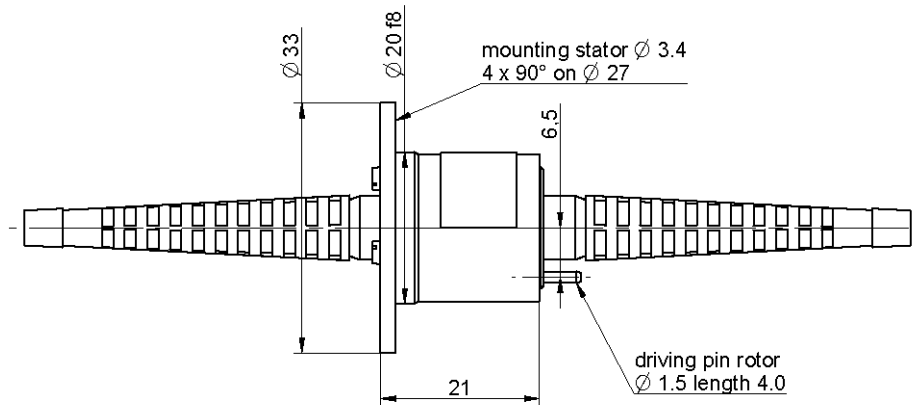
The single-pass Multi-Mode fiber optical rotary joint is suitable for the non-contacting bi-directional transmission of the highest data rates between a stationary and a rotating interface. This unit is available for Multi-Mode fibers with fiber diameters of 62.5/125 μm and 50/125 μm .

According to its optical features it is best suited for wavelength from 830 nm to 1580 nm.

This multi channel rotary joint will be delivered with a cable length of 2 m and is available with ST/PC or FC/PC connectors. Other customer specific mounting parts or different cable lengths are available upon request.

Options:

- Wavelength Division Multiplexing (WDM) for two separate channels at 850 nm and 1310 nm
- pressure compensated



Typical Applications:

- Industrial Applications
- Offshore and Wind Energy
- Military applications
- Surveillance
- Customer specific applications

MULTI-MODE FIBER

ON-AXIS



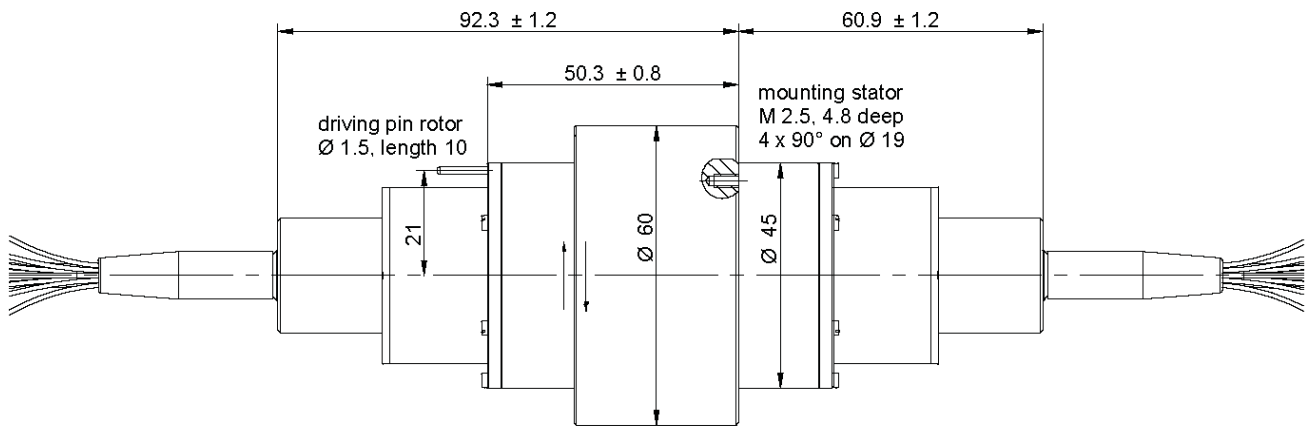
Micro Optical Rotary Joint 4 to 21 pass

This passive rotary joint unit facilitates the transmission of each data format and data protocol and may be even used for analog transmission.

It is suitable for the currently fastest common electronic transmission components, available for Multi-Mode fibers with fiber diameters of 62.5/125 μm and 50/125 μm and it is optimized for one wavelength (850 nm, 1310 nm or 1550 nm). The typical insertion loss is 2.0 dB.

Typical Applications:

- Remote Operated Vehicles
- Underwater applications
- Oil Exploration (FPSO)
- Industrial applications



Options:

suitable for

- Wavelength Division Multiplexing (WDM)
- Coarse Wavelength Division Multiplexing (CWDM)
- Dense Wavelength Division Multiplexing (DWDM)



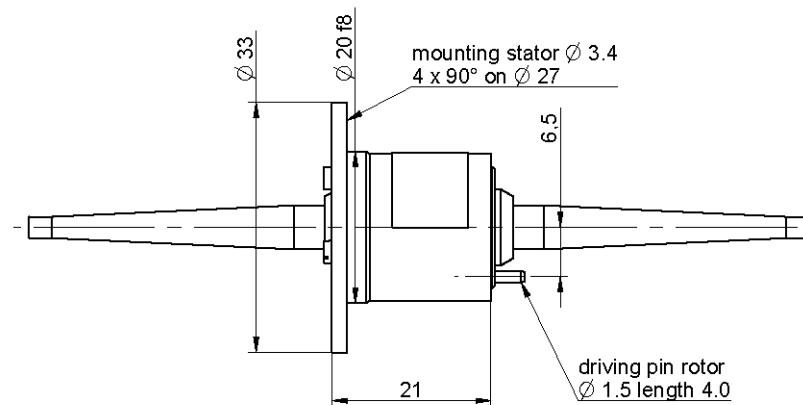
ON-AXIS

SINGLE-MODE FIBER

Single-pass

The base unit of the optical transmission technology is the single pass fiber optical rotary joint for a non-contacting transmission of the highest data rates. This unit offers bi-directional data transmission between a stationary and a rotating interface and is available for Single-Mode fibers with a fiber diameter of $9/125\ \mu\text{m}$. According to its collimation optic this unit is optimized for a wavelength of 1270 nm to 1610 nm.

This single pass rotary joint will be delivered with a cable length of 2 m and is available with FC/PC or FC/APC connectors. The assembly can be produced with mounting parts or cable lengths tailored to the customer's application.

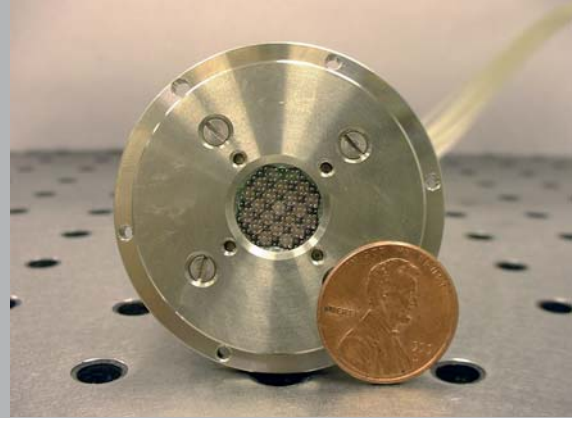


Typical applications:

- Offshore equipment and wind energy
- Infra red surveillance systems
- Remotely Operated Vehicles
- Military applications
- Industrial machine tools

SINGLE-MODE FIBER

ON-AXIS

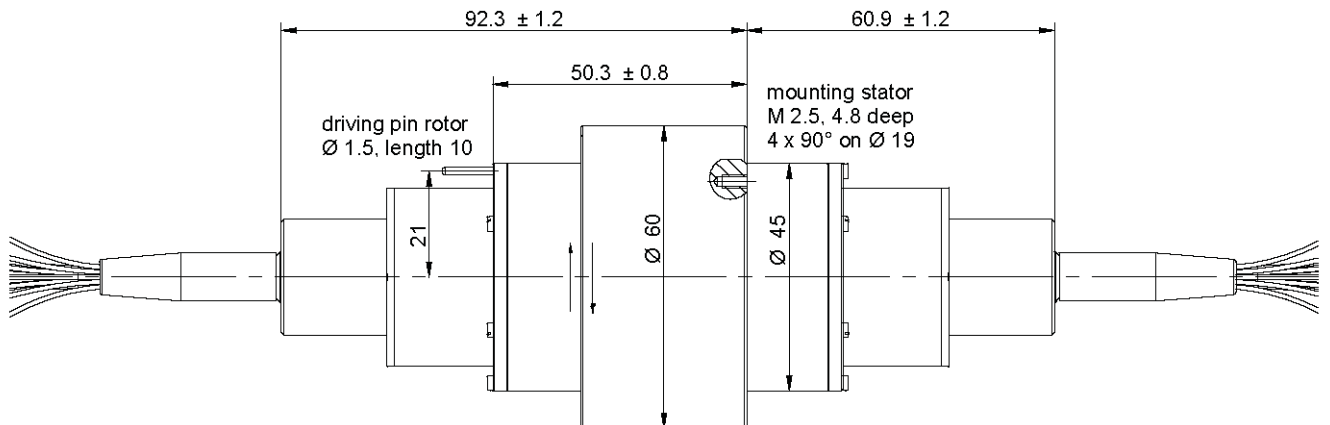


Micro Optical Rotary Joint 4 to 69 pass

This passive rotary joint unit facilitates each data format and data protocol and may even be used for analog transmission. It is suitable for currently the fastest common electronic transmission components, it can be optimized for one wavelength (1310 nm or 1550 nm) or for the wavelength range 1270 nm to 1610 nm. The typical insertion loss is 2.0 dB.

Typical applications:

- Remote Operated Vehicles
- Underwater applications
- Oil Exploration (FPSO)
- Industrial applications



Options:

suitable for

- Wavelength Division Multiplexing (WDM)
- Coarse Wavelength Division Multiplexing (CWDM)
- Dense Wavelength Division Multiplexing (DWDM)



ON-AXIS

PLASTIC OPTICAL FIBER

Plastic Optical Fiber (POF)

	1-pass POF	2-pass POF
Interface		
No. of optical channels	1	2
Fiber type	POF 980 μm / 1000 μm	POF 980 μm / 1000 μm
Fiber jacket	n/a	5 mm cable
Fiber length	n/a	1 m
Connector	FSMA	FSMA
Weight	~ 55g	~950g
Diameter	16 mm	40 mm
Length	24 mm	85 mm
Optical Performance		
Wavelength	~650 nm	~650 nm
Insertion loss	at 650 nm: < 0.5 dB	at 650 nm: < 7 dB
Insertion loss variation due to rotation	< 0.5 dB	< 1.3 dB
Back reflection	n/a	n/a
max. Optical power handling	n/a	n/a
Cross talk	n/a	>50 dB
Mechanical characteristics		
Rotating Speed	1000 rpm	300 rpm
Lifetime	>100 * 10 ⁶ rotations	>10 * 10 ⁶ rotations
Environmental characteristics		
Operating temperature	-25°C..70°C	-25°C..70°C
Storage temperature	-40°C..70°C	-40°C..70°C
Options		
Pressure compensation	n.a.	n.a.

SINGLE-MODE / MULTI-MODE

ON-AXIS



Single-Mode (SM) and Multi-Mode (MM)

	1-pass SM	1-pass MM	4 to 69-pass SM	4 to 21-pass MM
Interface				
No. of optical channels	1	1	4..69	4..21
Fiber type	Single-Mode 9 μm / 125 μm	Multi-Mode 62.5 μm / 125 μm or 50 μm / 125 μm	Single-Mode 9 μm / 125 μm	Multi-Mode 62.5 μm / 125 μm or 50 μm / 125 μm
Fiber jacket	900 μm loose tube or 3 mm cable	900 μm loose tube or 3 mm cable	900 μm loose tube or cable	900 μm loose tube or cable
Fiber length	2 m	2 m	2 m	2 m
Connector	FC/PC or FC/APC	ST/PC or FC/PC	FC/PC or FC/APC	ST/PC or FC/PC
Weight	~60g	~60g	~1200g	~1200g
Diameter	16 mm	16 mm	60 mm	60 mm
Length	34 mm	46 mm	155 mm	155 mm
Optical Performance				
Wavelength	1270 nm..1610 nm	830 nm..1580 nm	1270 nm ..1610 nm	830 nm ..1580 nm
Insertion loss at optimized wavelength	typ 1.0 dB max 2.0 dB	typ 1.0 dB max 1.5 dB	typ 2.0 dB max 3.5 dB	typ 2.0 dB max 3.5 dB
Insertion loss variation at opt. wavelength	typ 0.5 dB max 1.0 dB	typ 0.2 dB max 0.5 dB	typ 0.5 dB max 1.5 dB	typ 0.5 dB max 1.0 dB
Back reflection	PC-connector: - 35 dB APC-connector: - 50 dB	- 14 dB	PC-connector: - 35 dB APC-connector: - 40 dB	- 20 dB
max. Optical power handling	500 mW / 27 dBm	2 W / 33 dBm	10 mW / 10 dBm	200 mW / 23 dBm
Cross talk	n/a	n/a	>50 dB	>40 dB
Mechanical characteristics				
Rotating Speed	2000 rpm	2000 rpm	100 rpm	100 rpm
Lifetime	>100 * 10 ⁶ rotations	>100 * 10 ⁶ rotations	>10 * 10 ⁶ rotations	>10 * 10 ⁶ rotations
Environmental characteristics				
Operating temperature	-40°C..85°C	-40°C..85°C	-40°C..85°C	-40°C..85°C
Storage temperature	-40°C..85°C	-40°C..85°C	-40°C..85°C	-40°C..85°C
Shock	acc. to MIL-STD-202G Method 213 B			
Vibration	acc. to MIL-STD-810F Method 514.5 C-2			
Options				
Pressure compensation	request	available	under development	available



ON-AXIS

PRESSURE COMPENSATED

Multi-Mode 4 to 21 pass

Underwater and deep sea applications demand for special technical features. SCHLEIFRING offers two variations:

- Fluid-filled and pressure compensated system up to 6000 psi (400 bar)
- Pressure tight system including dynamic seals for dry use up to 3000 psi (200 bar).

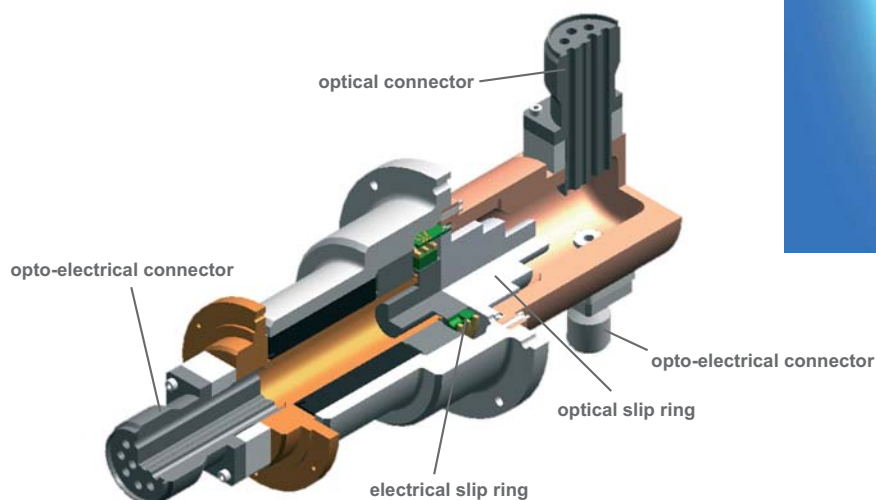
At data rates of >10 GBit/s and a rotational speed of 100 rpm the fiber optical rotary joint allows for extremely low insertion loss of typically 2.0 dB valid for all channels.

Hybrid units

The combination of electrical slip rings and fiber optical rotary joints for underwater applications are available as pressure tight systems as well as pressure compensated systems.

Typical Applications:

- Remotely Operated Vehicles
- Underwater applications
- Surveillance applications



SYSTEM COMPONENTS

ON-AXIS



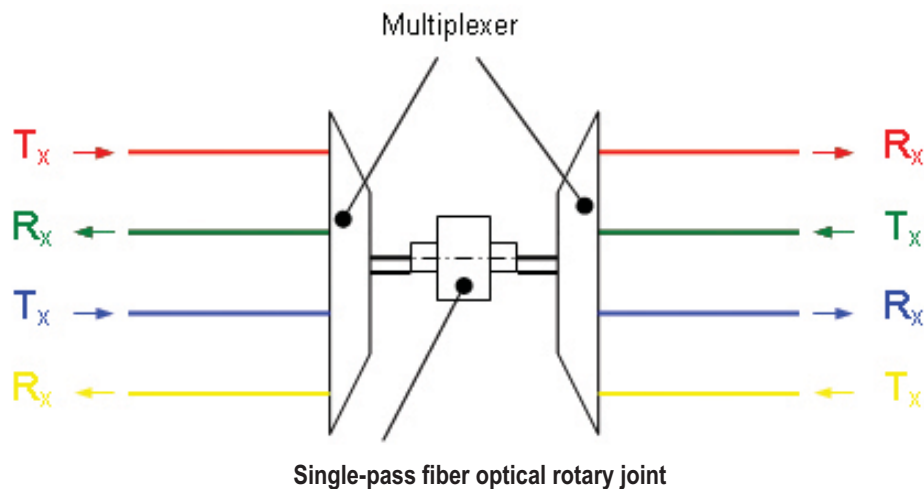
Multiplexer, Y-Coupler and Power Splitters

To transmit more than one optical signal by using just one channel, Multiplexers, Power Splitters and Couplers are appropriate components.

All of them have more or less the same features in common:

While the Multiplexer combines two or more signals into one output, the Power splitter/ Coupler combines or splits power from the optical fiber.

The Multiplexing of optical signals passing only one optical pass is possible with:



Wavelength Division Multiplexing (WDM):

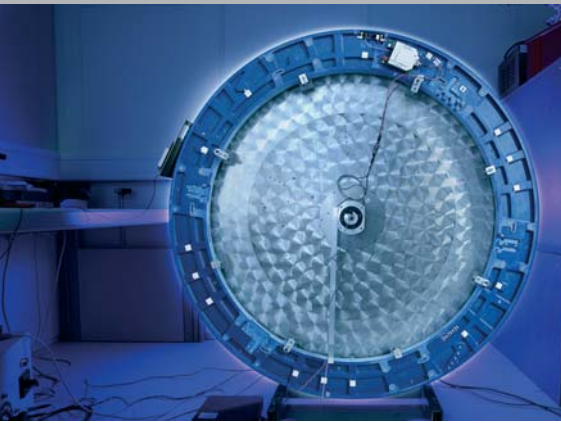
Sending two signals through one fiber with different wavelengths of light.

Coarse Wavelength Division Multiplexing (CWDM):

CWDM allows eight or fewer channels to be transmitted over one optical fiber in the 1550 nm region.

Dense Wavelength Division Multiplexing (DWDM):

DWDM allows the transmission of 16 or even more closely spaced wavelengths in the 1550 nm region over one single fiber. The wavelength spacings are usually 100 GHz or 200 GHz which corresponds to 0.8 nm or 1.6 nm.



OFF-AXIS

CAPACITIVE DATA LINK with optical interface

GigaCAP®

Advantages of this technology are wear-resistance, high noise immunity combined with excellent EMC-qualities, high reliability and bit error rates of $<10^{-12}$. The data channels are available in a multitude of variations as single-channel (uni-directional/ bi-directional) or multi-channel versions. The GigaCAP® channels consisting of transmitter and receiver are available with electrical (ECL/PECL) or with optical interfaces for the connection of fiber optic cables. The data transmission is transparent to protocols and electrically insulated. Because of the increasing need for high speed data, the application of standard protocols is becoming interesting. With this technology, for example, the transmission of fiber channel and Gigabit Ethernet is possible without any problem. This way, the system integration of the data channels is being simplified as components (COTS) from the IT-market-place can be used. The modular design allows for quick and easy adaptation to suit customer specific applications.

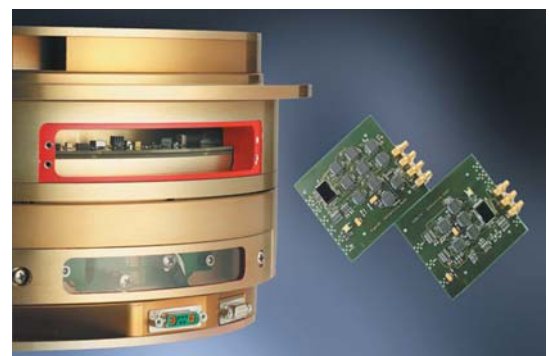
Features:

- Data rates up to 10 GBit/s depending on bore diameter
- High reliability (BER $< 10^{-12}$)
- Transparent for DC-free protocols
- High EMI and ESD immunity
- Rotational speed only limited by mechanical restrictions
- Immune to wear
- Long lifetime without maintenance
- Small and large bore diameters possible

Typical Applications:

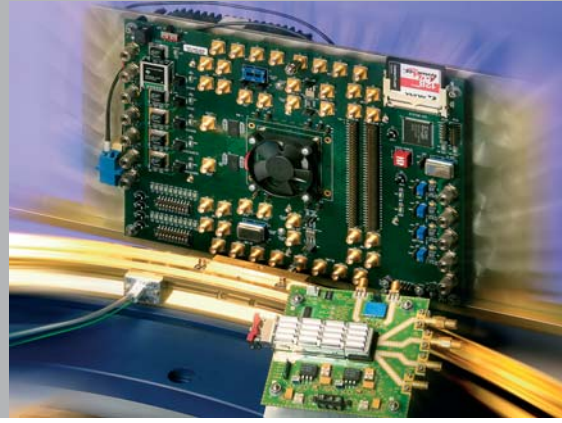
Large bore diameter application:

- Medical and industrial scanners
- Baggage detection scanners
- Various customer specific applications
- Radar, periscopes, defense
- Automation, industrial scanner
- Various customer specific applications



OPTICAL DATA LINK

OFF-AXIS



GigaFOS®

As the pace of development in imaging systems for medical and industrial applications gets faster and faster, the data rate to be transmitted rises continuously as well.

For this reason SCHLEIFRING has undertaken extensive research and development efforts in order to cope with the constantly and rapidly changing demands and embarked on its GigaFOS® project.

Based on a worldwide patented fiber optical transmission technology the GigaFOS® allows the transmission of electrical and optical data with data rates >10 GBit/s at up to 300 rpm.

Advantages

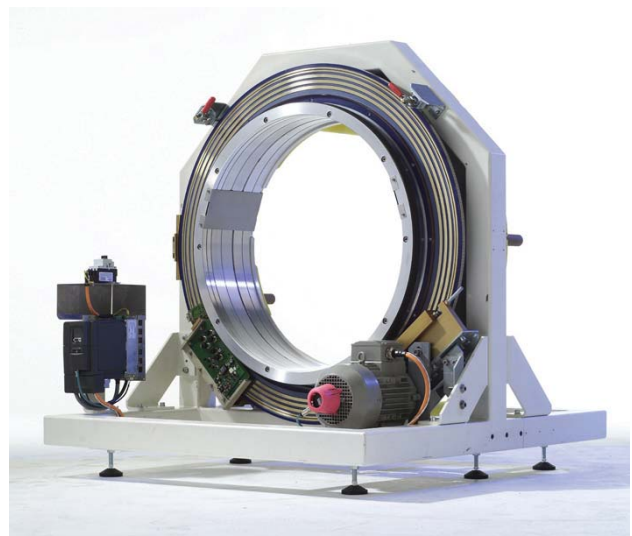
- The main advantage of the GigaFOS® technology is no emission of the electromagnetic field and immunity against radiated electromagnetic fields by using only passive optical components.
- The GigaFOS® fiber optic slip ring transmits any customer demanded data rate.
- Free inner diameter
- No wear
- High reliability and bit error rates $<10^{-12}$
- Using micro-optical components reduces the outer dimensions of the data transfer system.
- Modular design allowing quick and easy adaptation to customer specific applications.

Application example computed tomography systems: Inconceivable high digital detector/ scanning data – one single three-dimensional picture gobbles down the memory capacity of 30 CD ROMS - is transmitted optically between a rotating and a stationary plane. As the X-ray and the transmission speed is faster than a heart beat, the medical practitioner views a clear and high resolution image of the patient's heart on the monitor – like in a standstill mode.

This data transmission technology, developed in cooperation with the University of Applied Science Nuremberg, could theoretically transmit 100 000 phone calls per second in parallel.

Specification

Diameter:	0.6 m - 2 m
Data rate per channel (currently):	10 GBit/s
Data rate per channel (future):	up to 40 GBit/s
Data rate can be increased by WDM or by adding further channels.	
Rotational speed max. :	300 rpm
Error correction:	optional
Signal recovery:	optional





ON-AXIS

Plastic fiber rotary joints

Single-pass

Dual-pass

Single-Mode

Single-pass

Multi-pass

Multi-Mode

Single-pass

Multi-pass

Pressure compensated

OFF-AXIS

GigaCAP® - active

GigaFOS® - passive

System components

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