

### Advantage of Optical Fibers in your Application:

#### Bandwidth

Fiber optic cables have a much greater bandwidth than metal cables. The amount of information that can be transmitted per unit time of fiber over other transmission media is its most significant advantage.

#### Size

In comparison to copper, a fiber optic cable has nearly 4.5 times as much capacity as the wire cable has and a cross sectional area that is 30 times less.

#### Weight

Fiber optic cables are much thinner and lighter than metal wires. They also occupy less space with cables of the same information capacity. Lighter weight makes fiber easier to install.

#### Interference

Fiber optic cables are immune to electromagnetic interference. It can also be run in electrically noisy environments without concern as electrical noise will not affect fiber or the data.

#### Low Power Loss

An optical fiber offers low power loss, which allows for longer transmission distances.

#### Flexibility

An optical fiber has greater tensile strength than copper or steel fibers of the same diameter. It is flexible, bends easily and resists most corrosive elements that attack copper cable.

#### Security

Optical fibers are difficult to tap. As they do not radiate electromagnetic energy, emissions cannot be intercepted. As physically tapping the fiber takes great skill to do undetected, fiber is the most secure medium available for carrying sensitive data.



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## New Business Area for Protec GmbH focusing in Optical Components for Avionic, Military, Space and other HighRel Customers in Europe

Since high data rates are hitting space and other HighRel areas, we decided to focus on these parts in the future, to offer solutions which meet the needs of our Space and HighRel Customer base.

Following parts are already available from Protec GmbH, but we aim to add a wider portfolio in the future for these applications.

1. **Optical Transceivers 850nm**
2. **Active Optical Cables**
3. **Fibers (RadHard and HighRel)**
4. **RFoF (RF over Fiber) 1330nm**
5. **Fiber Optic Rotary Joints**
6. **Connectors**
7. **Fiber Cable Assemblies**
8. **Accessories for Connectors (Protection)**

### Projects were we are successfully involved with our Optical-Fiber solutions are:

- Space Projects: SARaH, KompSat7, OptSAT, EO/I, .....
- Space Applications: MassMemory, Cameras, Laser Terminals, .....
- Military: Fighter Aircraft, Helicopters, Radar....
- Avionic: In-Flight Entertainment, Databus, Displays...
- Industrial: Inspection Cameras, Autonomous Driving....

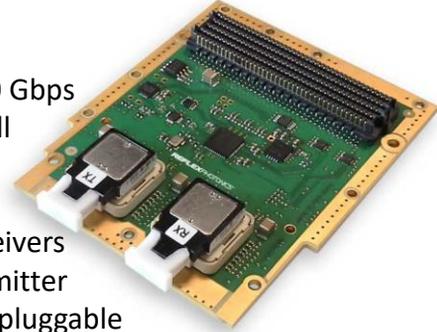
## 1. Optical Transceivers

Reflex Photonics embedded transceivers are chip-sized components based on 850 nm VCSEL and offering bandwidth up to 300 Gbps for short reach applications (<300 m).



These transceivers can be soldered or socketed to a printed circuit board and are well suited for small, compact systems requiring high I/O density, low power, and small space. Many of these transceivers have been qualified to operate in harsh environments, such as the ones found in space, and aerospace and defense applications.

The VITA 57.1/57.4 compliant LightABLE Optical FMC Board offers 150 Gbps of full-duplex bandwidth data communication and can be used with all the FPGA front end processing boards.



Moog Stiletto series optical fiber transceivers consist of 10 Gbps optoelectronic transmitter and receiver functions integrated into a pluggable Duplex LC compliant connector. The optical harsh environment transmitters are 850 nm VCSEL lasers. The transmitter input lines are driven with differential CML signals applied to the transmitter (TX+ and TX-) lines. Dual loop, temperature compensated, VCSEL drivers convert the transmitter input signals to suitable VCSEL bias and modulation currents.

Moog Protokraft Stiletto series optical fiber transceivers support the 2-wire serial communication protocol as defined in SFF-8472, offering end user access to device operating parameters such as transceiver temperature, laser bias current, transmitted optical power, received optical power and transceiver supply voltage. It also defines alarm and warning flags, to alert end users when particular operating parameters are outside of a factory defined normal range.



Moog Protokraft Lightning series fiber optic transceivers integrate multiple fiber optic transmitter and receiver functions into a MIL-DTL-38999 series III receptacle connector. The electrical interface to the Lightning series optical transceivers is a ribbon coax to Samtec EQCD high density cable assembly enabling SMT interconnection to a customer's backplane, motherboard or daughtercard. The D38999, series III shell provides a sealed optical interface that is water-tight to MIL-STD-810 / IP67 / NEMA-4x when mated. The multimode optical fiber interface supports applications where copper cable link distance, bandwidth limitations, weight or bulk make twisted pair, coax, twinax or quadax copper conductors unacceptable.

Moog Protokraft Sabre series fiber optic components integrate high performance fiber optic transmitter or receiver functions into a D38999 size 09-01 cylindrical connector intermate able with the ELIO® fiber optic connectors for unidirectional transmission. Sabre series optoelectronic D38999 size 09-01 transmitters consist of integrated into a printed circuit board mounted PIN contact. Sabre series optoelectronic D38999 size 09-01 receivers consist of optoelectronic receiver functions integrated into a printed circuit board mounted PIN contact.



## 2. Active Optical Cables

Moog Protokraft designs and manufactures high-speed optoelectronic components and communication subsystems for use in harsh environment networking equipment applications.

The company provides optoelectronic components and subsystems for short and intermediate reach harsh environment optical networks, including optical network switches, optical enterprise and storage area networks (SAN's) and tactical optical access networks. These active optical subsystems integrate the functions of optical transceivers into the natural structure of a passive optical connector.

Moog Protokraft Cobra series active optoelectronic cable assemblies consist of optoelectronic transmitter and receiver functions integrated into an environmentally sealed unit with a D38999 / 26xB35PN electrical connector interface. The D38999 electrical interface to the Cobra series enables the use of high speed fiber optic cable links in applications exposed to extremely harsh environments.

The electrical D38999 size 11-35 connector provides a rugged electrical interface that does not require cleaning or maintenance in order to perform in harsh environments. Signal conversion is done in the back shell of the electrical connector. The multimode or single mode optical fiber cable supports applications where copper cable link distance, bandwidth, weight or bulk make the use of twisted pair, twinax or quadrax copper conductors unacceptable.



## 3. Fibers (RadHard and HighRel)

DrakaElite™ Radiation Hardened Multimode and Single-Mode Fiber. These DrakaElite™ fibers have been designed for reduced sensitivity to radiation effects. One reason of this excellent behavior is the use of the proprietary PCVD glass deposition process, which allows phosphorous-free operation<sup>1, 2, 3</sup>. Moreover, Draka Communications maintains a dedicated production line, optimized for these RadHard products. In addition to that, Draka's PCVD process allows realization of very accurate refractive index profiles that guarantee enhanced performances in terms of bandwidth and attenuation. Draka Communications offers three optical fiber products, which have been qualified for MIL-PRF49291 specifications:

- DrakaElite™ RadHard 62.5 / 125 / 242 μm MMF (MIL-PRF-49291/6-03)
- DrakaElite™ RadHard 50 / 125 / 242 μm MMF (MIL-PRF-49291/1-01)
- DrakaElite™ RadHard 9 / 125 / 242 μm SMF (MIL-PRF-49291/7-01)



The Radiation-Induced Attenuation (RIA) of each fiber strongly depends on the radiation conditions. RIA generally decreases with: decreasing dose-rate, decreasing total dose, longer annealing time, increasing temperature, increasing injected power and longer wavelengths.

DrakaElite™ RadHard multimode fibers can be equipped with 500 μm coating DLPC2, also MIL-PRF-49291 approved. Also single-mode fibers can be equipped with this 500 μm DLPC2 coating, however this combination has not been offered for MIL approval.

## 4. RFoF (RF over Fiber) 1330nm

Six-channel RF over fiber components 40 MHz to 8 GHz frequency band, for Radar and other RF Applications.

The RF optical signal is generated by directly driving a DFB laser, which is then coupled into single-mode fiber. In addition to the two RF amplifiers, each ASIC contains a Serial Peripheral Interface (SPI), bias generation, built-in-test measurement system, and monitor diode readout circuitry. The monitor diode readout circuitry, combined with the six integrated photodiodes, allow for TSSI monitoring per TX channel. The T6 module also includes a microcontroller, which provides serial communication to the module.

The T6 module is controlled and configured through the Universal Asynchronous Receiver/Transmitters (UART) of the integrated microcontroller. The microcontroller internally communicates with the three Tannat ASICs through the SPI interface. The TXDIS pin is a discrete control input that allows power down of all six transmitter channels.



The TXDIS pin is active-high and has an internal 66kΩ pull-up resistor that disables the optical outputs upon power-up without any external connection. Each individual transmitter channel can also be powered down through the serial interface. The measurement system is enabled/disabled through the serial interface.

The R6 accepts six independent, modulated SMF optical inputs from the optical connector (1550nm and 1330nm). The R6 also receives DC voltages that are used to provide power to internal devices and functions.



**R6**

For external communication, R6 accepts a SPI bus input to provide command and control of the configurable functions on the RFICs. It can be commanded to perform BIT functions, such as received signal strength (RSSI), and to output internal voltages, currents, and IC status.

R6 accepts discrete control input signals that set which RFIC outputs are on or off. Discrete control signals allow for fast OFF to ON switching time. In addition, discrete control input signals are used to configure a pair of 32-step phase shifters.

## 6. Fiber Optic Rotary Joints

Fiber Optic Rotary Joints (FORJs) are to optical signals what electrical slip rings are to electrical signals, a means to pass signals across rotating interfaces, particularly when transmitting large amounts of data. FORJs maintain the intrinsic advantages of fiber end to end. Moog has been producing Fiber Optic Rotary Joints for over twenty years.

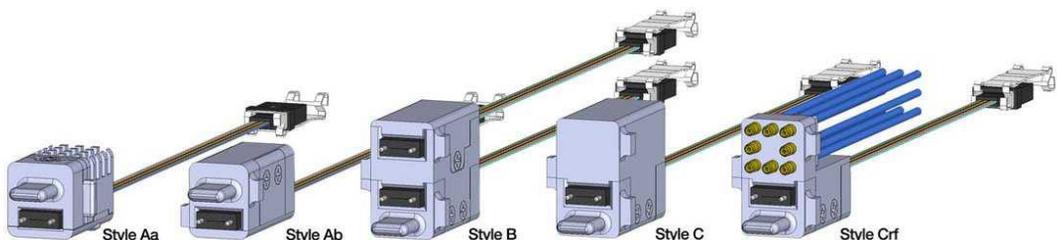
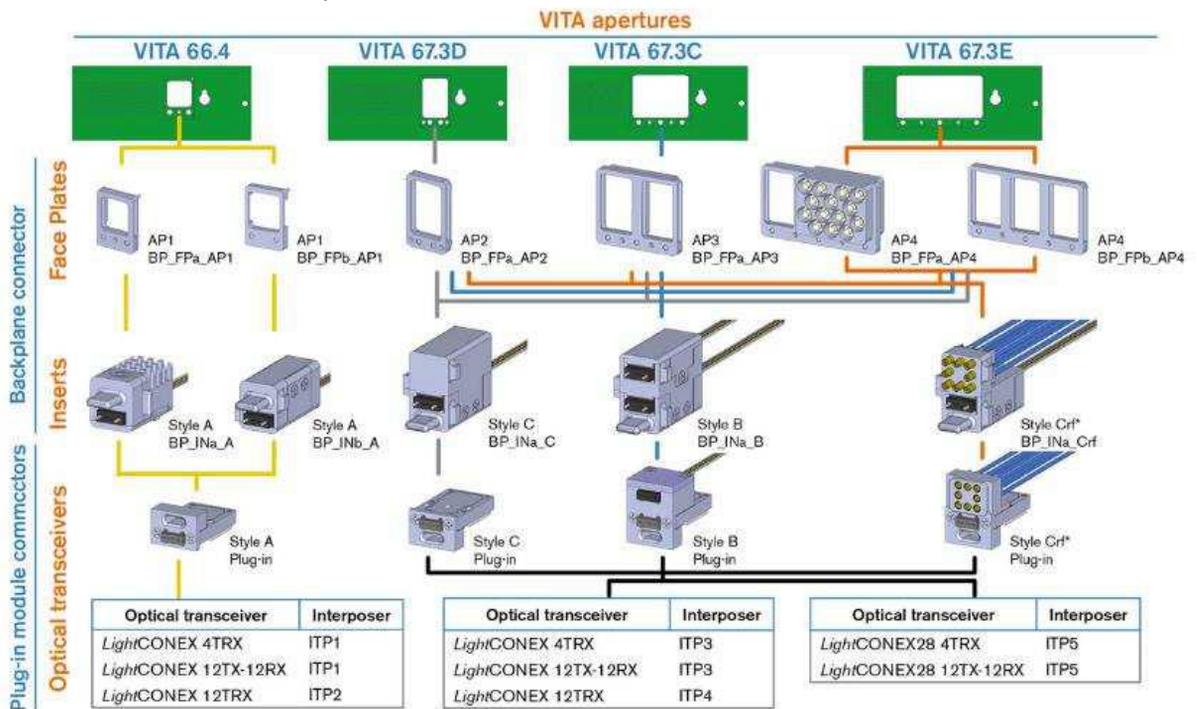


FORJs are available in single and multi-channel options. The most cost and size efficient options are the single and dual channel designs. If more than two fibers are present in a system, multiplexing solutions are available to combine multiple channels onto one or two fibers to allow the use of a one or two channel FORJ.

In cases where more than two fibers are required, Moog has three designs, the FO190, FO242 and FO291 where single channel modules are stacked to achieve the desired number of channels. The FO300 uses a common de-rotating optical element for all fiber channels.

## 7. Connectors

Fiber Optic Transceivers implemented into Backplane Connectors for Applications with VITA Standards, also available for Space VPX.



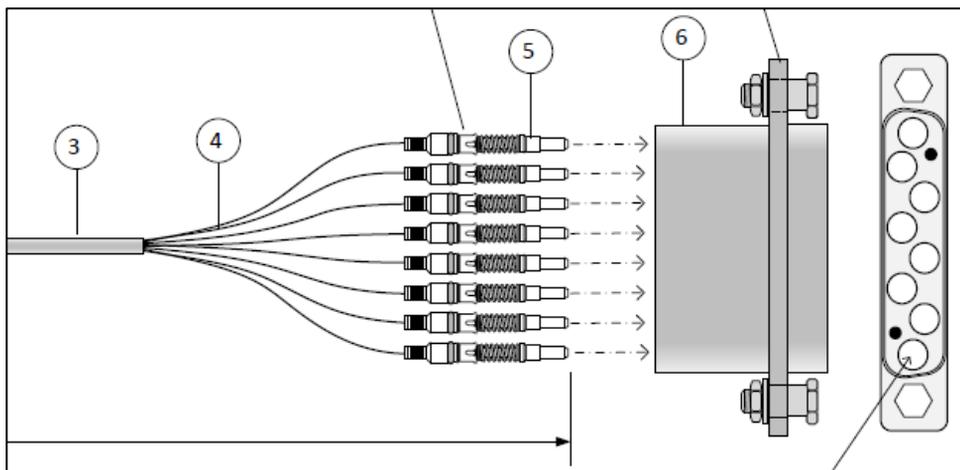
In addition to the Backplane Connectors from Reflex Photonics we can help to source almost any Fiber Optic Connectors and Terminis through our Partners if your intention is to procure Fiber Cable assembly for your HighRel Application.



## 6. Fiber Cable Assemblies

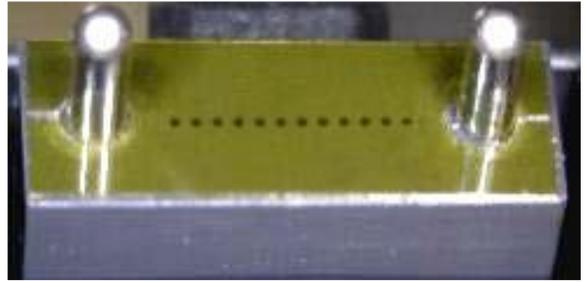
We do work with multiple partners in Europe and US for Fiber Cable Assemblies. The cables will be manufactured acc. to your Specs.

With your Choice of Connectors, Terminis, Fibers and length also depending on your Application you might have additional requirements to protect the fibers, we can offer many different solutions from PTFE or PFA Tubes to ribbonising or even Radiation Testing of the Fibers. All cables can be ordered with test protocols acc. to your specifications.



## 7. Accessories for Connectors (Protection)

The MT ferrule was designed to have multiple fibers (12 or more) all in physical contact at the connector interface. In reality, this is difficult, which results in air gaps in the optical path. Air gaps cause reflections and can trap foreign material. The MT Saver is a compliant film that removes the air gaps between the fiber end faces.



Eliminates open fibers within connectors, and Protects fibers from damage.  
Funded to perform qualification for flight application - Qualification on going.