

micronor sensors

Fiber Optic Product Guide

Our FO sensors can measure:



Temperature



Position



Force



Vibration



E-STOP

Signaling

FOTEMP
TEMPERATURE PROBES™ & INTERROGATORS
-200°C to +300°C

Fiber Optic Immunity Series

1-2-3 Axis
Up to 50 g's

MULTI-AXIS VIBRATION SENSORS

Fiber Optic Immunity Series

Load Cell

FEMTO OPTICAL FORCE SENSORS

Fiber Optic Immunity Series

High Resolution Force Sensing from 2 to 25 lbs (11.3 kg)

Grasper Gripper

Interference-Free VFD feedback to 2000m

ABSOLUTE POSITION & INCREMENTAL ENCODERS

Fiber Optic Immunity Series

Industrial & Non-Metallic MRI Safe Models

Rotary & Linear

MR361 Series

MV Drives, Conveyors, Dam Gates, etc.

Extend SSI Absolute & Incremental Encoders, up to 2000m

Fiber Optic Immunity Series

Without FO

With MR361

MR380 Series

E-STOP & MICROSWITCH FOR FUNCTIONAL SAFETY

Fiber Optic Immunity Series

FO E-STOP Links and Networks Up to 18 km

FLIP BOOKLET for Electromechanical Products

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*Many of these Fiber Optic Sensors are **Stocked** in
Ventura, California. These sensors can also be
directly ordered from our **Online Store**.*

*For information, quotations, or sales support,
please call or email us:*

**Micronor Sensors Inc.
2065 Sperry Ave, Suite B
Ventura, CA, 93003, USA
Main +1-805-389-6600
Email sales@micronor.com
www.micronor.com**

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Resellers, and OEMs.*

**Call The Fiber Optic Sensors Expert,
Dennis Horwitz
@ The Sensors Hotline
+1-805-242-4296
dennis@micronor.com**

www.micronor.com

***These FIBER OPTIC SENSORS
are produced by the most
innovative manufacturers
in their categories.
Many models are STOCKED
in VENTURA, CALIFORNIA
and can also be purchased
from ONLINE STORE...***

COMEM

MICRONOR[®]

optical sensors



The Fiber Optic Buzz!

Fiber Optic Sensors are replacing their Electrical Counterparts in Critical Applications

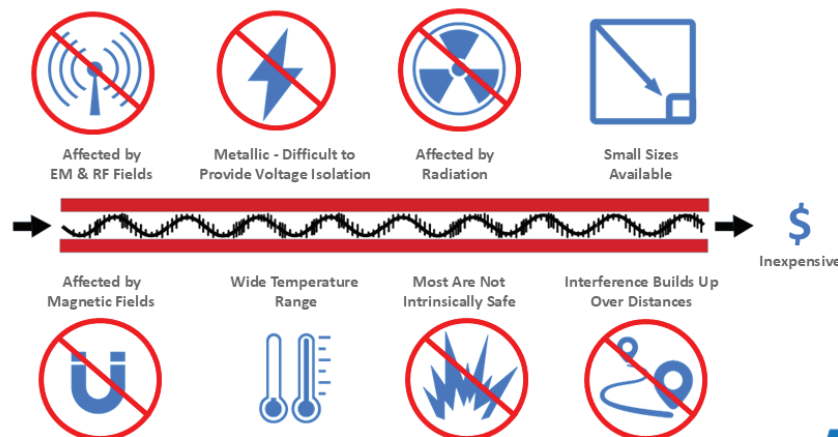
Presented by **Dennis Horwitz**, President

Sensors Converge
May 2026

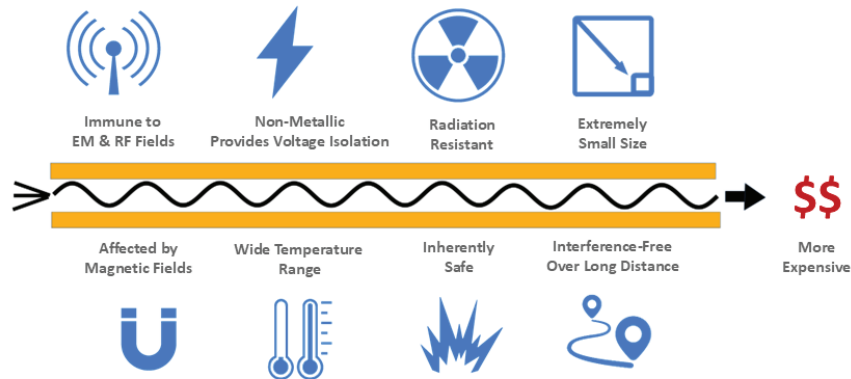
Today's Industrial Trends drive needs for Sensors of All Types

Trend	What/Why/Where	Issue
Electrification	Reduce use of fossil fuels, lower carbon footprint, combat climate change	Creates EMI/RFI Problems
Closed Loop Processing	Automation, robotics, process & equipment health feedback for increased efficiency and lower costs	Need for variety of sensors for better process monitoring, better yields, and predictive maintenance
Medical Devices	Surgical & biopsy robots, treatment delivery, MRI, patient rehabilitation	Need variety of sensors, low cost, small size, enhance health & longevity
Harsh Environments	Transformers, generators, oil & gas, pipelines, wind turbines, underwater, nuclear	Need very robust sensors – resistant to harsh environment factors
Hazardous Locations	Food industry, chemical, mines, food & process industries	Need for intrinsically safe or inherently safe sensors
Vehicle Health	Automotive, aerospace, rail transport	For increased safety and reliability
Structural Health	Buildings, dams, highways, railroad tracks, pipelines, transmission lines	For increased safety and reliability, eliminate waste caused by leakage

Electrical Sensors have many weaknesses...



Fiber Optic Sensor has one challenge ... cost



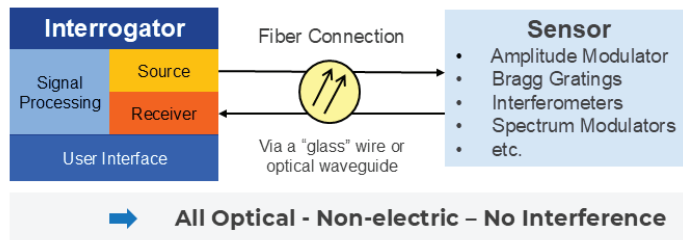
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What is a Fiber Optic Sensor?

"Remote sensing and measuring of a physical quantity using photonics for both sensing and transmission."

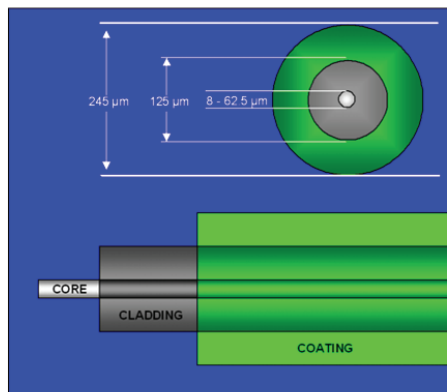
Since most Fiber Optic Sensors are not of transducer⁽¹⁾ type, they require an interrogator



Definition: Transducer – a device that converts one form of energy into another.

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What is Fiber Optics?



Core

- Carries the light signals
- Silica and a dopant, special pure silica core fiber
- POF uses polymer core
- 9μm for telecom SM, 5.6 μm for FiSens SM800 FBGs
- 50 or 62.5μm for multimode, 1mm for POF

Cladding

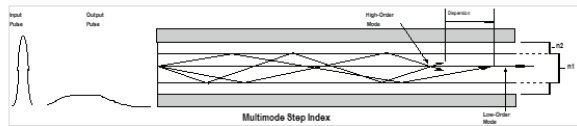
- Keeps light in the core
- Pure silicon or polymer

Coating

- Protects the bare fiber
- Acrylate (polymer) or Polyimide (for high temp)

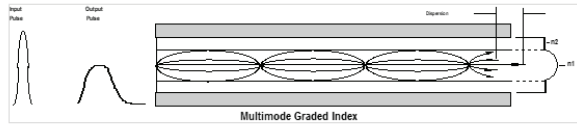
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Single Mode versus Multimode: Many Types and Sizes of Optical Fiber



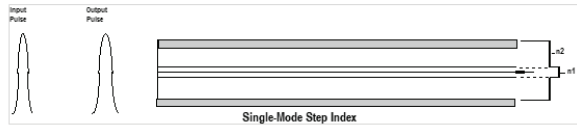
Multimode Step Index Fiber

- Short distance links, <100 m
- 10-100 Mb/s, Single λ
- POF, Large Core SI Fiber, Imaging Bundles



Multimode Graded Index Fiber

- Short-Medium distance links, 10m - 2000m
- 100 Mbs - 10Gb/s, Single λ
- 50/125 (OM2/OM3) or 62.5/125 (OM1)



Single Mode Fiber

- Long distance links, 1-100km, 1310-1550nm
- 10//100/1000 Gb/s, Single λ or WDM)
- 9/125 (OS1/OS2), Specialty SMF for other λ

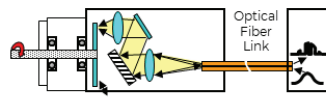
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Fiber Optic Absolute Encoders



Absolute Encoder/Position Sensor

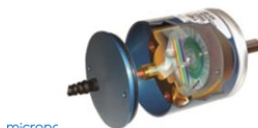
US Patent 8,461,514 B1



MR330 series
OM1 62/5/125 MMF
Optical Concept:
Spectral Domain



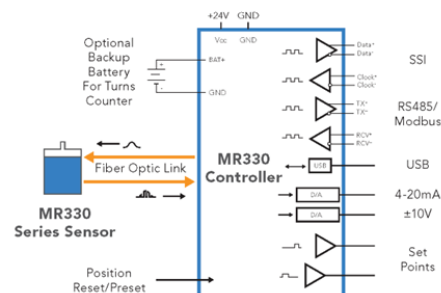
MR430 series
M-POF MMF
Optical Concept:
Visual Domain



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THEORY:

Code disk contains a single track,
non-repeating code. Internally
14-bit Position is derived from
10-bit value plus 4-bits phasing.



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Case Study #1: NASA Launcher Upgrades

Application: Elev and Azimuth Feedback



NASA/ORBITAL SCIENCES

- Global network of Cold War-era Launchers repurposed & upgraded for use with modern Sounding Rockets
- Azimuth and Elevation Position Feedback
- Operator safely situated outside the blast zone (300m)



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MR332
FO Absolute
Encoder

Programmable
SSI Readouts

Micronor
MR330
Controllers

FO Attributes



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Case Study #1: NASA Launcher Upgrades

Application: Elev and Azimuth Feedback

FO Attributes



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NASA/ORBITAL SCIENCES

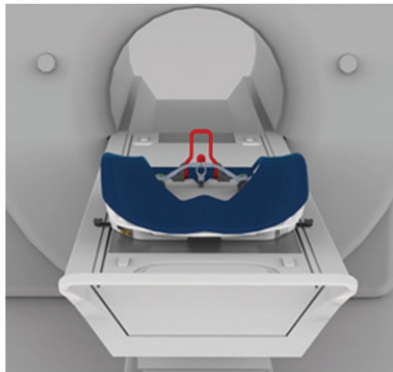
- Global network of Cold War-era Launchers repurposed & upgraded for use with modern Sounding Rockets
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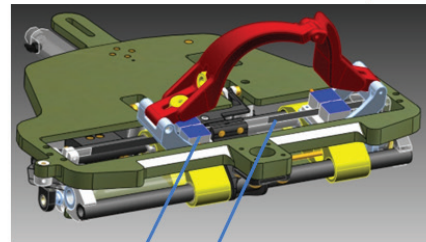
Case Study #2: MRI Guided Biopsy Robot

Application: MRI-Safe Linear Encoder for Position Feedback

FO Attributes



Photos and renderings courtesy of
Polymer Robotics / Umano Medical



2-Axis Feedback

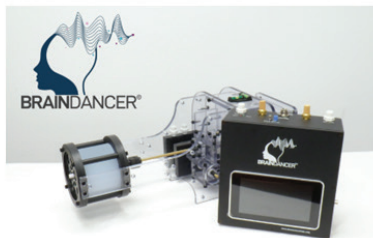
Dual MR343
Linear Incremental
Encoders and
Incremental Film Strips
shown.

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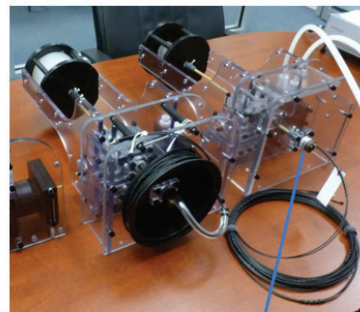
Case Study #2b: MRI Dynamic Brain Phantom

Application: MRI Operator Training & Calibration

FO Attributes



The ALA SCIENTIFIC MRI Dynamic Brain Phantom is designed to address training and quality assurance protocols for MRI machines by providing rapid control feedback from within the MRI bore, while remaining invisible to MRI scans.



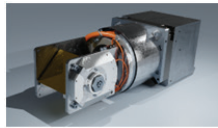
MR431 POF-based
Absolute Encoder

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Case Study #3: ITER Fusion for Energy Project

Application: High Resolution FO Encoders for IVVS

FO Attributes



APPLICATION

The mission of Fusion for Energy (F4E) is to make fusion possible on Earth. ITER ("The Way") will be the first fusion device to generate more heat than is used to start the reaction. The process involves raising the temperature to 150 million °C to generate super-hot plasma, producing 500 MW of heat for about 7 minutes.

CHALLENGE

When the fusion device is turned off, the In-Vessel Viewing System (IVVS) needs to examine plasma-facing components in the vacuum vessel. This requires an extremely precise inspection system.

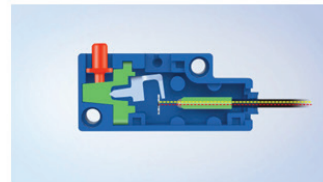
SOLUTION

Six probes are used at different points within the machine. Each uses a laser beam and rotating turret to scan the surface, producing a 3D map of the machine. Extremely high-resolution FO Encoders were developed by Micronor AG for IVVS.

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MR386 Series Fiber Optic Microswitch

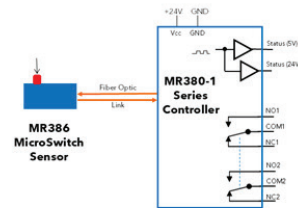
Operates on basic principle of photo interruption (light on / light off)



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MR386 with Omron VAL2 Roller Leaf Spring



- MR386 has same form factor as Omron/Honeywell V- series EM Micro Switch
- Compatible with all Omron and Honeywell V-series actuator accessories (leaf spring, roller leaf spring, wire leaf spring, etc.)
- Multiple FO Microswitches can be connected in linear or loop topologies using Multiple Controllers

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Case Study #4: St Louis Metro Railway System

Application: Remote Monitoring of HV Bypass Switch

FO Attributes

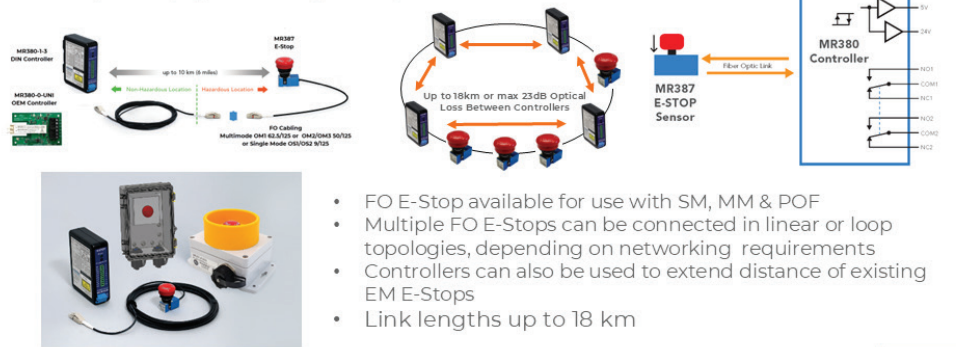


When manual bypass switch is engaged, the arm pushes down on extended actuator which depresses plunger. Status is monitored by the Control Center.

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MR387 Series Fiber Optic Emergency Stop

Operates on basic principle of photo interruption (light on / light off)



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Case Study #5: LAX Consolidated Rent-A-Car Ctr

Application: FO E-Stop between Main and Utility Buildings

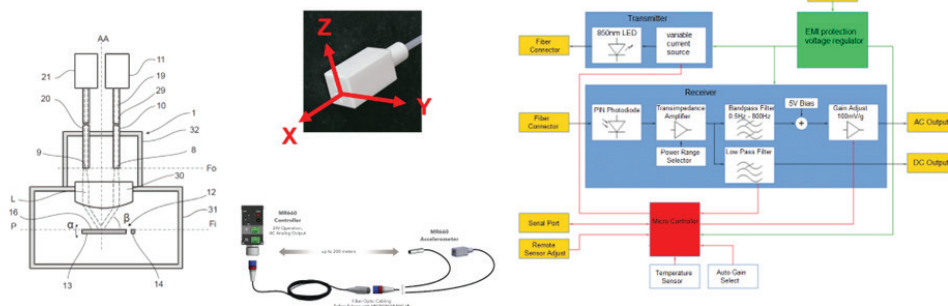
FO Attributes



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MR660 Multi-Axis Fiber Optic Acceleration/Vibration Sensor

A dedicated MEMS membrane/mirror is aligned with a specific axis and light is modulated only by that axis.



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Case Study #6: Electric Train Pantograph

Application: Pantograph & Catenary Vibration Anomalies

FO Attributes



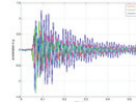
CHALLENGE

Dynamically monitor pantograph operation in real time during train operation. A serious failure of pantograph can not only damage contact wires but can also inflict widespread damage on the catenary system network.

SOLUTION

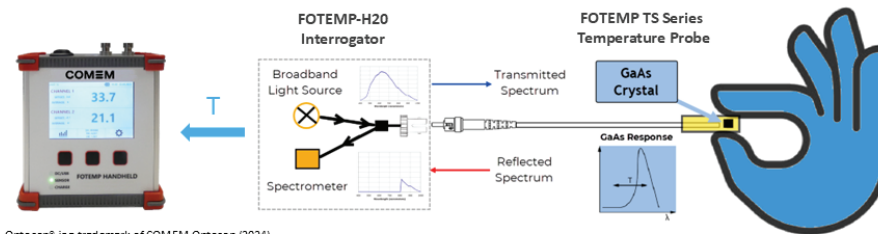
Providing high voltage immunity and isolation, a multi-axis fiber optic accelerometer mounts directly on the pantograph to monitor system health in real time. Data is also used to monitor the health of the catenary system.

Customer: Swiss Railway



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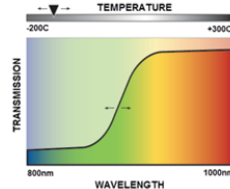
FOTEMP (GaAs) Fiber Optic Thermometry



Optocon® is a trademark of COMEM Optocon (2024)

Principles of Operation

1. GaAs is a non-metallic semiconductor crystal in which the effect of temperature is based on the inherent light absorption and transmission properties of the crystal.
2. Light source transmits light to the crystal. Some of the light is absorbed and the rest is reflected back to the spectrometer.



Optical beam probes the wavelength dependence of the intrinsic band-gap of GaAs which is dependent on absolute temperature.

$$E_{\text{gap}} = 1.423 \text{ eV}$$

$$\Rightarrow 300^\circ\text{K} = 872 \text{ nm}$$

$$dE_{\text{gap}}/dT = -0.452 \text{ meV}^\circ\text{K}$$

$$\Rightarrow \approx 0.315 \text{ nm}^\circ\text{K}$$

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Case Study #7: Induction Heating

Application: Measuring Temperature in RF Field

FO Attributes

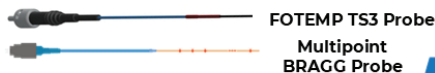


CHALLENGE

Magnetic nanoparticles are heated with induction to selectively ablate tumor cells, powers from 1kW to 10kW, frequencies from 150kHz to 400 kHz. This non-contact selective heating only elevates the temperature of the material or tissue with **embedded magnetic nanoparticles**. Requires RF immune temperature sensor to monitor actual temperature.

SOLUTION

Ambrell EASYHEAT® System is a compact induction heating system for the lab which offers COMEM Optocon's FOTEMP GaAs-based TS3 FO Temperature Probe (both non-metallic and RF-immune) for both temperature monitoring and control. Recently, customers have started to use Multipoint BRAGG FBG-based Temperature Probes for measuring gradients.



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Case Study #8: Microwave Oven & Reactors

Application: Measuring Temperature in MW Oven

FO Attributes



Microwave Food Processing and Process Development

CHALLENGE

Develop optimized process for meat thawing as well as production of partially cooked food product.

SOLUTION

A&B Famous Gefilte Fish uses the 4-Channel Bench Top FOTEMP signal conditioner together with FOTEMP TS3 series temperature probes.

A&B developed a proprietary microwave oven-based process for raw fish thawing as well as production of their partially cooked frozen gefilte fish product. For the latter, a microwave oven process was developed that precisely cooks and cools the product without rendering the proteins fully cooked.



FOTEMP TS3 Probe

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FEMTO FBG-Based Force and Strain Sensors

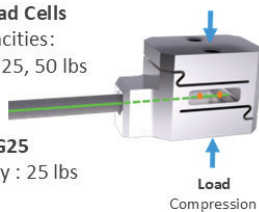


The FG25 Fiber Optic Load Cell can measure ± 25 lbf with 0.002% resolution

FG10 Series FO Load Cells Capacities: 2, 5, 10, 25, 50 lbs

FG25 Capacity: 25 lbs

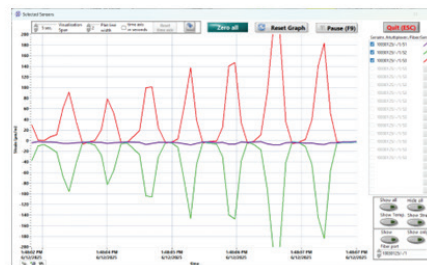
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Load Compression

Force = E * strain * area
where E = Young's Modulus

Gripper and Grasper FO Load Cells



$\pm 3500 \mu\epsilon = \pm 25$ lbf

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Case Study #9: Robotic Touch Force Sensing

Application: Force of Loads, Gripping and Grasping

FO Attributes



APPLICATION

Closed-loop robotic touch and force feedback in Harsh Environments characterized by electromagnetic fields and interference.

CHALLENGE

Conventional strain gauge sensors are susceptible to errors and interferences:

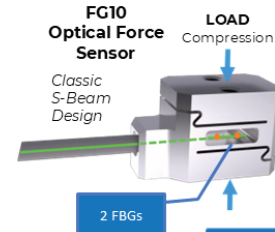
- Changes in resistance due to temp and humidity
- Hysteresis, creep, or fatigue that reduce accuracy and repeatability
- Require Calibration, compensation or correction for differing loading conditions.

SOLUTION

FBG-based Load Cells, Gripper and Grasper force sensors provide electromagnetic immunity, high precision, accuracy, and reliability.

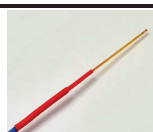
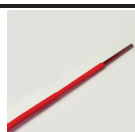
FG10 Optical Force Sensor

Classic S-Beam Design



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FOTEMP® TEMPERATURE PROBES



MODEL	TS2p Smallest	TS3 General Purpose	TS4 Harsh Chemicals	TS5 Medical & SFF	TST Transformers	SmartSpacer Disc, & Busbar
Key Features	Smallest size, for direct contact measurement or micro-vial immersion, Bare GaAs crystal (300µm x 300µm) and fastest measurement, Non-Conductive.	Semi Rigid Probe, Immune to EMI/RFI and Microwave Emissions, Non-Conductive.	High Accuracy, Corrosion Resistant, PTFE Coated, Non-Conductive.	Flexible Probe, Small Form Factor, and Compact Size, Non-Conductive.	Specifically Designed for Use in Oil-Filled & Dry Transformers, Non-Conductive. Supplied with DiscSpacer.	Non-conductive accessories used to embed TST and TS3 probes in transformers, busbar and switchgear.
Applications	RF environments, High Voltage applications, Semiconductors & Medical Testing	General Use: Food, Microwave Oven, and RF Environments	Harsh Chemical and Liquid Immersion	Medical Environments, Catheter Instrumentation, Semiconductor, Small FF	Oil-Filled Transformers	General Use: Transformer Windings, Bus Bars, & other Switchgear.
Continuous Temperature Range	-200 °C to +260 °C	-200 °C to +260 °C	-200 °C to +260 °C	-200 °C to +260 °C	-200 °C to +260 °C	Temperature depends on material, max +180 °C
Short-term Temp Range (max 1hr)	+260 °C to +300 °C	+260 °C to +300 °C	+260 °C to +300 °C	+260 °C to +300 °C	+260 °C to +300 °C	
Measurement Uncertainty (2σ)		± 1.0°C over -100°C to 5°C ± 0.3°C over 5°C to 95°C ± 1.0°C over 95°C to 250°C			± 1 °C	---
Thermal Response	20 °C/s	12 °C/s	7 °C/s	19 °C/s	19 °C/s	---
Probe Dimensions	D1: 0.45 mm D2: 1.70 mm D3: 1.30 mm	D1: 1.0 mm D2: 1.70 mm D3: 1.30 mm	D1: 1.0 mm D2: 1.7 mm D3: 1.3 mm	D1: 0.55 mm D2: 1.70 mm D3: 1.30 mm	D1: 1.70 mm D2: 1.30 mm D3: 3.00 mm	J-Spacer & DiscSpacer for use with TST probes. SmartBusbar with TS3.
Other Dimensions	L1: 2 mm L2: 42 mm L3: 2-20 m	L1: 15-550 mm L2: 20 mm L3: 2-20 m	L1: 15-550 mm L2: 10 mm L3: 2-20 m	L1: 15-550 mm L2: 20 mm L3: 2-20 m	L1: 10 mm L2: 15 mm L3: 2-20 m	Consult drawings
Cable Coating	Polyimide / PTFE	Polyimide / PTFE	PTFE	Polyimide / PTFE	PTFE	NOMEX T994, PEEK or Transformer Board
Connector Type	ST	ST	ST	ST	ST	---
STOCK PRODUCTS (L1 and L Lengths)	TS2p-02	TS3-15MM-02 TS3-15MM-05 TS3 for SmartBusbar	TS4-20MM-02 TS4-20MM-05	TS5-20MM-02, -06 TS5-50MM-02, -06	TST-02 (includes EOF0256 DiscSpacer)	EOF0200 J-Spacer EOF0256 DiscSpacer ZM0060 SmartBusbar

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FOTEMP® SIGNAL CONDITIONERS QUICK GUIDE



MODEL	FOTEMP-MN30 OEM SFF PCB	FOTEMP-C15 OEM SFF Module	FOTEMP-HD20 Portable Handheld	FOTEMP-C20 Bench Top Most Popular	FOTEMP-T20 Multi-Channel to 16 Ch	FOTEMP-T30 Transformer Apps
Description	Small Form Factor OEM PCB Module	OEM Module, Bench Top, Chassis or DIN Rail Mount	Handheld, Portable	Compact Bench Top	DIN Rail, Chassis Mount or Bench Top	Transformer-specific Monitoring System
No. of Channels	1 or 2	1, 2 or 4	1 or 2	1, 2 or 4 (Std)	4, 8, 12, or 16	2, 4, 6, 8, 12, 16
Measurement Range	-200 °C to +300 °C	-200 °C to +300 °C	-200 °C to +300 °C	-200 °C to +300 °C	-200 °C to +300 °C	-200 °C to +300 °C
Measurement Uncertainty (2σ)			± 1.0°C over -100°C to 5°C ± 0.3°C over 5°C to 95°C ± 1.0°C over 95°C to 250°C			± 1.0 °C (Trafo Apps)
Applications	Embedded OEM Application	Industrial Process, Switchgear & Transformer	Laboratory, Test, Industrial Process Monitoring	Laboratory, Industrial Process Monitoring	Industrial Process, Switchgear & Transformer	Transformer Hotspot Monitoring
Sample Rate/channel	250ms	250ms	250ms	250ms per Active Channel	1 sec for all channels	1 min for all channels
Internal Data Logging?	Yes, optional MicroSD	No	Yes	No	Yes, optional MicroSD	Yes, option USB Stick
Analog output	---	Std=0-10V Option=4-20mA	---	Std=0-10V Option=4-20mA	Std=None Option: 4-20mA or 0-10V	4-20mA
Relay output	---	Option=4	---	Option=4	Standard=4	Standard, 1 per Channel
Built-in Interfaces/Protocols	ASCII: USB-C, TTL-UART, and RS232 Modbus: RS485	P1=USB/ASCII +RS485/Modbus	USB-C/ASCII	P1= USB/ASCII +RS485/Modbus	P1= USB+RS485/Modbus P2= USB+Ethernet/Modbus	RS485/Modbus/RTU & Ethernet/ModbusTCP
Power Supply	P0= USB-C (5V 3A) P1= 9-24VDC, 350mA	24 VDC (includes AC power supply)	Internal Li-Ion battery Ext: USB-C or 24VDC	24VDC (includes AC power supply)	24VDC/Max 40W	24VDC/Max 40W
STOCK PRODUCTS	A1-CAL= -20C to +150C A2-CAL= -40°C to +200C B-CAL= -40°C to +300°C C-CAL= -200°C to +300°C	FOTEMP-MN30-1-P0-B	FOTEMP-H2-1-P0-B FOTEMP-H2-2-P0-B FOTEMP-H2-2-P0-C	FOTEMP-C20-P1-V-B FOTEMP-C20-P1-V-C	Special Order 4-6 Weeks ARO FOTEMP-T20-16-P1-A2 FOTEMP-T20-8-P2-A2	Special Order 4-6 Weeks ARO

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FOTEMP Sensor Connectivity & Mounting Accessories

FOTEMP + DIST + Feedthrough + TS

MODEL					
	DIST-CXXX-YY FOTEMP FO Extension Cables	MR320A General Purpose ST Bulkhead (F-to-F)	EOF0008 (NPT) EOF0246 (Metric) Single Port (F-to-F) Hermetic Feedthrough	EOF0049 (2 Port) EOF0050 (1 Port) KF40 Flange (M-to-M) Hermetic Feedthrough	Sensor Spacers Inter-Winding, Disc, or Busbar
Key Features	Ruggedized Extension Cable: • DIST-C320, General Purpose • DIST-C900, Industrial Grade • DIST-CABLE, High Temperature • All cables include MR320A	Standard ST Bulkhead Adapter, not for vacuum or pressurized applications	Threaded Hermetic Feedthrough, SAE NPT or Metric, For pressure or vacuum vessels, oil-filled transformers	KF40 Flange, Fiber Optic Hermetic Feedthrough, for Vacuum Chamber Applications	Non-conductive accessories used to embed TST probes in transformers, busbar and switchgear.
Applications	RF environments, High Voltage applications, Semiconductors & Medical Testing	General Purpose, for lab, plant or process monitoring applications	For Vacuum or Pressurized Chambers/Vessels. Oil-Filled Transformers	For Vacuum or Pressurized Chambers/Vessels	General Use: Transformer Windings, Bus Bars, & other Switchgear.
Temperature Rating	CXXX cable: -55 °C to +85 °C CABLE cable: -200 °C to +300 °C ST Connector: -40 °C to +85 °C	-40 °C to +85 °C	-40 °C to +120 °C	-40 °C to +120 °C	Temperature depends on material, max +180 °C
Key Characteristic1	CXXX cable: PUR, UL94-V0 CABLE cable: PTFE		SAE Thread: 1/4"-18 NPT Metric: Thread: M14 x 1.5		J-Spacer & Disc-Spacer for use with TST2J probe
Key Characteristic2	CXXX bend radius: 27mm CABLE bend radius: 60mm		Vacuum rating: 10-6 Torr	Vacuum rating: 10-6 Torr	Flush Mount and Magnetic Busbar Spacer for use with TS3 probe
Key Characteristic3			Pressure rating: EOF0008: 200 bar, 2'900 psi EOF0245: 2 Bar, 29 psi		Materials: NOMEX T994, PEEK or Transformer Board
Fiber Type	200/220	Any Fiber Size	200/220	200/220	TS series sensors
Connector Type	ST	ST	ST	ST	---
STOCK PRODUCTS (Cable lengths in m)	DIST-C320-03, -05, -10 DIST-C900-03, -05, -10 DIST-CABLE-03 Custom lengths upon request.	MR320A	EOF0008 (SAE NPT) EOF0245 (Metric)	EOF0049 EOF0050 Requires 2x MR320A per port	EOF0200 Trafo J-Spacer EOF0256 Trafo Disc Spacer ZM0060 Busbar (Flush-Mnt)

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FEMTO FBG-BASED OPTICAL FORCE SENSORS QUICK GUIDE

MODEL						
	WAVE FORCE ONE Interrogator	FG10 Series SFF Load Cell	FG25 25lb (11.3kg) Miniature Load Cell	GR25 Gripper Robotic Tactile Sensor	GS05 Grasper Robotic Tactile Sensor	FORCE VISUALIZATION Software
Description	Wideband (W) Interrogator	Inline Force Sensor, Capacity Options: 2, 5, 10, 25, 50 lb.	Inline Force Sensor,	Gripper Force Sensor. Optional dual Gripper for parallel actuation.	Grasping Finger Sensor. Optional grasper assembly with push rod actuation.	PC-based software for interrogators & optical transducers calibration.
No. of Channels	1, up to 30 FBGs	Sensor requires 1 channel interrogator	Sensor requires 1 channel interrogator	Each Gripper Sensor requires 1 channel interrogator	Each Grasper Sensor requires 1 channel interrogator	Requires 1 channel for each sensor
Measurement (or Force Capacity)	Temperature, °C Strain, µε	2, 5, 10, 25, 50 lb.	25lb (11.3kg)	25lb (11.3kg)	5 lb (2.2kg)	---
Precision (Interrogator Output)	0.1-1°C or 1-10µε depending on sample rate	3500µε at Full Scale, nominal	3500µε at Full Scale, nominal	3500µε at Full Scale, nominal	3500µε at Full Scale, nominal	---
Total # of FBGs	1-30	Internal FBGs=2 Tension & Compression	Internal FBGs=2 Tension & Compression	Internal FBGs=2 Tension & Compression	Internal FBGs=2 Tension & Compression	FBG-Interrogator software can recognize multiple channels and multiple interrogators
Sample Rate/channel	1-200Hz	Determined by FBG Interrogator settings	Determined by FBG Interrogator settings			---
Operating Temperature	0°C to +60°C	-55°C to +200°C (-67°F to +392°F)	-55°C to +200°C (-67°F to +392°F)	-55°C to +200°C (-67°F to +392°F)	-55°C to +200°C (-67°F to +392°F)	---
Applications	Laboratory or Embedded OEM	Applied force	Applied force	Gripping force per finger	Grasping force per finger	For visualization of optical sensor operations and calibration
Electrical Interface	microUSB, RS232	---	---	---	---	---
Optical Interface	FC-APC	FC-APC	FC-APC	FC-APC	FC-APC	---
Power Supply	+5VDC or USB	---	---	---	---	---
STOCK PRODUCTS	FBGX100	FG10-XX where XX is capacity in lbs	FG25	GR25	GS05	Supplied with interrogator

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FIBER OPTIC ABSOLUTE ENCODER & FO EXTENDER QUICK GUIDE

PRODUCT MODEL	 MR330-1 DIN Controller	 MR332 Industrial Grade Position Sensor	 MR338 MRI Safe Position Sensor	 MR430-1 DIN POF Controller	 MR431-A06 MRI Safe POF Position Sensor	 MR361-2 FO Extender for non-FO SSI Encoders
Description	Controller	Industrial Grade Size 58mm	MRI Safe Size 58mm	Size 100mm, Ø38mm Bore C Thru Bore: IP54 PC Pocket Hole: IP66	MRI Safe, Non-Metallic, Size 11 Synchro or Flange Mount	FO Transmitter/Receiver, provides interference-free extension of non-FO incremental encoders
Resolution	Multiturn 12-bit + Single Turn 13-bit or 14-bit (13,950)			Multiturn 12-bit + Single Turn 13-bit		4-Channels, typically for A/B or A/B/Z encoder interfaces
Compatible Fiber	OM1 (62.5/125) multimode fiber interface only			1mm POF + 1mm POIF		OM1/OM2/OM3
Optical System Margin	12dB	---	---	23dB	---	6dB
Maximum Distance	---	Up to 200m	Up to 200m	---	Pigtail Lengths: 3/5/10/15/20m	Up to 2000m
Encoder Interface	SSI	---	---	SSI	---	SSI Clock+Data (RS422)
Communications Interfaces	Analog Output, SSI, USB, ModbusRTU	---	---	Analog Output, SSI, USB, ModbusRTU	---	Input Error Status (Logic)
Optical Interface	Duplex LC	Duplex LC pigtail or IP-LC	Duplex LC pigtail	MPOF	MPOF	Simplex ST
Power Supply	24 VDC	---	---	24VDC	---	5V or 10-30VDC
Accessories	FO Cabling Junction Boxes	---	---	---	Non-metallic synchro clamps	FO Cabling Junction Boxes
RECOMMENDED PRODUCTS	MR330-1	MR332-Y06D00 MR332-Y10D00	MR338-N10C05 MR338-N10C10	MR430-1	MR431-A06 sensor MR439-Pxx pigtails	For use with 10-30V Encoders: MR361-2-0-1-0 (XMTR) MR361-2-1-1-0 (RCVR)

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FIBER OPTIC INCREMENTAL ENCODER & FO EXTENDER QUICK GUIDE

PRODUCT MODEL	 MR340-1 Controller	 MR343 Linear Encoder	 MR342/MR346 Shaft Encoder	 MR344 MR345 1024ppr Encoders	 MR348 MRI Safe Shaft Encoder	 MR361-1 FO Extender for non-FO Encoders
Description	Controller	MRI Safe	Synchro or Flange Mount MR342: Size Ø58mm, IP64 MR346: Size Ø90mm, IP66	MR344: Hollow Shaft , C Thru Bore: IP54 PC Pocket Hole: IP66 MR345: Shaft, IP66	MRI Safe, Non-Metallic, Size Ø58mm, Synchro or Flange Mount	FO Transmitter/Receiver, provides interference-free extension of non-FO incremental encoders
No. of Channels or Resolution	Each MR34X Encoder requires an MR340-1 Controller	400µm (Pulse to Pulse)	256 or 360ppr	1024ppr	360ppr	4-Channels, typically for A/B or A/B/Z encoder interfaces
Compatible Fiber	OM1 (62.5/125)					
Optical System Margin	12dB	One MR340-1 Controller controls one MR34X series FO Incremental Encoder				
Maximum Distance	---	Up to 2000m	Up to 2000m	Up to 2000m	Up to 2000m	Up to 2000m
Encoder Output	Programmable 5V/12V/24V Level	---	---	---	---	RS422 or HTL option
Communications Interfaces	Analog Output, SSI, USB, ModbusRTU	---	---	---	---	Unused channel(s) can transmit other signals – including overspeed limit, emergency stop, etc.
Optical Interface	Duplex LC	Duplex-LC pigtail	Duplex LC pigtail or IP-LC	MR344: DxLC Pigtail MR345: IP-LC	Duplex LC pigtail	Simplex ST
Power Supply	24 VDC	---	---	---	---	5V or 10-30V DC
Accessories	FO Cabling Junction Boxes	TD5334 series Incremental Film Strips	---	MR344-99-XX Shaft Adapters: 8-32mm, ½" to 1¼"	---	FO Cabling Junction Boxes
RECOMMENDED PRODUCTS	MR340-1	MR343-B400C1R5	MR342-D06D00 MR346-D12D00	MR344-F38C1R5 MR344-F38C1R5E MR345-F12D00	MR348-D06C05 MR348-D06C10	For use with HTL Encoders: MR361-1-0-3-0 (XMTR) MR361-1-1-3-0 (RCVR)

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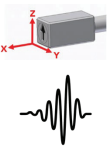
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MULTI-AXIS FO ACCELERATION/VIBRATION SENSORS QUICK GUIDE

MODEL						
						
MR661 1-Axis, Round	MR662 1-Axis, Rectangular	MR663 2-Axis	MR664 3-Axis	MR660 Signal Conditioners	ISOLATOR For >5kV	
Key Features					AC output per axis	High isolation for HV Rail Systems
General Purpose 100% passive design, immune to magnetic and electric fields						
Applications					Vibration Analysis	For pantograph applications where addition cabin/pantograph isolation is required
Electric Train Pantograph, Transformers, Generators, Heavy Equipment, Medical, MRI (in ceramic housing)						
Measurement Range					Output= 100mw/g pk-pk Non-Linearity= 5% max	+180 °C Max
0-50 g, Minimum Frequency= 0.5 Hz, Max Frequency= 1100 Hz (-3dB BW) Linearity= 3% max, Max Shock 1500 g						
Operating Temperature					-40 °C to +85 °C	---
Operating= -40 °C to +85 °C, Storage= -40 °C to +155 °C						
Housing					Aluminum	---
Aluminum						
Standard Aluminum or Optional Ceramic						
Length					---	---
6m						
Cable Jacket					---	---
Polyimide / Teflon						
Connector Type					BNC Output(s)	Dual FO4, supports two 1-axis or 2-axis sensors only
FO4						
FO4						
FO4						
3x Duplex-E2000						
STANDARD PRODUCTS					MR660-1 (for MR661/MR662) MR660-2 (for MR663) MR660-3 (for MR664)	9800.03.007 (25kV) 9800.03.002 (50kV)
MR661 6099.26.180 (Mtg Adapter)						
MR662						
MR663						
MR664						

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