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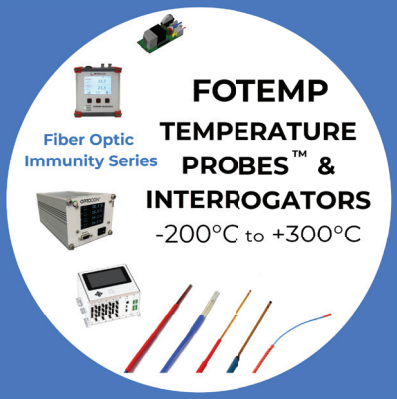
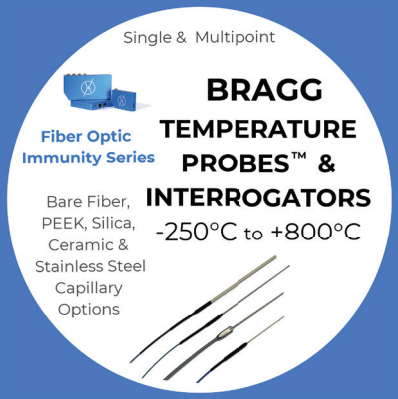
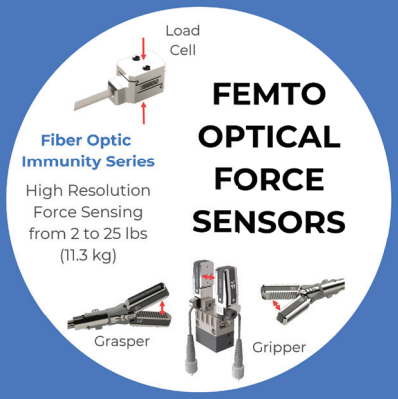
Fiber Optic Product Guide

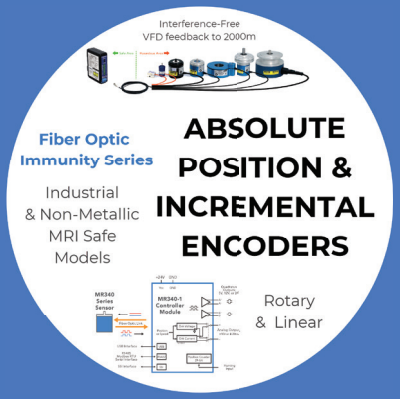
Our FO sensors can measure:

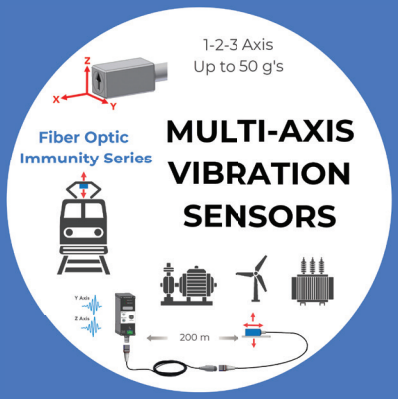
Temperature | Position | Force | Vibration | Signaling











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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.
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Email sales@micronor.com
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Dennis Horwitz
@ The Sensors Hotline
+1-805-242-4296
dennis@micronor.com

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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

FiSens

LILIKOI innovation

MICRONOR®
optical sensors

OCC
OPTICAL CABLE CORPORATION

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Booth 829

The Fiber Optic BUZZ!

Fiber Optic Sensors are replacing their Electrical Counterparts in Critical Applications

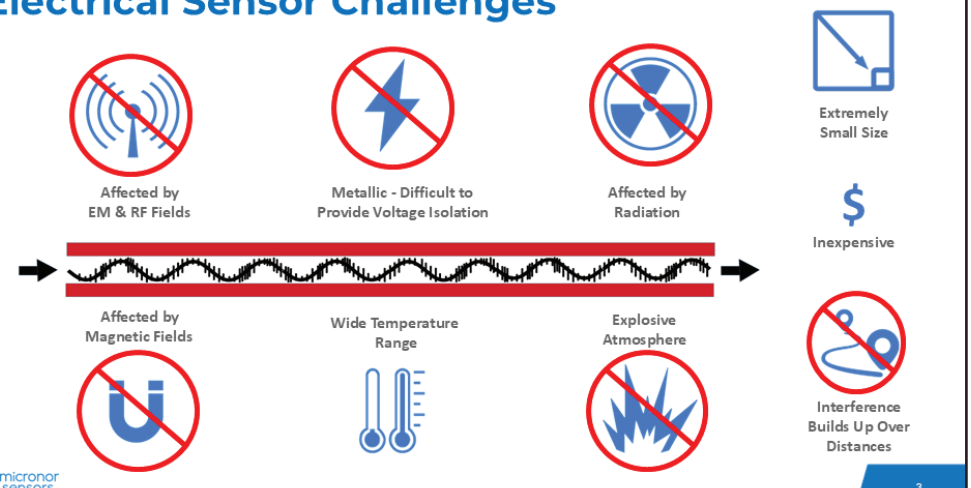
Presented by **Dennis Horwitz**, President

Sensors Converge LIVE Theater
Wednesday, June 25 2025

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 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 Sensor Challenges



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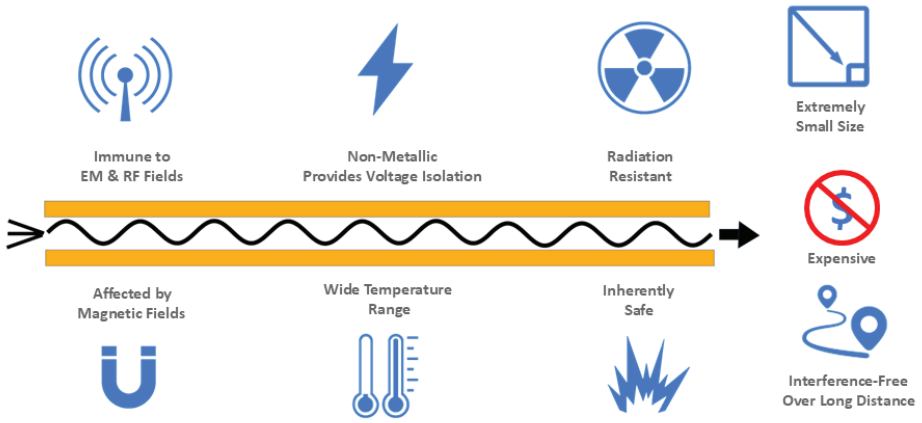
Fiber Optic Sensor Challenges … Just Cost



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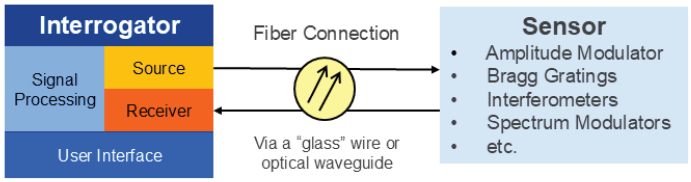
What is a Fiber Optic Sensor?

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

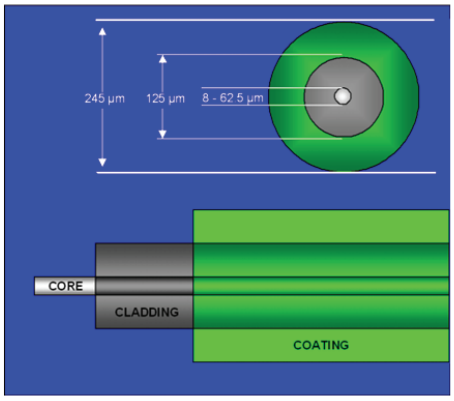
Since most Fiber Optic Sensors are not of transducer[1] type, they require an interrogator



➡ **All Optical - Non-electric – No Interference**

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

What is Fiber Optics?

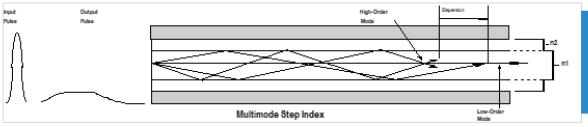


Core
- Carries the light signals
- Silica and a dopant, special pure silica core fiber
- POF uses polymer core
- 9µm for telecom SM, 5.6 µm for FiSens SM800 FBGs
- 50 or 62.5µm for multimode, 1mm for POF

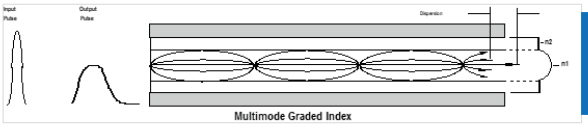
Cladding
- Keeps light in the core
- Pure silicon or polymer

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

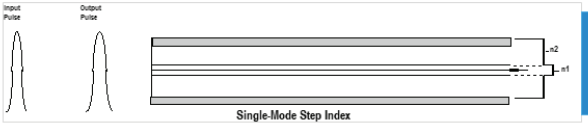
Single Mode versus Multimode: Many Types and Sizes of Optical Fiber



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)



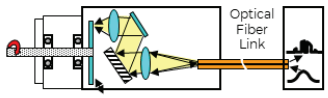
Single Mode Fiber
- Long distance links, 1-100km,1310-1550nm
- 10//100/1000 Gb/s, Single λ or WDM)
- 9/125 (OS1/OS2), Specialty SMF for other λ

Fiber Optic Absolute Encoders

Absolute Encoder/Position Sensor

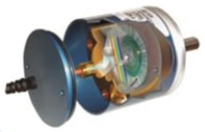
US Patent 8,461,514 B1

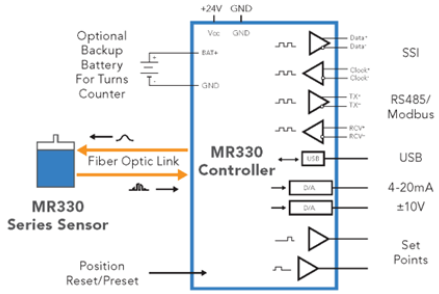
THEORY:
Code disk contains a single track, non-repeating code. Internally 14-bit Position is derived from 10-bit value plus 4-bits phasing.



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

MR430 series
M-POF MMF
Optical Concept:
Visual Domain





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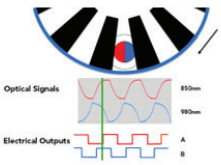
Fiber Optic Incremental Encoders

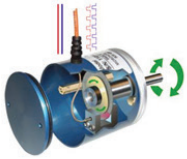
Incremental Encoder

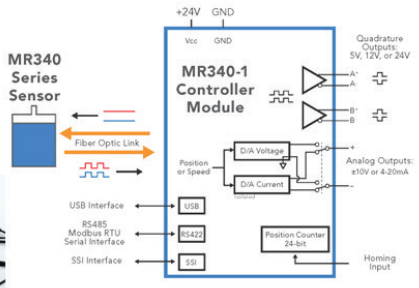
US Patent 7,196,320

THEORY:
Wavelength Division Multiplexing (WDM) used to emulate the A/B Quadrature Pulses as separate wavelengths - 850nm and 980nm.

MR340
MMF-62.5/125 Series







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Case Study #1: NASA Launcher Upgrades

Application: Elev and Azimuth Feedback

FO Attributes

Micronor MR332 FO Absolute Encoder

Programmable SSI Readouts

Micronor MR330 Controllers

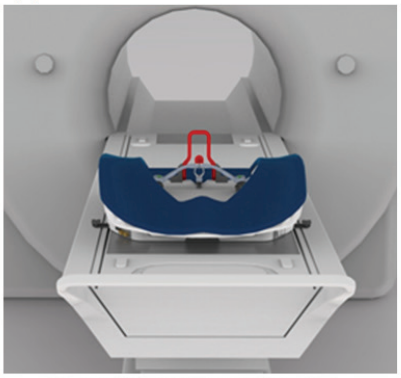
NASA/ORBITAL SCIENCES

- 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)

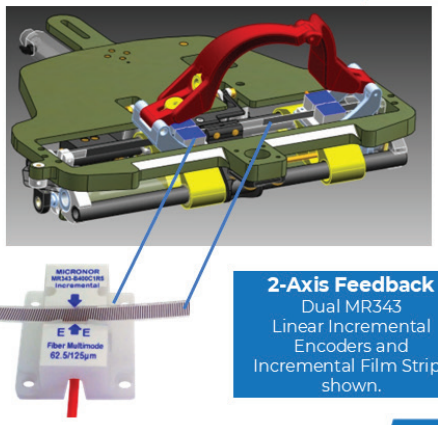
Case Study #2a: MRI Guided Biopsy Robot

Application: MRI-Safe Linear Encoder for Position Feedback

FO Attributes



Photos and renderings courtesy of Polymer Robotics / Umano Medical

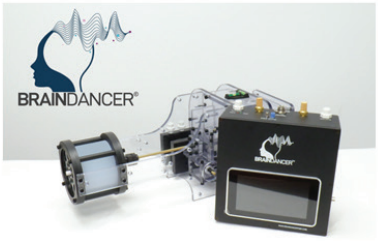


2-Axis Feedback
Dual MR343 Linear Incremental Encoders and Incremental Film Strips shown.

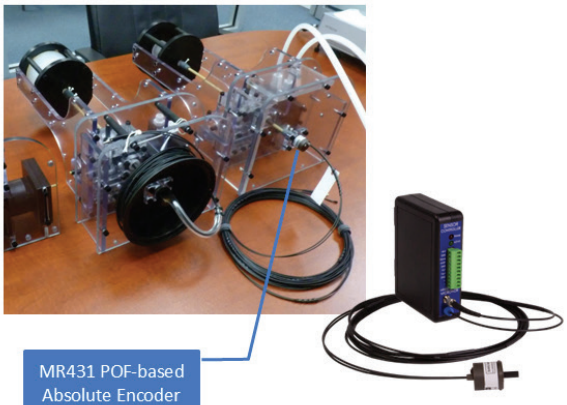
Case Study #2b: MRI Dynamic Brain Phantom

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

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.

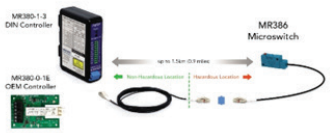
CHALLENGE
When the fusion device is turned off, the In-Vessel Viewing System (IVVS) needs to examine plasma-facing components in the vacuum vessel. This requires an extremely precise inspection system.

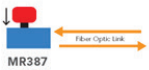
SOLUTION
Six probes are used at different points within the machine. Each uses a laser beam and rotating turret to scan the surface, producing a 3D map of the machine. Extremely high-resolution FO Encoders were developed by Micronor AG for IVVS.

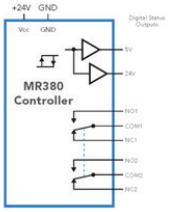
13

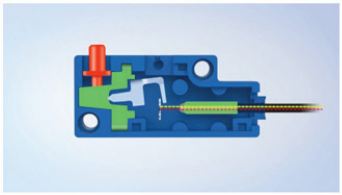
MR380 Series Fiber Optic Emergency Stop and Microswitch

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









- FO E-Stop available for use with SM, MM & POF
- Multiple FO E-Stops can be connected in linear or loop topologies, depending on application needs
- Controllers can be used to extend distance of existing EM E-Stops
- Distances up to 18 km

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14

Case Study #4: LAX Consolidated Rent-A-Car Ctr

Application: FO E-Stop between Main and Utility Buildings

FO Attributes

15

Case Study #5: St Louis Metro Railway System

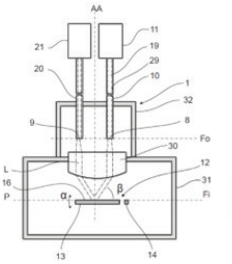
Application: Remote Monitoring of HV Bypass Switch

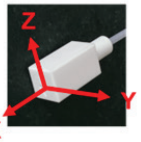
FO Attributes

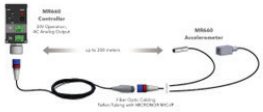
When manual bypass switch is engaged, the arm pushes down on extended actuator which depresses plunger. Status is monitored by the Control Center.

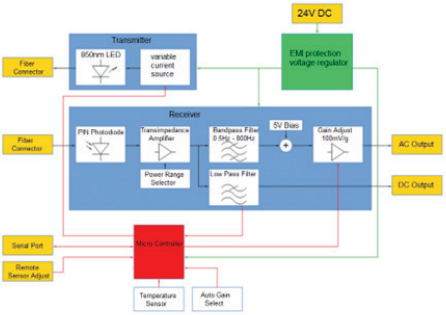
MR660 Multi-Axis Fiber Optic Acceleration/Vibration Sensor

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

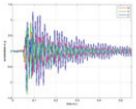
CHALLENGE

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.

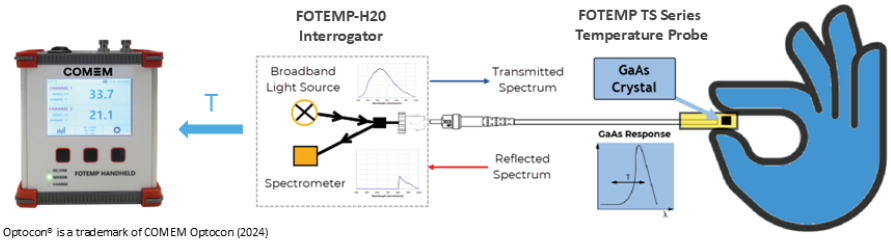
SOLUTION

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



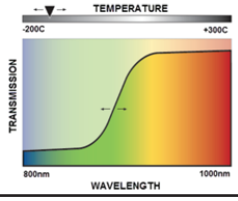
FOTEMP (GaAs) Fiber Optic Thermometry



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_{gap} = 1.423eV ⇨ 300°K = 872nm

dE_{gap}/dT = -0.452meV/°K ⇨ ≈ 0.315nm/°K

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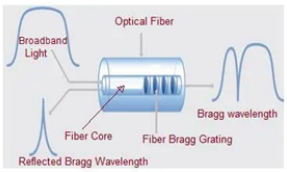
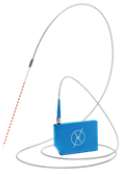
BRAGG Temperature & Strain Sensing with Multipoint Fiber Bragg Gratings (FBG)

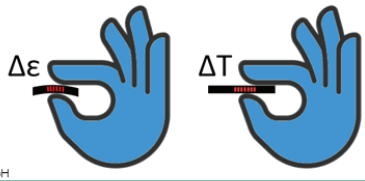




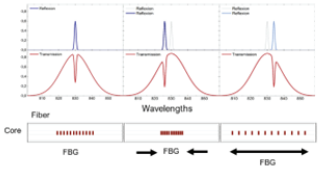
SM800 850nm FBG Sensor Chain

FBGX100 850nm FiSpec® Interrogator

FiSpec® is a trademark of Fisens GmbH



Principles of Operation



The Bragg wavelength is sensitive to both strain and temperature. The relative shift in the Bragg wavelength Dl_B/l_B, is due to applied strain $\Delta\varepsilon$ and temperature change ΔT:

$$\left[\frac{\Delta\lambda_B}{\lambda_B}\right] = C_S\epsilon + C_T\Delta T$$

where:

C_S = coefficient of strain (physical tension or compression)

C_T = coefficient of temperature (thermal expansion or contraction)

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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.

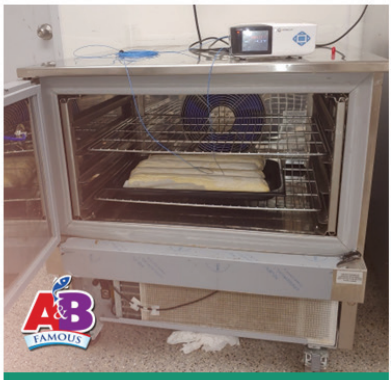
FOTEMP TS3 Probe

Multipoint BRAGG Probe

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.

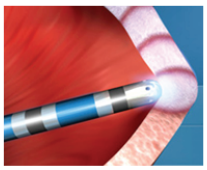
A&B developed a proprietary microwave oven-based process for raw fish thawing as well as production of their partially cooked frozen gefilte fish product. For the latter, a microwave oven process was developed that precisely cooks and cools the product without rendering the proteins fully cooked.

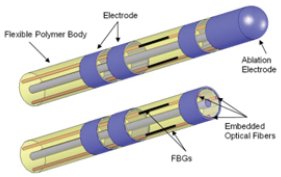
FOTEMP TS3 Probe

Case Study #9: Medical – RF Ablation

Application: Contact Force of Ablation Catheter

FO Attributes





ABBOTT TactiCath™ Contact Force Ablation Catheter, Sensor Enabled™

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CHALLENGE

RF ablation catheter is directed through the body and positioned to burn off tumors. Physicians require real-time, objective measure of contact force during treatment of cardiac arrhythmias or tumors.

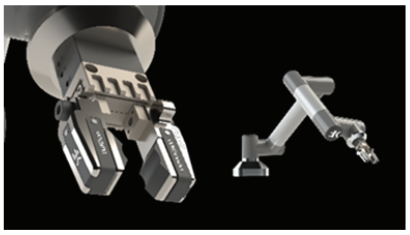
SOLUTION

The TactiCath force-sensing ablation catheter provides physicians with a real-time, objective measure of contact force during the treatment of cardiac arrhythmias. It includes a smaller fiber optic sensor at the tip, a force-time integral display and automatically generated summary reports of the procedure. Contact force is derived from three sensor fibers which measure micro deformation of the catheter tip using Fiber Bragg Grating technology.

Case Study #10: 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

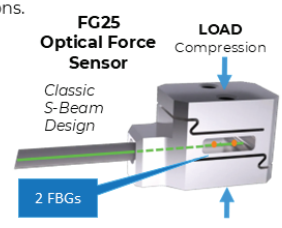
Conventional strain gauge sensors are susceptible to errors and interferences:

- 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.

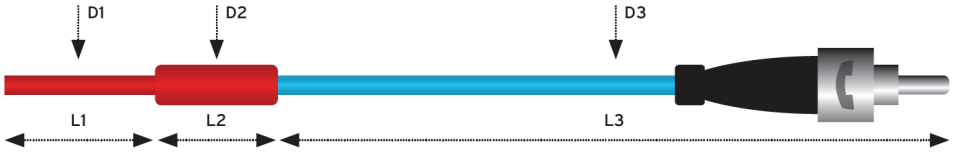
SOLUTION

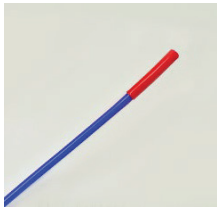
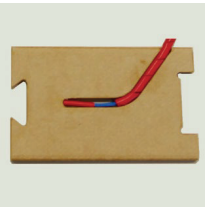
FBG-based Load Cells, Gripper and Grasper force sensors provide electromagnetic immunity, precision, repeatability and resolution.

FG25 converts Interrogator reading of 3500με to 25 lbf with 0.002% F.S. resolution.



FOTEMP® TEMPERATURE PROBES™



MODEL	TS2p Smallest	TS3 General Purpose	TS4 Harsh Chemicals	TS5 Medical & SFF	TST Transformers	SmartSpacer SmartDisc, & Busbar
						
Key Features	Smallest size, Bare GaAs crystal (300µm x 300µm) for Very Small Surface Areas, Semi devices, and Micro-Vials, 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	Non-conductive accessories used to embed TST and TS3 probes in transformers, busbar and switchgear.
Applications	General Use: RF, Voltage, Semiconductor Device, and 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.
Temperature Range	–200 °C to +300 °C	–200 °C to +300 °C	–200 °C to +300 °C	–200 °C to +300 °C	–40 °C to +200 °C	+180 °C Max
Accuracy	± 0.2 °C	± 0.2 °C	± 0.2 °C	± 0.2 °C	± 0.2 °C	---
Thermal Response	20 °C/s	12 °C/s	7 °C/s	19 °C/s	19 °C/s	---
Probe Dimensions	D1: 0.25 mm D2: 1.7 mm D3: 1.3 mm	D1: 1.0 mm D2: 1.7 mm D3: 1.3 mm	D1: 1.0 mm D2: 1.7 mm D3: 1.3 mm	D1: 0.6 mm D2: 2.0 mm D3: 1.3 mm	D1: 1.75 mm D2: 1.2 mm D3: 3.1 mm	SmartSpacer & SmartDisc for use with TST probe. SmartBusbar used with TS3 probe.
Dimensions Other lengths on request	L1: 4 mm L2: 10 mm L3: 1 – 20 m	L1: 10 – 130 mm L2: 30 mm L3: 1 – 20 m	L1: 15 - 550 mm L2: 10 mm L3: 1 – 20 m	L1: 10 – 600 mm L2: 15 mm L3: 1 – 20 m	L1: 10 mm L2: 70 mm L3: 1 – 20 m	Consult drawings
Cable Coating	Polyimide / Teflon	Polyimide / Teflon	Polyimide / Teflon	Polyimide / Teflon	Polyimide / Teflon	PEEK or NOMEX
Connector Type	ST	ST	ST	ST	ST	---
STOCK PRODUCTS (L1 and L3 Lengths)	TS2p-02	TS3-15MM-02 TS3-15MM-05	TS4-20MM-02 TS4-20MM-05	TS5-20MM-02, -06 TS5-50MM-02, -06	Special Order	EOF0200 SmartSpacer EOF0203 SmartDisc ZM0060 SmartBusbar

98-OPTC-27-D3

QR Code to TS sensors

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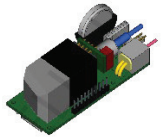
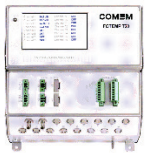
FOTEMP® SIGNAL CONDITIONERS QUICK GUIDE

MODEL	 **FOTEMP-PLUS** Most Popular	 **FOTEMP-H2** Handheld	 **FOTEMP-OEM**	 **FOTEMP-MINI3** OEM	 **FOTEMP-T2** Multi-channel to 16	 **FOTEMP-T3** Transformer Apps
Description	Compact Bench Top	Handheld, Portable	OEM Module, Bench Top, Chassis or DIN Rail Mount	Small Form Factor OEM PCB Module	DIN Rail, Chassis Mount or Bench Top	Transformer-specific Monitoring System
No. of Channels	1, 2 or 4	1 or 2	1, 2 or 4	1	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
Accuracy	± 0.3 °C	± 0.2 °C	± 0.2 °C	± 0.2 °C	± 1 °C	± 0.2 °C
Applications	Laboratory, Industrial Process Monitoring	Laboratory, Industrial, Process Monitoring	Industrial Process, Switchgear, Generator, Transformer	Embedded OEM Application	Industrial Process, Switchgear, Generator, Transformer	Transformer Hotspot Monitoring
Sample Rate/channel	250ms	250ms	250ms	250ms	250ms	1 min for all channels
Internal Data Logging?	No	Yes	No	Yes	Yes	Yes
Data Logging Storage	No	MicroSD Card	No	MicroSD Card	MicroSD Card	USB Stick
Analog output	Std=0-10V Option=4-20mA	---	Std=0-10V Option=4-20mA	---	M= 4-20mA, V=0-10V (First 8 Channels Only)	4-20mA
Relay output	Option=4	---	Option=4	---	Std=4	Programmable Alarms
Interface	Std=USB+RS232 Option=USB+RS485	USB-C	Std=USB+RS232 Opt=USB+RS485/Modbus	USB-C, UART, RS232, RS485/ModbusRTU	P1= USB+ModbusRTU P2= USB+ModbusTCP	RS485/Modubus/RTU & Ethernet/ModbusTCP
Power Supply	12VDC (includes AC power supply)	12VDC or USB-C, (Internal Li-Ion battery)	12 VDC (includes AC power supply)	USB-C (5V 3A)	24VDC (includes DIN AC-DC Power Supply)	24VDC (includes DIN AC-DC Power Supply)
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	FOTEMP4-PLUS-P0-V-B FOTEMP4-PLUS-P0-V-C	FOTEMP-H2-1-P0-B FOTEMP-H2-2-P0-B	Special Order	FOTEMP-MN30-P0-B	Special Order: FOTEMP-T2-8-P2-V-A2 For Ethernet/ModbusTCP	Special Order

98-OPTC-28-D3

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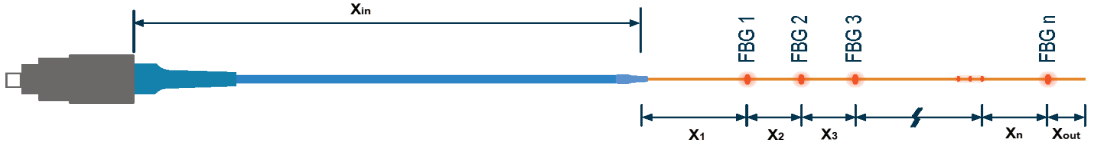
BRAGG TEMPERATURE PROBES™ & 850NM FBG INTERROGATOR QUICK GUIDE



B Distance Parameter

Example: B=2000-90-10

MODEL Capillary Type	FBGX100 FBGX400 Interrogators	FI Sensor Chain Bare Fiber Capillary	PK Sensor Chain PEEK Capillary	SI Sensor Chain Silica Capillary	SSC Sensor Chain Stainless Steel Capillary	AC Sensor Chain Alumina Ceramic Capillary
Description (Capillary Description)	Compact FiSpec 850nm Interrogator, Wideband (W)	Bare Fiber, SM800, Flexible, A or P fiber only	Non-metallic, flexible PK1= Ø 0.55mm PK2= Ø 0.95mm Max 350°C	Non-metallic SI= Ø 0.44mm Max 350°C	Metallic SSC= Ø 1mm Max 600°C	Non-metallic AC= Ø 3.3mm Max 800°C
No. of Channels (Software Provided)	FBGX100=1 Ch FBGX400=4 Ch	Visualize and log data for all channels and all interrogators with supplied Multi-Channel FBG-Interrogator Software				
Measurement	Temperature, °C Strain, με	Temperature or Strain	Temperature or Strain	Temperature	Temperature	Temperature
Precision (Sensor A Configuration)	0.1-1°C or 1-10με depends on sample rate	**Sensor Array A Configuration:** A= A-n-W-GL-FI A= P-n-W-GL-FI	A-n-W-PK2-PK2 P-n-W-PK2-PK2	A-n-W-PK2-SI P-n-W-PK2-SI UHT-n-PK2-SI	P-n-W-PK2-SSC P-n-W-SST-SSC UHT-n-W-PK2-SSC UHT-n-W-SST-SSC	P-n-W-PK2-AC P-n-W-SST-AC UHT-n-W-PK2-AC UHT-n-W-SST-AC
# of FBGs per Sensor (n)	1-30	n= 1-30	n= 1-30	n= 1-30 for A or P n= 1-10 for UHT	n= 1-30 for P n= 1-10 for UHT	n= 1-30 for P n= 1-10 for UHT
Sample Rate/channel (Min Capillary Length)	1-200Hz	Min FBG spacing=2mm Max length=500m	Min spacing=2mm Min cap length=20mm	Min spacing=2mm Min cap length= 50mm	Min spacing=2mm Min cap length= 100mm	Min spacing=2mm Min cap length= 100mm
Operating Temperature (Capillary Section)	0°C to +60°C	Capillary Section: A= -40°C to +80°C P= -40°C to +300°C	A= -40°C to +80°C P= -40°C to +200°C	A= -40°C to +80°C P= -40°C to +300°C UHT= -40°C to +350°C	P= 250°C to +300°C UHT= -250°C to +600°C	P= 250°C to +300°C UHT= -250°C to +800°C
Applications	Laboratory or Embedded OEM	General purpose, FBGs must be strain-relieved for temperature measurements.	PEEK tubing provides flexible fiber protection for strain or temp.	Ideal for induction heating or microwave oven/reactor.	For high temperature applications where, metallic capillary is suitable.	For high temperature applications where, non-metallic capillary is required.
Electrical Interface	UART and microUSB	---	---	---	---	---
Optical Interface	FC-APC	FC-APC	FC-APC	FC-APC	FC-APC	FC-APC
Power Supply	+5VDC or USB	Typical Xin lead-in is either PK2 (PEEK tubing, Ø0.95mm, max 200°C) for SST (Corrugated SS tubing, Ø1mm, max 350°C) Customer-specified FBG sensor chain configurations also available upon request				
STOCK PRODUCTS	FBGX100 FBGX400	FBG-MR0050, P, 1-FBG FBG-MR0125, P, 2-FBG FBG-MR0055, P, 4-FBG FBG-MR0010, P, 10-FBG		FBG-MR0126, P, 2-FBG FBG-MR0058, P, 4-FBG FBG-MR0155, UHT, 1-FBG	FBG-MR0166, P, 2-FBG FBG-MR0073, P, 4-FBG FBG-MR0128, UHT, 1-FBG	FBG-MR0167, P, 2-FBG FBG-MR0129, UHT, 1-FBG

P= Polyimide-Coated SM800P Fiber, rated -40°C to +300°C
A= Acrylate-Coated SM800 Fiber, rated -40°C to +80°C
UHT= Ultra High Strength, Pure Silica Core, rated -250°C to +800°C

98-FISN-06-A3

QR Code to FBGs

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FEMTO FBG-BASED OPTICAL FORCE SENSORS QUICK GUIDE

MODEL	 **FBGX100 WAVE FORCE ONE** Interrogator	 **FBGX400** Interrogator	 **FG Series Inline** Miniature Load Cell	 **GR25 Gripper** Robotic Tactile Sensor	 **GS05 Grasper** Robotic Tactile Sensor	 **FORCE VISUALIZATION** Software
Description	Wideband (W) Interrogator	Wideband (W) Interrogator	Inline Force Sensor, Capacity Options: 2, 5, 10, 25, 50 lb.	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	4, up to 120 FBGs	Sensor requires 1 channel,	Dual Gripper Sensor requires 2 channels	Dual Grasper Sensor requires 2 channels	Requires 1 channel for each sensor
Measurement (or Force Capacity)	Temperature, °C Strain, με	Temperature, °C Strain, με	FG02= 2 lb, FG05= 5 lb, FG10= 10 lb, FG25= 25 lb, FG50= 50 lb	GR25= 25lb (11.3kg)	GS05= 5 lb (2.2kg)	---
Precision (Interrogator Output)	0.1-1°C or 1-10με depending on sample rate	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	---
Total # of FBGs	1-30	1-120	Internal FBGs=3 Tension, Compression & Temperature	Internal FBGs=3 Tension, Compression & Temperature	Internal FBGs=3 Tension, Compression & Temperature	FBG-Interrogator software can recognize multiple channels and multiple interrorgators
Sample Rate/channel	1-200Hz	1-200Hz	Determined by FBG Interrogator settings			---
Operating Temperature	0°C to +60°C	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)	---
Applications	Laboratory or Embedded OEM	Laboratory or Embedded OEM	Applied force	Gripping force per finger	Grasping force per finger	For visualization of optical sensor operations and calibration
Electrical Interface	UART, microUSB	UART, microUSB	---	---	---	---
Optical Interface	FC-APC	FC-APC	FC-APC	FC-APC	FC-APC	---
Power Supply	+5VDC or USB	+5VDC or USB	---	---	---	---
STOCK PRODUCTS	FBGX100	FBGX400	FG25	GR25	GS05	Supplied with interrogator

98-LLKI-01-A1
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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)

98-0330-23-A1

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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)			Compatible with multimode OM1 (62.5/125) and OM2/OM3 (50/125)
Optical System Margin	12dB	One MR340-1 Controller controls one MR34X series FO Incremental Encoder				6dB
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)

98-0340-17-A1

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FIBER OPTIC SIGNALING SENSORS – EMERGENCY STOP & MICROSWITCH

PRODUCT MODEL						
	MR380-0-UNI OEM Controller	**MR380-1-3** DIN Controller	**MR386** FO Microswitch	**MR387** MM/SM FO E-Stop	**MR388** Outdoor FO E-Stop	**TD5412** POF E-Stop
Description	Universal SM/MM OEM Controller (PCB)	Universal SM/MM DIN Rail Controller	V-series compatible Microswitch	Emergency Stop, Pigtail or IP66 housing	MR387 E-Stop in IP67 Weatherproof Enclosure	POF E-Stop
No. of Channels	1 (Duplex)	1 (Duplex)	Multiple sensors can be wired in series up to the limits of the Controller's optical loss margin. Consult application note AN118 for link examples and calculations.			1 (Duplex)
Compatible Fiber	OM1 (MM 62.5/125) OM2/OM3 (MM 50/125) OS1 (SM 9/125)		Available with OM1 pigtail only. Compatible with OM2/OM3 fiber links.	OM1 interface compatible with OM2/OM3 fiber links. OS1 interface compatible with OS2 fiber links.	Available with OM1 or OS1 fiber interfaces only. OM1 interfaces compatible with OM2/OM3 fiber links.	1mm POF
Optical System Margin	OM1=21dB, OS1=18dB	23dB	Use with MR380	Use with MR380	Use with MR380	User provides 650nm (red) optical interface
Maximum Distance	Depends on # of sensors wired in series, # of interconnections, and cable segment lengths		Up to 12km	MM, up to 13km SM, up to 18km	MM, up to 13km SM, up to 18km	Up to 20m
Function Safety Rating	Not rated	SIL1/PLc when used with MR387 FO E-Stop	Not rated	SIL1/PLc when used with MR380-1-3 Controller	SIL1/PLc when used with MR380-1-3 Controller	Not rated
Digital Status Outputs	5V Logic, OC	5V & 24V Logic	---	---	---	---
Internal Relay	---	DPDT contacts	---	---	---	---
Optical Interface	Duplex LC	Duplex LC	Duplex LC pigtail	Duplex LC pigtail or IP-LC receptacle	Internal Duplex LC or External: IP-LC receptacle	Duplex 1mm POF
Power Supply	5-24 VDC	24 VDC	---	---	---	---
Accessories	---	---	Compatible with Omron and Honeywell V-series lever arm accessories	---	---	---
RECOMMENDED PRODUCTS	MR380-0-UNI	MR380-1-3	MR386-21-1R5 (NO) MR386-25-1R5 (NC)	MR387-2S-1R5 (MM) MR387-2S-D00 (MM) MR387-3S-1R5 (SM) MR387-3S-D00 (SM)	Special Order	TD5412

98-0380-22-B

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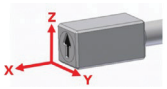
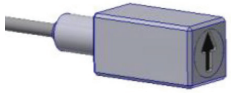
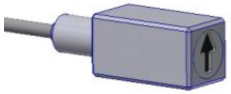
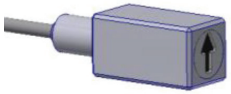
MULTI-AXIS FO ACCELERATION/VIBRATION SENSORS QUICK GUIDE

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

98-0660-03-A1

QR Code to MR660 Sensors

micronor sensors

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MY SENSORS CONVERGE FO NOTES