micronor sensors

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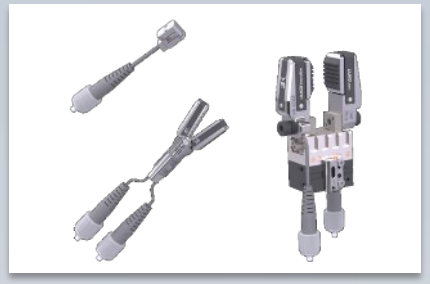
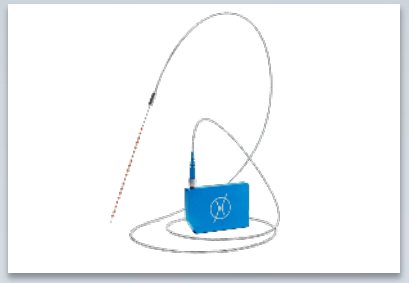
Company and Product Overview

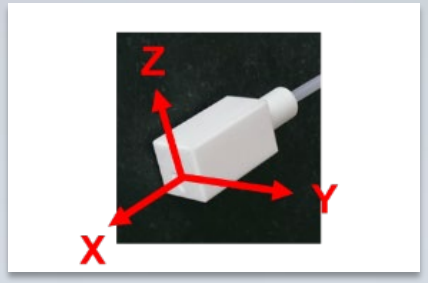
Revision B
7/25/2024

Micronor Sensors

Fiber Optic and Electromechanical Kinetic Sensors







Fiber Optic

- ❑ Absolute and Incremental Encoders (Micronor AG)
- ❑ Emergency Stop (Micronor AG)
- ❑ Microswitch/Limit Switch (Micronor AG)
- ❑ Multi-axis Acceleration/Vibration Sensors (Micronor AG)
- ❑ High Precision GaAs Temperature Sensors (COMEM Optocon)
- ❑ Multipoint FBG Temperature and Strain Sensors (FiSens GmbH)
- ❑ Gripper, Grasper and Inline Force Sensors (Lilikoi Innovation)

Electromechanical

- ❑ Smart Bracket Strain Gauge Force Sensors (Lilikoi Innovation)
- ❑ Position Transducers/Feedback Units (Micronor AG)
- ❑ Rotary Limit Switches (Micronor AG)
- ❑ Optical/Magnetic Absolute and Incremental Encoders (Micronor AG)
- ❑ Resolvers (Micronor AG)
- ❑ Cam Timers/Motorized Potentiometers (Micronor AG)
- ❑ HMI – Handheld Pendants and MPGs (Micronor AG)

micronor sensors MICRONOR® COMEM OPTOCON FiSens LILIKOI innovation

Micronor Sensors

We are a world-class supplier of **fiber optic sensors**, and achieve business success through a shared commitment to meet or exceed our customer's expectations through teamwork, continuous improvement, and innovation.

To achieve our mission, it is essential that we focus on quality and pragmatic thinking in everything we do throughout our organization.

Offering both **Fiber Optic** and **Electromechanical** Sensor solutions, we want our customers to consider us a one-stop shop for their sensor needs.

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Micronor Technical Achievements

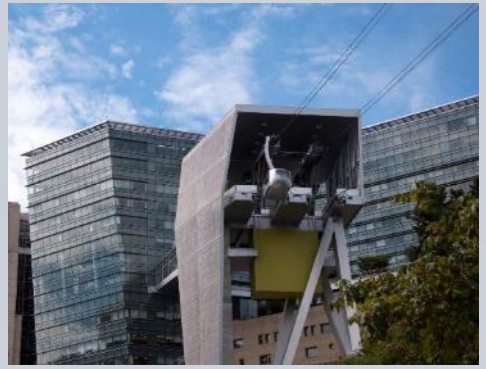
Micronor employees have in depth and proven Fiber Optics Experience. Since the company's founding in 2003, numerous inventions have led to new products. Some technologies are patented.

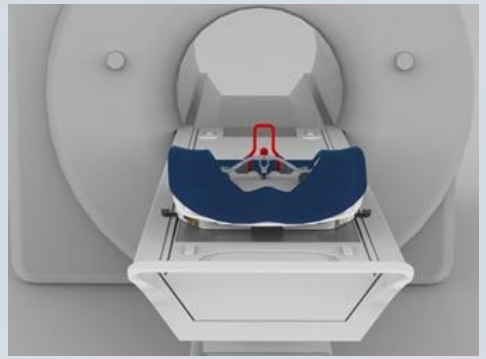
2004 – World's First Commercial FO Incremental Encoder (MR310)
2007 – US Patent 7,196,320 awarded for FO Incremental Encoder
2010 – World's First Commercial MRI-compatible FO Encoder (MR318)
2011 – World's First 13-bit FO Position Sensor (MR330)
2012 – World's First Commercial MRI Safe FO Position Sensor (MR338)
2013 – US Patent 8,461,514 awarded for FO Absolute Position Sensor
2016 – World's First Single Mode Fiber Optic E-Stop (MR387)
2016 – World's First Fiber Optic Microswitch (MR386)
2017 – POF Based Fiber Optic Absolute Encoder (MR430)
2019 – FO Incremental Encoder for ITER (Fusion for Energy) with 62'400 ppr resolution
2020 – FO Incremental Encoder for ITER (Fusion for Energy) with 157,050 ppr resolution

Micronor Sensors

Our products are used everywhere that you can think of:

- industrial automation and robotic systems
- process automation and control
- medical equipment and MRI imaging
- railway, aerial cable cars and other transportation
- food processing and manufacturing
- petrochemical plants, refineries and oil rigs
- utilities, dams, hydroelectric and nuclear power plants
- advanced research laboratories including CERN, PSI, and LLNL
- mines and ore processing
- steel mills and rolling plants
- cranes, hoists and conveyors
- moveable bridges
- military and aerospace





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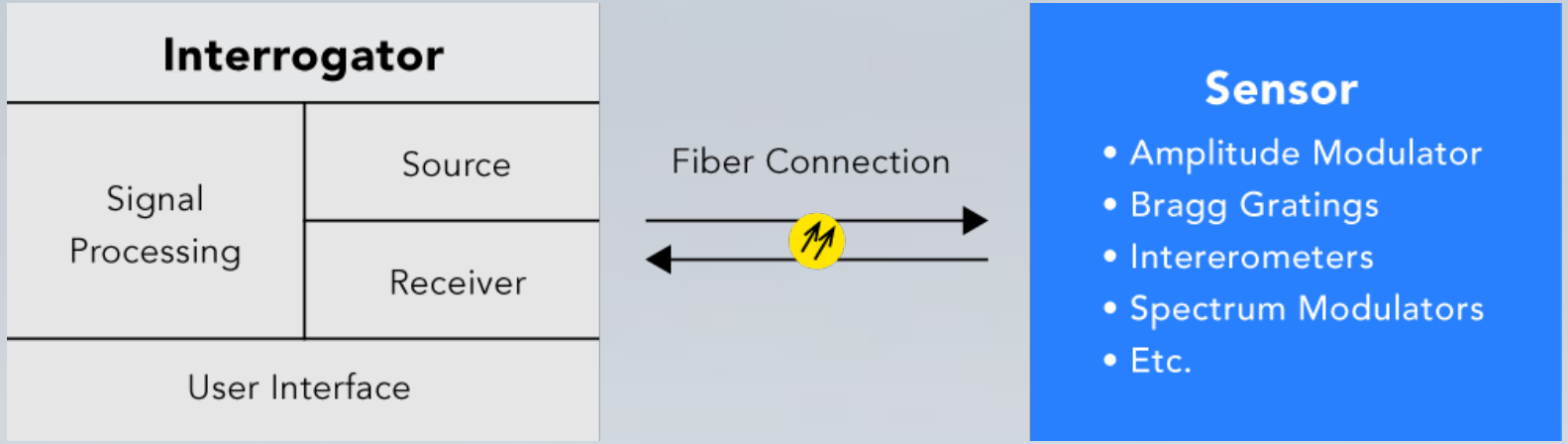
Principle of Fiber Optic Sensors



1. A fiber optic sensor is by definition entirely controlled by light and does not include any electrical components whatsoever.

2. Typically, a fiber optic sensor is "interrogated" using a quantity of light, and the sensor alters the properties of this light signal in proportion to the physical quantity to be measured.

3. The interrogator translates the received optical signals back into electronic quantities in either analog or digital form and serves as the interface to the attached control equipment.

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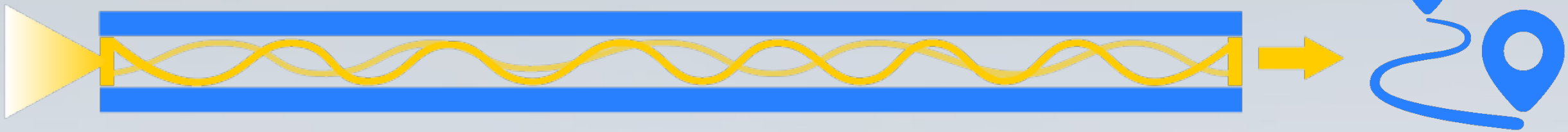
Why Fiber Optics

Immune to
Electrical and RF Fields

Immune to Lightning
and High Voltage

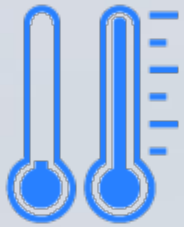
Radiation Resistant



Distance

Transparent to
Magnetic Fields

Wide Temperature Range



Inherently Safe

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sensors

Applications

Medical

Energy

Process

Robotics

Transportation

Infrastructure

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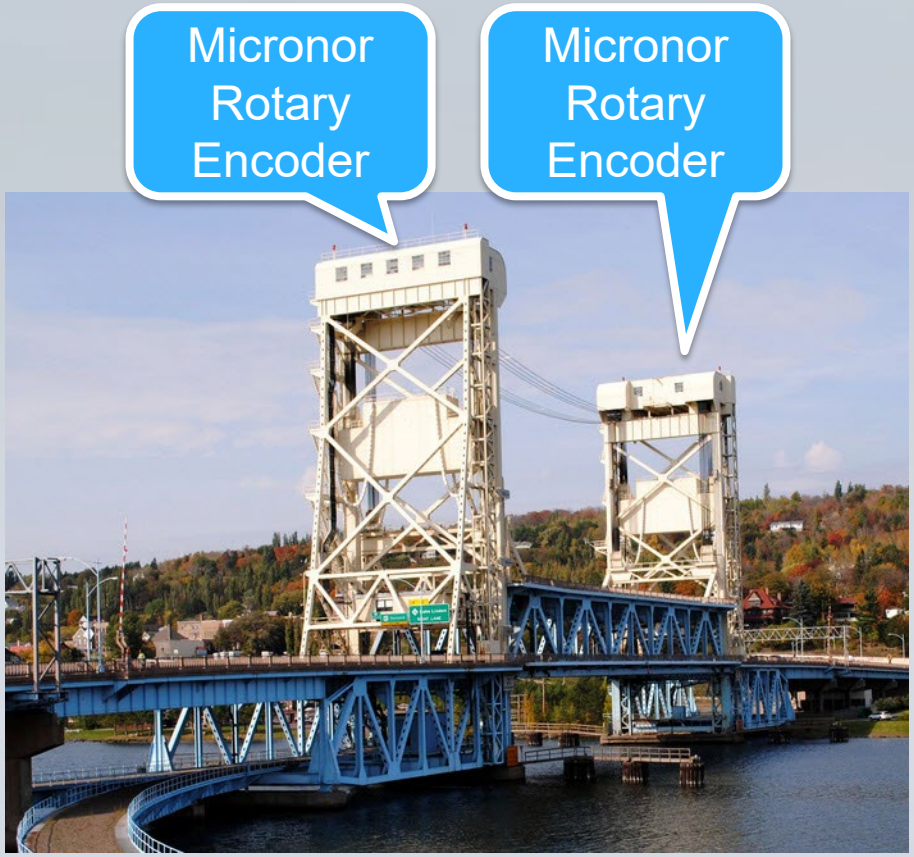
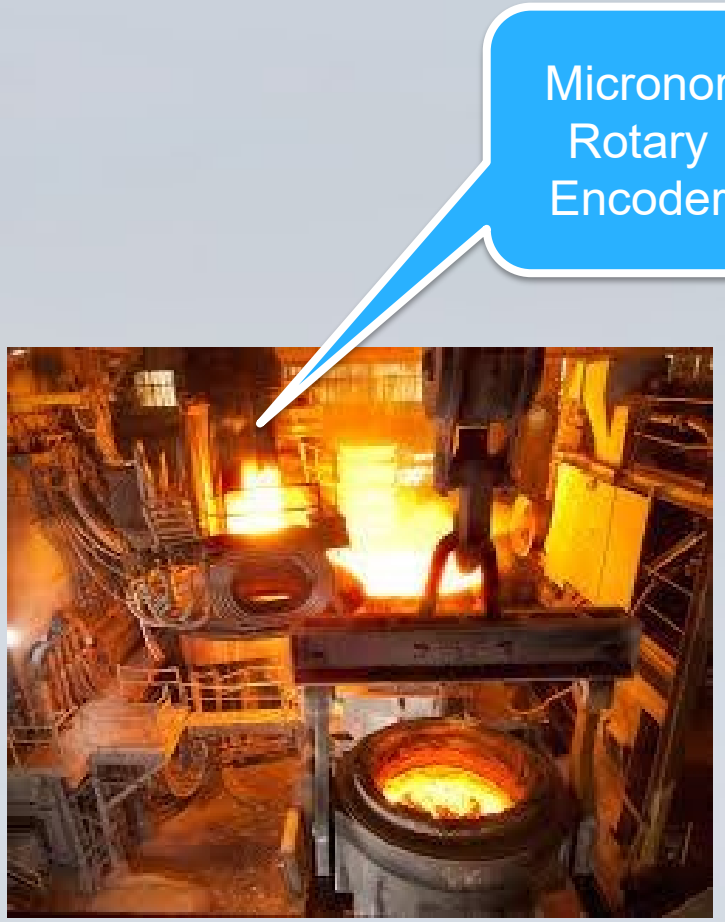
Industrial & Civil Applications



Lift Bridge
Position Feedback

NASA Sounding
Rocket Launcher
Upgrades



Arc Furnace
Electrode
Position

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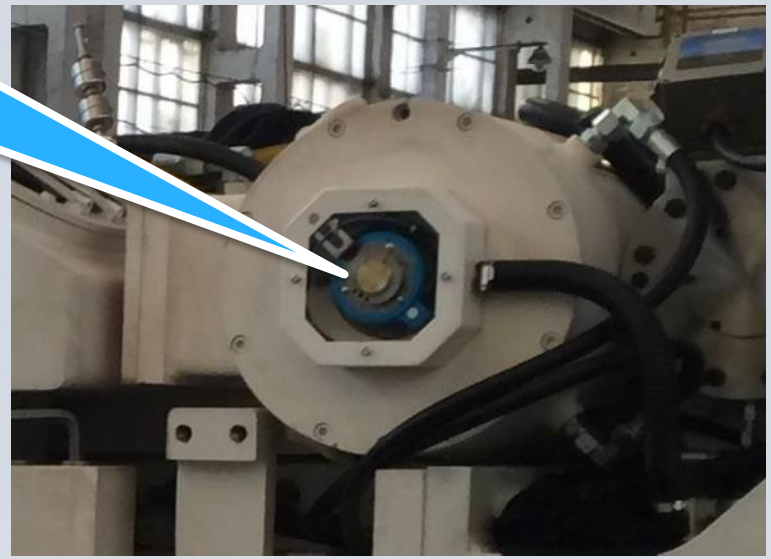
Oil, Gas & Mining Applications

Micronor Hollow Shaft Encoders

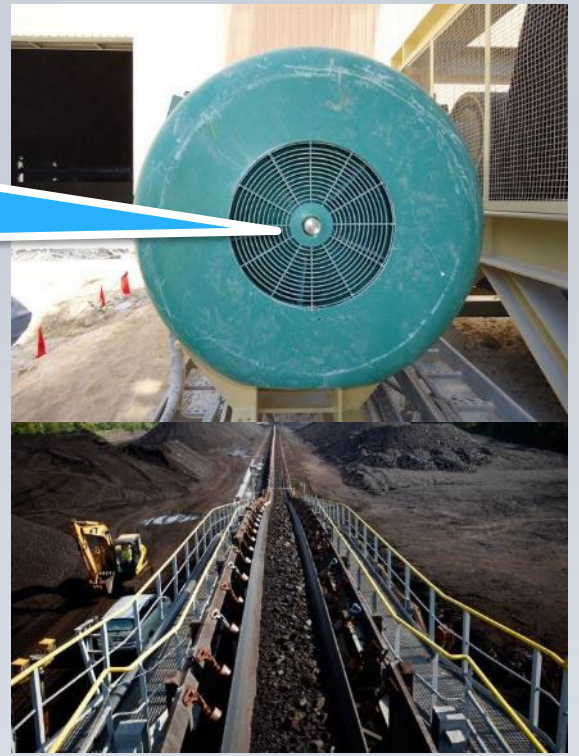
Top Drive On Oil Rig

Underground Mining Equipment

Micronor Rotary Encoder



Micronor Rotary Encoder



High Voltage Drives, Mine Conveyor Systems, and Railcar Dumpers

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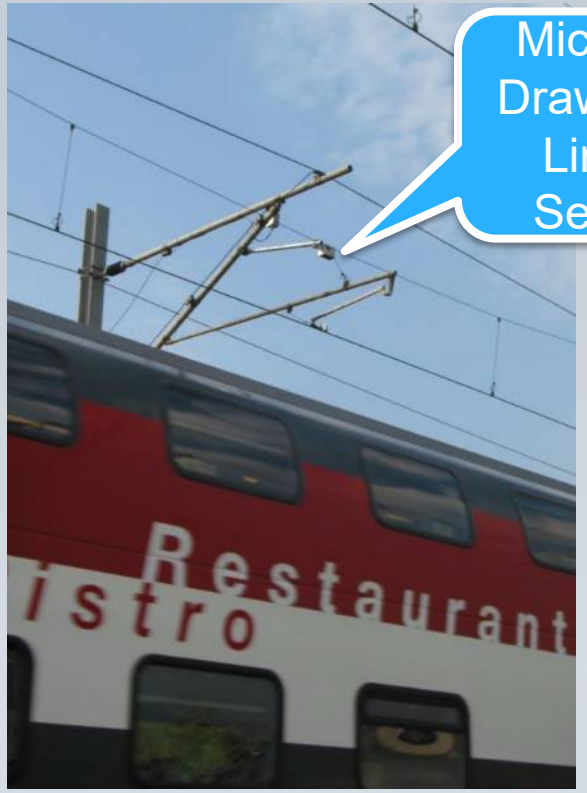
Transportation Applications



Electric Railway
Contact Line Lift
Measuring System

Electric Train
Pantograph

Las Vegas
High Roller
Observation
Wheel

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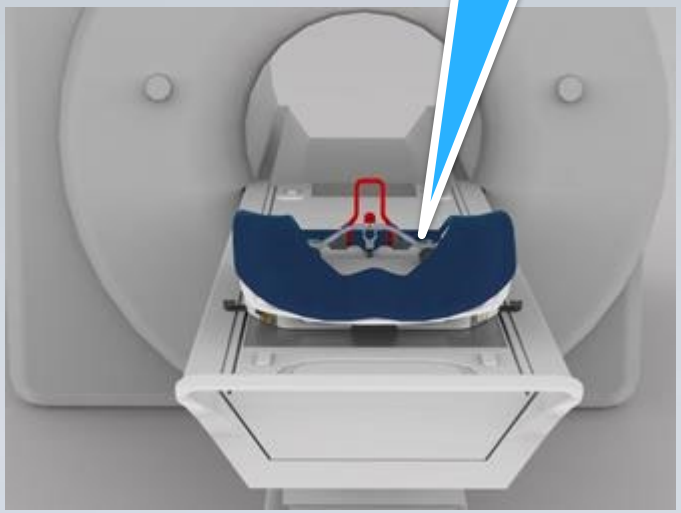
Medical Applications

Micronor MRI Safe Linear Encoders



MRI Guided Biopsy Robot

MRI Dynamic Brain Phantom

Micronor POF Encoder

Micronor MRI Safe Position Sensor

fMRI Brain Trauma Research

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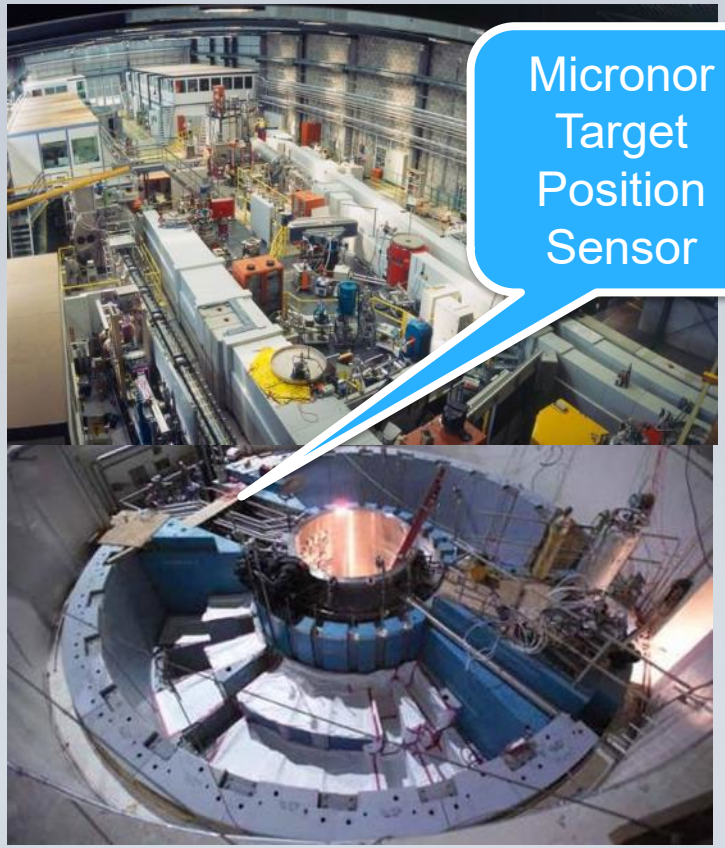
Research Applications

Micronor Lift Sensor

Paul Sherrer Institute
Robotic Radioactive
Fuel Handling

Nuclear
Research



Swiss Spallation
Neutron Source
(SINQ)

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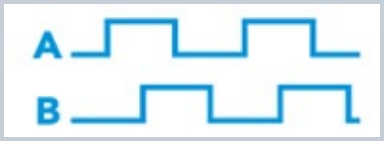
Encoder Product Family

Micronor offers encoders in all different shapes, sizes, and form factors

- The encoder “landscape” is very fragmented: Solid Shaft, Hollow Shaft
- Application Specific Configurations: Measuring Wheel, Draw Wire, Ball Screw, Linear Scale, Linear Guided, Piston

Fiber Optic Encoders



Incremental Encoder

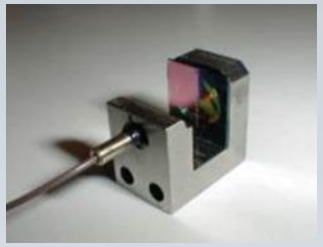
US Patent 7,196,320

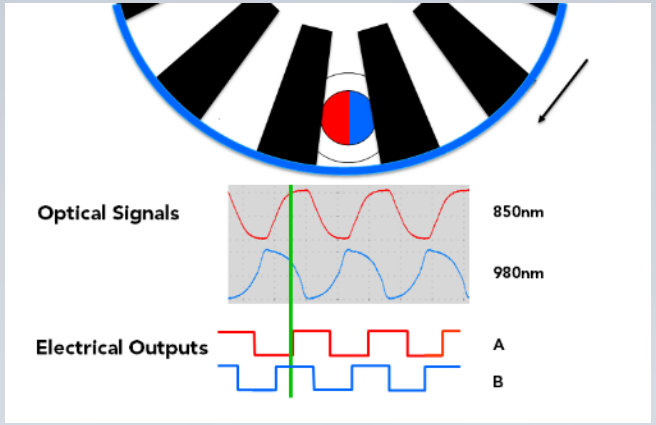
Absolute Encoder

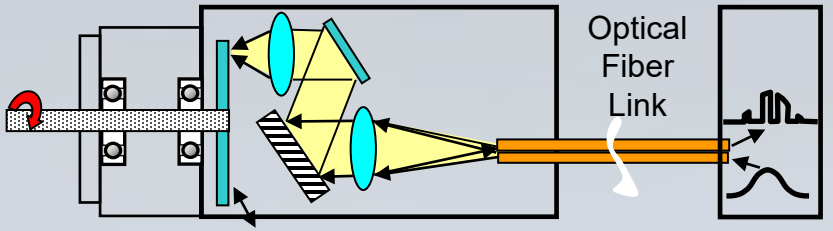
US Patent 8,461,514 B1

MR340

MMF-62.5/125 Series





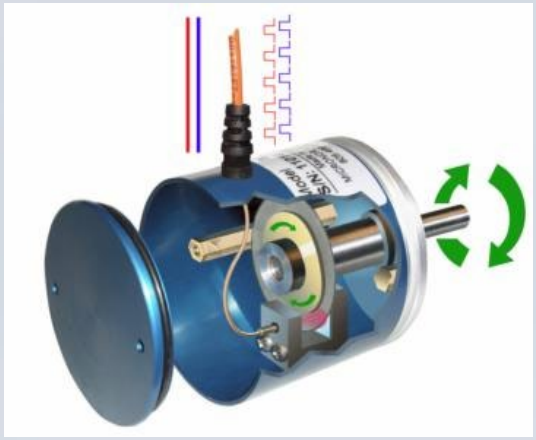


MR330

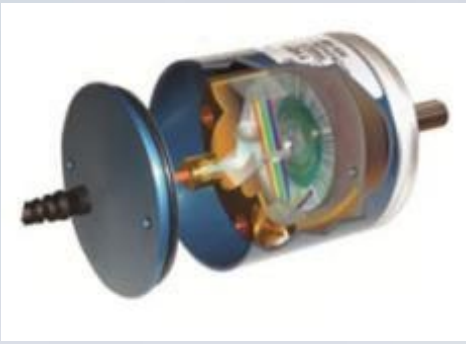
MMF-62.5/125 Series

MR430

M-POF Series



- Sensor is all-optical.
- No electronics. No power supply required.
- Sensor system consists of 3 components: passive sensor, fiber link and optoelectronic controller/converter.



FIBER OPTIC INCREMENTAL ENCODER & FO EXTENDER QUICK GUIDE

PRODUCT MODEL	 **MR340-1** Controller	 **TD5482** Controller in IP Housing	 **MR342/MR346** Shaft Encoder	 **MR344** Hollow Shaft Encoder	 **MR348** MRI Safe Shaft Encoder	 **MR361-1** FO Extender for non-FO Encoders
Description	Controller	MR340-1 Controller in IP Housing, with extended 30C wiring block for additional signal routing	Synchro or Flange Mount MR342: Size Ø58mm, IP64 MR346: Size Ø90mm, IP66	Size 100mm, Ø38mm Bore C Thru Bore: IP54 PC Pocket Hole: 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	One MR340-1 Controller interfaces to one MR34X series FO Incremental Encoder		256 or 360ppr	1024ppr	360ppr	4-Channels, typically for A/B or A/B/Z encoder interfaces
Compatible Fiber	Multimode Fiber Only – OM1(62.5/125) and OM2/OM3 (50/125)					
Optical System Margin	12dB	11dB	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
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	IP-LC	Duplex LC pigtail or IP-LC	Duplex LC pigtail	Duplex LC pigtail	Simplex ST
Power Supply	24 VDC	24 VDC	---	---	---	5V or 10-30VDC
Accessories	FO Cabling Junction Boxes	FO Cabling Junction Boxes	---	MR344-99-XX Shaft Adapters: 8-32mm, ½" to 1¼"	---	FO Cabling Junction Boxes
STOCK PRODUCTS	MR340-1	TD5482	MR342-D06D00 MR346-D12D00	MR344-F38C1R5E (Extended Temp)	Special Order	For use with HTL Encoders: MR361-1-0-3-0 (XMTR) MR361-1-1-3-0 (RCVR)

98-0340-17-A
QR Code to Encoders

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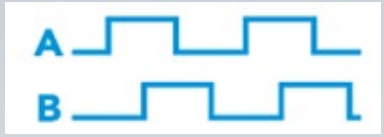
MR340 Series
FO Incremental Encoders
The 3rd Generation (2018)



Incremental Encoder

US Patent 7,196,320

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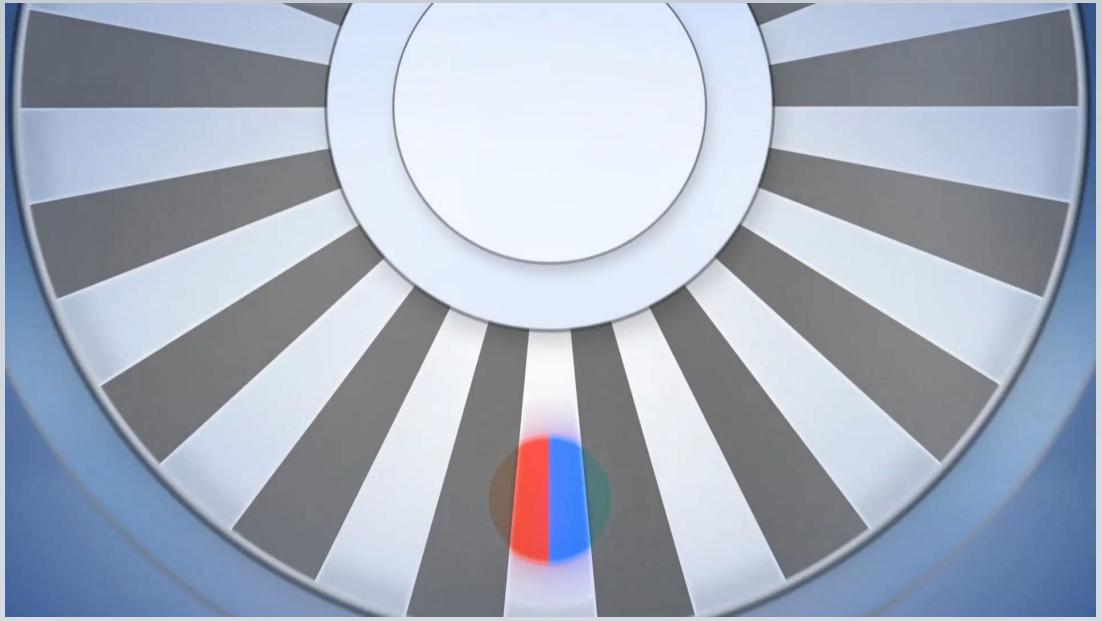
MR340 Encoder in Operation



US Patent: 7,196,320

How it Works:

1. Optical signals at two distinct wavelengths sense the direction of a moving graduated disk.
2. This disk modulates the light, creating an A/B quadrature signal.

Features:

- Resolution up to 1024 Pulses Per Revolution (PPR)
- Outdistances Copper – Encoder Links to 2000+ Meters
- Proven Coarse Wavelength Division Multiplexing (WDM) Technology

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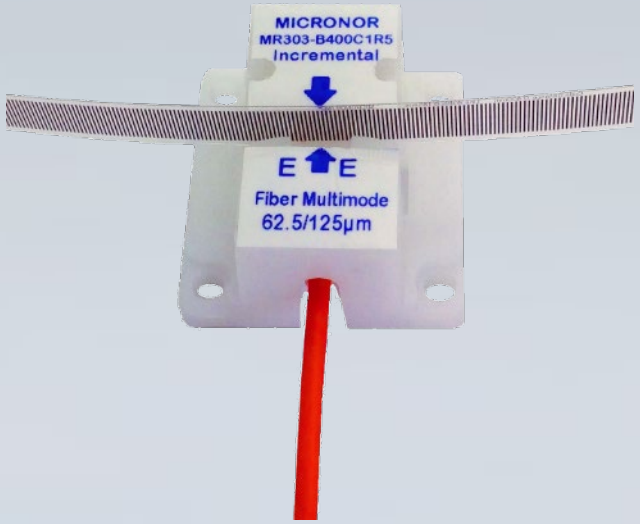
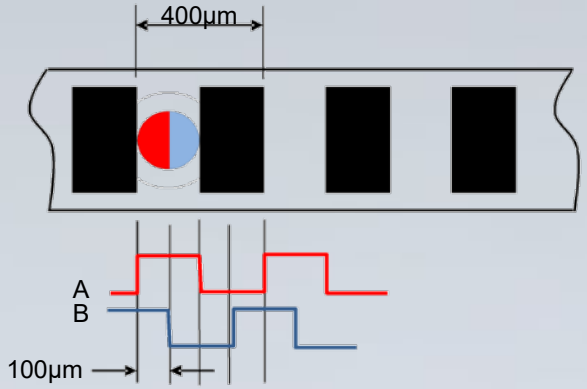
MR343

MRI Safe Linear Encoder





Features:

- MRI Safe (No Metals Used)
- Small Compact Design
- 0.1 mm Resolution
- Special Homing Zone on Left or Right of Films Active Area – Allows for Accurate Position Tracking

Applications:

- Medical
- Robotics
- Industrial

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MR341

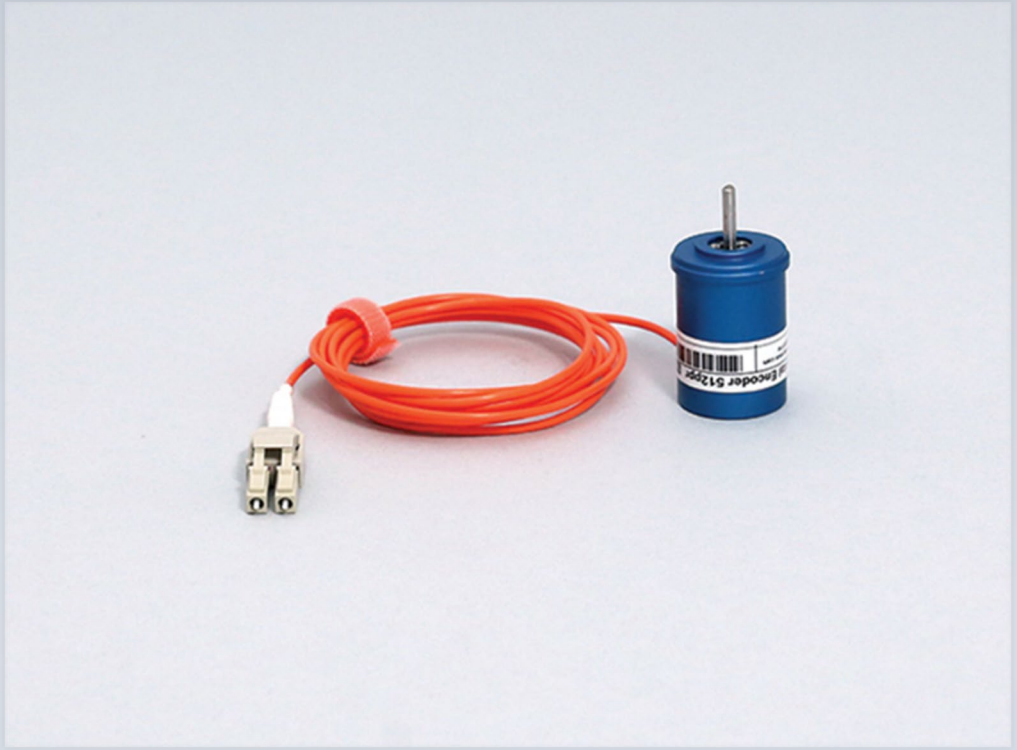
Size 11 Incremental Rotary Encoder

Features:

- Size 11 Form Factor
- Up to 512 PPR Resolution
- Fiber Optic Links up to 2000 meters
- Maximum Speed of 10,000 RPM

Applications:

- Medical
- Industrial
- Robotics
- Transportation



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MR342

Size 58mm Incremental Rotary Encoder

Features:

- Size 58mm Form Factor
- Up to 360 PPR Resolution
- Fiber Optic Links up to 2000 meters
- Maximum Speed of 8,000 RPM
- LC-Duplex pigtail and IP-LC interconnect options

Applications:

- Industrial
- Transportation

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MR344

Size 100mm Hollow Shaft Incremental Rotary Encoder

Features:

- Size 100mm Hollow Shaft Form Factor
- 1024 PPR Resolution
- Thru-Bore (IP54) and Pocket Hole (IP66) versions
- Fiber Optic Links up to 2000 meters
- Maximum Speed of 3,300 RPM
- Standard Temp (-40°C/+80°C) and Extended Temperature (-60°C/+150°C) options

Applications:

- Industrial
- Mining
- VFD drive feedback

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MR345

Size 125mm Incremental Rotary Encoder

Features:

- Size 125mm Shafted Form Factor
- 1024 PPR Resolution
- Fiber Optic Links up to 2000 meters
- Maximum Speed of 3,600 RPM
- IP-LC connector interface
- IP67

Applications:

- Industrial
- Mining
- VFD drive feedback

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MR346

Size 90mm Incremental Rotary Encoder

Features:

- Size 90mm Form Factor
- Up to 360 PPR Resolution
- Fiber Optic Links up to 2000 meters
- Maximum Speed of 8,000 RPM
- Standard Temp (-40°C/+80°C) and Extended Temperature (-60°C/+150°C) options
- LC-Duplex pigtail and IP-LC interconnect options
- IP66

Applications:

- Industrial
- Transportation

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MR348

MRI Safe Incremental Rotary Encoder

Features:

- Size 58mm Form Factor
- 360 PPR Resolution
- Fiber Optic Links up to 2000 meters
- Maximum Speed of 6,000 RPM

Applications:

- Medical
- Extreme magnetic field strength – MRI, fMRI, MEG
- Low magnetic field strength – Superparamagnetic relaxometry
- Industrial

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MR340-1 Controller

Adjustable Real Time A/B Quadrature Outputs: 5V, 12V or 24V

User Selectable Analog Outputs: 0-±10V or 4-20mA

Duplex LC 62.5/125µm Optical Interface

Bottom: USB, SSI and RS485/Modbus Interfaces

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MR360-1 Series Fiber Optic Extender Conventional Incremental Enoders

4-Channel Fiber Optic Transmitter/Receiver System for extending reach of electronics-based absolute and incremental encoders via Simplex ST 50/125 or 62.5/125 MM fiber optic link.

- Can support one A/B/Z encoder with a 4th channel for other signaling, or
- Can support two A/B encoders
- Distance up to 2 km

3 Models Available For Incremental Encoders:

- For 5V Operation, RS422 L/D Outputs
- For 10-30V Operation, RS422 L/D Outputs
- For 10-30V Operation, Push/Pull Outputs

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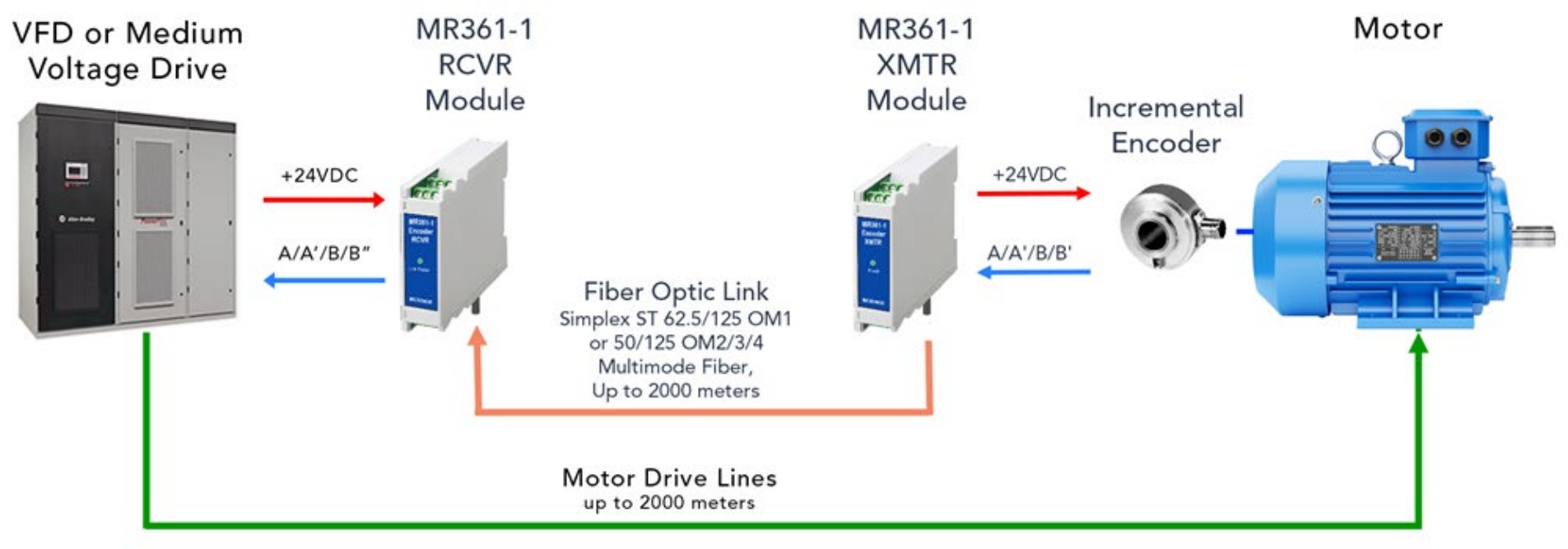
Typical MR360 Application: Interference Free Feedback for VFD or MV Drive System



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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	Multimode Fiber Only OM1 (62.5/125) and OM2/OM3 (50/125)			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
STOCK PRODUCTS	MR330-1	MR332-D06D00	MR338-D06D00	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-A
QR Code to Encoders

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VENTURA, CA 93003 USA
+1-805-389-6600
sales@micronor.com

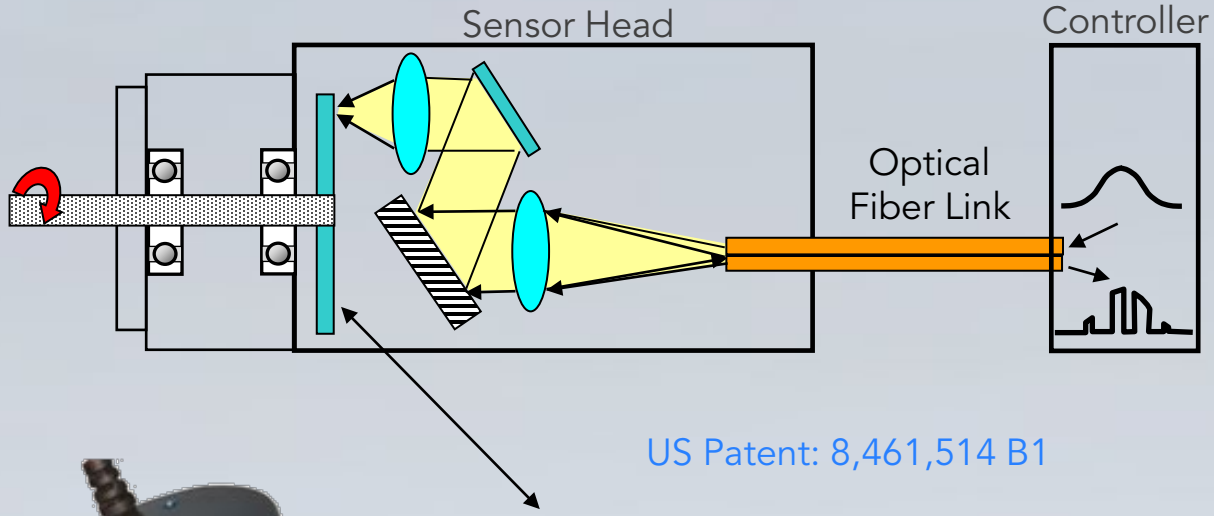
MR330 Series
High Precision 14-Bit
FO Absolute Encoder Systems

micronor sensors

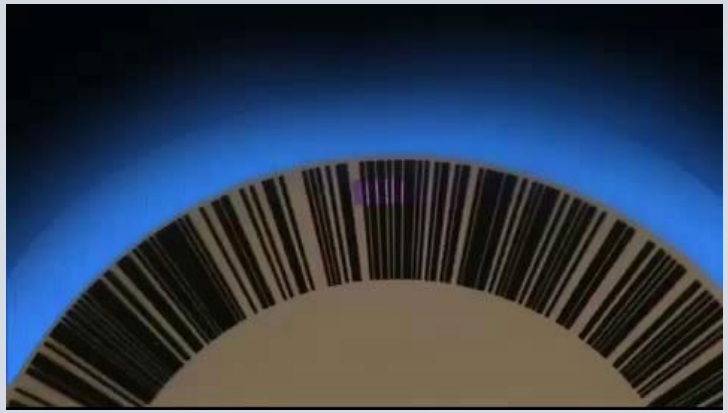
MR330 Encoder in Operation

How it Works:

1. Controller sends a broadband light pulse for position interrogation.
2. Sensor modulates the optical spectrum with position specific information by using a uniquely coded disk.
3. Controller receives the modulated light spectrum and converts it into electrical signals.
4. Embedded firmware extracts the position information from the spectral information.



US Patent: 8,461,514 B1



Features:

- Absolute Position with 0.0258° (14 bit) Resolution
- Fiber Optic Cable Length Exceeding 300m
- Fast Update Rate of 825µs

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MR330 Controller

Home Position Switch
& Two Programmable
Set-Point Outputs

Duplex LC
62.5/125µm
Optical Interface

RS485/Modbus RTU
25 bit SSI Position Output
and USB

Analog Outputs:
0-±10V and 4-20mA

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MR430 Series

Plastic Optical Fiber
(POF) Based

Fiber Optic

Position Sensor

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Sensor

M-POF Cable Assembly

Controller

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Size

- Small Form Factor
- Size 11 (Ø1.1”)
- Non-Metallic, All Dielectric Construction
- MRI Safe

Performance

- 0.044° Resolution
- 13 Bits Single Turn
- 12 Bits Multi-Turn
- Up to 2200 RPM
- Up to 30 meters

Cost

- Lowest Cost FO Absolute Encoder
- POF fiber is easy to install
- Price Comparable to Electronic Encoders
- Enables New Designs That Would Benefit from FO Technology

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Technology

- Absolute Position Sensing Design using Imaging Fiber
- Dual Fiber – 1mm POF and iPOF

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MR430-1 Controller

HOME Input

User Programmable
Analog Outputs:
10V and 4-20mA

Dual Fiber
M-POF
Optical Interface

Bottom:
SSI, RS485/Modbus RTU
and USB Interfaces

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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)		Multimode Only OM1, OM2, OM3	MR387-2 series for use with MM OM1/OM2/OM3 fiber MR387-3 series for use with SM OS1 fiber	MR387-2 series for use with MM OM1/OM2/OM3 fiber MR387-3 series for use with SM OS1 fiber	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	SIL=1, PL=c	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 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	---	---	---
STOCK PRODUCTS	MR380-0-UNI	MR380-1-3	MR386-21-1R5	MR387-2S-1R5 (MM) MR387-2S-D00 (MM) MR387-3S-1R5 (SM) MR387-3S-D00 (SM)	Special Order	TD5412

98-0380-22-A
QR Code to MR387

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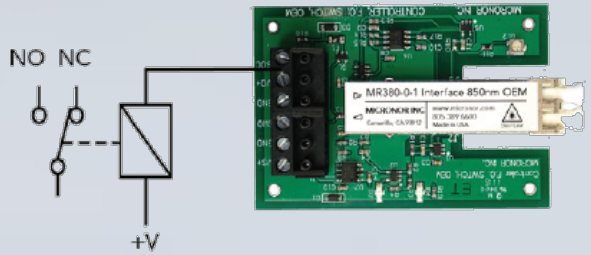
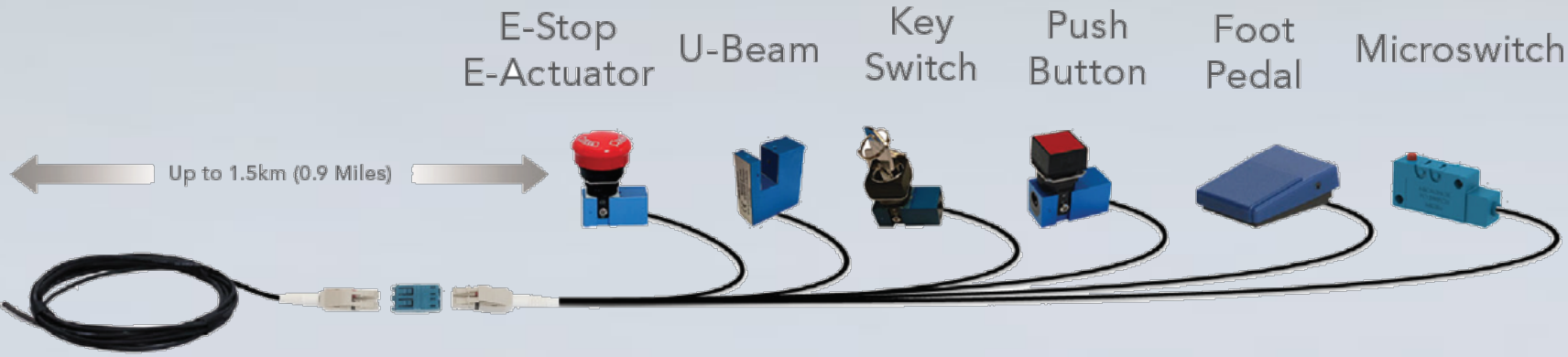
MR380 Series

Fiber Optic Signaling Devices





Fiber Optic Cabling
Duplex LC Connections
Multimode 50/125 or 62.5/125 FIber

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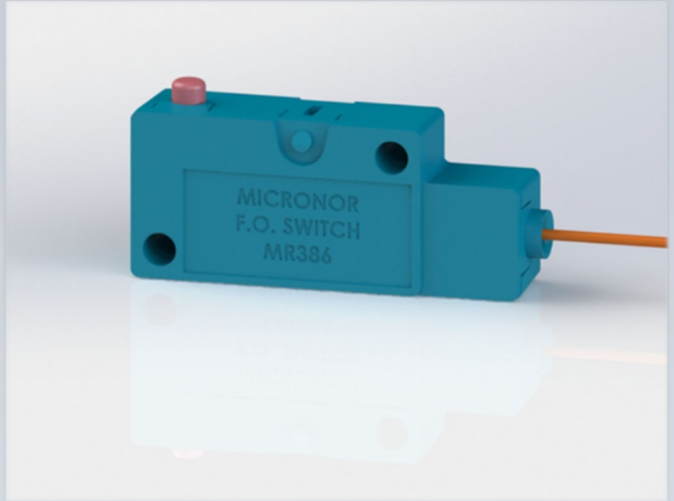
MR386

Microswitch Sensor

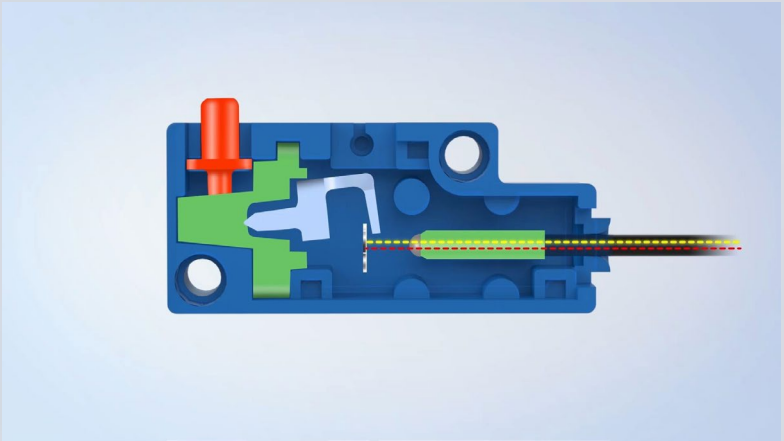
Features:

- Defined Mechanical Switching Point Offering Tactile Feedback.
- Entirely Non-Metallic, Non-Conductive Material.
- Interchangeable with Industry Standard Omron and Honeywell V-Series Micro Switches
- Operates Using Multi-Mode Fiber.



Applications:

- MRI Cradle Position Tracker
- Explosive Liquid Level Monitoring
- MRI Operator Hands Free Foot Pedal
- Valve Detection in Hazardous Environment
- Pressure Detection in a Corrosive Atmosphere
- Tamper Free Key Switch



micronor sensors

MR387

Emergency Stop Signaling Sensors

Features:

- Emergency Stop
- Available in POF, Multimode or Single Mode for Extended Distance Capabilities
- Up to 18km
- Panel Mountable Sensor
- Daisy Chain Multiple Sensors
- Reliable and Secure Fiber Optic Connection

Applications:

- Hazardous or Explosive Atmospheres such as Gas, Dust, or Mines
- Extended distance E-Stop links

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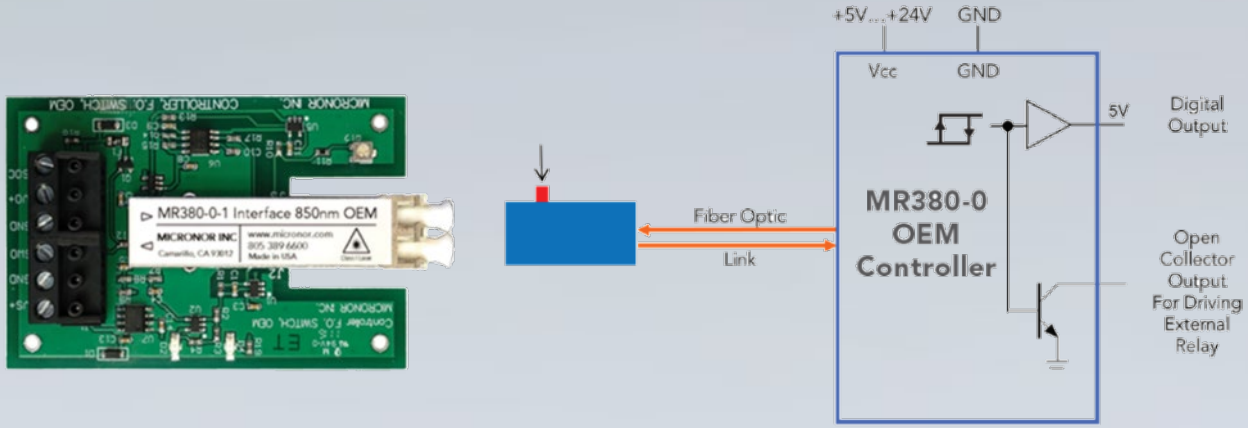
MR380 Controllers

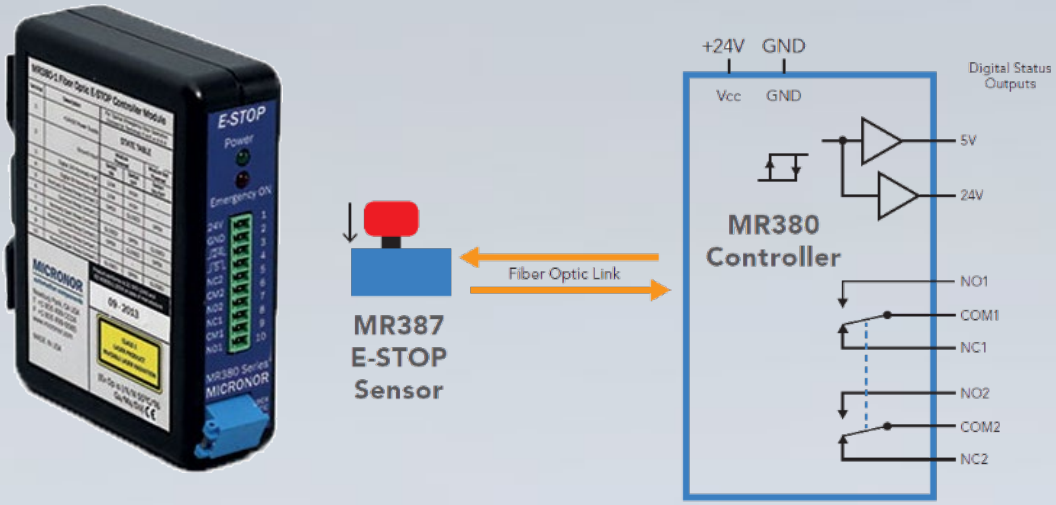
MR380-0 OEM



Features:

- Lowest Cost Solution for Embedded Applications
- Multimode 850nm Operating Wavelength
- Logic and Open Collector Output
- Operates from 5-24 V

MR380-1 DIN Rail Mount



Features:

- Multimode 1310nm or Single-Mode 1310nm
- Built in Double Pole Double Throw (DPDT) Relays
- Operates from 24V (10V – 30V)

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Comparing Performance Specifications of Key Thermometry Technologies

Typical Characteristics	K-Type Thermocouple	GaAs	FBGs
Temperature Range	-270°C to 1260°C	-200°C to +300°C	-150°C to +600°C
No. of Measuring Points per Sensor	1	1	1-30
Accuracy	±2.2°C	±0.2°C	~1°C
Resolution	0.1°C	0.1°C	0.1°C – 0.5°C
Update Rate	0.1 Hz	1-ch = 4 Hz 4-ch = 1 Hz	1-300 Hz
Max Distance	50m	2000m	500m
Wire Used	Metallic	Multimode Glass Fiber 200/220	Single Mode SM800 5.6/125
Ease of Integration	Plug-and-play	Plug-and-play	Requires Hardware and Software Integration

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Comparing Environment Properties of Key Thermometry Technologies

Environment	K-Type Thermocouple	GaAs	FBGs
Benign, Short Distance <30m	✓	✓	✓
Benign, Long Distance	✗	✓	● < 500m
High Temperature > 300°C	✓	✗	✓
Low Temperature < -40°C	✗	✓	✓
EMI/RFI	✗	✓	✓
Magnetic Fields	✗	● <1 Tesla	✓
High Voltage	✗	✓	✓
RF Fields	✗	✓	✓
RF or Conductive Heating	✗	✓	✓
Microwave Oven	✗	✓	✓
Radiation (Nuclear)	● Requires Radiation Compensation	✓	● Requires Radiation Resistant Fiber

✓ Recommended

● Provisional

✗ Not Recommended

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Weidmann Technologies

GaAs Fiber Optic Temperature Sensors

Features:

- Measuring Range: -200°C to +300°C
- Resolution : 0.1°C
- High Accuracy: ±0.2°C (1σ)
- Digital Interfaces: RS232, USB, RS485 and Ethernet
- Analog Outputs: 4-20mA or 0-10V

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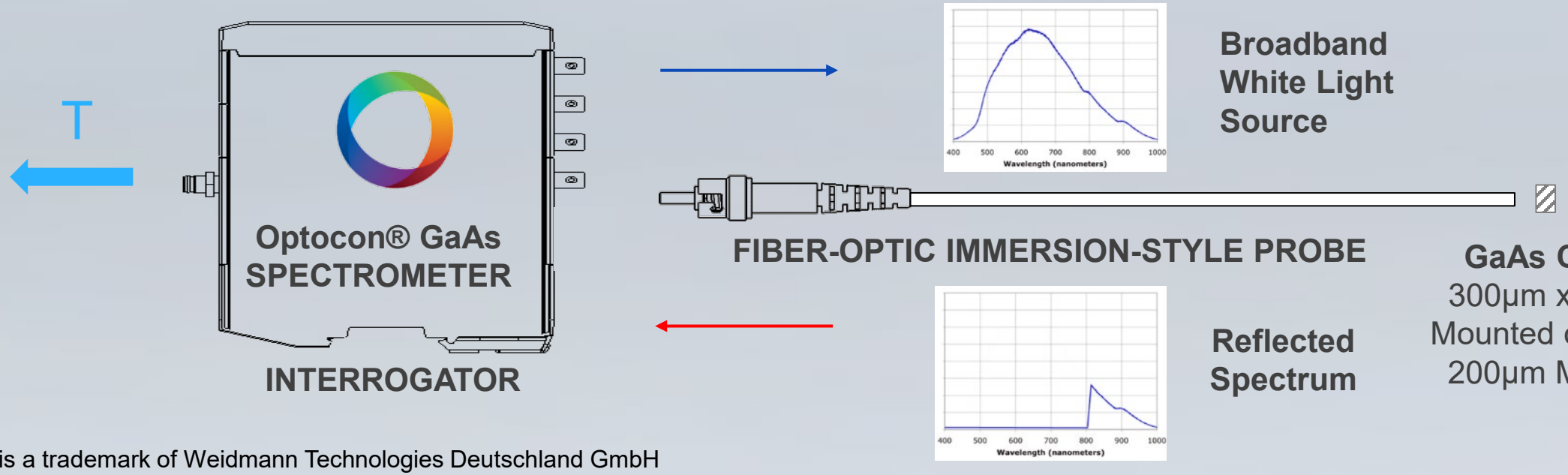
Gallium Arsenide (GaAs) Thermometry



Optocon® is a trademark of Weidmann Technologies Deutschland GmbH

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.

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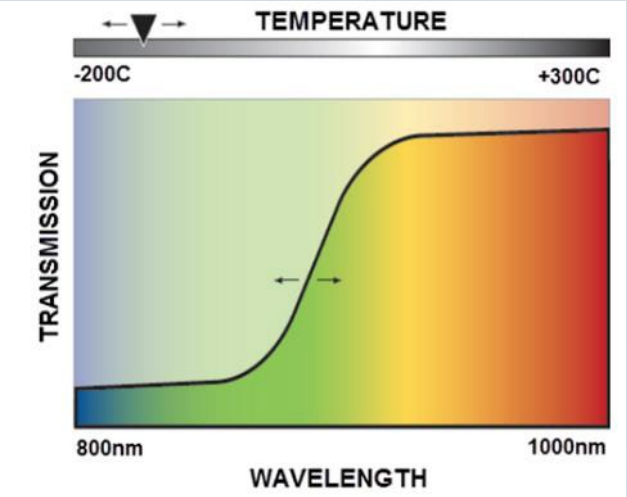
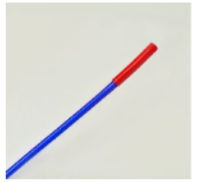


Optical beam probes the wavelength dependence of the intrinsic band-gap of GaAs which is dependent on absolute temperature.

$E_{gap} = 1.423eV$ ⇨ 300°K = 872nm

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

FOTEMP® FO 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 transformer, 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-06	TS4-15MM-02	TS5-20MM-02, -06 TS5-50MM-02, -06	Special Order based on required lengths	EOF0200 SmartSpacer EOF0203 SmartDisc ZM0060 SmartBusbar

98-OPTC-27-D1
QR Code to TS sensors

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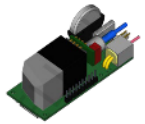
FOTEMP® FIBER OPTIC SIGNAL CONDITIONERS

MODEL	 FOTEMP-PLUS Most Popular	 FOTEMP-H2 Handheld	 FOTEMP-OEM	 FOTEMP-MINI 3	 FOTEMP-T2	 FOTEMP-MODULAR
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	Multichannel Modular System
No. of Channels	1, 2 or 4	1 or 2	1, 2 or 4	1	4, 8, 12, or 16	1-255
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	Laboratory, Process Monitoring
Sample Rate/channel	250ms	250ms	250ms	250ms	250ms	250ms
Internal Data Logging?	No	Yes	No	Yes	Yes Requires programming via Modbus	No
Data Logging Storage	---	MicroSD Card	---	MicroSD Card	MicroSD Card	---
Analog output	Std=0-10V Option=4-20mA	---	Std=0-10V Option=4-20mA	---	Std=4-20mA (First 8 Channels Only)	Option: 0-10V or 4-20mA
Relay output	Option=4	---	Option=4	---	Std=4	Option=1-255
Interface	Std=USB+RS232 Option=USB+RS485	USB-C	Std=USB+RS232 Opt=USB+RS485/Modbus	USB-C, UART, RS232, RS485/ModbusRTU	Std=USB+ModbusRTU Option=USB+ModbusTCP	RS485 or RS232
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)	100-240VAC
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-A2 FOTEMP-H2-2-P0-A2	Special Order	FOTEMP-MIN3-P0-A2 Special Order	FOTEMP-T2-8-P1-B	Special Order

98-OPTC-28-D1
QR Code to FOTEMPs

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Flagship FOTEMP-PLUS

4-Channel Bench Top Signal Conditioner

- Compatible with all TS series FO Temperature Probes
- Measurement Range determined by Calibration Option
  - Cal A (Special Order): -40°C to +200°C
  - Cal B (Stock, Standard): -40°C to +300°C
  - Cal C (Stock, Extended Temperature): -200°C to +300°C
- Accuracy (2σ): 0.2° (Factory Calibration) or 0.5° (Micronor One-Point Calibration)
- Interfaces (Stock Units): USB, RS232, 0-10V Analog Output
- Special Order: AO 4-20mA, Progrrammable Relays

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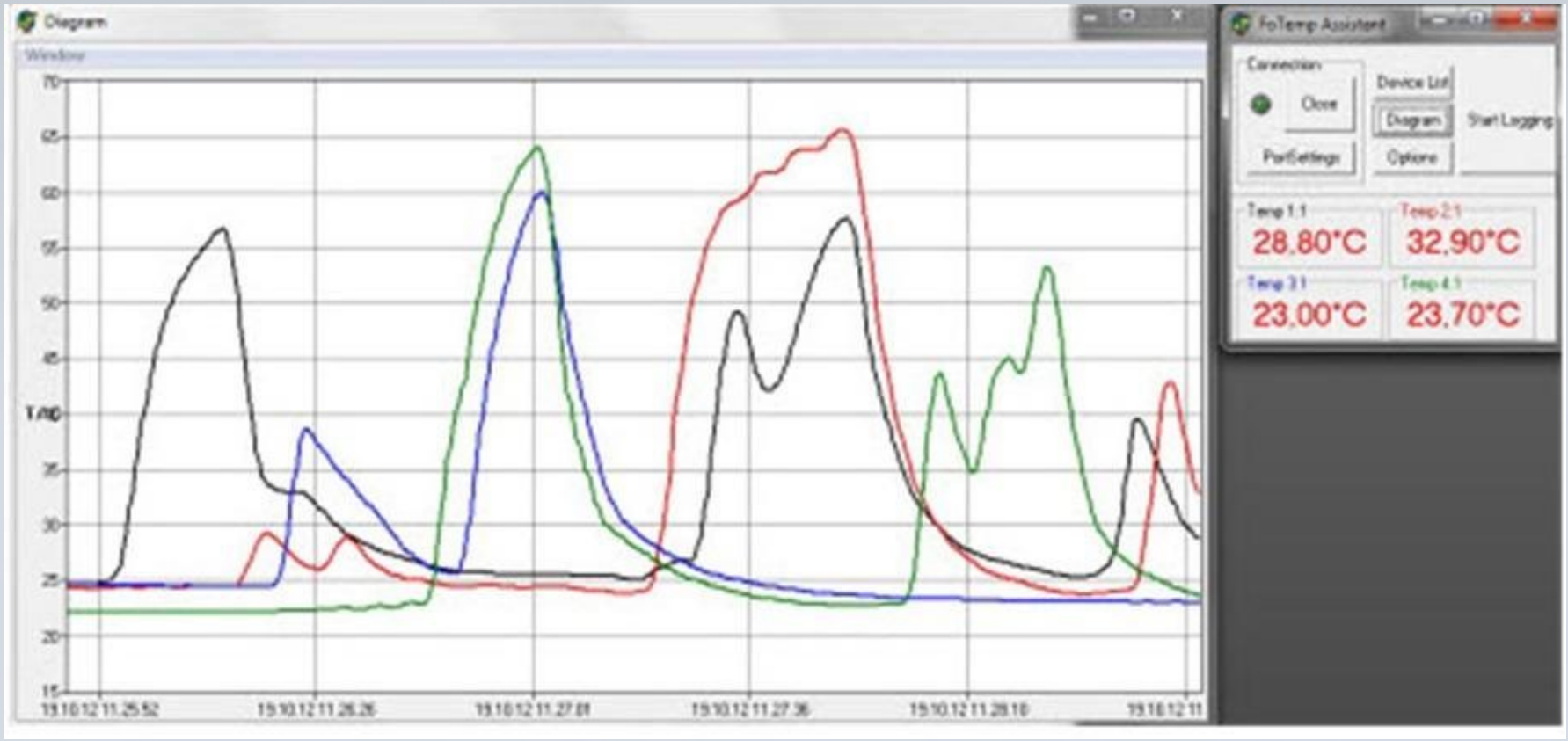
FOTEMP-Assistant

Graphical Display and Data Logging Software



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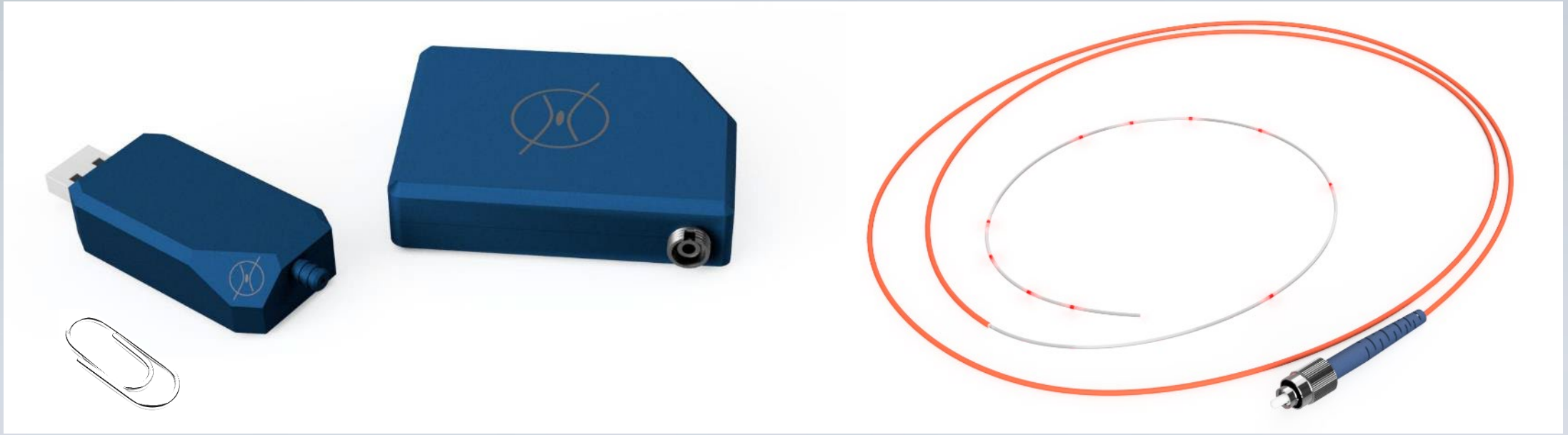
FiSens Multipoint FBGs



FBG Interrogator/Spectrometer

Fiber Bragg Grating (FBG) Sensor Chains

FiSens

We established a **strategic partnership** with FiSens to bring an innovative FBG sensor product to the North American market

FiSens

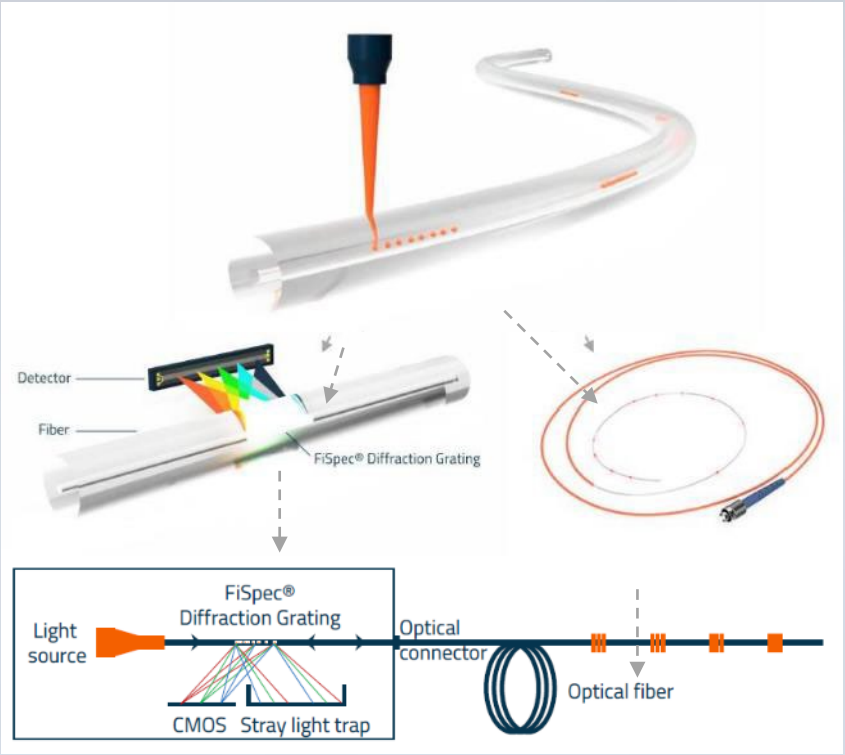
- Spin off from the Fraunhofer HHI Institute staffed with several PhD holders

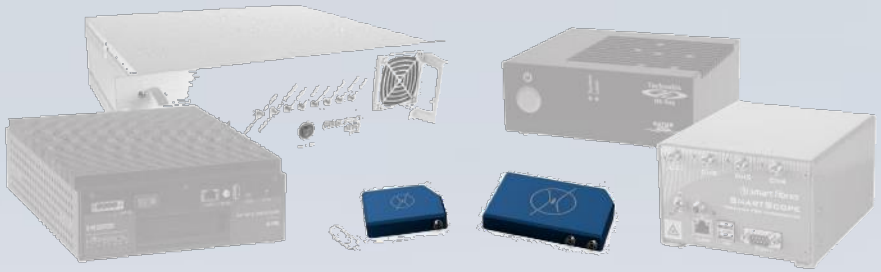
Femtosecond (fs) laser processing and FBG sensors

- fs-Laser inscription enables FBGs to be as small as 1 mm in length (conventional FBGs are ~10 mm long)
- Spacing of FBGs is highly customizable down to 1 mm – high spatial resolution

Disruptive technology to change the FBG interrogator landscape

- Simplest way to interrogate an FBG
- Worldwide smallest and most economic interrogation system for multiple FBGs (arrays) with embedded light source
- Significant reduction in footprint (core interrogator 1/10th the size of competitors) and cost





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* Patented Technology

Chamber Component Integration

Integrating into Semiconductor chamber components

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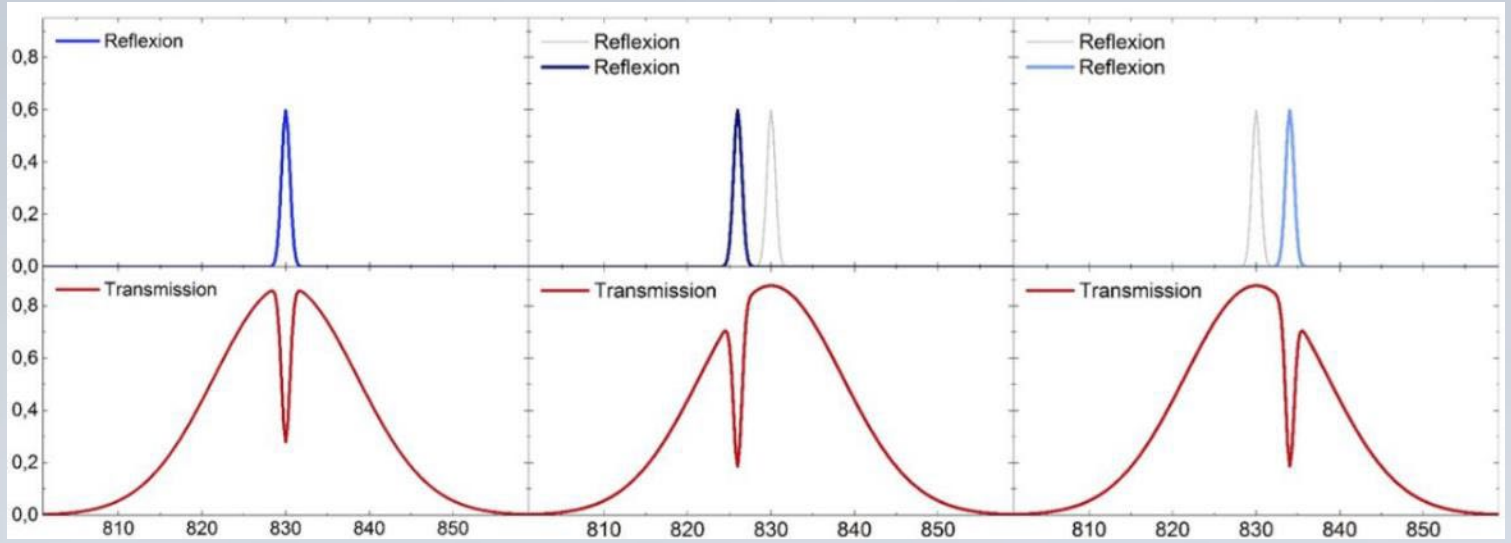
Basic Concept of Fiber Bragg Gratings (FBG)

- FBG technology enables multiplexing of sensors along a single optical fiber
- an FBG is a periodic structure that reflects only one wavelength of the light guided within an optical fiber
- a fiber and its FBG is compressed (strain) -> wavelength decreases
- a fiber and its FBG is stretched (strain) -> wavelength increases
- Temperature expands not only fiber and FBG but also change in refractive index -> wavelength increase/decrease
- The FBG Interrogator (light source & spectrometer system) analyzes the wavelength shift and converts to temperature, strain, or pressure



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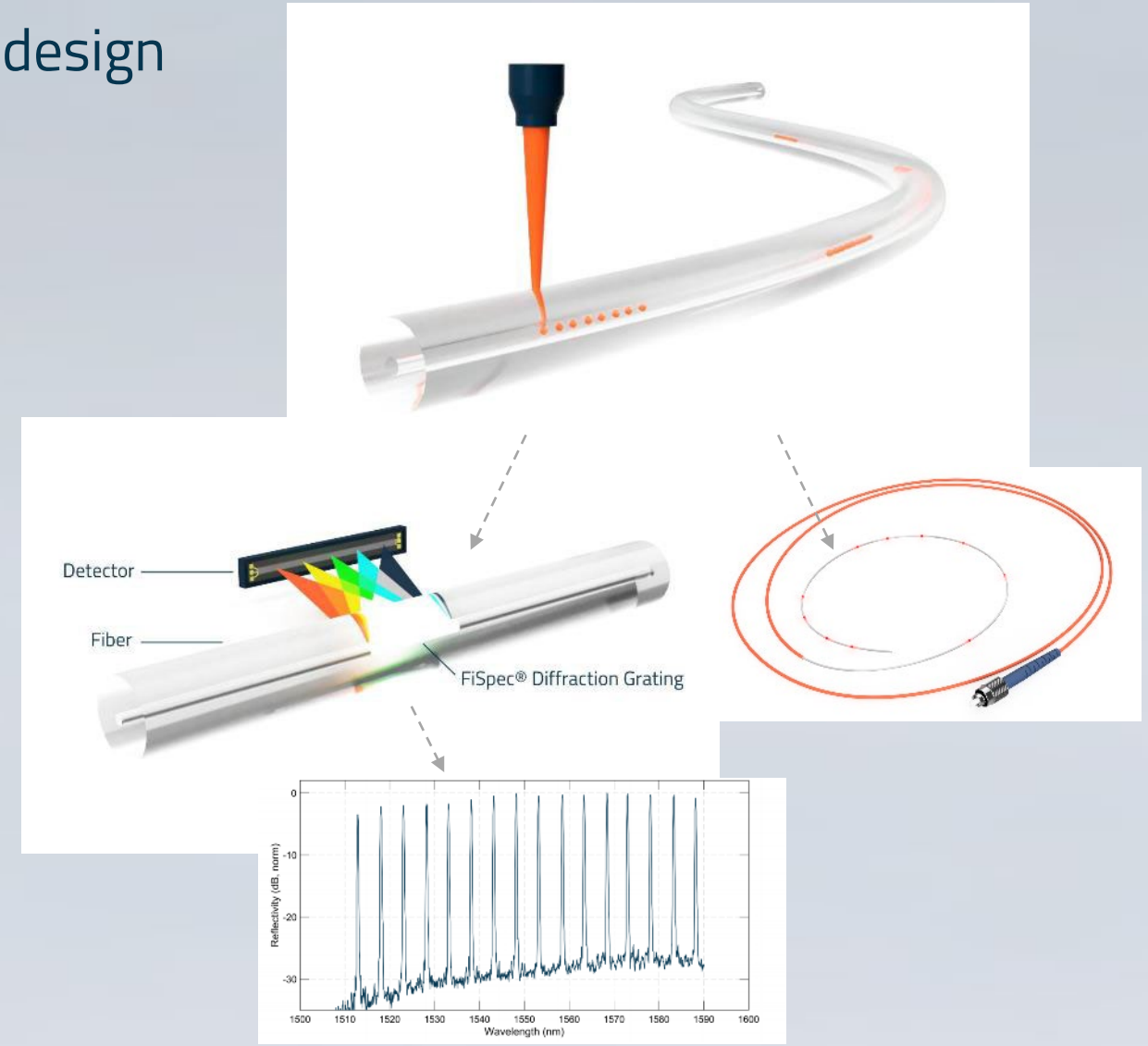
Leading Edge FBG Manufacturing

4th generation proprietary laser processing design

- Ultra-short fento-second laser pulses create high-precision nanoscopic structures in common low-cost telecom optical fibers
- Direct focus into core of the fiber trough almost any coating
- Complete freedom in positioning fiber Bragg gratings (FBG) along the fiber
- Fastest Prototyping of any possible spectral configuration utilizing own simulation software and point-by-point inscription

→ Simple waveguides are transformed into customized multifunctional spectrometer and sensors with one click

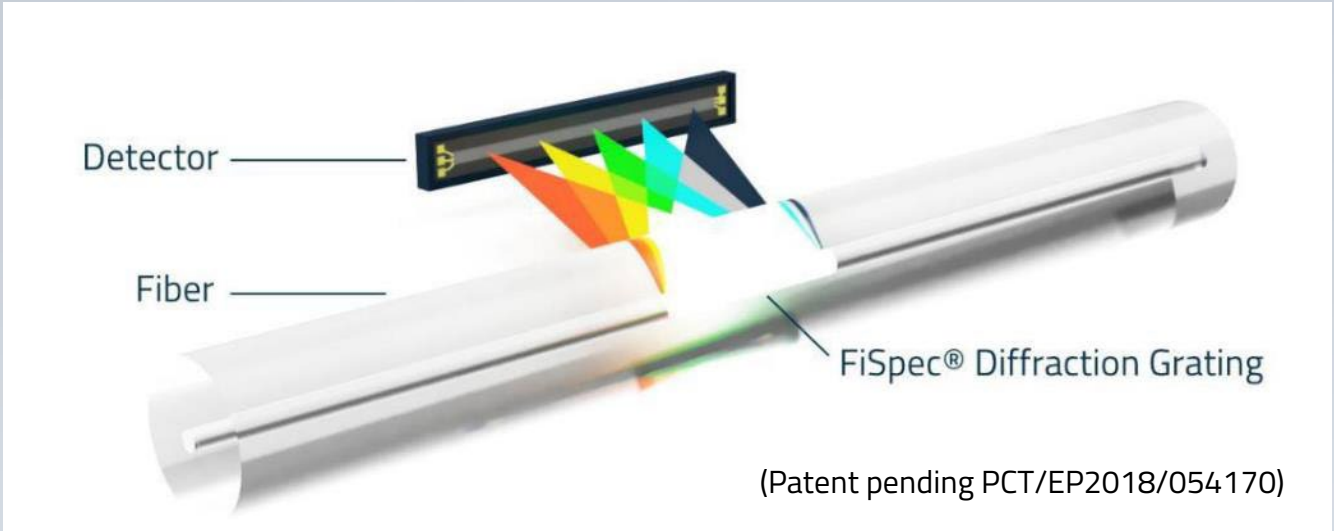


micronor sensors

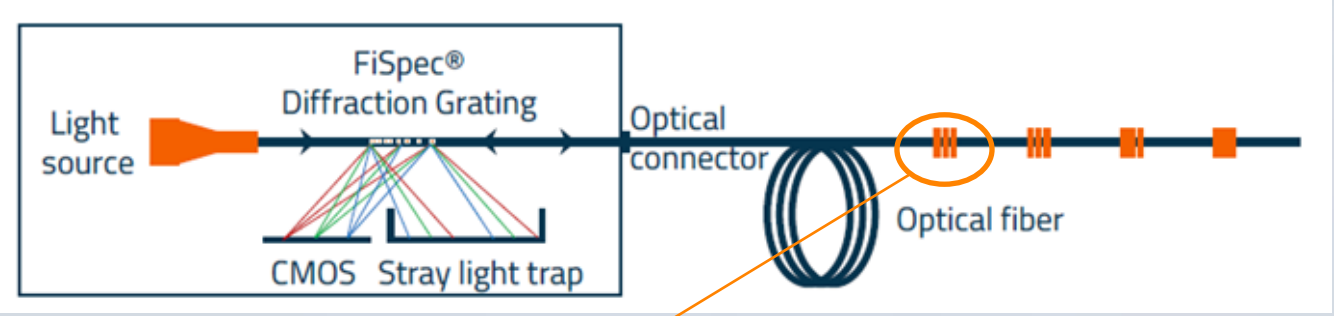
Fiber Integrated Spectrometer

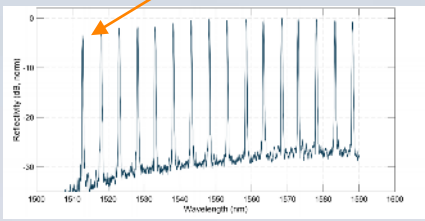
All optical components of a spectrometer within a single optical fiber

- Unique in-core grating for outcoupling and directly focusing onto image sensor with ultra-high diffraction efficiencies and light intensities
- Spectral resolutions from 50pm to 2nm directly encodable
- Customizeable to almost any desired wavelength sensitivity (200-2000nm)
- Quasi-monolithic design for highest shock-resistance and thermal stability
- Unprecedented cost-effectiveness and automated production scalability
- FiSens patented technology



(Patent pending PCT/EP2018/054170)





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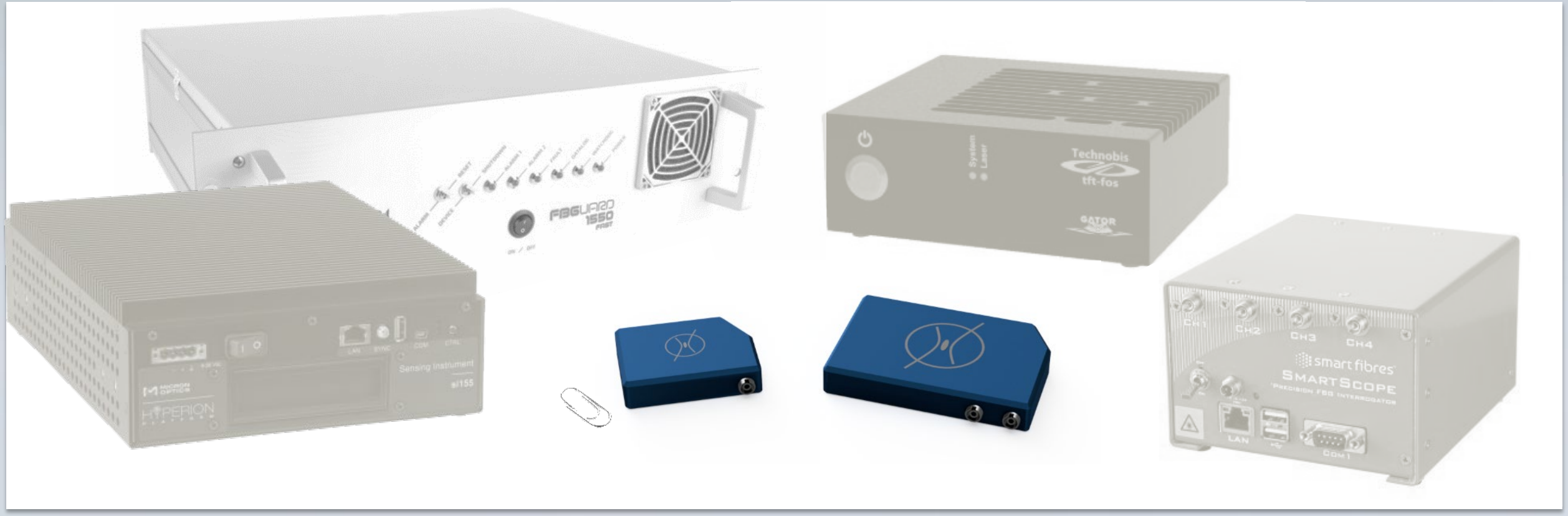
Setting A New FBG Standard

1/10 the size and 1/4 the cost while maintaining highest performance



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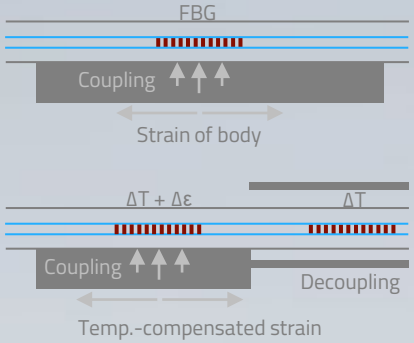
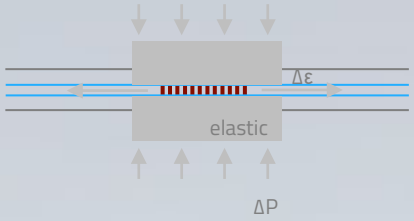
FBG Measurement Applications

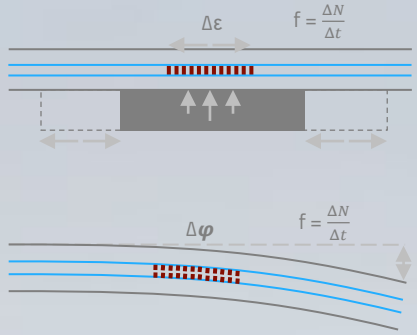
Strain



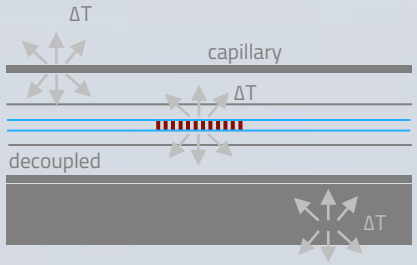
Pressure



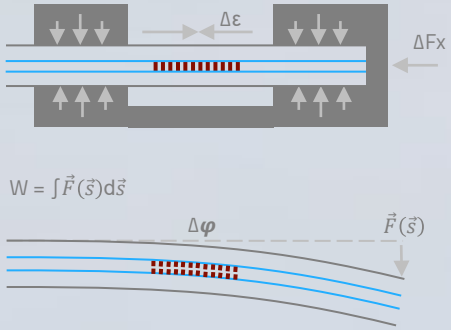
Vibration



Temperature



Force



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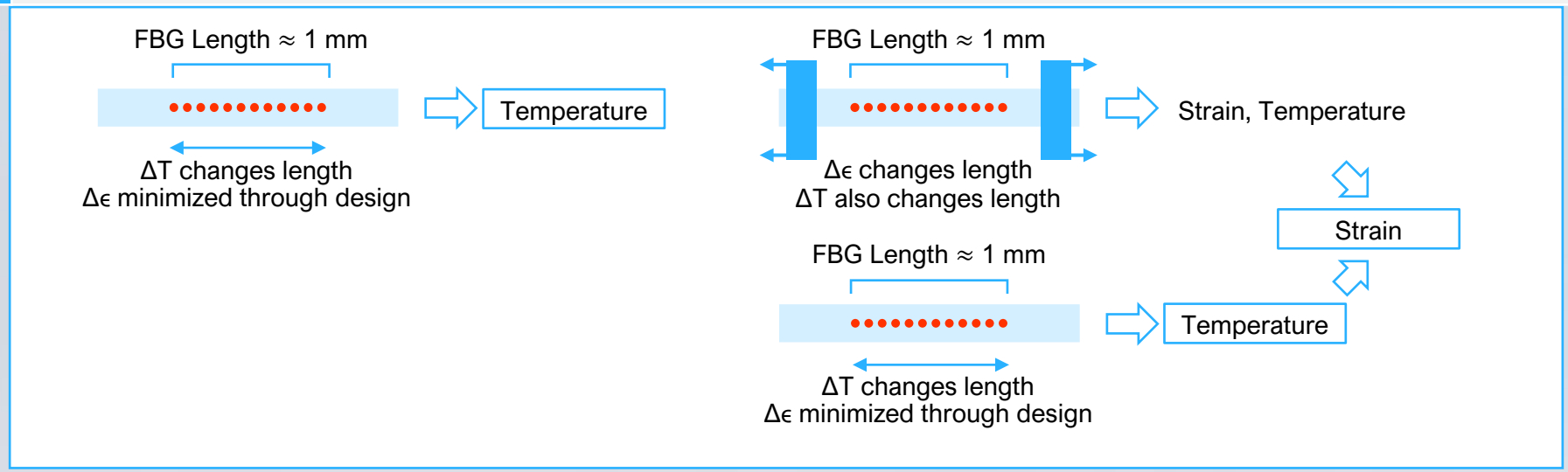
FBG Application Details

Parameter	Temperature, T	Strain, ϵ	Pressure, Acceleration, Displacement, more
Geometry	Strain-relieved bare fiber	Bare fiber	Combination of temperature and strain geometries, mountings, challenges, and solutions
Mounting	Inside capillary, loop secured with Kapton tape	Embedded in material, glued to surface	
Challenges	Strain also enlarges FBG	Temperature increase also enlarges FBG	
Solutions	Choose geometry to avoid strain-related effects	Compensate for thermal expansion with second FBG	
Typical Applications	Structural health, wind turbine, switchgear, winding hot spot, injection molding		



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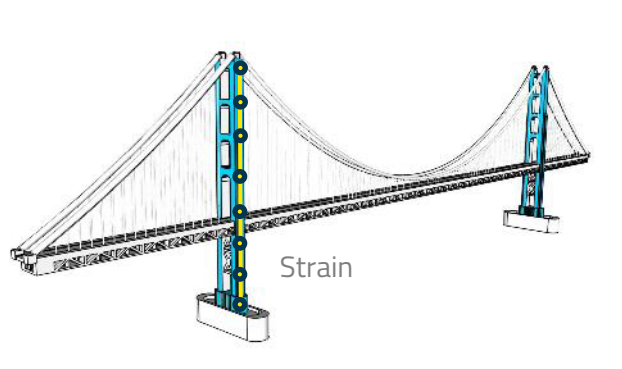
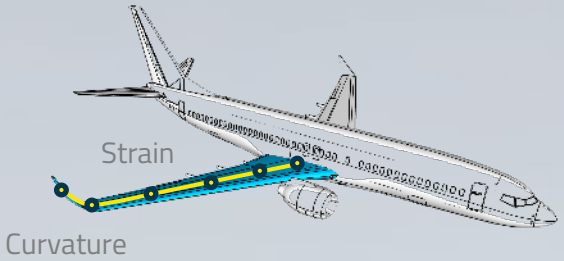
Exemplary FBG Sensor Applications

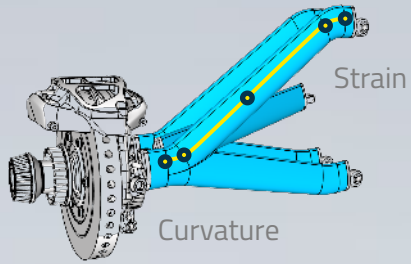
Structural Health Monitoring



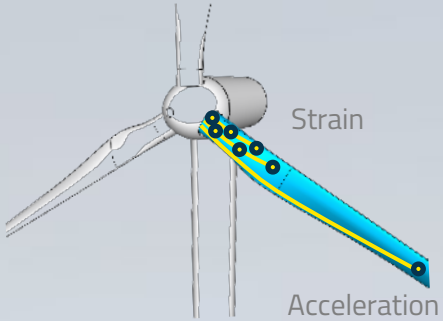
Condition Monitoring



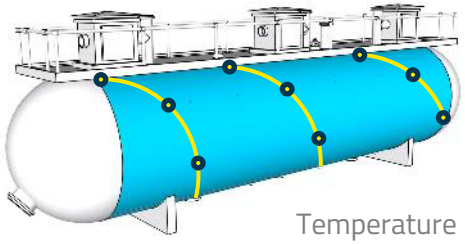
Load Monitoring



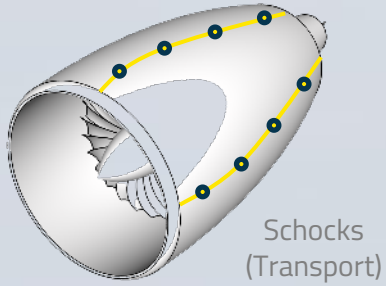
Rotor Blade Sensing



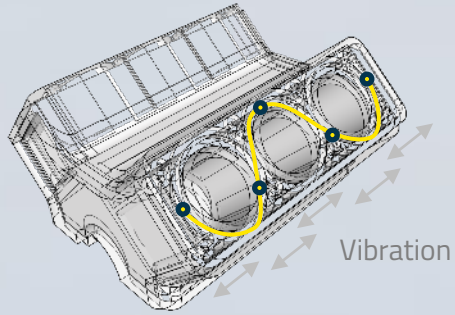
Process Control



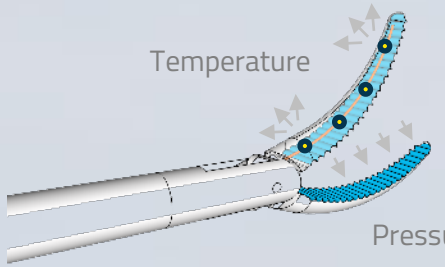
Asset Monitoring



Vibration Sensing



Instrument-integrated Sensing



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FISENS® FBG INTERROGATOR & SENSOR CHAIN QUICK GUIDE

MODEL	FBGX100 Interrogator	FBGX400 Interrogator	FI Sensor Chain Bare Fiber Capillary	PE Sensor Chain PEEK Capillary	SI/AC Sensor Chain SI=Silica, AC=Al Ceramic	SSC Sensor Chain Stainless Steel Capillary
Description	Compact Interrogator	Compact Interrogator	Bare Fiber, Polyimide-coated SM800 Single Mode Fiber	Bare Fiber mounted in PEEK tubing	Bare Fiber mounted in Silica or Alumina Ceramic Capillary Tube	Bare Fiber mounted in Stainless Steel Capillary Tube
No. of Channels	1, Wideband (W)	4, Wideband (W)	1	1	1	1
Measurement	Temperature, °C Strain, με	Temperature, °C Strain, με	Temperature or Strain	Temperature or Strain	Temperature	Temperature
Precision	0.1-1°C or 1-10με depending on sample rate	0.1-1°C or 1-10με depending on sample rate	Sensor Configurations: T-n-W-GL-FI S-n-W-GL-FI UHS-n-W-GL-FI	Sensor Configurations: T-n-W-GL-PK S-n-W-GL-PK	Sensor Configurations: T-n-W-GL-SI UHT-n-W-GL-SI UHT-n-W-GL-AC	Sensor Configurations: T-n-W-SST-SSC UHT-n-W-SST-SSC
# of FBGs per Sensor (n)	1-30	1-30	1-30	1-30	1-30	1-30
Sample Rate/channel	1-100Hz	1-100Hz	Min FBG spacing=2mm Max cap length=500m	Min FBG spacing=2mm Max cap length=10m	Min FBG spacing=2mm Max length, SI=2m, AC=1m	Min FBG spacing=2mm Max cap length=3m
Operating Temperature	0°C to +60°C	0°C to +60°C	Capillary Section: -250°C to +300°C	Capillary Section: -250°C to +300°C	Capillary Section: -250°C to +300°C Up to +800°C (with UHT)	Capillary Section: -250°C to +300°C Up to +800°C (with UHT)
Applications	Laboratory or Embedded OEM	Laboratory or Embedded OEM	General purpose. Supports both temperature and strain measurements. FBGs must be strain-relieved for temperature applications.	Flexible tubing provides protection of internal FBGs, as required by specific applications.	Provides strain-relieved, semi-rigid temperature probe for measurements to +300°C.	Provides strain-relieved, rigid temperature probe, especially well-suited for high temperature measurements to +600°C.
Electrical Interface	UART and microUSB	UART and microUSB	---	---	---	---
Optical Interface	FC-APC	FC-APC	FC-APC	FC-APC	FC-APC	FC-APC
Power Supply	+5VDC or USB	+5VDC or USB	---	---	---	---
STOCK PRODUCTS	FBGX100	FBGX400	Available for initial engineering evaluation: FBG-MR0050, 1-FBG FBG-MR0010, 10-FBG Or ordered per customer-specified configuration	Ordered per customer-specified configuration	Ordered per customer-specified configuration	Ordered per customer-specified configuration

UHS=Ultra High Strength, Pure Silica Core Fiber with No Coating
UHT= Ultra High Strength, Pure Silica Core Fiber with Polyimide Coating

98-FISN-06-A
QR Code to FBGs

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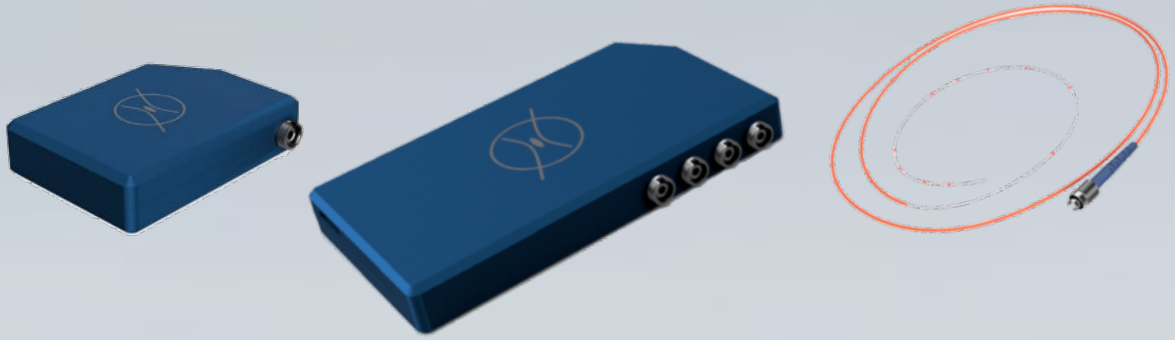
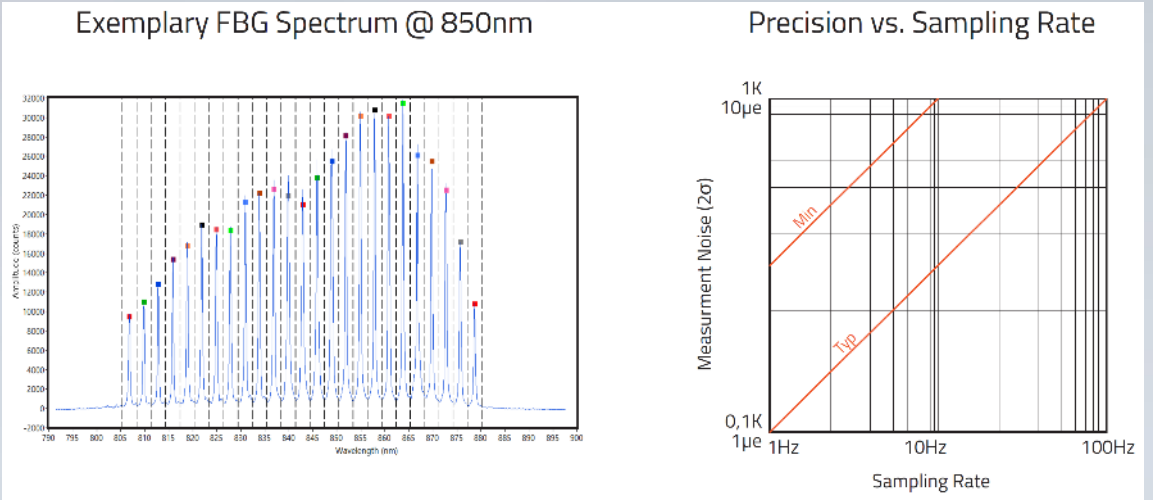
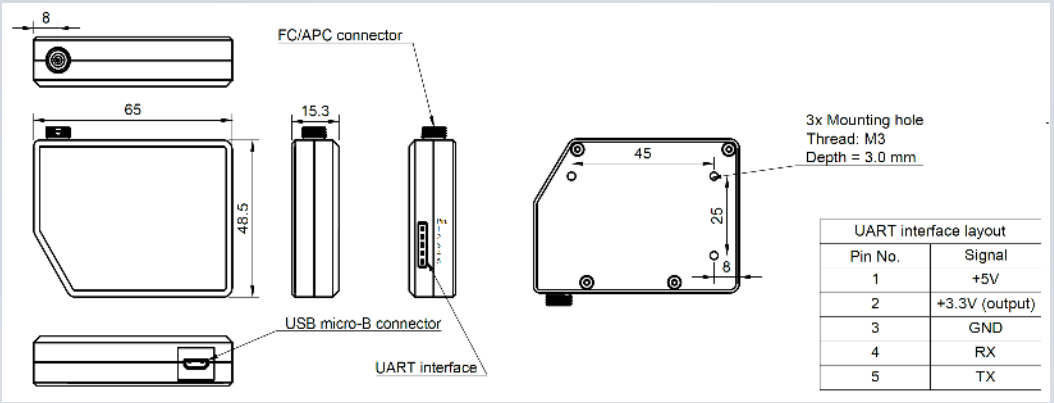
Flagship FBG Interrogators
1-Ch FBGX100 and 4-Ch FBGX400

Radical innovative design for mass market FBG-analysis



- Worldwide smallest and most economical interrogation system for mutiple FBGs (array) with embedded light source
- Interrogate up to 30 FBGs per channel, Wideband, 808-880nm
- Sampling rate 1-100 Hz (applies to all FBGs)
- Measurement precision : @ 1Hz: 0.1°C or 1µe
  @ 100Hz: 1°C or 10µe
- Digital Measurement Resolution: 0.001°C or 0.01µe
- Interfaces: Micro-USB, 3.3V UART Port





UART interface layout

Pin No.	Signal
1	+5V
2	+3.3V (output)
3	GND
4	RX
5	TX

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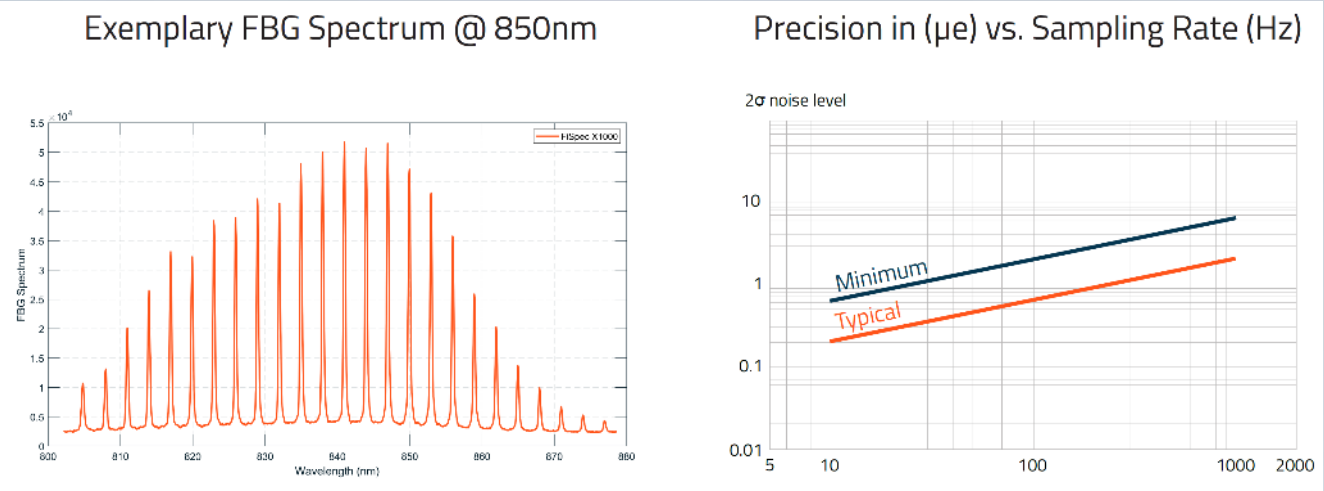
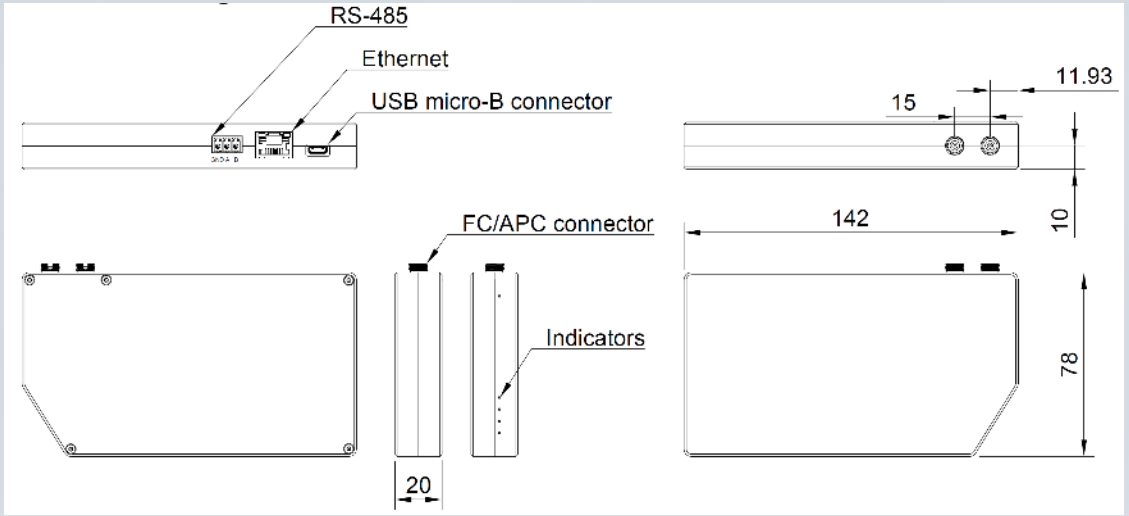
Faster Interrogation – FBGX1002/4

Fast FBG-interrogation



- 2 (FBGX1002) or 4 Channels (FBGX1004)
- Interrogate up to 25 Narrow-Band FBGs, 808-868nm
- Sampling rate: 1.2 kHz (normal, 2kHz (fast)
- Measurement precision : 0.1°C or 1με (at 1kHz)
- Digital Measurement Resolution: 0.01°C or 0.01με
- Interfaces: Micro-USB, RS485/ModbusRTU, Ethernet



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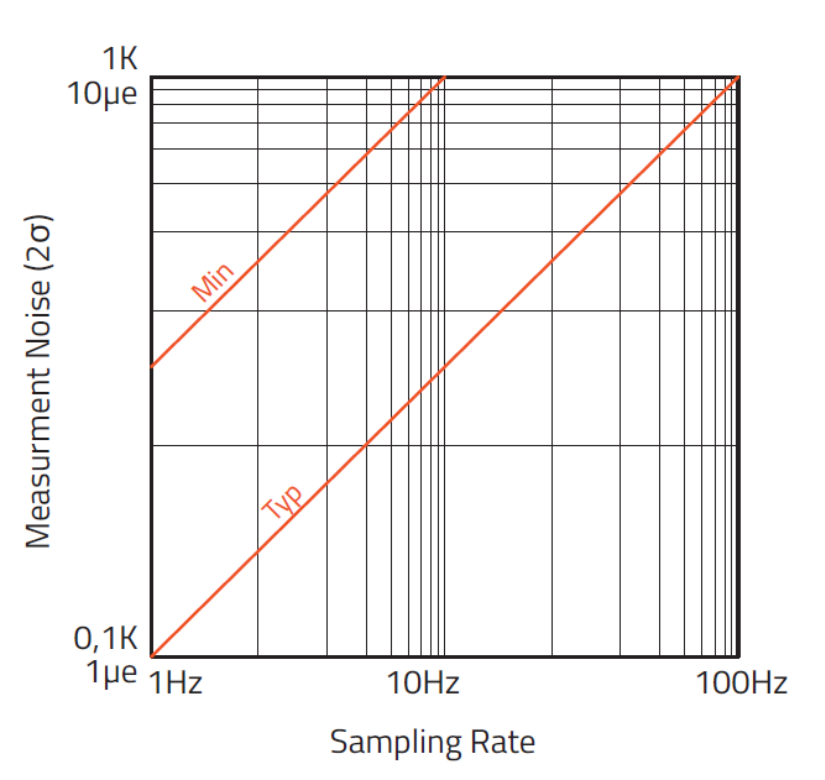
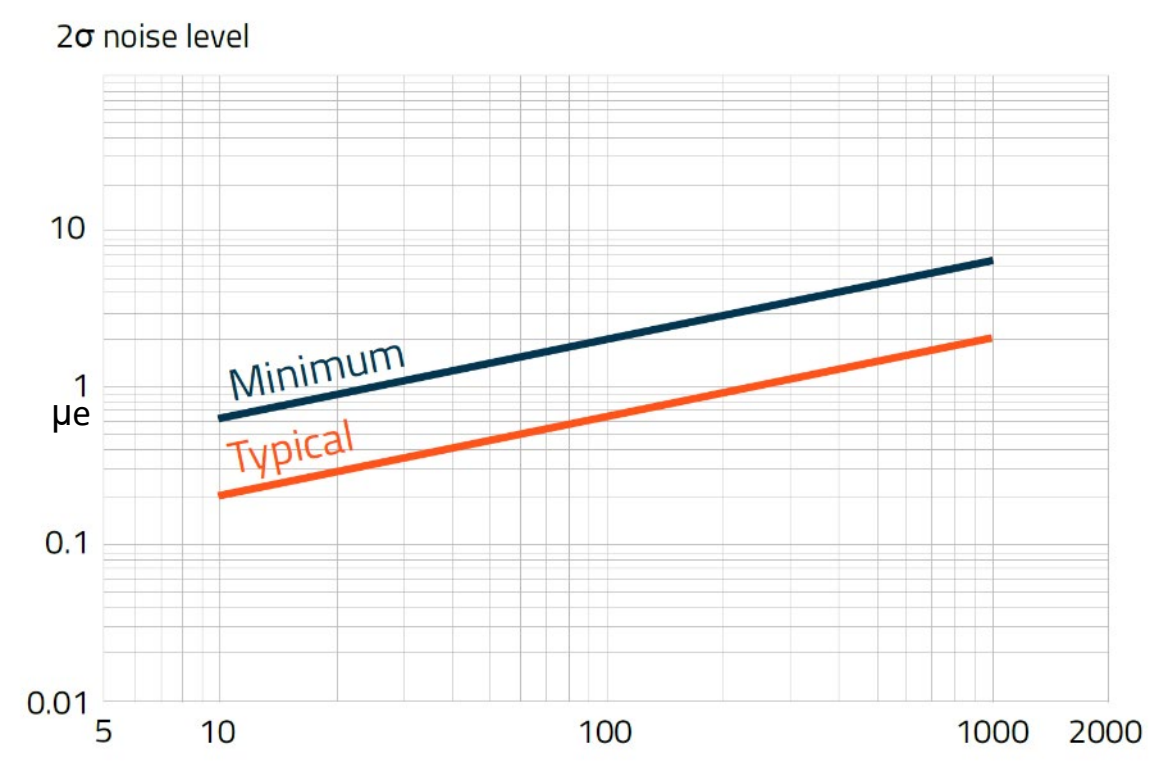
Precision vs Sampling Rate

FBGX100/FBX400



FBGX1000



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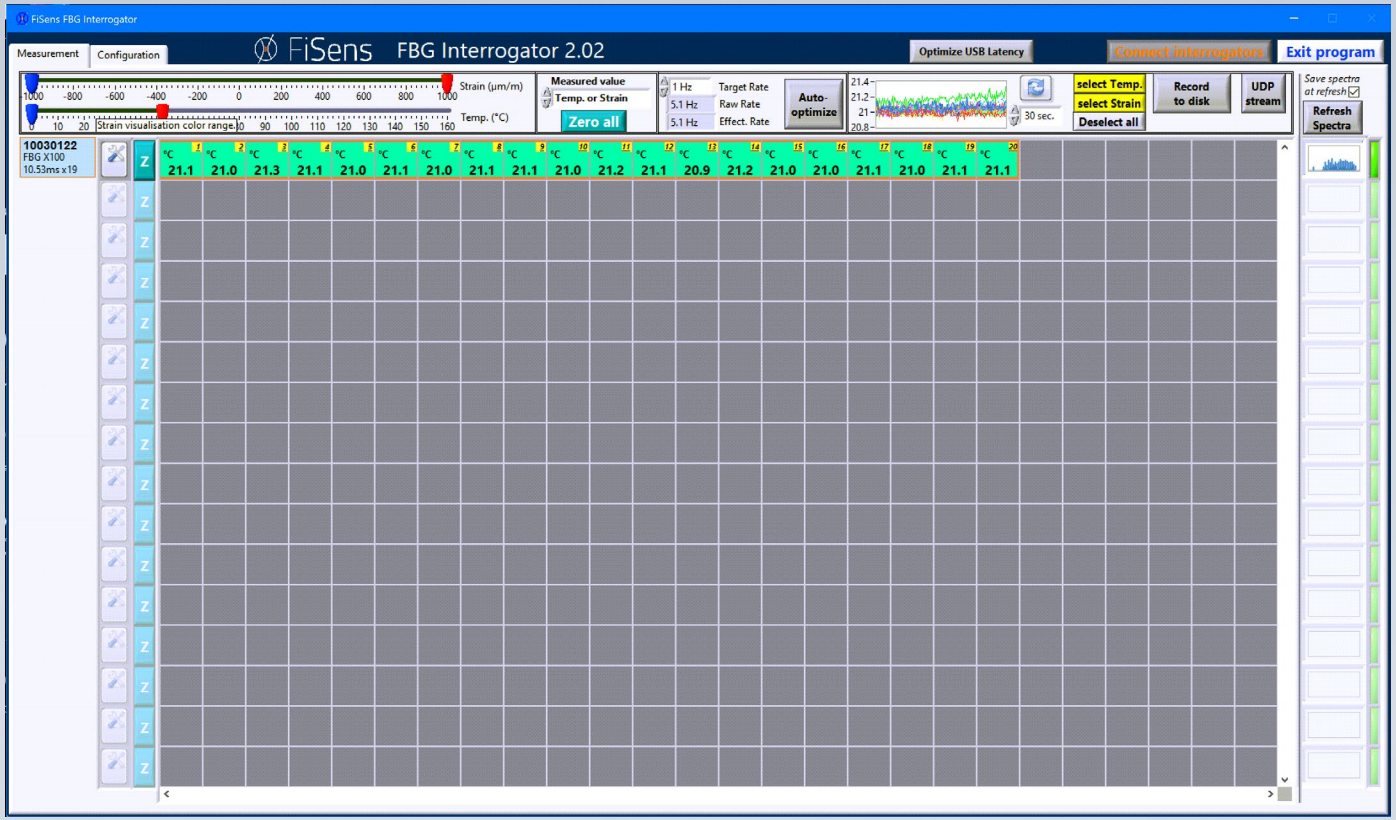
Multichannel FBG-Interrogator Software Included



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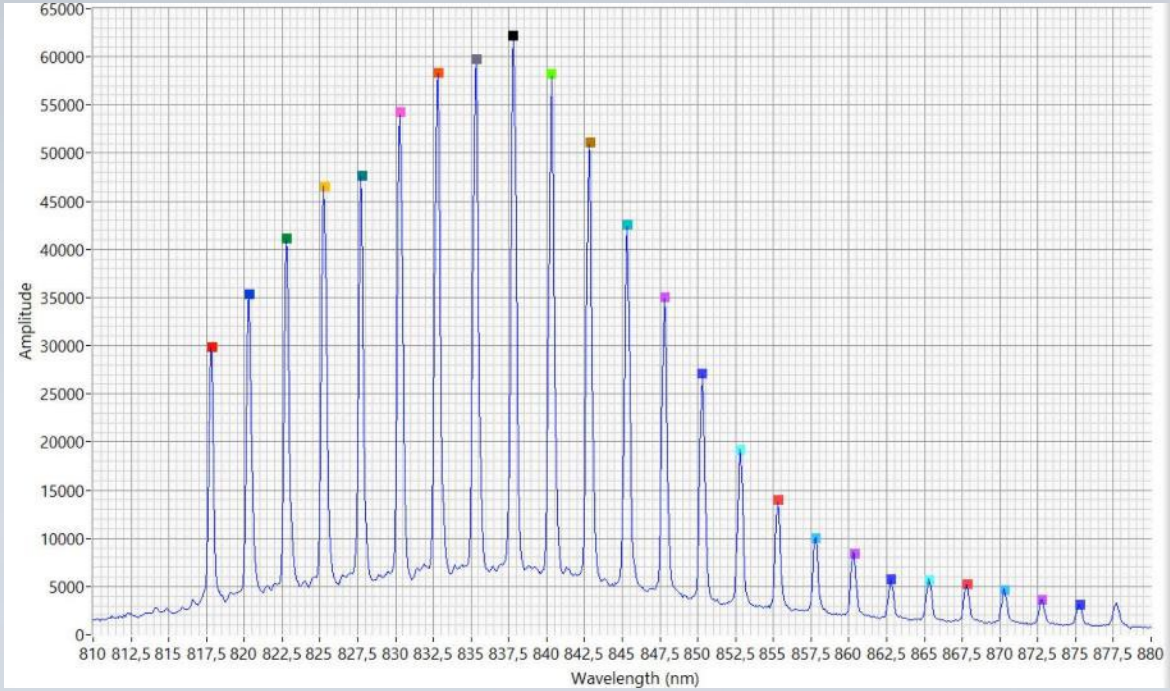
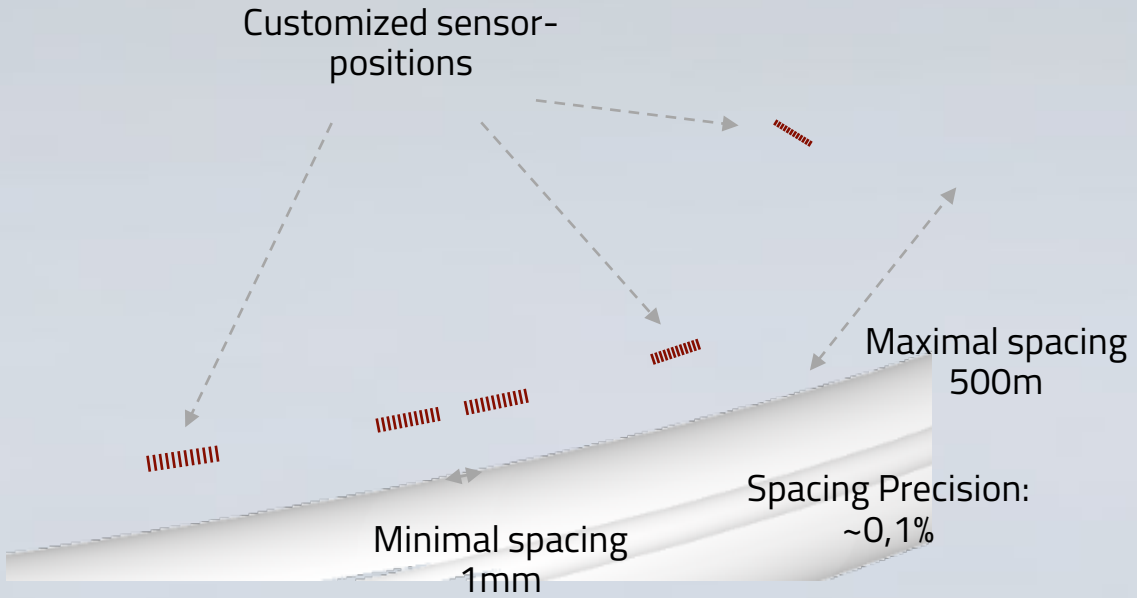
Customized FBG Arrays Industrially Scaled





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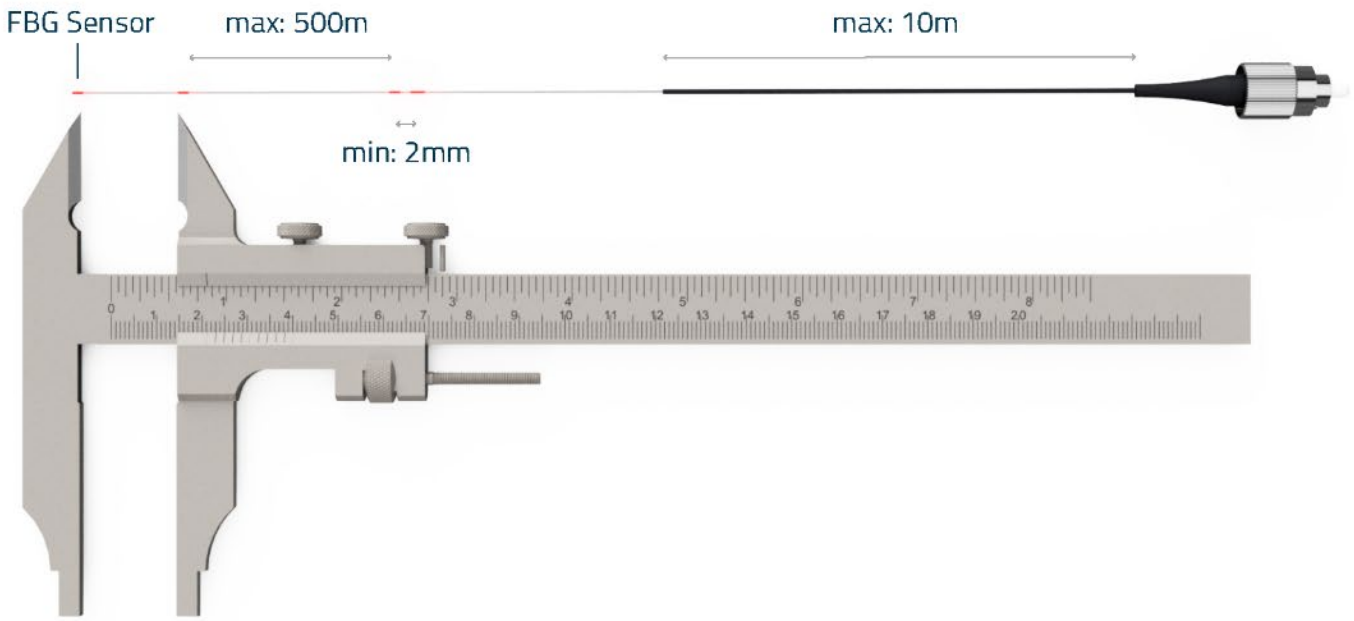
How To Specify an FBG Sensor Chain

Up to 30 FBG at arbitrary Positions

Position Tolerance: 0,3%/m



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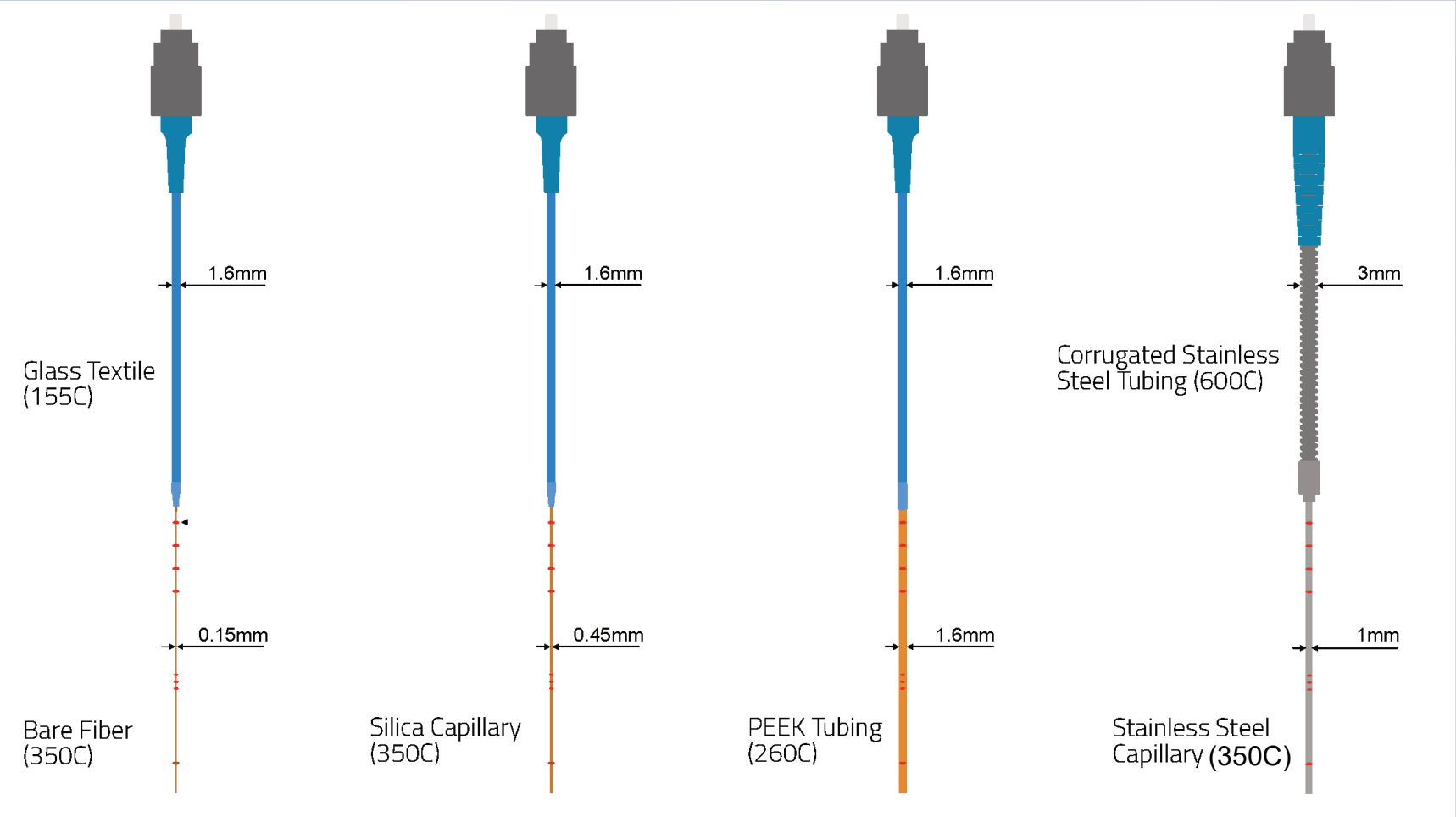
How To Specify an FBG Sensor Chain



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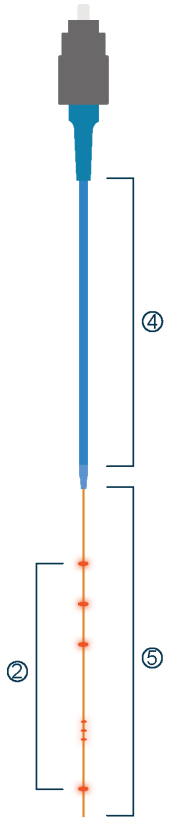
How To Specify an FBG Sensor Chain

Step 1



Ⓐ FBG Array Part Number

① Sensor Type
T - *Temperature*
S - *Strain*

③ Spectral Range
N - *Narrow [808-865]*
W - *Wide [808-880]*

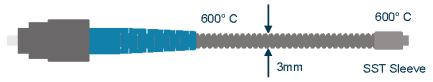
⑤ Sensor Capillary
FI - *Bare Fiber*
PE - *PEEK Tubing*
SSC - *SST Capillary*
SI - *Silica Capillary*

T - 5 - N - GL - FI

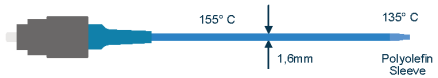
② FBG Quantity
1 - 1 FBG
2 - *2 FBGs*
...
30 - *30 FBGs*

④ Lead-in Protection
GL - Glass Textile
SST - SST Corrugated Tube
HY - Hytrel Buffer
PVC - Standard PVC Tube

④ SST - Stainless Steel (1.4301) Corrugated Tube

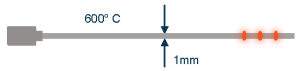


GL - Glass Textile

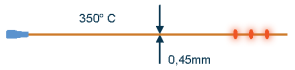


⑤ FI - Bare Fiber with Polyimide Coating

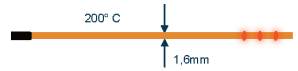
SSC - Stainless Steel (1.4301) Capillary



SI - Silica Capillary



PE - PEEK Tubing



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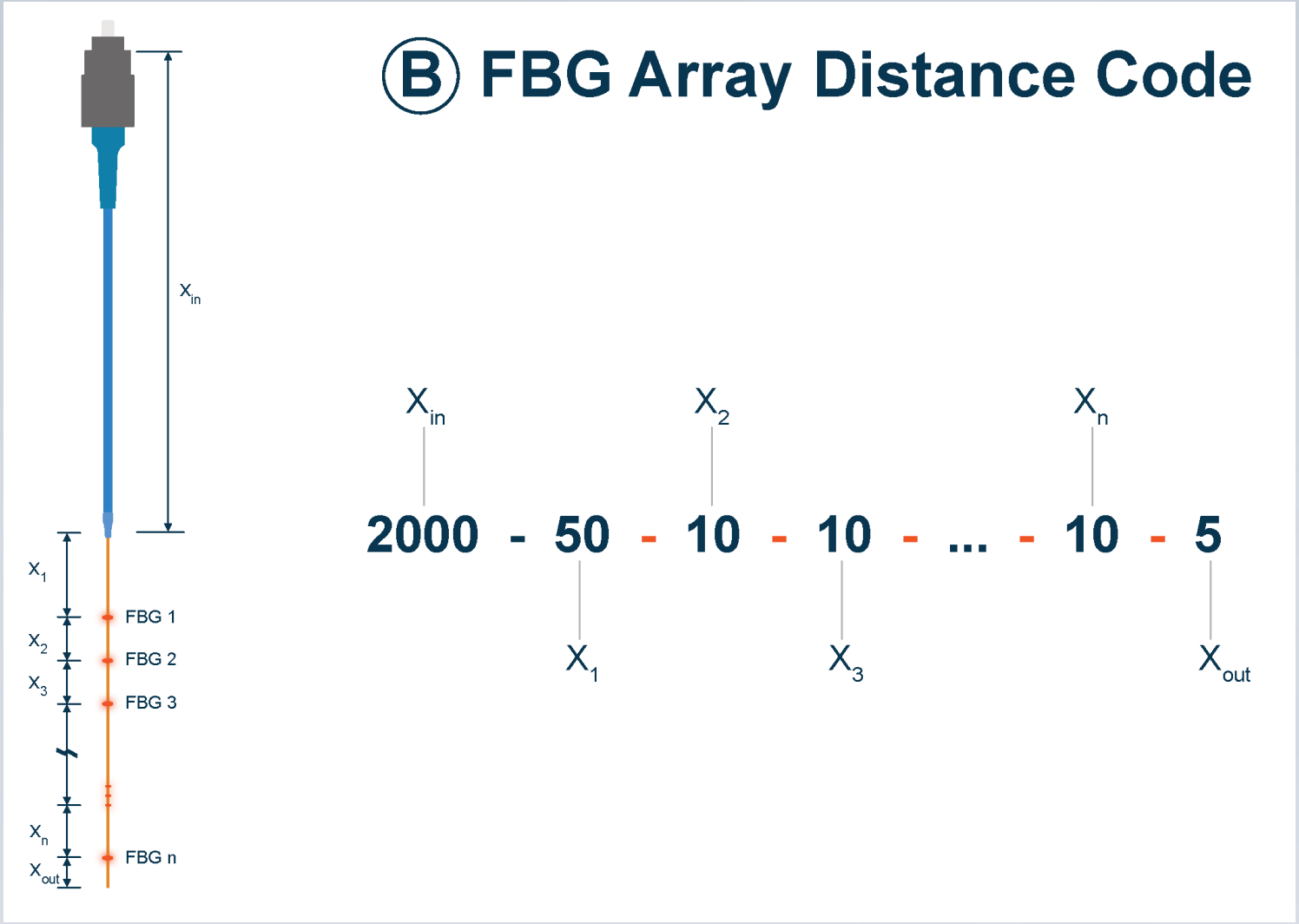
How To Specify an FBG Sensor Chain

Step 2



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LILIKOI® FEMTO OPTICAL AND SMART BRACKET FORCE SENSORS QUICK GUIDE

MODEL	 **FBGX100** Interrogator	 **FBGX400** Interrogator	 **FG25 Inline** Optical Force Sensor	 **GR25 Gripper** Optical Force Sensor	 **GS05 Grasper** Optical Force Sensor	 **SB20, SB30** Smart Bracket Load Cells
Description	Wideband (W) Interrogator	Wideband (W) Interrogator	Inline Force Sensor, Capacity=25lb (11.3kg)	Gripper Force Sensor. Optional dual Gripper assembly with parallel actuator.	Grasping Finger Sensor. Optional grasper assembly with push rod actuation.	Mounts directly into standard Aluminum T-Slot Extrusions using standard T-Nuts
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 Strain Gauge amplifier, not optical
Measurement (or Force Capacity)	Temperature, °C Strain, με	Temperature, °C Strain, με	Force Capacity= 25lb (11.3kg)	Force Capacity= 25lb (11.3kg)	Force Capacity= 5 lb (2.2kg)	SB20 = 25 lbs SB30-1 = 25 lbs SB30-2 = 50 lbs, 2.5mV/V
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	Interrogator Output= 3500με at F.S nom	Interrogator Output= 3500με at F.S nom	Interrogator Output= 3500με at F.S nom	SB20 = 2mV/V SB30-1 = 1.25mV/V SB30-2 = 2.5mV/V
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	-
Sample Rate/channel	1-200Hz	1-200Hz	Determined by FBG Interrogator used			Determined by User Amplifier
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)	-51°C to +71°C (-60°F to +150°F)
Applications	Laboratory or Embedded OEM	Laboratory or Embedded OEM	Applied force	Gripping force per finger	Grasping force per finger	Two SBs mounted on opposite corners can monitor load balance on T-Frame
Electrical Interface	UART, microUSB	UART, microUSB	---	---	---	---
Optical Interface	FC-APC	FC-APC	FC-APC	FC-APC	FC-APC	4-Wire
Power Supply	+5VDC or USB	+5VDC or USB	---	---	---	-
STOCK PRODUCTS	FBGX100	FBGX400	FG25	GR25	GS05	SB20 SB30-1, SB30-2

Contact Micronor Sensors sales for special configurations.

98-LLKI-01-A
QR Code to Femto

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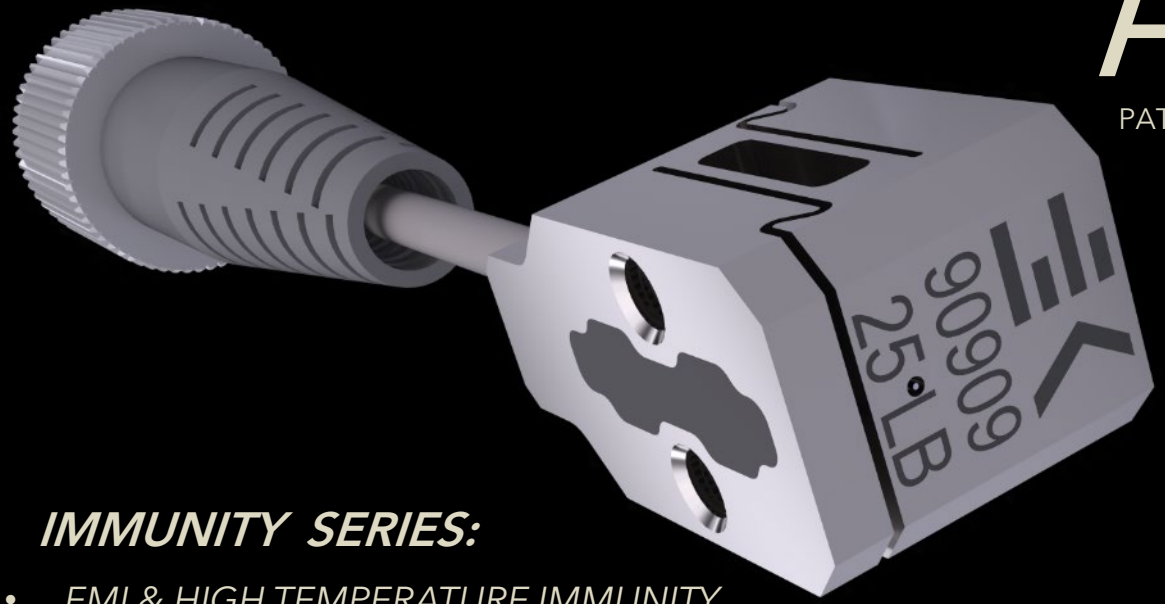
+1-805-389-6600
sales@micronor.comhttps:

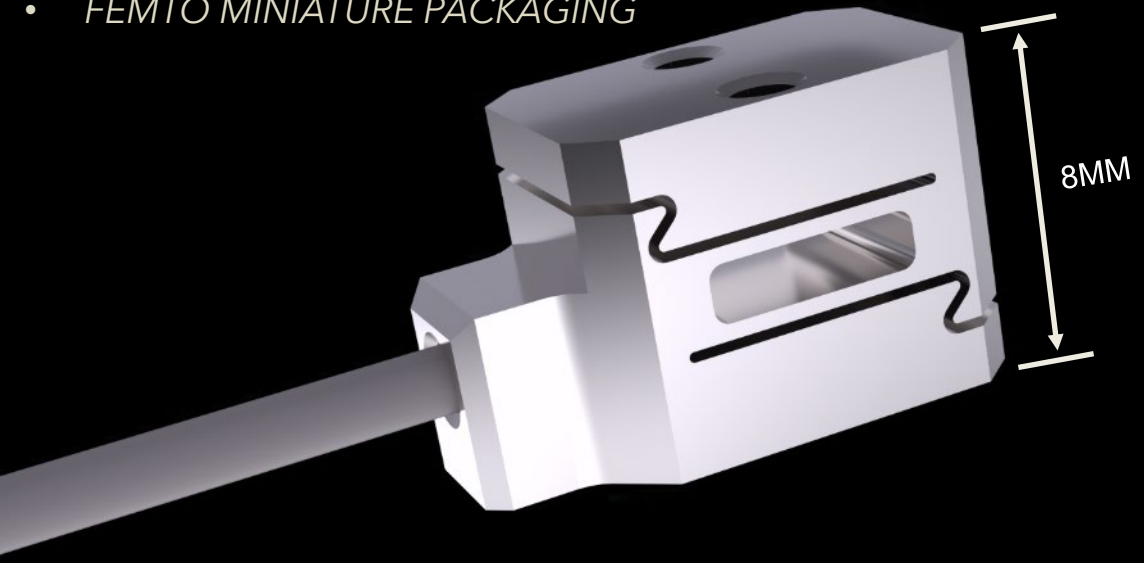
FG25 FEMTO FBG IN-LINE FORCE SENSOR

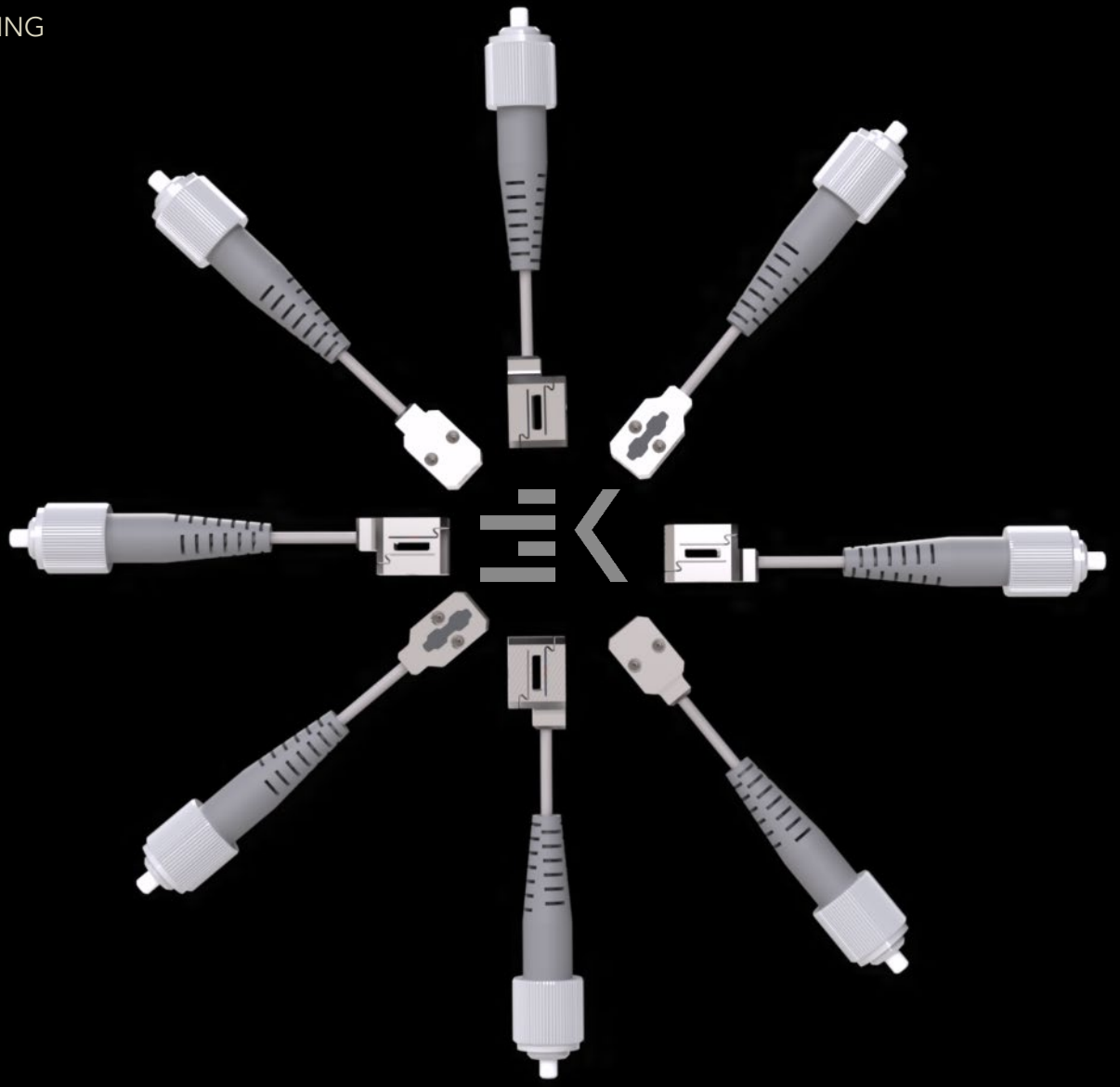
PATENT PENDING

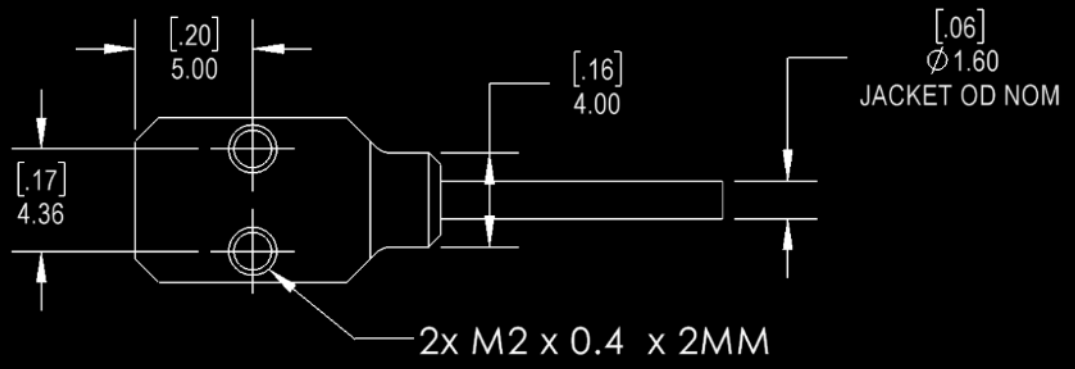


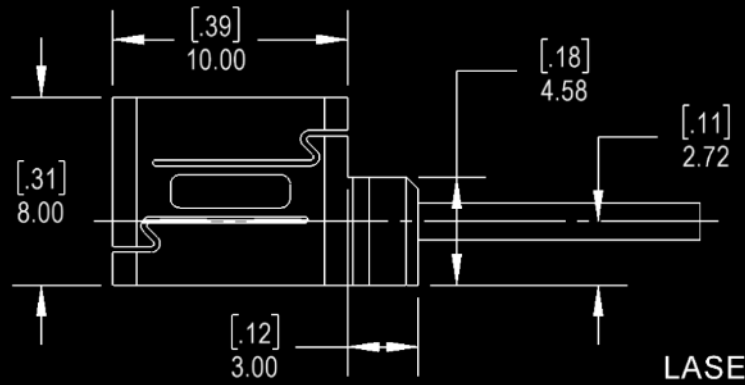
IMMUNITY SERIES:

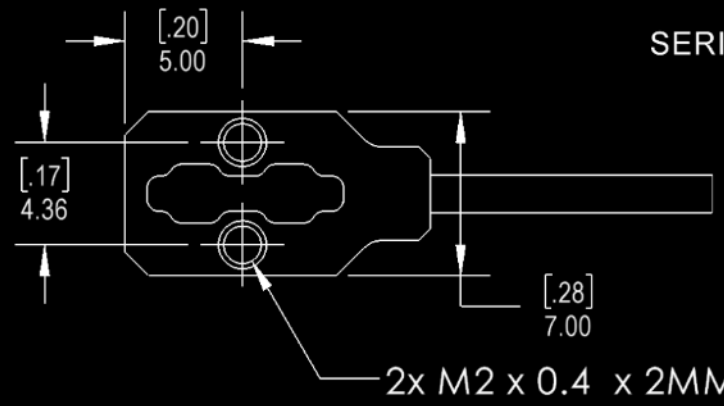
- *EMI & HIGH TEMPERATURE IMMUNITY*
- *TEMPERATURE COMPENSATION*
- *HIGH ACCURACY FORCE MEASSUREMENT*
- *FEMTO MINIATURE PACKAGING*

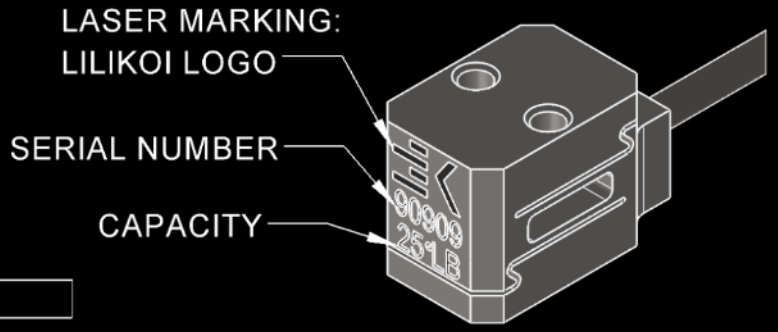


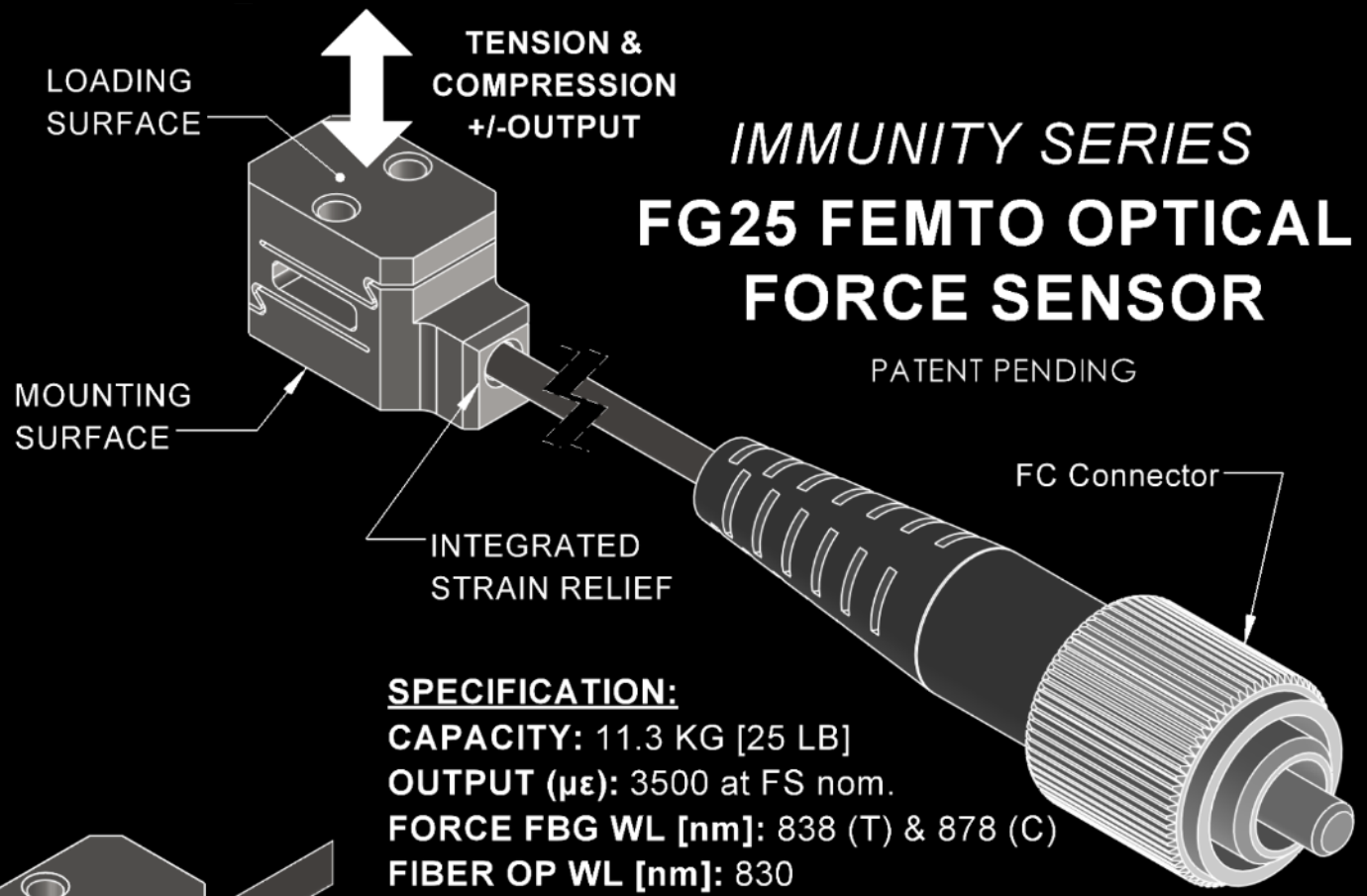












IMMUNITY SERIES

FG25 FEMTO OPTICAL FORCE SENSOR

PATENT PENDING

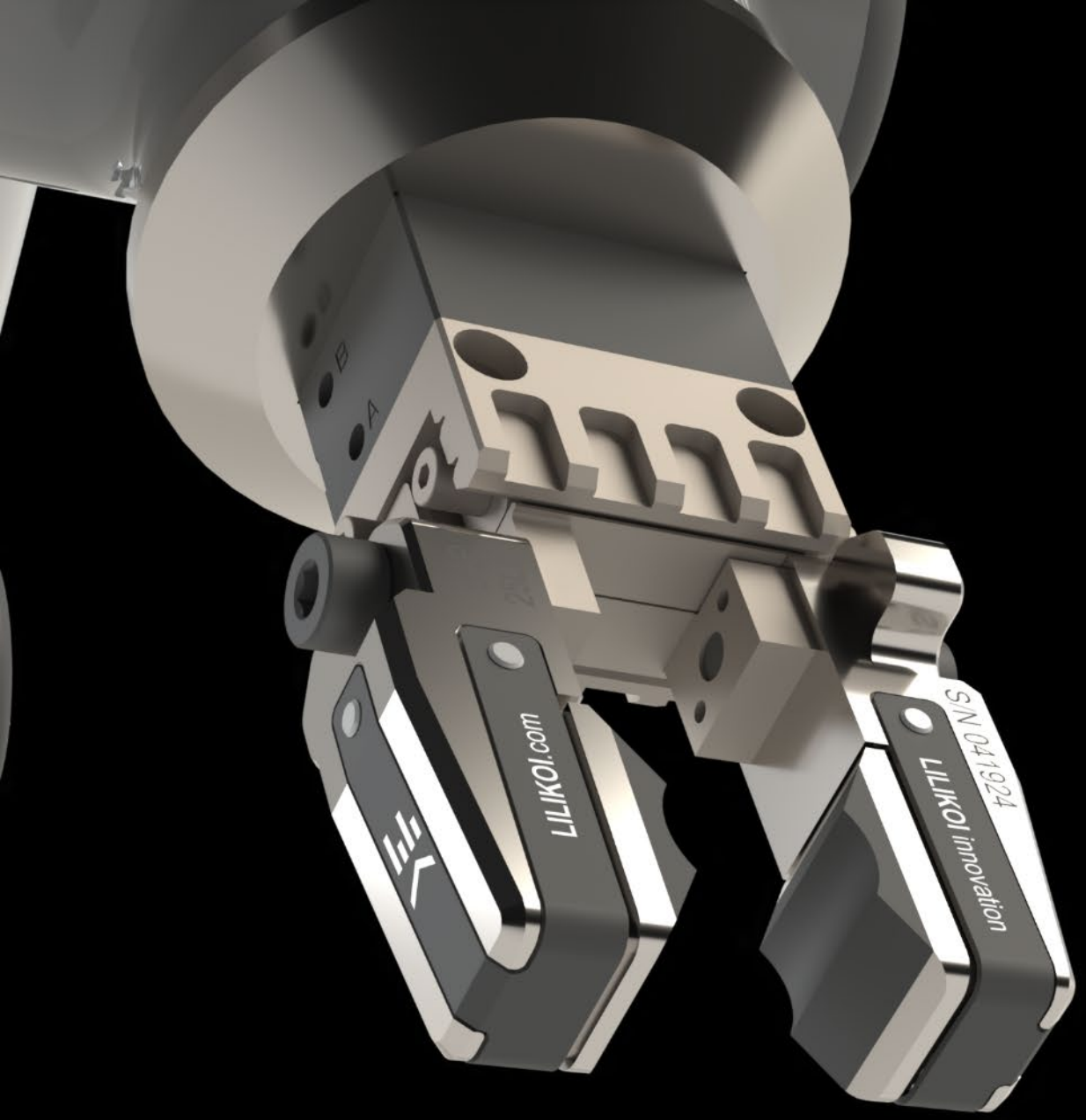
SPECIFICATION:

CAPACITY: 11.3 KG [25 LB]
OUTPUT (με): 3500 at FS nom.
FORCE FBG WL [nm]: 838 (T) & 878 (C)
FIBER OP WL [nm]: 830
NON-LINEARITY: 0.5% R.O.
OPERATING TEMP: -55°C[-67°F] to 200°C[392°F]
TEMP SHIFT ZERO: +/- 0.005% R.O./°C
TEMP SHIFT SPAN: +/- 0.002% R.O./°C
SENSOR BODY: STAINLESS STEEL
CABLE LENGTH: 1m [3.3ft]
CABLE JACKET: 1.6mm GLASS TEXTILE
CONNECTOR: OPTICAL FC

ITEM#: LLK-0001

LILIKOI innovation

TACTILE SENSORS



GR25 GRIPPER FINGER

PATENT PENDING

IMMUNITY SERIES:

- *EMI & HIGH TEMPERATURE IMMUNITY*
- *TEMPERATURE COMPENSATION*
- *HIGH ACCURACY FORCE MEASSUREMENT*
- *FEMTO MINIATURE PACKAGING*

TACTILE FINGER FORCE SENSORS

PATENT PENDING

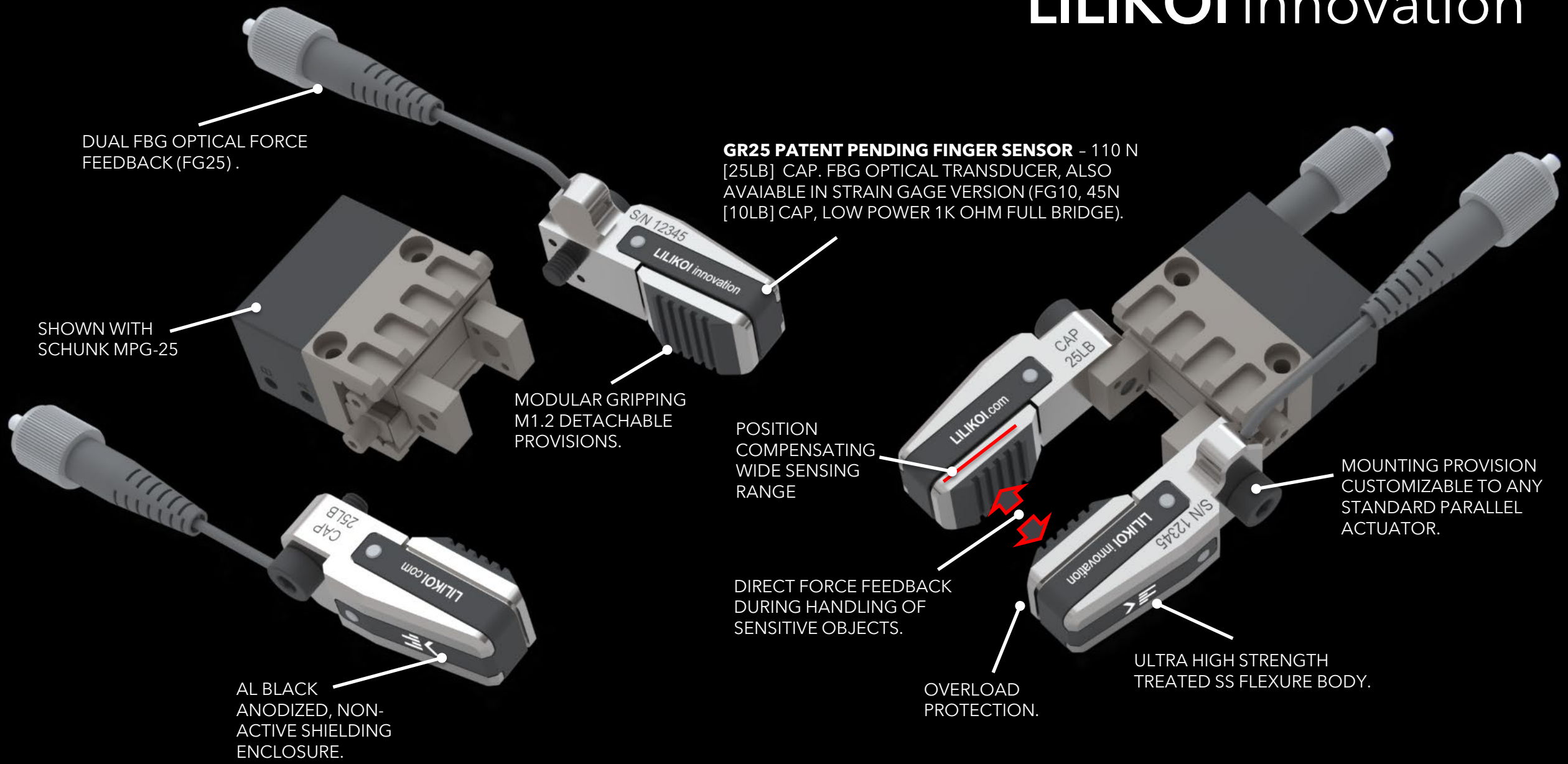
GR25

FBG OPTICAL FINGER
FORCE SENSOR

GR10

STRAIN GAUGE FINGER
FORCE SENSOR

LILIKOI innovation



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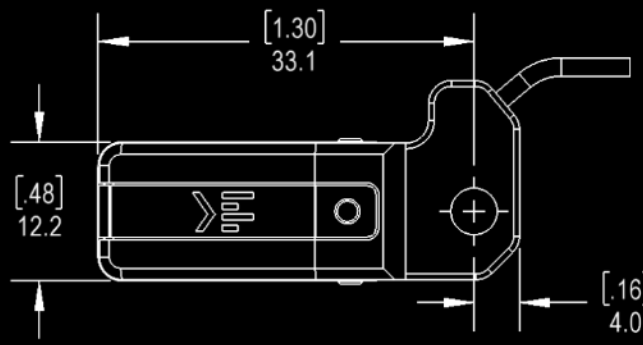
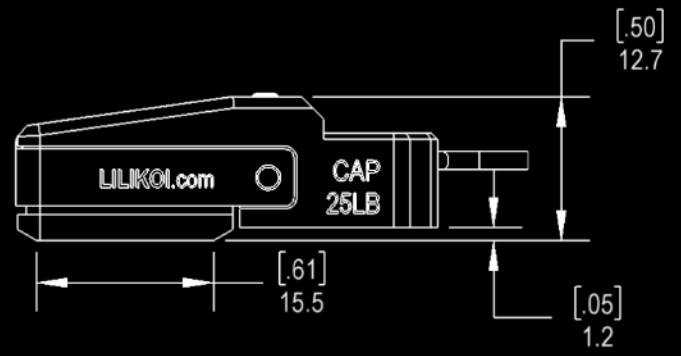
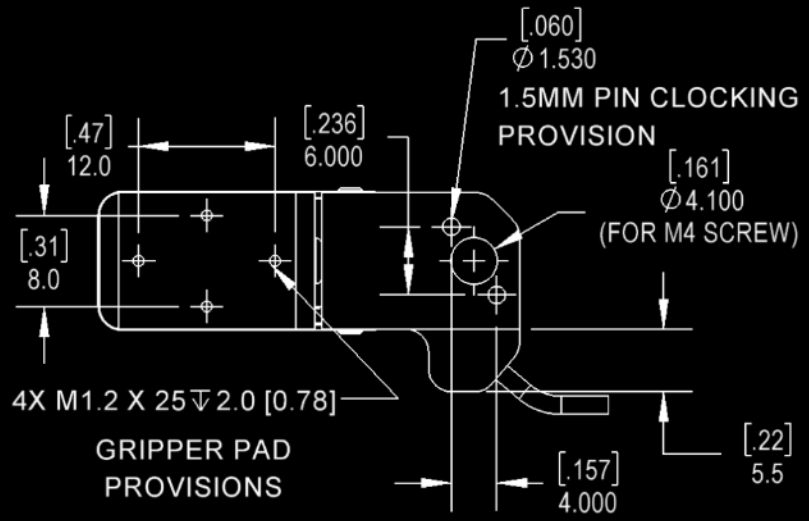
IMMUNITY SERIES

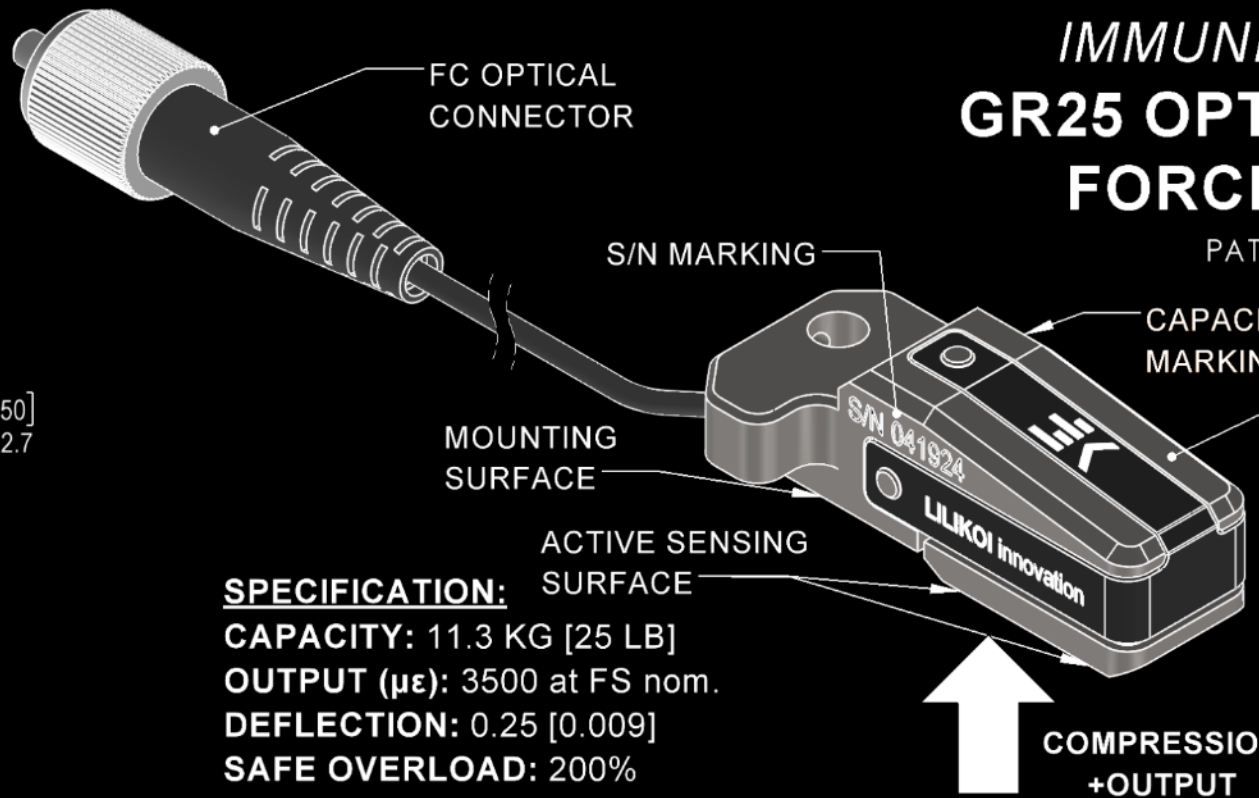
GR25 OPTICAL FINGER FORCE SENSOR

PATENT PENDING







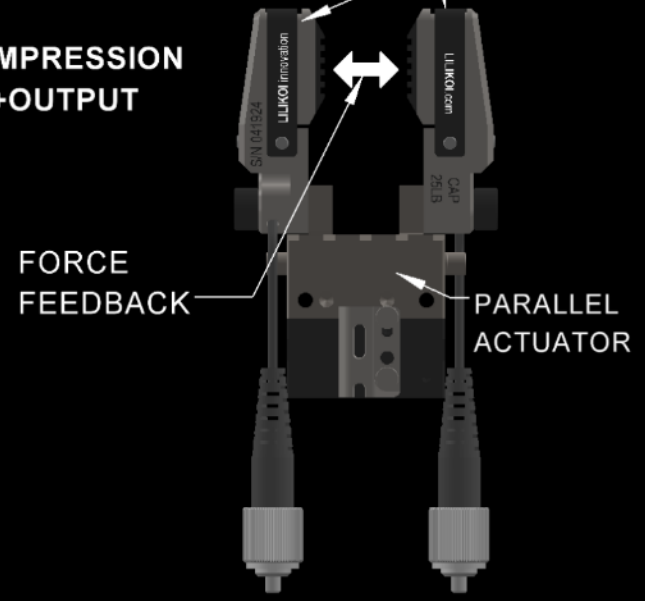


SPECIFICATION:

CAPACITY: 11.3 KG [25 LB]
OUTPUT (με): 3500 at FS nom.
DEFLECTION: 0.25 [0.009]
SAFE OVERLOAD: 200%
FORCE FBG WL [nm]: 838 (T) & 878 (C)
FIBER OP WL [nm]: 830
NON-LINEARITY: 0.5% R.O.
OPERATING TEMP: -55°C[-67°F] to 200°C[392°F]
TEMP SHIFT ZERO: +/- 0.005% R.O./°C
TEMP SHIFT SPAN: +/- 0.002% R.O./°C
SENSOR BODY: STAINLESS STEEL
CABLE LENGTH: 1m [3.3ft]
CABLE JACKET: Ø1.6mm GLASS TEXTILE
CONNECTOR: OPTICAL FC

ITEM#: LLK-0007

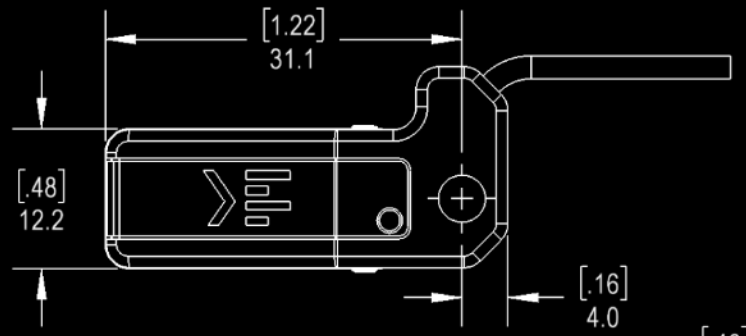
APPLICATION EXAMPLE

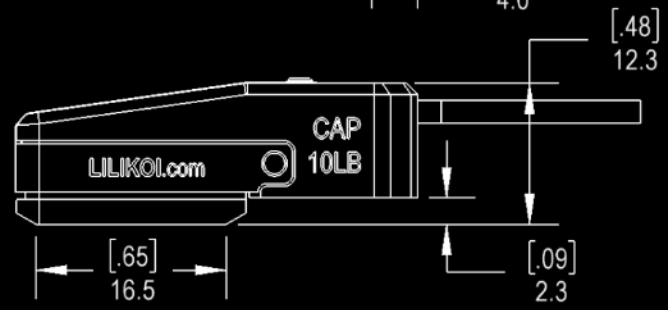


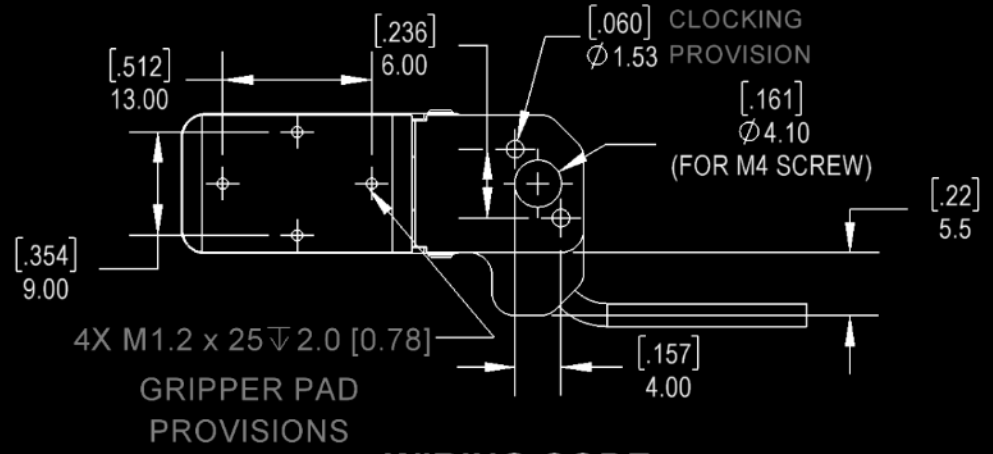
GR10 FINGER SENSOR

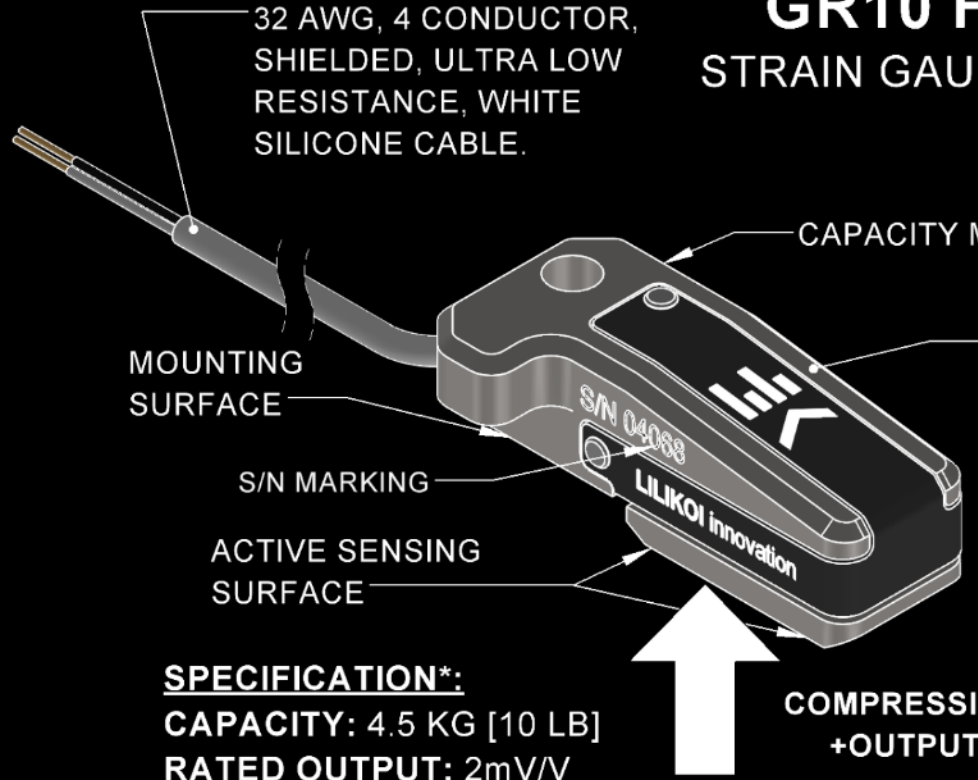
STRAIN GAUGE FORCE TRANSDUCER

PATENT PENDING





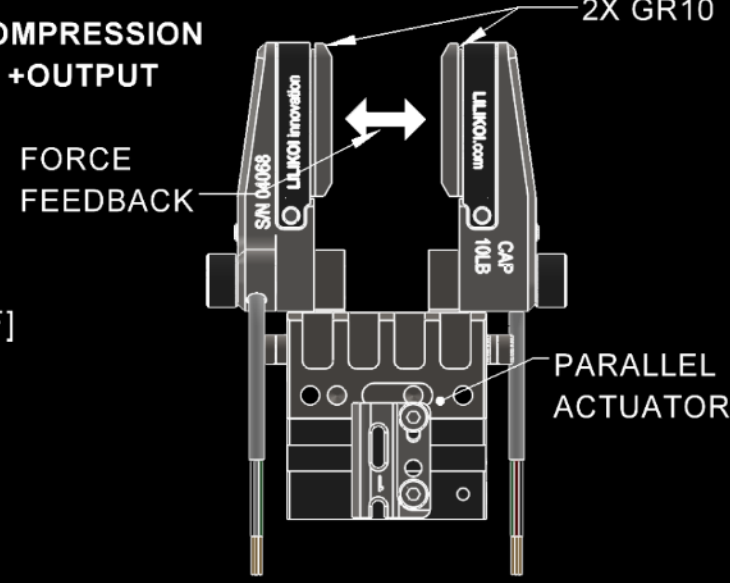




SPECIFICATION*:

CAPACITY: 4.5 KG [10 LB]
RATED OUTPUT: 2mV/V
NON-LINEARITY: 0.1% R.O.
DEFLECTION: 0.10 [0.009]
SAFE OVERLOAD: 400%
BRIDGE RESISTANCE: 1000 Ohm
OPERATING TEMP: -51-71°C [-60-160°F]
TEMP SHIFT ZERO: 0.01% R.O./degC
SENSOR BODY: STAINLESS STEEL
CABLE LENGTH: 2m [6.5ft]
CABLE TERMINATION: PIGTAIL
ITEM#: LLK-0006

APPLICATION EXAMPLE



WIRING CODE

+Excitation	-Excitation	+Signal	-Signal
RED	BLACK	GREEN	WHITE

GS05

IMMUNITY SERIES

PATENT PENDING

DUAL FBG FEMTO OPTICAL GRASPER

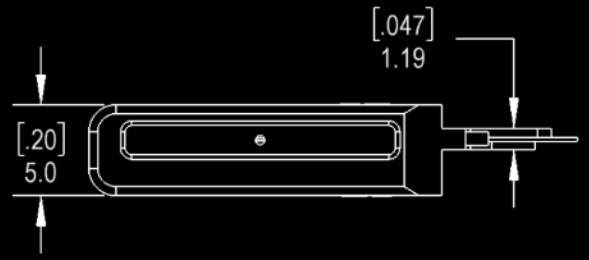
FINGER FORCE SENSOR

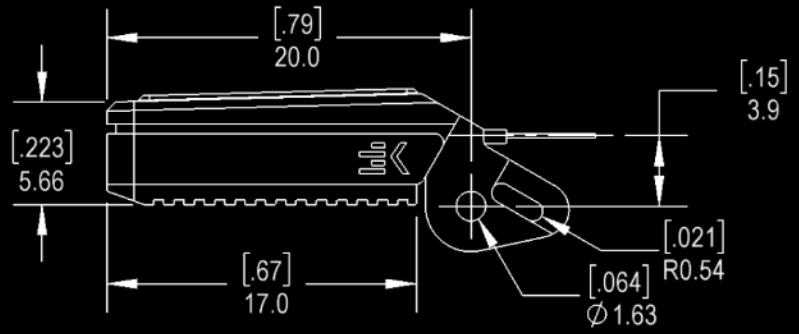
LILIKOI innovation

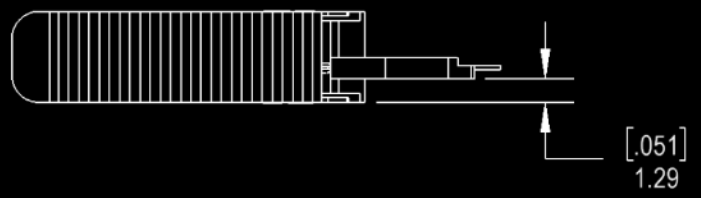
IMMUNITY SERIES

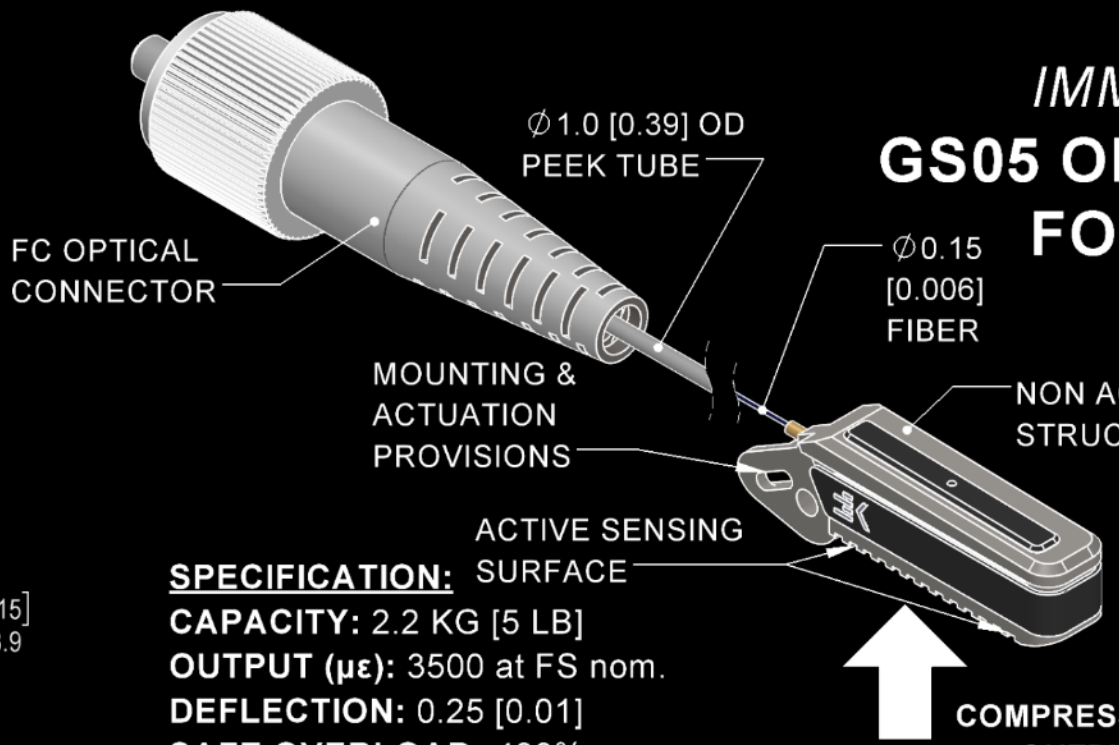
GS05 OPTICAL GRASPER FORCE SENSOR

PATENT PENDING







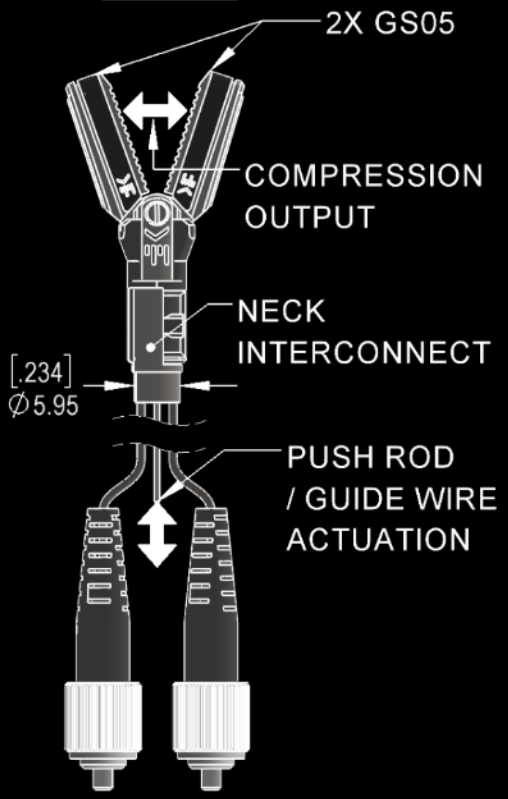


SPECIFICATION:

CAPACITY: 2.2 KG [5 LB]
OUTPUT (με): 3500 at FS nom.
DEFLECTION: 0.25 [0.01]
SAFE OVERLOAD: 400%
FORCE FBG WL [nm]: 838 (T) & 878 (C)
FIBER OP WL [nm]: 830
NON-LINEARITY: 0.5% R.O.
OPERATING TEMP: -55°C[-67°F] to 200°C[392°F]
TEMP SHIFT ZERO: +/- 0.005% R.O./°C
TEMP SHIFT SPAN: +/- 0.002% R.O./°C
SENSOR BODY: STAINLESS STEEL
CABLE LENGTH: 1m [3.3ft]
CABLE JACKET: ∅1mm PEEK TUBE
CONNECTOR: OPTICAL FC

ITEM#: LLK-0005

APPLICATION EXAMPLE



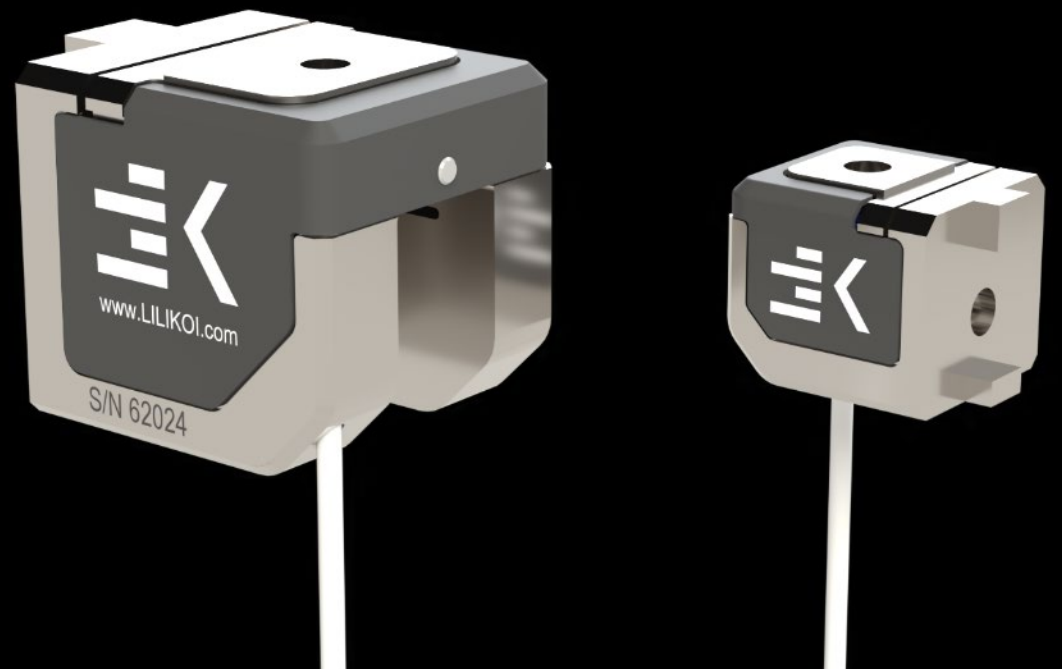
TRANSFORMING THE LANDSCAPE

Aluminum T-Slot Extrusion Integration

LILIKOI innovation

SMART BRACKETS

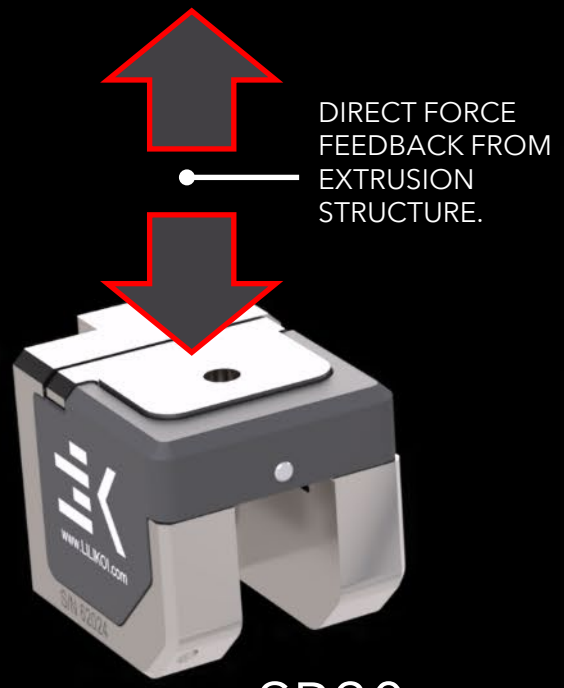
Strain Gauge Force Sensors



LILIKOI innovation

SMART BRACKETS

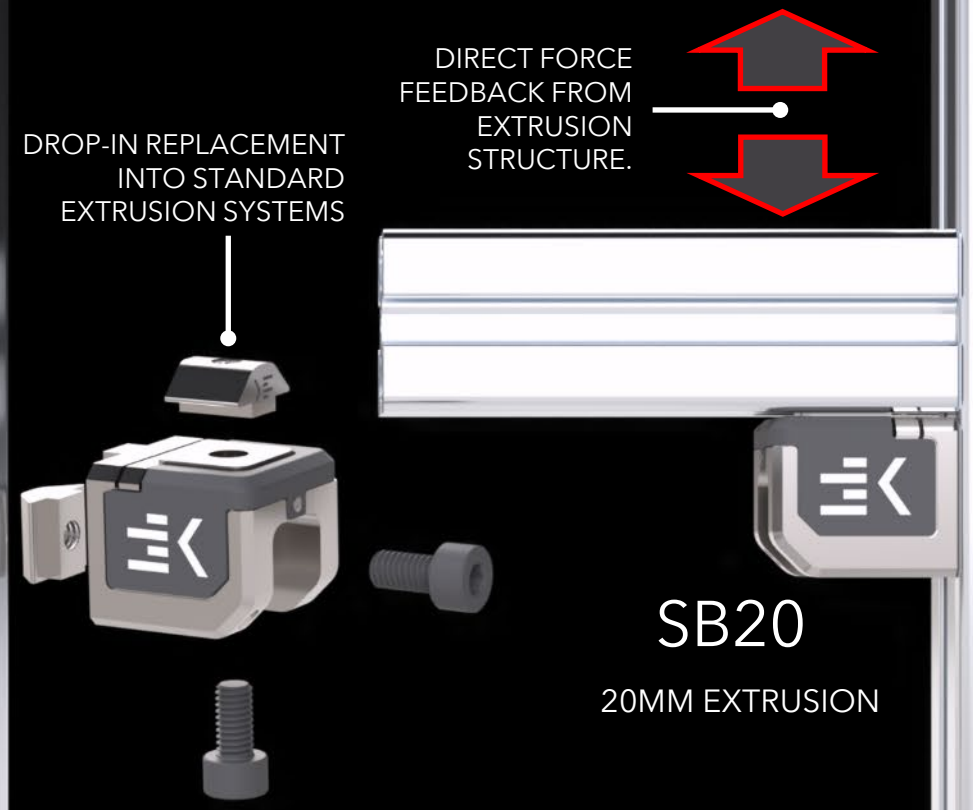
Strain Gauge Force Sensors



SB30

30MM EXTRUSION

PATENT PENDING



SB20

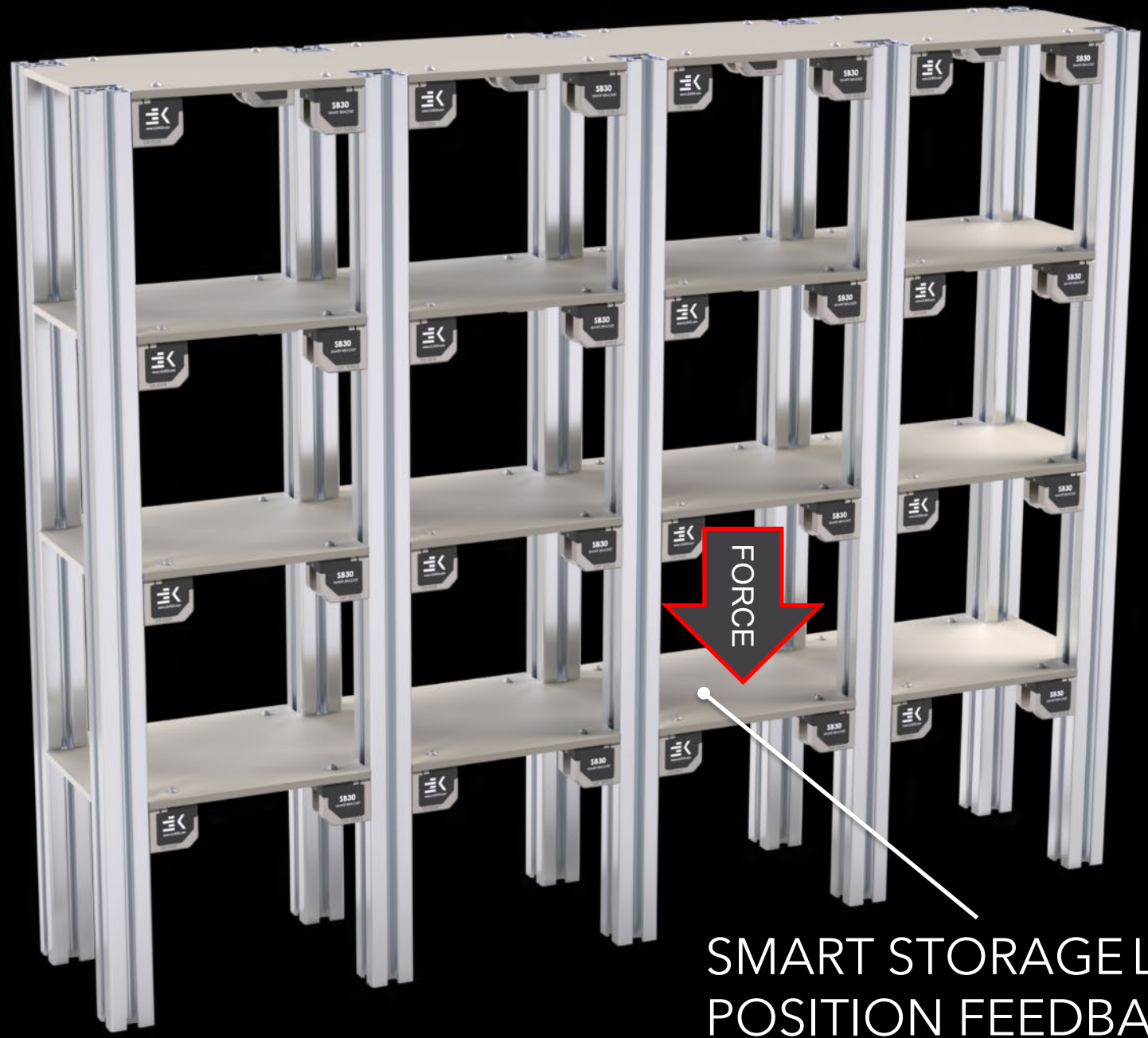
20MM EXTRUSION

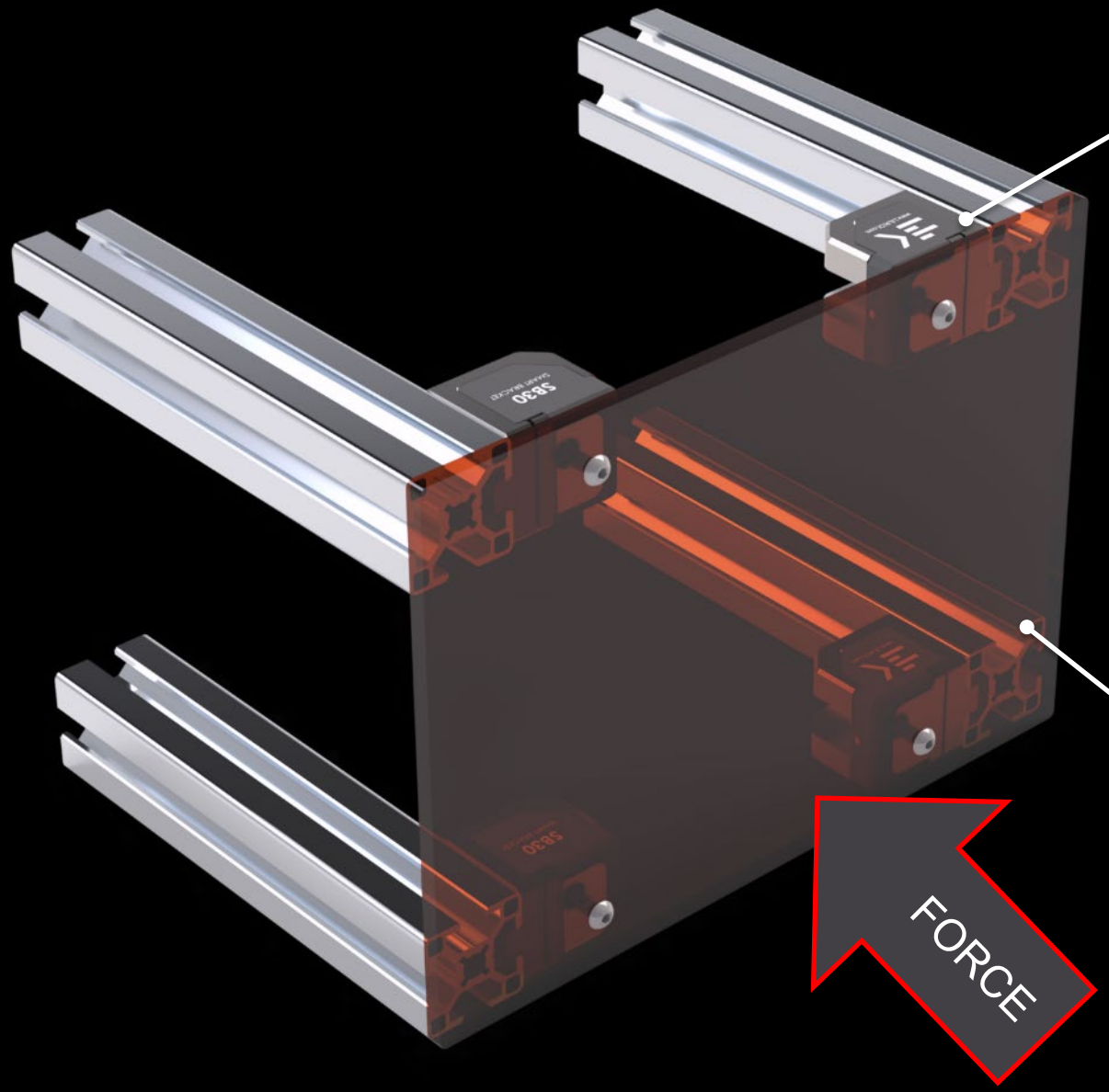
T-Slot Extrusion Integration

LILIKOI innovation

T-Slot Extrusion Integration

SMART BRACKETS





LILIKOI innovation

SMART BRACKETS

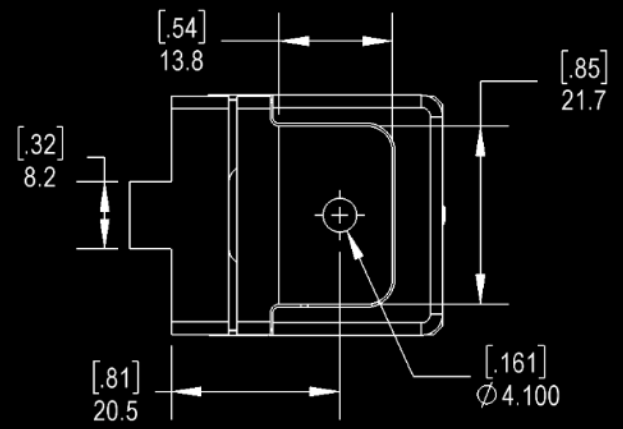
Strain Gauge Force Sensor

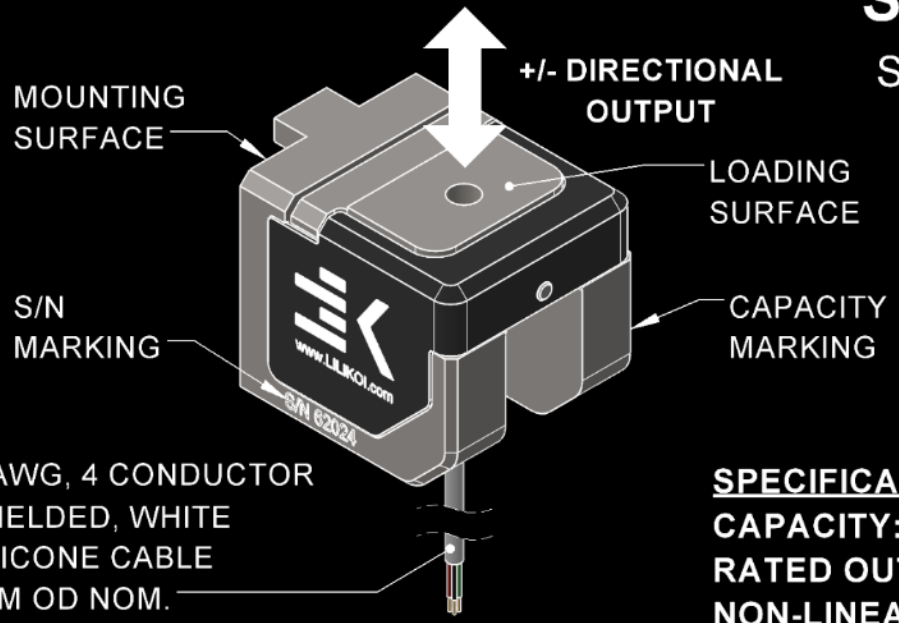
SMART PANEL
FORCE FEEDBACK

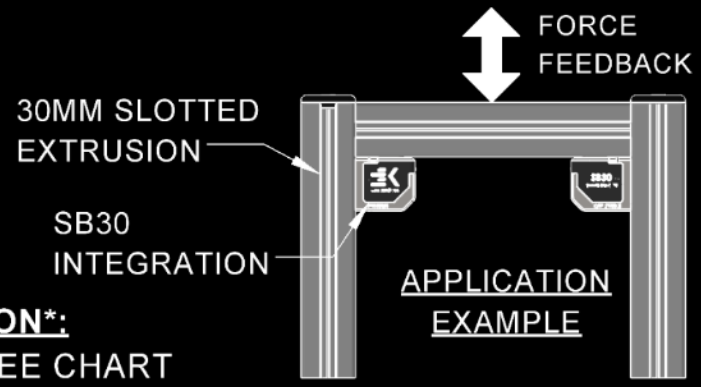
SB30 SMART BRACKET

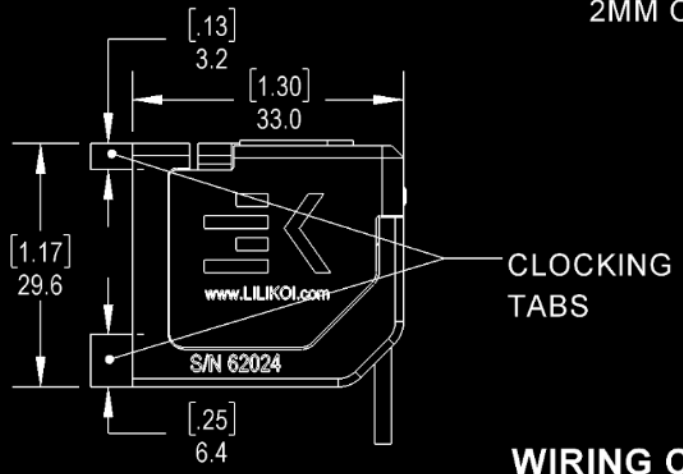
STRAIN GAUGE FORCE SENSOR

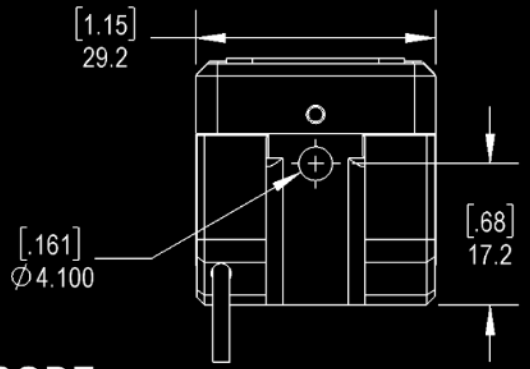
PATENT PENDING











SPECIFICATION*:

CAPACITY: SEE CHART
RATED OUTPUT: SEE CHART
NON-LINEARITY: 0.1% R.O.
DEFLECTION: 0.25 [0.009]
SAFE OVERLOAD: 400%
BRIDGE RESISTANCE: 1000 Ohm
OPERATING TEMP: -51-71°C [-60-160°F]
TEMP SHIFT ZERO: 0.01% R.O./degC
SENSOR BODY: STAINLESS STEEL
CABLE LENGTH: 2m [6.5ft]
CABLE TERMINATION: PIGTAIL

WIRING CODE

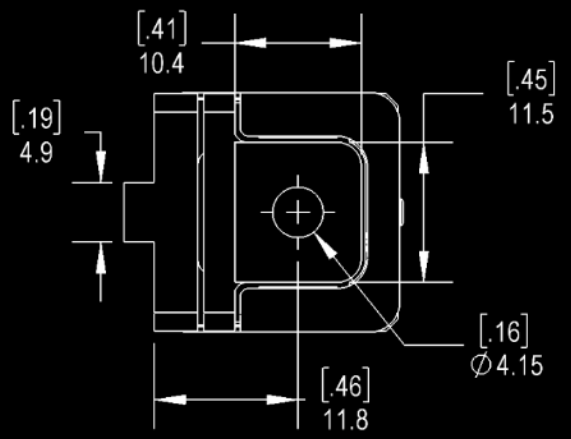
+Excitation	-Excitation	+Signal	-Signal
RED	BLACK	GREEN	WHITE

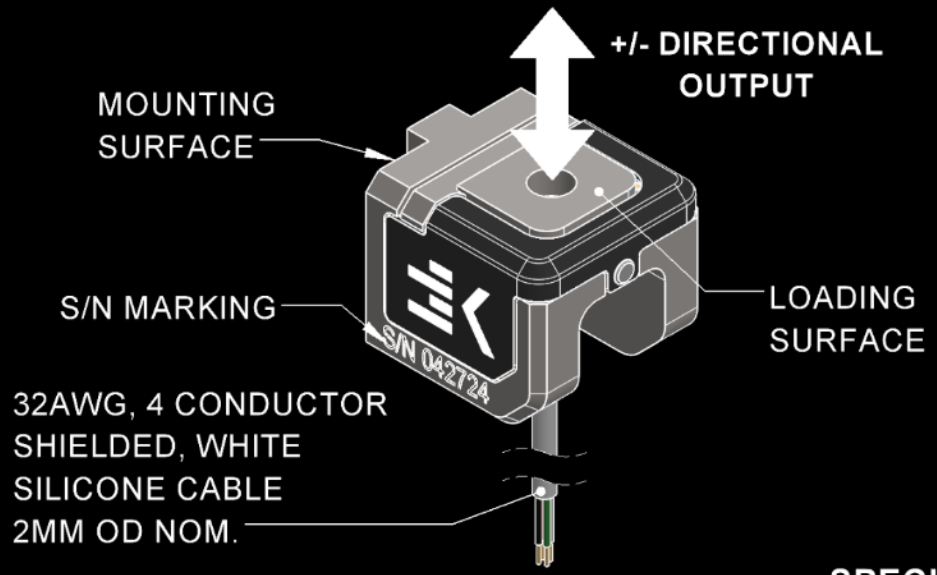
ITEM #	CAP (KG [LB])	R.O. [mV/V]
LLK-0002	11.3 [25]	1.25
LLK-0003	22.7 [50]	2.5

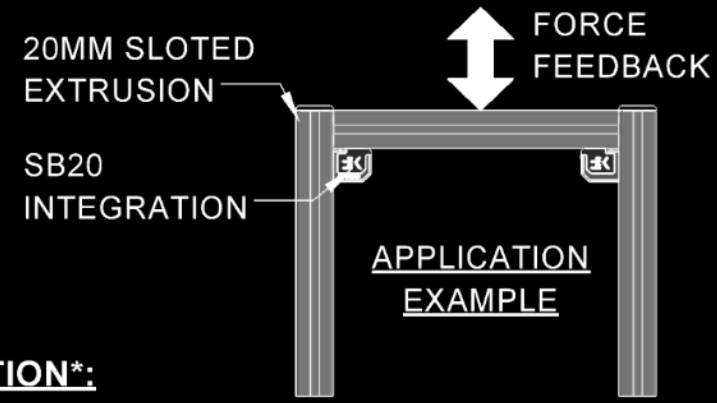
SB20 SMART BRACKET

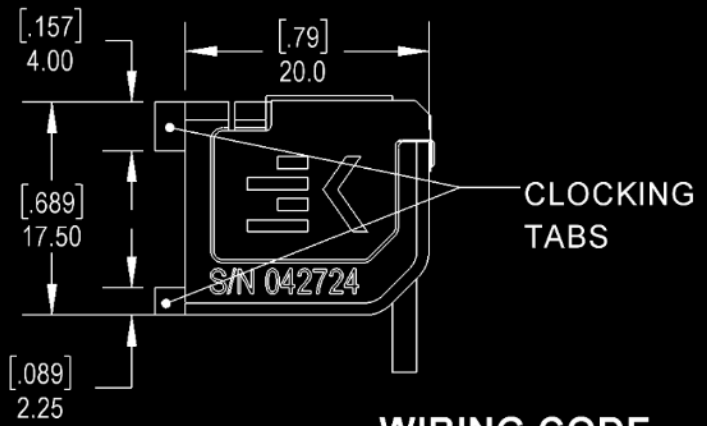
STRAIN GAUGE FORCE SENSOR

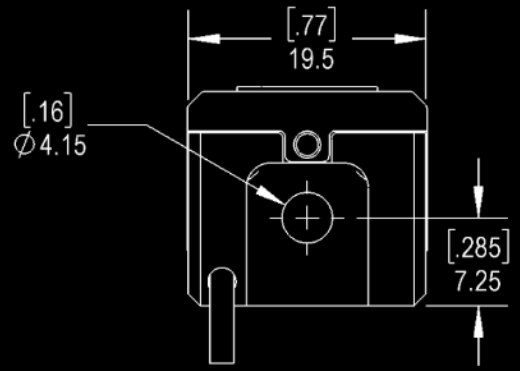
PATENT PENDING











WIRING CODE

+Excitation	-Excitation	+Signal	-Signal
RED	BLACK	GREEN	WHITE

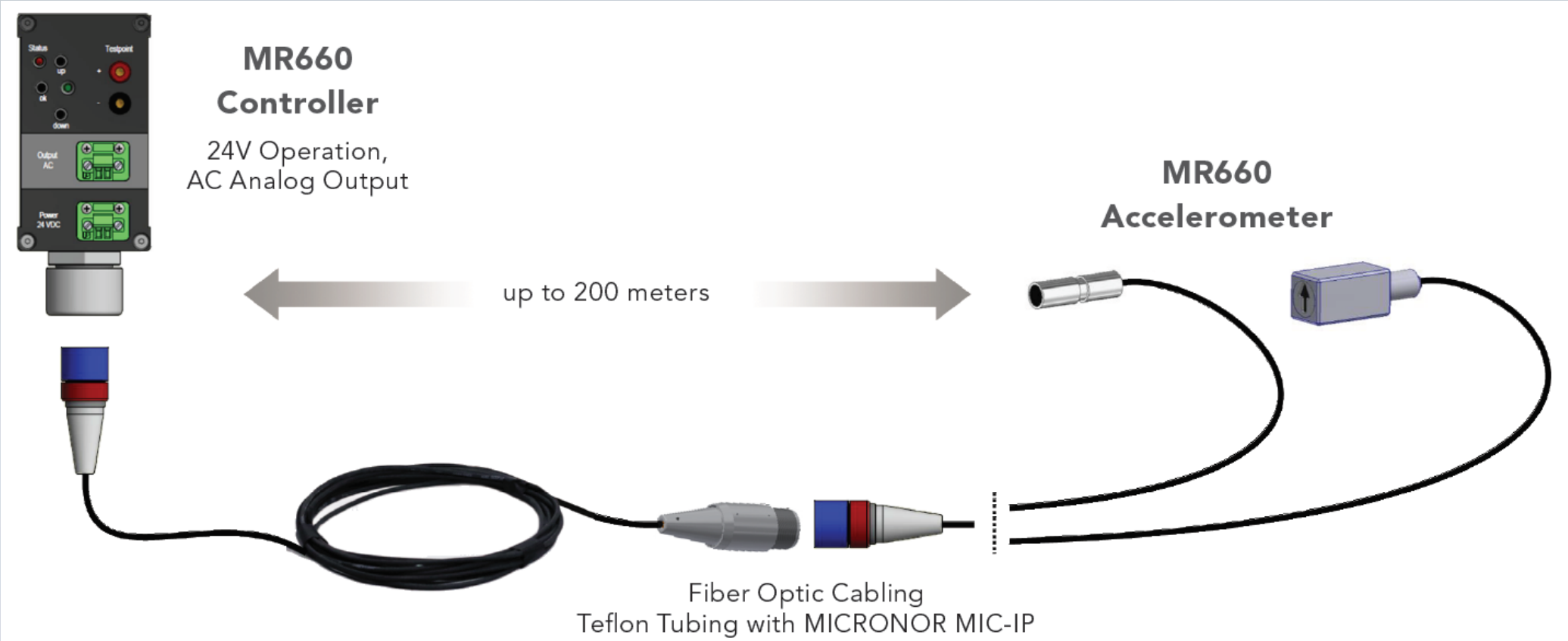
SPECIFICATION*:

CAPACITY: 11.3 KG [25 LB]
RATED OUTPUT: 2mV/V
NON-LINEARITY: 0.1% R.O.
DEFLECTION: 0.25 [0.009]
SAFE OVERLOAD: 400%
BRIDGE RESISTANCE: 350 Ohm
OPERATING TEMP: -51-71°C [-60-160°F]
TEMP SHIFT ZERO: 0.01% R.O./degC
SENSOR BODY: STAINLESS STEEL
CABLE LENGTH: 2m [6.5ft]
CABLE TERMINATION: PIGTAIL

ITEM#: LLK-0004

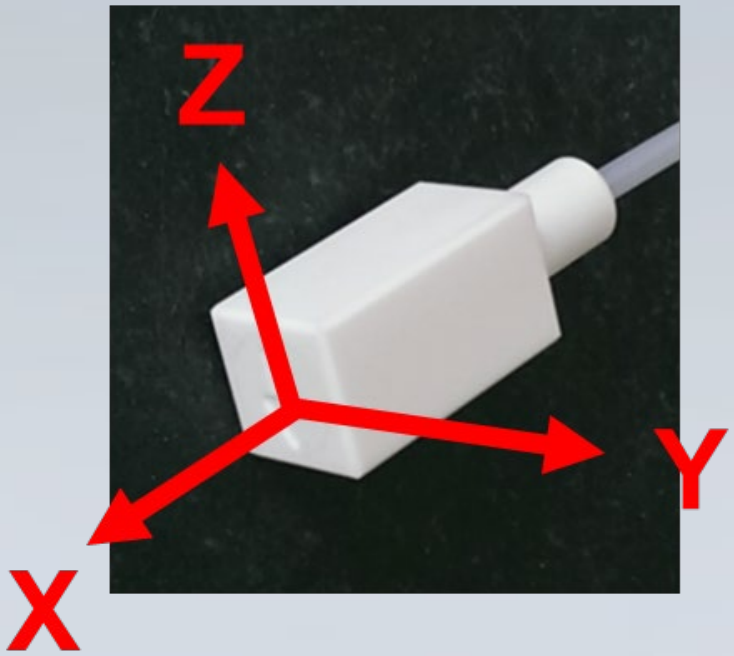
MR660

Micronor AG Multi-Axis Fiber Optic Accelerometer



micronor sensors

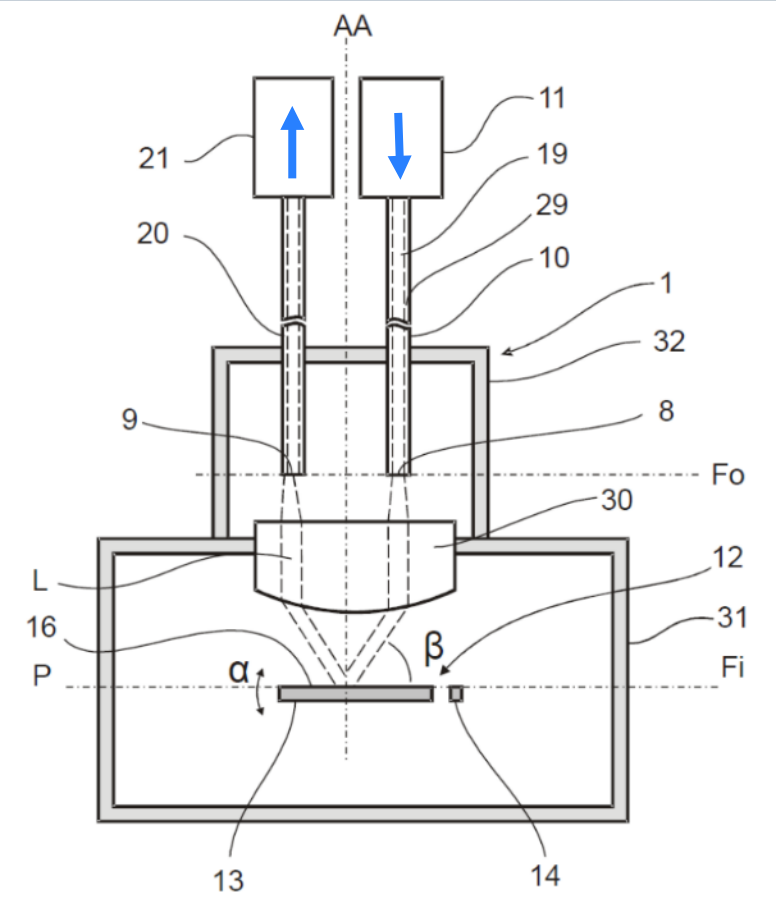
Features



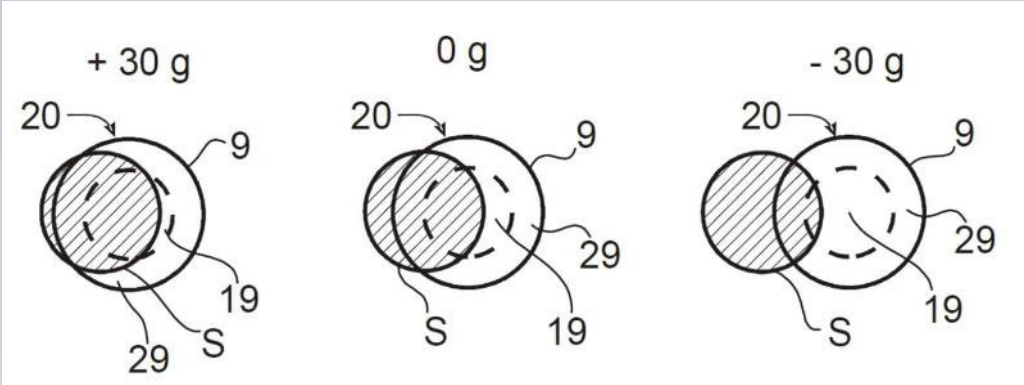
- 1-Axis /2-axis / 3-Axis
- Frequency Response 0.5Hz – 800Hz
- Range 0g – 50g
- Noise Density <100µg/Hz
- Voltage Output 100mV/g
- Linearity Deviation <5%
- Temperature Range -40°C – +200°C
- Distance up to 200m

micronor sensors

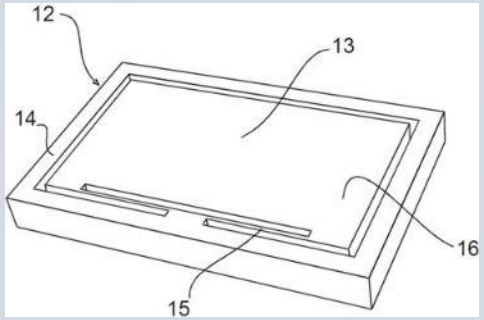
How the MR660 Works



Optical components are encapsulated for IP68 protection



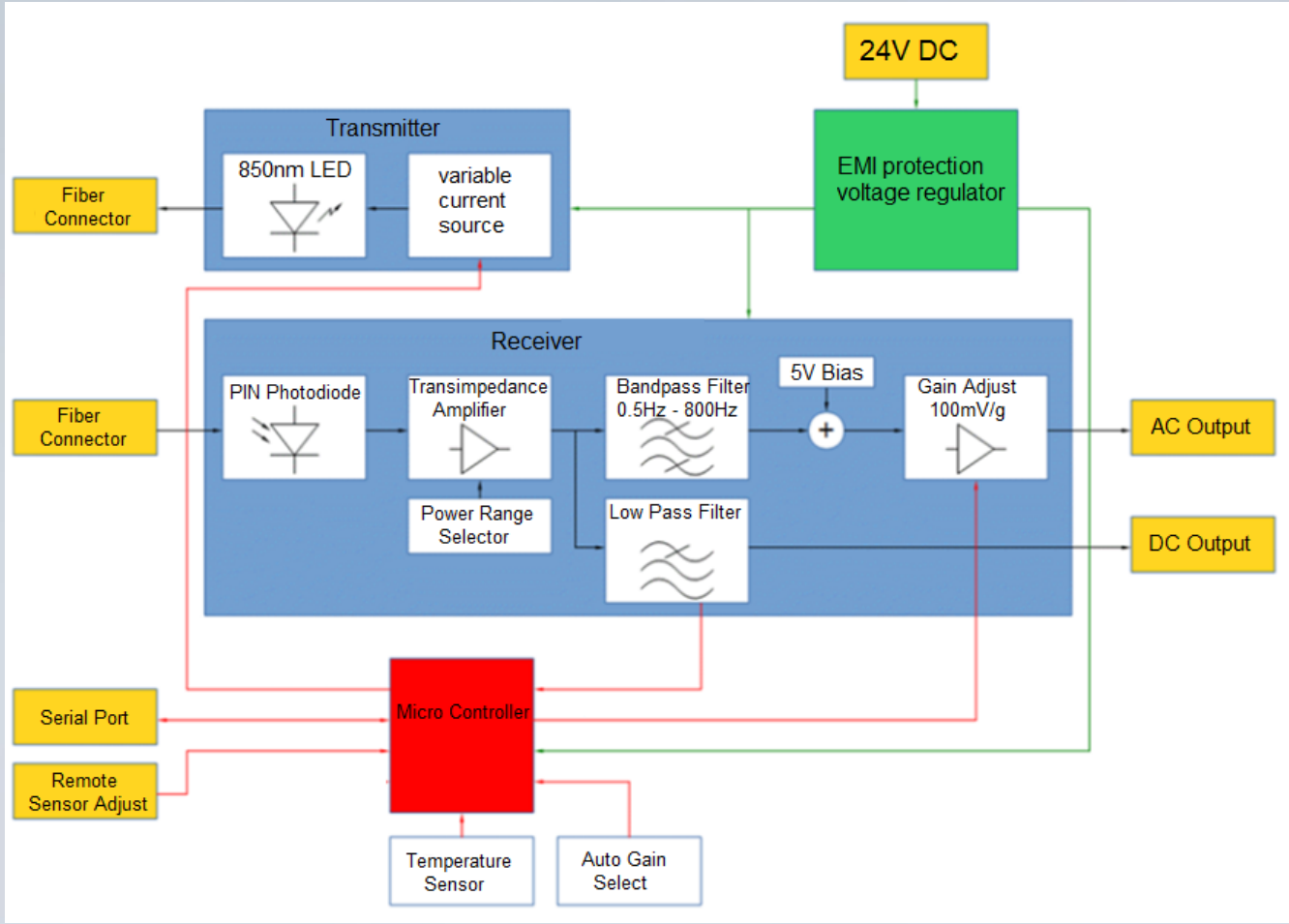
Reflective MEMS Membrane changes spatial position of light injected into the optical fiber end face. The light is thus position dependent and intensity modulated



MEMS Reflective Membrane

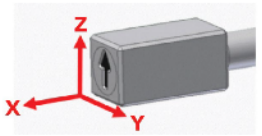
micronor sensors

How the MR660 Works



micronor sensors

Multi-Axis FO Acceleration/Vibration Sensors



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-A
QR Code to MR660 Sensors

micronor sensors

MICRONOR SENSORS, INC.
www.micronor.com
2085 SPERRY AVE, STE A-1
VENTURA, CA 93003 USA
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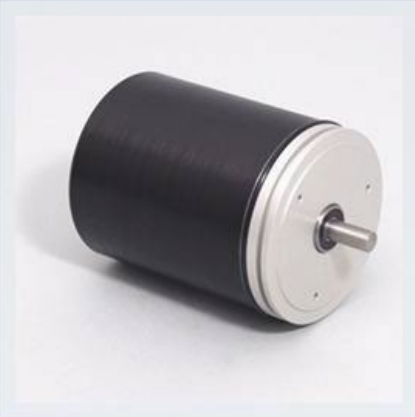
Electromechanical Products

Made in Switzerland



- Rotary Limit Switches
- Draw Wire Linear Limit Switches
- Rotary Encoders & Resolvers
- Draw Wire Linear Encoders
- MICRON Position Transducers
- Motorized Potentiometers & Cam Timers
- Handheld Pendants & Manual Pulse Generators

micronor sensors

MICRONOR®

MICRONOR® AG ROTARY-LINEAR LIMIT SWITCHES

GP=General Purpose, IP64
HD=Heavy Duty, IP66

MODEL	KW60 Open Frame, OEM	DWG120-KWG120 GP, Single Shaft	MR221-MR231 HD Single Shaft	MR222 HD Dual Ended Shaft	KWG120W GP Draw Wire/Linear	MR221W HD Draw Wire/Linear
Applications	For position feedback or safety limits on machinery where movement based on rotation angle or no. of shaft revolutions. Examples: crane, winch, drum hoist, door, conveyor, dam gates, locks, flood control gate, water intake gate, lift bridge, bascule bridge, swing bridge.				For position feedback or safety limits, on machinery where movement based on linear motion. Examples: lift platform, elevator, dam gate, hydraulic cylinder.	
No. of Cam Switch Channels	1-10	DWG120: 1-5 DWG160: 6-10	2-8	2-8	DWG120W: 1-5 DWG160W: 6-10	2-8
Switch rating (resistive continuous spec shown)	KS25B4, VDE rated, 4A 240VAC, 1A 60VDC Option: S840	KS25B4, VDE rated, 4A 240VAC, 1A 60VDC Option S840	S840, UL rated, 6A 240VAC, 6A 24VDC Option: MT, 125VDC/10A	S840, UL rated, 6A 240VAC, 6A 24VDC Option: MT, 125VDC/10A	KS25B4, VDE rated, 4A 240VAC, 1A 60VDC	S840, UL rated, 6A 240VAC, 6A 24VDC
Cam option	 Standard: NK4201.180, User Programmable Double Cams Options: NK4101.20 Adjustable Single Cams PSN Cam Programming Tool Stored Internally (except KW60)					
Gear Ratio options	Gear ratio options apply to Rotary Limit Switches ONLY. Draw Wire/Linear Limit Switches are internally geared per Travel Length. Step UP (D1:x): D2 (1:2, usually for travel less than 180 degrees. Step DOWN (Single Stage Gearing Ux:1): U1 (direct drive), U1.25, U2.0, U2.6, U2.75, U3.5, U4.0, U5.0 Step DOWN (Multi-stage Gearing Mx:1): M12.5, M20, M25, M30, M37.5, M40, M50, M52.5, M75, M100, M200, M300, M420, M600, M750, M1600, M2250, M2500				n/a	
Draw Wire Travel options	n/a	n/a	n/a	n/a	1.5m, 3m, 5m, 7.5m, 10m, 15m, 30m, 40m, 50m	1.5m, 3m, 5m, 7.5m, 10m, 15m, 30m, 40m, 50m
Position Feedback Output options	n/a	DWG120 (potentiometer) KWG120 (4-20mA transducer) KWG160 (4-20mA transducer)	MR221 (4-20mA transducer) MR231 (4-20mA encoder)	MR222 (4-20mA transducer)	KWG120W (4-20mA transducer) KWG160W (4-20mA transducer)	MR221W (4-20mA transducer)
Mechanical options	Rear shaft (geared end)		Without conduit hubs	Without conduit hubs	n/a	Without conduit hubs
Housing /IP standard and option	n/a	Proprietary copper free aluminum alloy (corrosion resistance similar to SS) die cast housing with powder coat (NEMA 4/4X)) Option: Stainless steel (NEMA 4/4X), not available KWG, MR231 and Draw Wire models				
Operating Temperature	-30°C to +70°C	-30°C to +70°C Special High and Low Temperature Models Available			-20°C to +60°C	

98-0221-06-A

QR Code to Limit Switches

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For Satellite Antennas

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Any Questions?

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