Air Insulated Switchgear Monitoring Solution

Designed for Diverse Utility and Industry Applications

Achieve increased asset value with improved productivity and utilization

Electrical switchgear plays an important role in operating the electrical power system safely with high reliability. Malfunction in switchgear operations can lead to severe failures in transformers and other connected electrical assets. The switchgear failures may lead to damage of electrical assets, unplanned outages, as well as cost and resources. Monitoring and tracking their performance are important for an efficient and increased asset lifetime.

Rugged Monitoring offers an advanced comprehensive condition monitoring solution for various switchgear systems from; sensors, monitors to software which can monitor and analyze the performance of switchgear equipment. Depending on specific operating requirements and application, we customize our condition monitoring solutions for air insulated switchgear.

Our condition monitoring system can be installed and integrated in new installations as well as in existing switchgears. Our advanced condition monitoring solution provides operators with valuable insights about switchgear systems enabling them to increase asset effectiveness.

Temperature Monitoring

The increasing demand for electric power and growing renewable energy sources call for the need to protect power systems from huge failures that could lead to a prolonged shortage of power supply. To ensure a continuous supply of power, condition monitoring of Switchgears becomes utmost important.

Overheating caused by uneven loads on circuits, or loose or damaged connections will lead to catastrophic failure's and thereby reduce the life span of the equipment. Temperature rises in switchgear and switchboard components can occur suddenly, often causing thermal run-away, resulting in burning, melting and destruction of components. Periodic visual inspections are always expensive and require special safety considerations and are unlikely to detect these conditions in time.

Rugged Monitoring offers an advanced comprehensive condition monitoring solution for various switchgear systems from; sensors, monitors to software which can monitor and analyze the performance of switchgear equipment. Depending on specific operating requirements and application, we customize our condition monitoring solutions for air insulated switchgear.

What Can Be Monitored

|			
Temperature	Power	Partial Discharge	Humidity
Trip Close Characteristics	SF6 Analysis	Stored Energy Analysis	Contact Wear

Partial Discharge Monitoring

We at Rugged Monitoring offer an advanced comprehensive condition monitoring solution for various switchgear system from; sensor, monitor to software which can monitor and analyze the performance of switchgear equipment. Depending on specific operating requirements and application, we customize our condition monitoring solutions for.

The major concern is to extract useful diagnostic data from noisy measurements (this holds especially for PD) and get global health condition/residual life algorithms. For noise recognition, while techniques are available for filtering out noise under AC sinusoidal voltage, that are based on the capability to distinguish noise from PD pulses in measurement records and, particularly, resorting to phase-resolved PD (PRPD) patterns, the same does not apply for DC and pulse-modulated (PWM) voltage waveforms.

Sample System Architecture for Air Insulated Switchgear

HPM

CPM

R501

Monitoring Software "RM EYE"
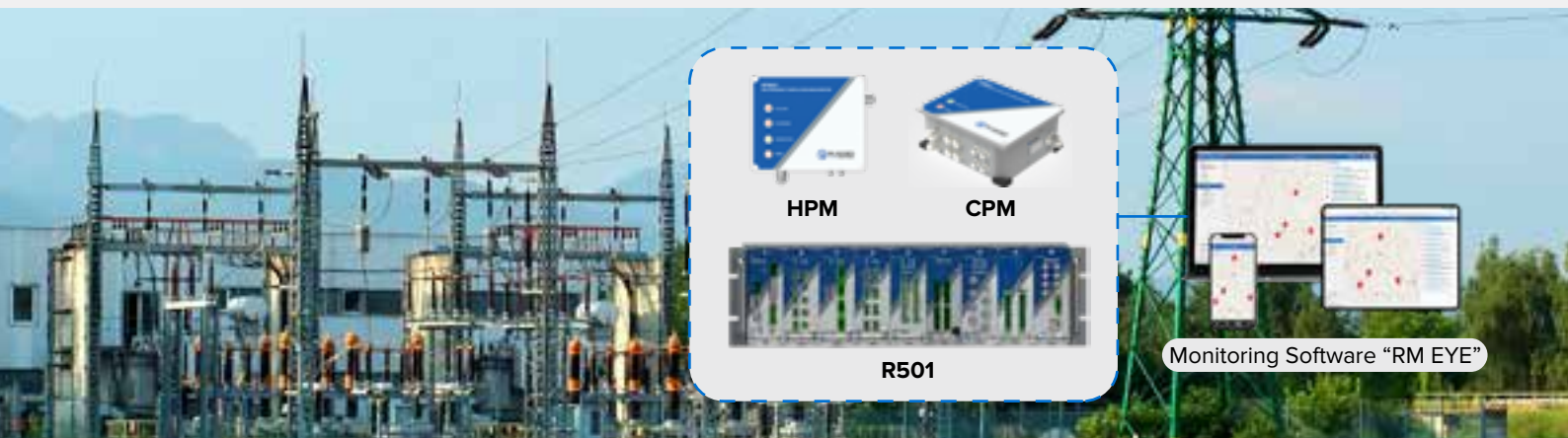
Partial Discharge Monitoring
- PD Detection
- PD Localization
- PD Severity Analysis
- PD Test and Measurement Services

Intrusion Detection
- Video camera
- Integrated with thermal imaging camera
- Real-time monitoring and Alarm Notification

Thermal Monitoring
- Thermal Profiling
- Hot Spot Identification
- Hot Spot Localization

Features

- Most advanced remote monitoring solution with contact wear analysis
- Trip & Close Operations Time Monitoring and Analysis
- SF6 Monitoring & Analysis with versatile and scalable operation
- Get Switchgear & Bay Level Information with Quick and flexible configuration options
- Realtime and consistent monitoring solution
- Built on well-established remote and cloud-based monitoring technology
- Robust and highly reliable

Benefits

- Increased asset life with reduced unplanned outages
- Accurate alarm and alert system
- Greater diagnostic capability
- Increased ROI with reduced operation cost
- Precise fault identification
- Ability to monitor multiple switchgear systems with one software

T301 Rugged Monitoring Temperature Monitor

The Rugged Monitoring T301 is a multi-channel fiber optic temperature monitor with precision measurement for Industrial and Laboratory applications. The T301 fiber optic monitor combines compact form factor and user-friendly interface in the monitor and software.

It is designed to operate reliably in extreme EMI, RFI, Microwave and high voltage environments. The T301 has a measuring range from -271°C to +300°C. The system offers complete immunity to RFI, EMI, Chemical, microwave radiation, and high voltages making it an optimal choice for environments where the limitations of conventional temperature sensors / monitors impact usage in extreme conditions. The system is based on proven zero-drift GaAs technology and designed for Plug and Play operation.

The T301 is designed to collect data and to easily integrate into existing systems through serial communication like RS-485 or Gigabit Optical Ethernet. The T301 monitor comes with Rugged Connect software which is designed with the needs of Test Platform or Industrial Process monitoring integration needs. It has the data integration capability of multiple test platforms. Rugged Connect software is designed to collect data from 256 channels simultaneously. Plug and Play functionality provides the flexibility to interchange sensors without the inconvenience / concerns of calibration.

Rugged Monitoring has a dedicated team for application specific customizations for fiber optic sensors, monitor configuration and software integration to simplify the data collection of testing and monitoring applications.

Applications

- Transformer Hot Spot monitoring
- Industrial process control and monitoring
- Electric Vehicle and Battery Testing
- Medical Equipment testing (MRI, PETSCAN, NMR)
- Commercial Grade Microwave Radiation
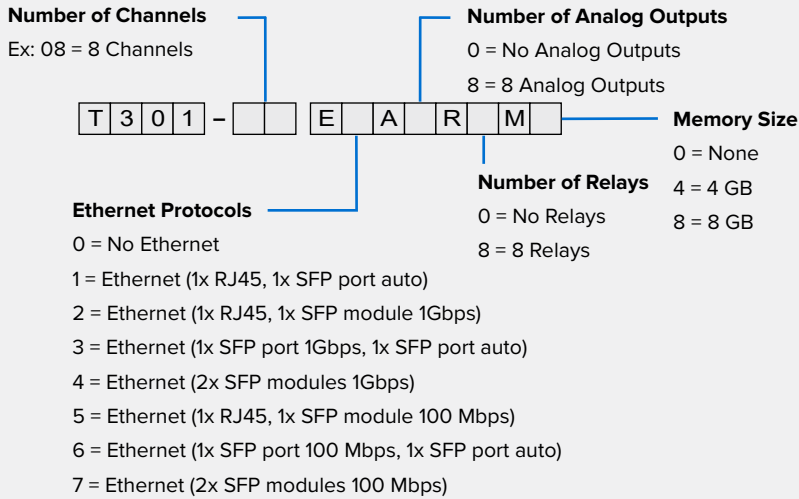- Food and Beverage Processes

Features

- Rugged, Compact Design
- 4 to 24 Channels, Expandable
- Plug and Play, No field calibration
- Best in class EMI, ESD Immunity
- 8 Programmable relays, Form - C
- Software designed to be interfaced with other testing platforms

Benefits

- No shift over time, high stability
- Robust packaging
- Each Monitor comes with a complete NIST calibration Certificate

- Software designed for integration into test platforms
- Robust datalogging and analytics
- Customizable according to customer specific applications
- Suitable for OEM-type applications.

Ordering Code

Number of Channels
Ex: 08 = 8 Channels

Number of Analog Outputs
0 = No Analog Outputs
8 = 8 Analog Outputs

```
T 3 0 1 – [ ][ ] E [ ] A [ ] R [ ] M [ ]
```

Memory Size
0 = None
4 = 4 GB
8 = 8 GB

Number of Relays
0 = No Relays
8 = 8 Relays

Ethernet Protocols
0 = No Ethernet
1 = Ethernet (1x RJ45, 1x SFP port auto)
2 = Ethernet (1x RJ45, 1x SFP module 1Gbps)
3 = Ethernet (1x SFP port 1Gbps, 1x SFP port auto)
4 = Ethernet (2x SFP modules 1Gbps)
5 = Ethernet (1x RJ45, 1x SFP module 100 Mbps)
6 = Ethernet (1x SFP port 100 Mbps, 1x SFP port auto)
7 = Ethernet (2x SFP modules 100 Mbps)

Technical Specifications

Measurement Range	-80 °C to +300 °C (cryogenic 4 °K range optional)
Measurement range (Optional Range extensions)	Down to 2 °K / Up to +300 °C
Power Supply	24V to 48V DC, 30 W
Resolution	0.1 °C
Accuracy	±1.0 °C (±0.2 °C in relative temperature)
Scan rate	200 ms / channel
Memory	MicroSD external memory slot (Up to 2 TB)
Logging	10 years at 10 sec interval rate (8 GB)
Serial Port	RS-485 with Modbus
Ethernet Option	RJ-45 or Fiber Ethernet; Optional PRP support built-in 2 x RJ-45 or Fiber Ethernet; With advance communication protocols (IEC 61850, Modbus over Ethernet, IEC 60870-5-104 and DP3)
Fiber Optic Communication	SFP module can be added to the Ethernet option; the standard SFP module is compatible with LC fiber connectors (850 nm multimode communication with a distance capability of 550 meters)
Analog Outputs	8 fully configurable 0-10 V / 4-20 mA optional module available - Optional
Max # of Channels	256 Channels, Daisy chain up to 32 units (with Modbus)
Relays	8 Programmable Form-C Relays (5A) plus 1 system fault relay - Optional
Operating temp	-40 to 72 °C
Storage temp	-40 to 85 °C
Number of Channels	4 - 24 channels
Dimensions	10.5'' x 7.4" x 2.8'' 26.7W x 18.7D x 7.2H cm
Humidity	95% Non Condensing

O201 Fiber Optic Temperature Monitoring with most advanced

RM's Fluorescence technology based O201 is designed with high accuracy, reliable for operation in extreme EMI, RFI, Microwave and high voltage environments. It is a multi-channel fiber optic temperature monitor with precision measurement for Original Equipment manufacturers. The O201 has a measuring range from -271 °C to +300 °C. The system is based on proven Fluorescence technology and designed for Plug and Play operation.

The system offers complete immunity to RFI, EMI, microwave radiation, and High Voltages making it an optimal choice for environments where the limitations of conventional temperature sensors/ monitors impact usage in extreme conditions.

The O201 is designed to collect data and is easy to integrate into existing systems through serial communication like RS-485 or analog outputs like 0-10 V / 4-20 mA. The O201 supports Modbus, CANbus protocols and a system fault relay. The module is designed with capability to add additional application logic for customer specific applications. It is designed with the needs of Monitoring, Test platforms or Industrial Process monitoring integration needs. It has the data integration capability of multiple test platforms. Industry standard drivers available for a quick and easy connect to most popular laboratories software. The fluorescence based fiber optic temperature sensor is highly capable of operating in a series of complex environments such as strong electromagnetic and high voltage.

Rugged Monitoring designs and manufactures customized state of the art fiber optic sensor systems for the measurement of temperature, strain and other physical parameters.

Our fiber optic temperature monitor with Fluorescence technology suits the requirement of measurements with difficult environmental conditions.

Features

- Rugged, Compact Design
- 1 to 8 Channels, Expandable
- Plug and Play
- Best in class EMI, ESD Immunity
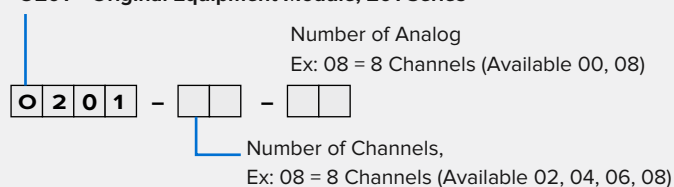- Software designed to be interfaced with other testing platforms

Applications

- Electric Vehicle and Battery Testing
- Medical Equipment testing (MRI, PETSCAN, NMR)
- Commercial Grade Microwave Radiation
- Industrial process control and monitoring applications
- Chemical and process Industries Food and Beverage Processes
- Wood drying industry

Benefits

- Robust and Reliable
- Offers a low-cost interrogator
- Suitable for OEM-type applications
- Sensors do not require any recalibration
- No shift over time, high stability and repeatability
- Robust packaging

- Each Monitor comes with a complete NIST calibration certificate
- Software designed for integration into test platforms
- Robust datalogging and Analytics
- Customizable according to customer specific applications
- Suitable for OEM-type applications.

Ordering Code

O201 = Original Equipment Module, 201 Series

Number of Analog
Ex: 08 = 8 Channels (Available 00, 08)

O 2 0 1 – ☐☐ – ☐☐

Number of Channels,
Ex: 08 = 8 Channels (Available 02, 04, 06, 08)

Technical Specifications

Measurement Range	-80 °C to +300 °C (cryogenic 4 °K range optional)
Measurement range (Optional Range extensions)	Down to 4 °K / Up to +300 °C
Resolution	0.1°C
Accuracy	±1.0 °C (+/- 0.2 °C in relative temperature)
Number of Channels	1 - 8 Channels
Logging	1 sec interval on USB / Micro SD card
Config port	USB (to use with Rugged connect windows software)
Max # of Channels	Expandable to 256 Channels, Daisy chain up to 32 units (with Modbus, Canbus)
Communication Ports	RS-485 (RS-232 optional converter) with Modbus, CANbus
Power	24 VDC
Memory	MicroSD external memory slot (up to 2 TB)
Analog output module	Fully configurable eight 0-10 V / 4-20 mA module (Optional)
Dimensions	4.72" x 6.34" x 1.89" 120 x 161 x 48 mm
Scan rate	200 ms / channel (Optional: Faster scanning rates available)
Operating temp	-40 to 72 °C
Storage temp	-40 to 85 °C
Humidity	95% Non-Condensing
Relay	System Fault relay (5A)

LSENS-R Fiber Optic Temperature Sensor

Recommended for hostile environment where it is exposed to high vibration and immunity to electric fields is mandatory

A multiuse fiber optic temperature sensor designed for a wide range of applications, especially for the use in demanding applications. The sensor offers complete immunity to RFI, EMI, NMR and microwave radiation. The standard temperature sensor has a response time of 0.2 s. With a standard deviation of +/-0.2 °C it allows for precise and repeatable measurements.

The coating of the temperature sensor is made of PTFE, and the fiber tip has a diameter of 1.7 mm with Rugged Polyimide coating and has a stainless steel ST-connector. For mechanical stability and applications e.g. in oil special protective coatings and hoses are available. The fiber optic probe consists of a PTFE protected glass fiber and a GaAs-crystal (Gallium Arsenide) at the sensor tip. It is totally free of metal and immune to external fields, therefore probes are explicitly suitable for the use in high temperature ranges as well as in aggressive operating environments. The sensor cable can be from several meters to kilometers long without influencing the accuracy of the measurement result. Other sensor lengths and connector types are available upon request.

Applications

- Industrial process control and monitoring applications
- High voltage environments
- Harsh and Hazardous environments
- Temperature measurements conducted in confined spaces, hazardous or strong EMI/RFI/MRI environments
- Wood drying industry

Features

- Industrial use with rigid polyimide tip, 1.7 mm diameter
- Rugged tip ideal for industrial application
- Complete immunity to EMI/RFI/lightning
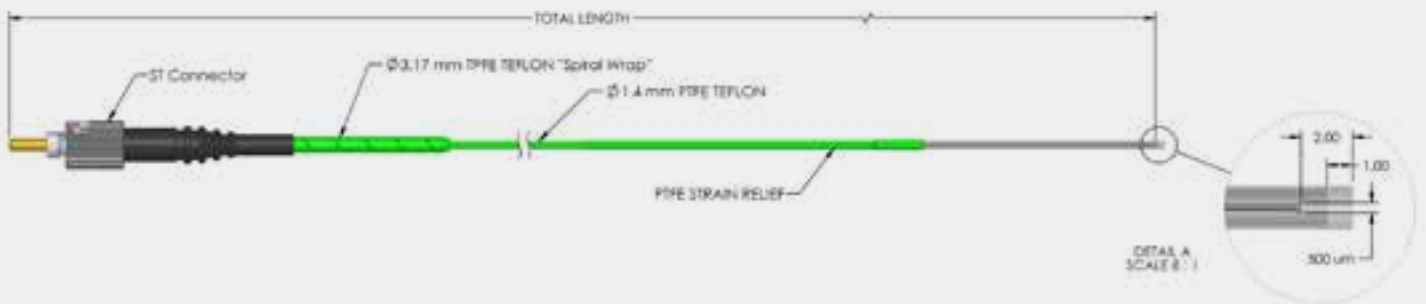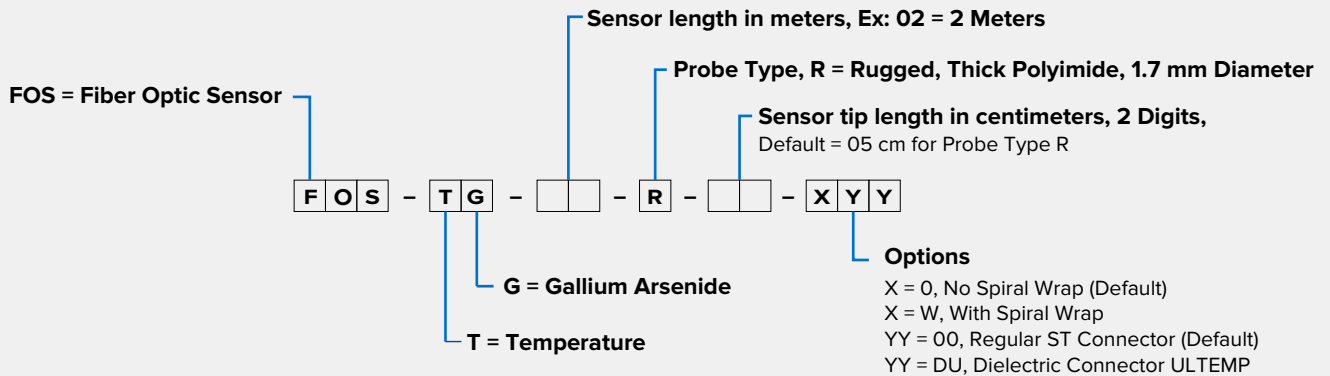- High vibration environments

Benefits

- Sensors do not require any recalibration
- No shift over time, high stability
- Robust packaging
- Each sensor comes with a complete test certification

- Robust fiber optic temperature sensor
- Available in different cables and sheath options
- Customizable according to customer specific applications
- Suitable for OEM-type applications.

Technical Specifications

Temperature range	-200 °C to +250 °C
Temperature range (Optional Range extensions)	Down to 4 °K / Up to +300 °C
Repeatability	0.2 °C
Accuracy absolute temperature	+/- 0.8 °C
Accuracy relative temperature	+/- 0.2 °C
Probe sheathing material	Teflon Coated, Rugged Polyimide protection for sensor tip
Connector	Stainless Alloy / Optional - Dielectric
Response time	Up to 0.2 Sec
Probe sensitive area - Diameter	1.7 mm Diameter
Longevity	Probe accuracy & repeatability constant over time

Ordering Code

Sensor length in meters, Ex: 02 = 2 Meters

Probe Type, R = Rugged, Thick Polyimide, 1.7 mm Diameter

FOS = Fiber Optic Sensor

Sensor tip length in centimeters, 2 Digits,
Default = 05 cm for Probe Type R

F O S – T G – ☐☐ – R – ☐☐ – X Y Y

G = Gallium Arsenide

T = Temperature

Options
X = 0, No Spiral Wrap (Default)
X = W, With Spiral Wrap
YY = 00, Regular ST Connector (Default)
YY = DU, Dielectric Connector ULTEMP

LSENS-T Fiber Optic Temperature Sensor

A multiuse fiber optic temperature sensor for measurement in a wide range of demanding applications where immunity to electromagnetic fields and explosion proof requirements are mandatory
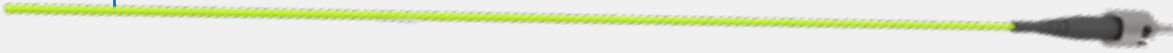
A multiuse fiber optic temperature sensor designed for a wide range of applications, especially for the use in R&D and industrial applications. The sensor offers complete immunity to RFI, EMI, NMR, Corrosive and microwave radiation making it the best choice for all demanding applications. The standard temperature sensor has a response time of 0.2s. With a standard deviation of +/-0.2 °C it allows precise and repeatable measurements. The coating of the temperature sensor is made of PTFE, while the fiber tip has a diameter of 1.1mm and has a stainless steel ST-connector. For mechanical stability and applications e.g. in oil special protective coatings and hoses are available. The fiber optic probe consists of a PTFE protected glass fiber and a GaAs-crystal (Gallium Arsenide) at the sensor tip. It is totally free of metal and immune to external fields, therefore probes are explicitly suitable for use in high temperature ranges as well as in aggressive operating environments. The sensor cable can be from several meters to kilometers long without influencing the accuracy of the measurement result. Other sensor lengths and connector types are available upon request.

Applications

- Magnetic, RF and Microwave environments
  High voltage environments
- Nuclear and hazardous environments
- Medical applications
- Aggressive Chemical environments
  Sterilization applications
- RF and microwave drying applications

Features

- PTFE protected
  Outstanding repeatability with high flexibility
- Complete immunity to RFI, EMI, NMR and
- microwave radiation
- Does not require recalibration or complex input to operate
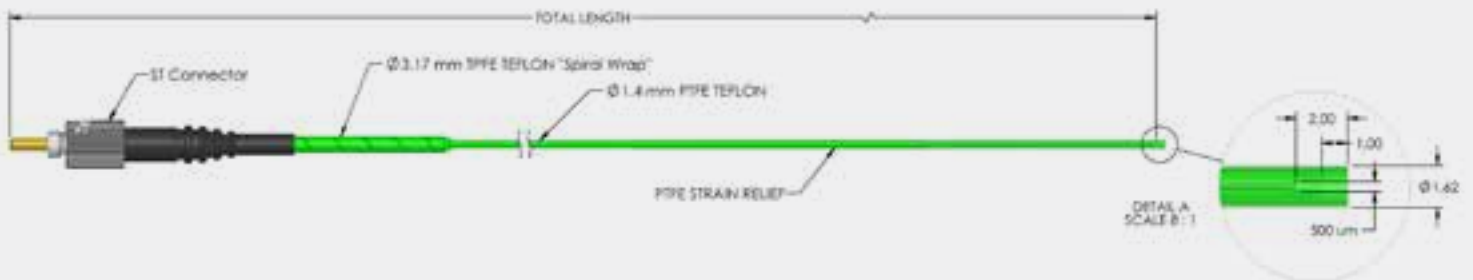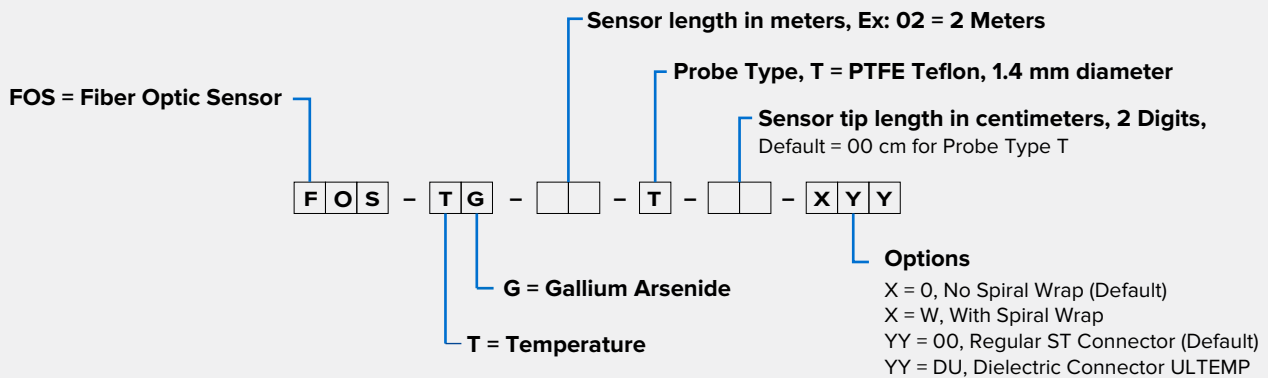 Liquid proof and withstands aggressive chemical solutions

Benefits

- Sensors do not require any recalibration
- No shift over time, high stability
- Optional spiral wrap
- Robust fiber optic temperature sensor

- Available in different cables and sheath options
- Customizable according to customer specific applications
- Suitable for OEM-type applications

Technical Specifications

Temperature range	-200 °C to +250 °C
Temperature range (Optional Range extensions)	Down to 4 °K / Up to +300 °C
Repeatability	0.2 °C
Accuracy absolute temperature	+/- 0.8 °C
Accuracy relative temperature	+/- 0.2 °C
Probe sheathing material	Teflon Coated
Connector	Stainless Alloy / Optional - Dielectric
Response time	Up to 0.2 Sec
Probe sensitive area - Diameter	1.4 mm

Ordering Code

Sensor length in meters, Ex: 02 = 2 Meters

Probe Type, T = PTFE Teflon, 1.4 mm diameter

FOS = Fiber Optic Sensor

Sensor tip length in centimeters, 2 Digits,
Default = 00 cm for Probe Type T

| F | O | S | – | T | G | – | | | – | T | – | | | – | X | Y | Y |

G = Gallium Arsenide

Options
X = 0, No Spiral Wrap (Default)
X = W, With Spiral Wrap
YY = 00, Regular ST Connector (Default)
YY = DU, Dielectric Connector ULTEMP

T = Temperature

LSENS-U Fiber Optic Temperature Sensor

A Heavy duty fiber optic temperature sensor for measurement in a wide range of demanding applications where robustness of sensors, immunity to electromagnetic fields and explosion proof requirements are mandatory

A heavy duty fiber optic temperature sensor specially designed for harsh and dynamic operating conditions where stress on the Fiber Optic Cable is more than normal. The sensor offers complete immunity to RFI, EMI, NMR, Corrosive and microwave radiation making it the best choice for all demanding applications. The standard temperature sensor has a response time of 0.2 s. with a standard deviation of +/-0.2 °C. Each sensor allows precise and repeatable measurements.

The coating of the temperature sensor is made of heavy duty material, while the fiber tip has a diameter of 1.1mm and has a stainless steel ST-connector. For mechanical stability and applications e.g. in oil special protective coatings and hoses are available.

The fiber optic probe consists of a PTFE protected glass fiber and a GaAs-crystal (Gallium Arsenide) at the sensor tip. It is totally free of metal and immune to external fields, therefore probes are explicitly suitable for use in high temperature ranges as well as in aggressive operating environments. The sensor cable can be from several meters to kilometers long without influencing the accuracy of the measurement result. Other sensor lengths and connector types are available upon request.

Features

- Heavy duty protection gives longevity to sensors under harsh and dynamic operating conditions
- Complete immunity to RFI, EMI, NMR and microwave radiation
- Outstanding repeatability improves accuracy of testing instruments
- Plug and Play operation, does not require recalibration or complex input to operate
- Liquid proof and withstands aggressive chemical solutions

Applications

- RF and microwave drying applications
- Food Processing and sterilization applications
- Electric Vehicle and Battery Testing
- Medical Applications
- Industrial process control and monitoring applications
- Nuclear, Magnetic and hazardous environments
- High voltage environments
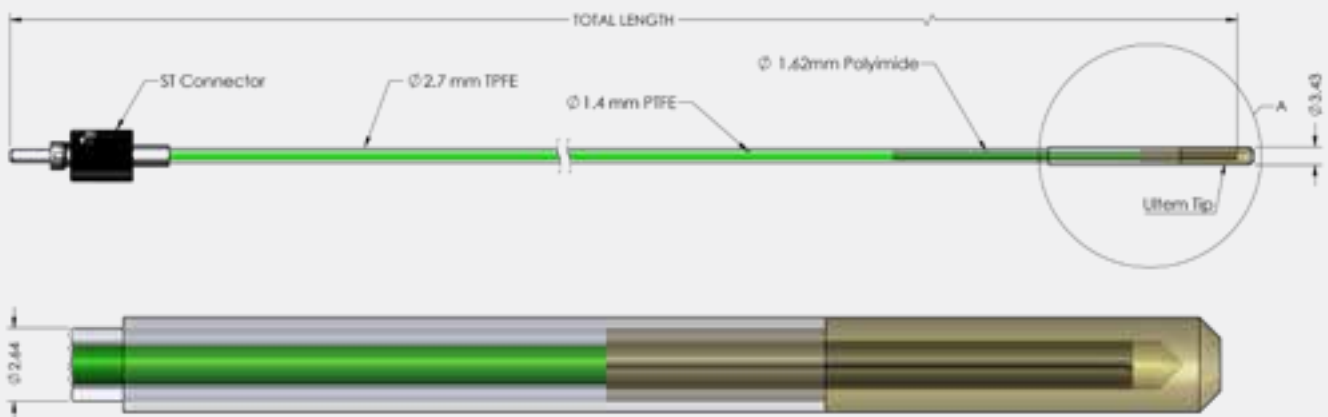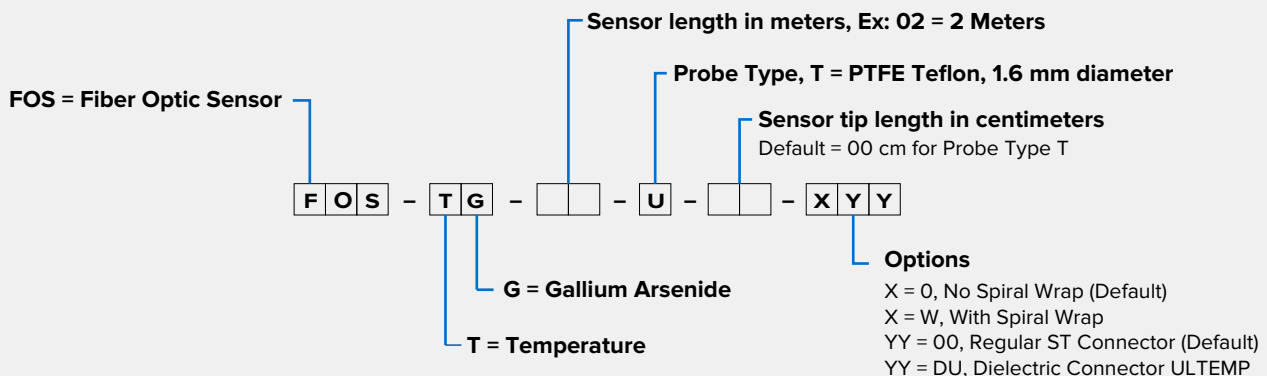- Aggressive Chemical environments

Benefits

- Longer life of sensors under harsh and dynamic operating conditions
- Cost saving on recalibration; sensor does not require any recalibration
- Customizable to meet different requirements of customer applications
- Optional spiral wrap reinforces robustness of sensor cable

- Suitable for OEM-type applications and during operation of machines
- Higher accuracy and repeatability increase confidence of validation and measurement
- Faster support from industry known fiber optic experts
- Available in different cables and sheath options

Technical Specifications

Temperature range	-200 °C to +250 °C
Temperature range (Optional Range extensions)	Down to 4 °K / Up to +300 °C
Repeatability	0.2 °C
Accuracy absolute temperature	+/- 0.8 °C
Accuracy relative temperature	+/- 0.2 °C
Probe sheathing material	Teflon Coated
Connector	Stainless Alloy / Optional - Dielectric
Response time	Up to 0.2 Sec
Probe sensitive area - Diameter	1.6 mm

Ordering Code

Sensor length in meters, Ex: 02 = 2 Meters

Probe Type, T = PTFE Teflon, 1.6 mm diameter

FOS = Fiber Optic Sensor

Sensor tip length in centimeters
Default = 00 cm for Probe Type T

F O S – T G – ☐☐ – U – ☐☐ – X Y Y

Options
X = 0, No Spiral Wrap (Default)
X = W, With Spiral Wrap
YY = 00, Regular ST Connector (Default)
YY = DU, Dielectric Connector ULTEMP

G = Gallium Arsenide

T = Temperature

Asset Monitoring :
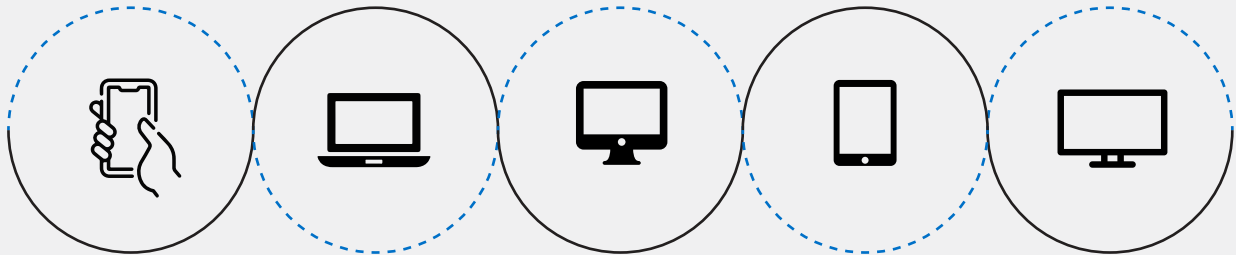# **Enterprise Architecture**

Compatible with Rugged Monitoring Enterprise Solution

UI UX

- Data Layer
- Analytics
- User Interface
- Custom Dashboards
- Reporting
- Email/SMS Notifications

RM EYE

Private Cloud (Customer Cloud),
Rugged Monitoring Cloud

IEC 60870-104	**ODBC**
IEC 61850	**MODBUS**
FTP/SFTP	**DNP 3.0**
- XML, JSON	**HTTPS**
- CSV, COMTRADE	**MQTT**

Data Collection

Asset Data
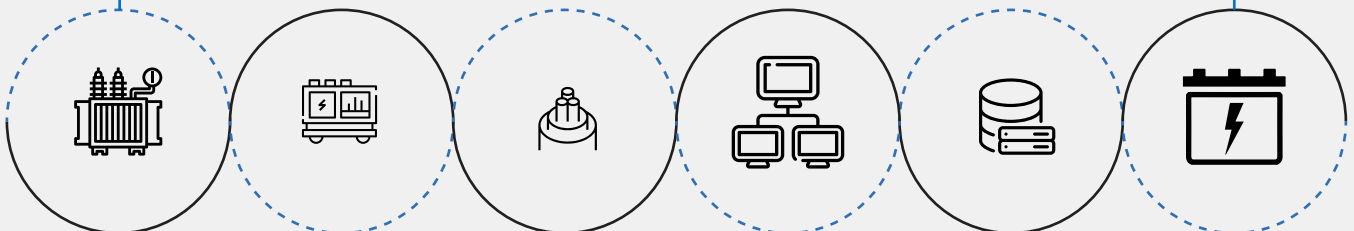
Transformer Monitoring System

Switchgear Monitoring System

Power Cable Monitoring System

- Offline Test Results
- Inspection Records
- Name Plate

- Historian
- CMMS
- SCADA/ DCS

Power Electronics (Battery, UPS, VFD, Relay)

One Solution for Multi-Site
Multi Asset Monitoring

RM Eye - Unified platform to monitor entire network of electrical assets

Features

- **Advanced asset health monitoring** with analysis and recommendations to increase asset effectiveness in addition to maximizing equipment uptime

- **Modern remote monitoring solutions** provide valuable insights to Multiple Assets at Multiple Sites from time to time

- **Establish a real time and consistent monitoring** by getting the right information into right hands

- **Simple and user-friendly interface** providing easy and fast access to all the features

- **Everything about the asset at one place** The raw data, analysis and recommendations

- **Advanced asset algorithms** for electrical assets to evaluate asset health

- **Advanced reporting technology with automated alerts**

- **An efficient, reliable partial discharge monitoring for all the assets**

- **A detailed comprehensive DGA analysis**

- **Built on well-established remote and cloud-based monitoring technology**

- **Quick configuration** so that you are not required to configure separately.

- **Protocols: IEC 61850, MODBUS, MQTT**

- **Robust integration with 3rd party systems and devices** with industry standard protocols

- **Bulk configuration imports for fast deployment**

- **Encompasses a secure access to data and configuration**

- **QR code scanner on mobile devices**

- **Accessible on web browser and mobile app**

- **Historical data storage and on demand access** via export feature

- **Extended multilingual support** to handle product inquires or troubleshoot problems proactively

- **Systematic fleet management analysis**

- **Offline test data integration and analysis**

Why Customers Choose Us?

RM solution, the trusted monitoring solution for over 10000+ assets across 50+ countries. We are a leading High Value Electrical Asset Monitoring Company integrating fibre optic technology to the assets.

Attention to Details
It's our attention to the small stuff, scheduling of timelines and keen project management that makes us stand out from the rest.

A plan for Success
Our Customers are well satisfied with the advisory services that we offer to help them with best in class technological performance and a long durable life.

Experts only
We bring in our diversified experienced team with over 100+ years of experience in Asset Monitoring

Meeting Deadlines
Work with us, and you'll work with seasoned professionals – vigilant of deadlines, and committed to exceeding client expectations.

Money Matters
We protect you against currency fluctuation with competitive and fair market prices

Rugged Monitoring Services

Rugged Monitoring provides customization of sensors, monitors & software. In addition we offer on-site commissioning services, maintenance contracts and technical support to all customers worldwide.

About Rugged Monitoring

Industry's leading team of asset condition monitoring experts with 100+ years of combined experience committed to delivering customizable solutions for challenging applications. We offer a range of reliable, high performance, customizable sensors and monitoring solutions that are immune to external influence.

Certification

ISO 9001	ISO 14001	ISO 45001/ OHSAS 18000	Llyod's Register	ATEX Certification

Our Presence **Across the Globe**

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RUGGED MONITORING
MONITORING SIMPLIFIED