

SAFE Microwave Digestion with Fiber Optic Sensors



Microwave heating is very popular for quick and selective digestion of materials in various industries e.g. Food and feed, Pharmaceutical, Chemistry, Environmental, etc. In these application, the sample is mixed into an acid mixture and heated to high temperature, up to 250 or 300°C. However, spontaneous heating of acid mixture induces exothermic reaction resulting into very rapid change in temperature and pressure.

Therefore, faster and accurate monitoring of temperature and pressure is crucial in minimizing safety risks. Fiber optic sensors for temperature and pressure measurement have been widely successful in microwave assisted digestion applications due their immunity to electro magnetic field within the microwaves.

Benefits of Temperature Monitoring

- Vessel temperature monitoring increases safety of digestion operation
- Increases lifetime of digestion vessel by direct temperature monitoring
- Programmable temperature limits for starting cooling operation
- Close observations, recording and reporting
- Sample temperature monitoring for highly accurate research analysis
- Precise and automatic sample temperature control

Benefits of Fiber Optic Temperature Sensors

• **Faster reaction time**

The measuring speed of the sensor is extremely important for controlling exothermic reactions effectively. The in-situ Fiber optic temperature sensors provide fastest response time (within 0.1s) in detecting temperature change.

• **Direct and Accurate Measurement**

Direct contact with vessels and sample ensures efficient and safe control of the digestion process. It also helps in analyzing different vessel's reaction for consistency and detecting any abnormality.

• **Immunity to Microwaves and EMI fields**

Immunity to microwave and EMI fields helps in using Fiber Optic temperature sensors without any bulky shielding (as it would be required in case of thermocouples). Bulky shielding always introduces delay and inaccuracy in measurements.

• **No Contamination to Digestion Sample**

Fiber optic temperature sensors bounded with PTFE material never pose a risk of contaminating digestion sample and leading to failure of experiment or safety measures.

• **Corrosion Resistant**

Corrosion from the sensor coating / shielding always have risk of failing experiments. Fiber optic temperature sensors are bounded by PTFE, the same material that is used for making vessel caps. Therefore no risk of corrosion.

• **Pressure Neutral Temperature Measurement**

GaAs (Gallium Arsenide) based Fiber Optic temperature sensors are not impacted by pressure and provide similar accuracy in high pressure and low pressure environment. Ideal for pressure digestion applications.

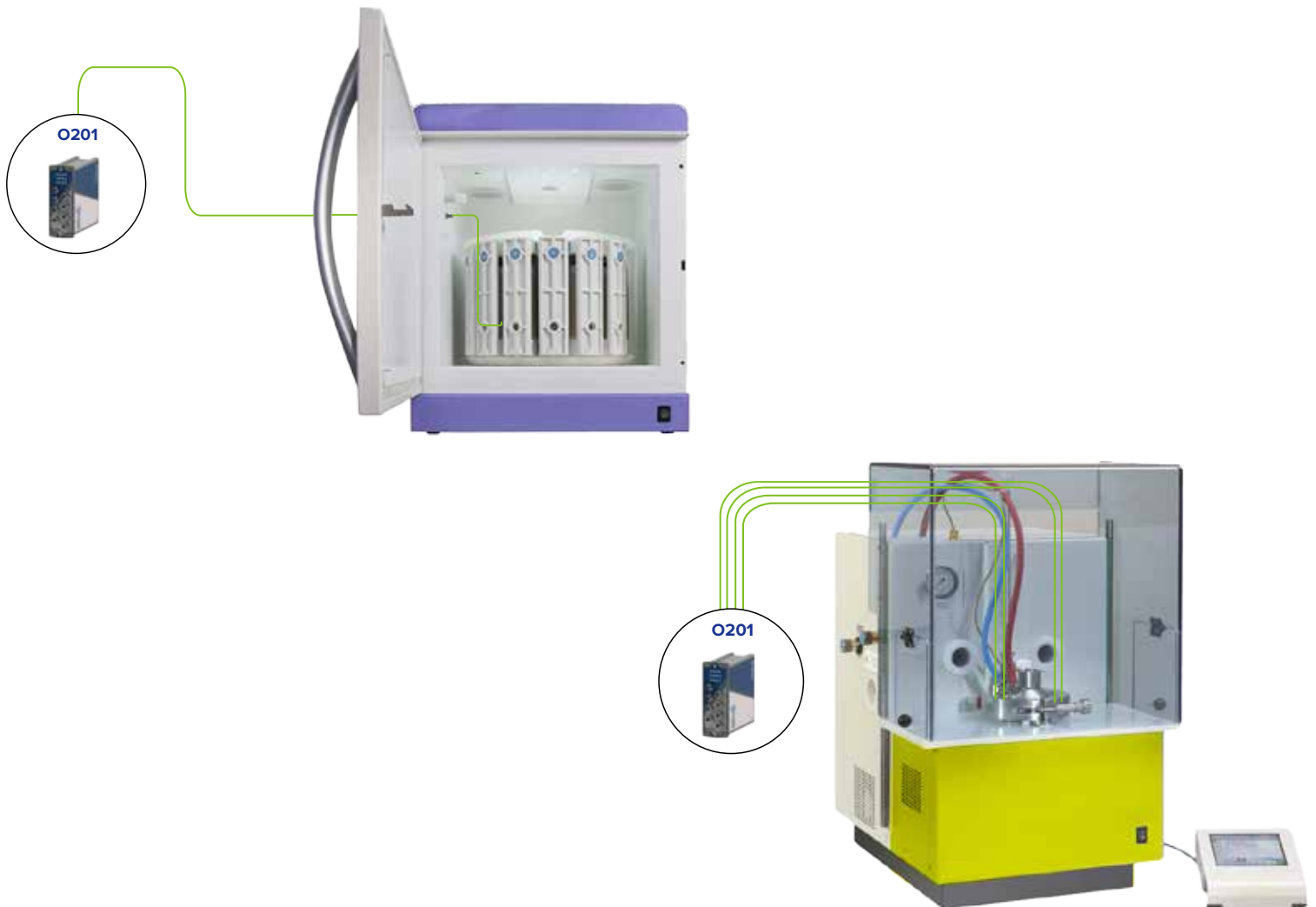
• **Ease of Handling (Plug and Play)**

Fiber optic temperature sensors do not need any special mounting requirements and can be mounted at tiny spaces. These sensors do not require complex calibration and can be reused in different applications.

Our Solution: System Architecture

We provide range of fiber optic temperature sensors, monitors and accessories to microwave manufacturers for digestion applications. Fiber optic sensors and monitors are being used during the product testing of microwaves and installed into microwaves for temperature monitoring during the digestion process.

Our solution is capable of monitoring variety of microwave digestion applications ranging from one sensor per microwave (in the reference vessel) to large quantity of sensors (up to 256 sensors) for independent vessel and sample monitoring.



System Configuration

Equipment (System Component)	Quantity with Comments
FO Temperature Sensors on the vessel surface	1 (for each Vessel)
FO Temperature Sensors for Sample temperature	1 (for each Sample)
FO Temperature Monitor (to fit with Temperature control electronics)	Multi-Channel (up to 08 in one board) OEM Module - O201
FO Temperature Monitor (independent temperature monitoring during microwave development)	Multi-Channel (up to 08 in one board) Monitor - L201
FO Temperature Monitor for applications that require to monitor large number of temperature points (up to 256)	Multi-Channel (up to 256 sensors) Monitor - R501
Accessories: V-Pin Crimp and Cleave connector	01 (for each sensor)

Typical Applications

Pharmaceutical: ICP-MS Analysis

- Monitor elemental impurities in pharmaceutical raw material, drugs and dietary supplements
- Measurement of inorganic contaminants in pharmaceutical samples
- Trace metal analysis in pharmaceutical drugs and dietary supplements
- Detailed analysis of homeopathic and traditional medicines
- QA/QC; Determination of chemical composition and impurities into Multi-Vitamins, Mineral Tablets, Ointments and Creams, and Wax
- Determination of Total Mercury in Nutraceutical Samples



Clinical

- Testing of biomedical samples such as body fluids (urine, serum, whole blood) and hair
- Low-level trace metal detection in biomedical / clinical samples
- Determination of Mercury in Blood, Hair and Urine Samples
- Test for drug levels in the blood
- Testing of bones and their composition

Food and Feed: ICP-MS Analysis

- Trace metal analysis in food and beverages including cooking oil
- Determination of Mercury in Fish & Biological Tissues
- Toxic element determination in medicinal plants by ICP-MS
- Trace metal analysis in animal feed
- Nutritional Analysis of food, beverages and animal feed
- Mineral Analysis in Carbohydrate-Rich Samples



Environmental (US-EPA)

- Analysis of soil contamination for toxic elements
- Hazard assessment of waste and other pollutants
- Assessment of Sewage Sludge (DIN EN 13346, EPA 3051A)
- Elemental and toxic analysis of Tar, Wood Chips / Pellets
- Determination of Heavy Metals in Soil, Sediment, and Rock
- Total analysis in a variety of matrices including sludge, oils, biological and botanical materials

Metal, Alloy and Ceramic

- Determining Chemical composition of Orthopedic Alloy i.e. Ti
- QA/QC and contamination identification on metals, alloys and ceramic
- Trace metal analysis of Metals, Alloys and Ceramics
- Determination of traces of Precious Metals



Consumer Products

- Trace metal analysis in cosmetic products i.e. sunscreen, moisturizers, deodorants, lipsticks etc.
- Trace metal analysis in cleaning agents, and personal care products
- QA/QC and Determination of chemical composition and impurities into consumer products
- Identification of toxic metals and Lead into kid's toys and Jewelry
- Determining lead in Paint and similar surface coatings



Petrochemical

- Crude Oil, Petroleum products and Secondary Recovered Fuel Testing and Analysis
- Determination of Total Mercury in Liquid Hydrocarbons
- Rare earth element determination in heavy crude oil
- Elemental and toxic analysis of Refinery Ash, Petroleum bi-products
- Multielement analysis of Petroleum Products

Plastic and Polymers

- Quantification of flame resistance metals into Polymers and Plastics
- Determination of hazardous metals into Polymers and Plastics
- Trace metal analysis in Polymer Matrices
- Elemental and toxic analysis of Plastic Waste



Geochemical, Mining and Refractory

- Elemental analysis of Ocean bed polymetallic nodules or manganese nodules
- Trace metal analysis of ores, slags, metals, catalysts and refractories
- Arsenic determination in complex mining residues
- Determination of Total Mercury in coal and fly ash samples
- Recovery of resistate minerals

Cannabis

- Identification of heavy metal in Cannabis-based drug and products
- Quantitation of agrochemicals, moisture content, microorganisms in Cannabis-based drug and products
- Cannabinoid profiling and potency
- Terpene profiling and potency



University Labs and Research Centers

- Basic material research
- Acid digestion and extraction projects
- Compositional analysis: Moisture, Fat, Protein, Ash, Bones etc.
- QA/QC and Product certifications for various industries

Fiber Optic Temperature Sensor (LSENSP)

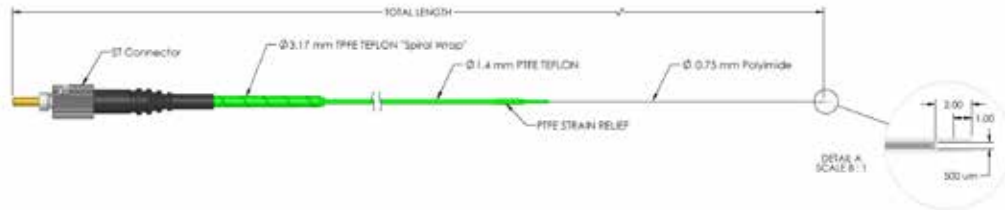


Features

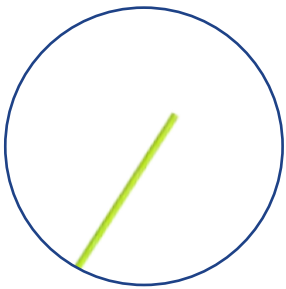
- Rugged sensor suitable for HV applications
- Meets the harsh testing conditions of electric motors and transmission system
- Very high resistance to pulling (>60N)
- Solvent and chemical resistant
- Highly stable sensor, does not require any calibration

Specifications

- Measurement range: -80°C (-112°F) to $+250^{\circ}\text{C}$ ($+482^{\circ}\text{F}$)
- Response time: 200ms; 1ms available as a separate option
- Accuracy: $\pm 0.2^{\circ}\text{C}$ (relative temperature)
- Repeatability: 0.2°C
- Available in any lengths, up to 25 meters
- With industry standard ST connector



Fiber Optic Temperature Sensor (LSENST)

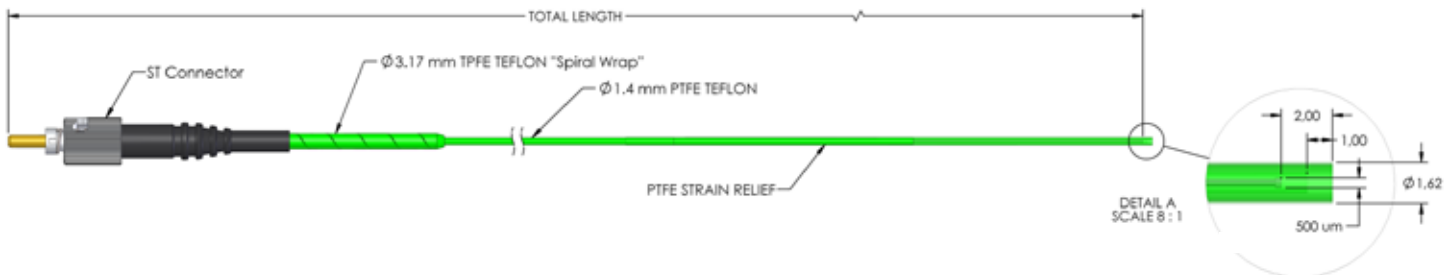


Features

- Small diameter (04mm) for fast response and fitting into places with very limited space
- Outstanding repeatability improves accuracy of testing instruments
- Rugged sensor suitable for HV applications
- Plug and Play operation, does not require setup or calibration
- Minimal thermal shunting

Specifications

- Measurement range: -80°C (-112°F) to $+250^{\circ}\text{C}$ ($+482^{\circ}\text{F}$)
- Response time: 35ms; 1ms available as a separate option
- Accuracy: $\pm 0.2^{\circ}\text{C}$ (relative temperature)
- Repeatability: 0.2°C
- Available at any length
- With industry standard ST connector



Accessories

The following standard accessories for fiber optic temperature sensors are provided in order to fit to customer needs and installation requirements:



Fiber Optic extension cables for applications where test equipment are very far from test object



Terminal rings for fiber optic probe tip mounting for places like cable terminals, battery etc.



Fiber Optic Cable connectors (Metal and Dielectric) to connect two Fiber Optic and Extension cables



Disposable Dielectric Tip that allows Fiber Optic sensors to be reused

Fiber Optic Temperature Monitor (O201)



Features

- Rugged compact design for automotive industry
- Plug and Play installation and operation
- Best in class EMI, ESD Immunity
- Multiple mounting options: Independent, Dinrail, and direct (without enclosure)
- Analog and Relay outputs with custom logic feature (Customer configurable)
- Range of communication options for third party system integration
- High speed CANBUS implemented to suit automotive industry applications

Specifications

- Input Power requirement: 24Vdc, Optional USB powered
- Number of Channels: 01 to 08
- Resolution: 0.1°C
- Measurement Range: Measurement range: -80°C (-112°F) to +250°C (+482°F)
- Operating Temperature: -40°C (-40°F) to +72°C (+162°F) with 95% Humidity
- Dimensions: 125 mm x 125 mm x 48 mm
- Protocol: CANBUS, Modbus, DNP3.0, IEC61850

Fiber Optic Temperature Monitor (L201)



Features

- Rugged compact design for automotive OEM
- Handheld unit for quick testing (Plug and Play)
- Best in class EMI, ESD Immunity
- No shift over time, high stability and repeatability
- Range of communication options for third party system integration
- High speed CANBUS implemented to suit automotive industry applications

Specifications

- Input Power requirement: 24Vdc, Optional USB powered
- Number of Channels: 02 to 08 (expandable)
- Resolution: 0.1°C
- Measurement Range: Measurement range: -80°C (-112°F) to +250°C (+482°F)
- Operating Temperature: -40°C (-40°F) to +72°C (+162°F) with 95% Humidity
- Dimensions: 125 mm x 18 mm x 69 mm
- Protocol: CANBUS, Modbus, DNP3.0, IEC61850

Fiber Optic Temperature Monitor (R501)



Features

- Fully flexible rack mount and distributed architecture support
- Scalable and field upgradable from 02 to 256 channels with plug and play modules
- Best in class EMI, ESD Immunity
- Rugged design to suit harsh testing conditions of automotive industry
- Expandable to add different analog and (or) digital inputs and outputs
- Range of communication options for third party system integration
- High speed CANBUS implemented to suit automotive industry applications

Specifications

- Input Power requirement: 24Vdc, Optional USB powered
- Expandable to 256 Channels, Daisy chain up to 32 units (with Modbus, Canbus)
- Resolution: 0.1°C
- Measurement Range: Measurement range: -80°C (-112°F) to +250°C (+482°F)
- Operating Temperature: -40°C (-40°F) to +72°C (+162°F)
- Operating Humidity: 95% Non Condensing
- Protocol: CANBUS, Modbus, DNP3.0, IEC61850

Monitoring Software (Rugged Connect)



Features

- Web client based real time data visualization
- Historic trending for user selectable duration
- Easily customizable dashboards to meet different application requirements
- Monitoring of Signal strength for Fiber Optic signals for easy troubleshooting
- Flexibility to Enable / Disable Channels remotely
- Support for multiple languages
- Drivers available for LabView, MATLAB and python computing environments
- CANBUS / MODBUS data output for high resolution data logging such as CAN Dataloggers

WHY RUGGED MONITORING

We are an industry leading team of fiber optic experts with 100+ years of combined experience, and are committed to deliver customizable solutions for challenging applications. Our team of experts leads through product innovation to deliver best in class reliability. We deliver reliable, high performance, precision sensors and monitoring solutions. Our mission is to:

- Customer Service** At Rugged Monitoring customers come first. Deliver best in class customer service, be first in mind and choice for customers.
- Rugged Design** Deliver Rugged, intrinsically safe sensors / solutions for the toughest applications.
- Innovation** Leading next generation product innovations with patented technologies.
- Fiber Optic Experts** Our team has extensive knowledge of Power Transformer Industry and viewed as leaders in fiber optic sensing technology.
- Quality Focus** Provide peace of mind to our customers by delivering quality products consistently.



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 leading team of fiber optic 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.

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