

**Distributed  
Temperature  
Sensing**

# **Optical Fiber Temperature Monitoring System**



**ELECTRONIC NEWS  
IMPIANTI**

# Applications



## PIPELINES

### Leakage Detection

To detect oil leakage the sensor must be installed under the pipeline, (often underground) and when a leakage of oil is occurring the system will detect a change in temperature's level in that specific area. Usually there are permanent differences between temperatures of oil and underground but due to season's cycle and different environmental areas crossed by pipeline, it's necessary to fit the sensor to the environment as well as possible to clean our detection from potential fake-alarms.



## DRILLING

Drilling activities in Oil & Gas market need to know the vertical thermal profile of the underground at different depths. The best solution to get such information is to use a DTS fiber optic system based on RAMAN effect. DTS detects all the distributed temperatures, meter by meter, up to 10 Km and more, with a spatial resolution of 1 meter, with a temperature resolution of 0.1 °C.. We are available to develop customize DTS system in relation with drilling's needs and moreover in relationship with environmental condition during drilling activities: on-field system with appropriate power unit and other portable tools.



## FLOATING-ROOF TANKS / FIXED-ROOF TANKS

Temperatures monitoring and fire detection on floating-roof oil tank is for us a standard activity. Year after year consumption and corrosion of the gasket of the floating-roof can generate some leaks of hot-gas, coming from the inner part of tank and passing through the holes of the gasket, generating a potential risk of fire-triggering on the roof. For this reason it's really important to check in real time the temperatures on the roof to understand in time when there is danger leaks of hot-gasses.



## COAL CONVEYOR

Auto-combustion of coal:

Often the coal coming from the boat has high temperatures inside and sometime it start an auto-combustion process. For this reason it's very important to detect temperatures and hot-spot along the coal conveyor, before that coal arrive to the hopper.

### Mechanical friction:

Mechanical gears of a coal conveyor are subjected to overheating process due to mechanical friction aggravated by the "packing effect" of the coal posed around the gear that doesn't let go away the heat generated by mechanical friction.

# Applications



## POWER CABLE

Temperatures detection on power cables for long distances

For installation on high-voltage and medium-voltage distribution net, is useful to install our DTS fiber optic application that is able to cover big distances up to 25 km and more and to detect all the distributed temperatures existing on the cable and not only the hot-spot. Fiber Optic is immune to electromagnetic fields and can be easily inserted directly in the power cable.



## DAM

Using our DTS system is possible to detect potential leakage of water from the front-wall of the dams.

Water Leakage Detection it's realized by analyzing the temperatures changes occurring on the wall.

This is an indirect type of detection but it's almost sure that temperatures changes on the wall are related to water leakage or other critical problems occurring on the wall and this needs accurate analysis.

With DTS system is possible to create the entire thermal profile of the wall, starting from the top it's possible to install the fiber optical cable in many different ways to cover the surface as preferred.



## HIGHWAY TUNNELS

In many countries tunnel's safety is under national regulations; in many European countries fiber optic technology has been selected as one of the best solution for fire detection. Our DTS system is able to detect all the temperatures distributed along the tunnels until 25 Km /each instrument. It's possible to know in real time all the temperatures meter by meter and to receive alarms in case of hot-spot everywhere along the tunnel and moreover we always know where is located the hot-spot. For this reason DTS solution is used for medium/long tunnel because we need to know where is the heat-source in an accurate way.



## RAILWAYS TUNNELS

**Fire detection: please take a look at high-way tunnels applications.**

Railway tunnels have similar fire detection requirements of highway tunnels. We provide two different applications: FCT for short tunnels; DTS for medium/ long tunnels, up to 25 Km and more.



## DTS•LD

## DTS-Long Distance

**DTS•LD:** Distributed Temperatures Sensor - Long Distance is our innovative Fiber Optic based sensor able to detect all the distributed Temperatures existing along the entire Fiber Optic Cable, until maximum of 25 km length with a Temperature-Resolution until 0.1 °C and a space-resolution until 1 meters.

This Application, based on RAMAN effect, is a breakthrough technology able to open new opportunities in Heating Control and Temperatures Monitoring Processes in hazard environments, such as:

- Oil & Gas, Power Generation,
- Tunnels and others.

Every new technology needs some years to understand all the available Applications. At the moment this new technology is requested for the following Applications:

- Leak Detection System for Pipeline for transportation of oil or gas
- Fire Detection in Tunnels (Highway/Railway/Underground) or in other Application such as Coal Conveyor/Paper Industry.
- Industrial Processes needing Temperatures-Monitoring to maintain its standard-productivity level.
- Smart Grid: to detect Electric-Consumption in high/medium voltage grid, as well as to detect Hot-Spot due to over-voltage in the grid > to prevent black-out and fire.



## DTS•SD

## DTS•HT

## DTS-Short Distance

**DTS•SD:** Distributed Temperatures Sensor - Short Distance is our innovative Fiber Optic based Sensor able to detect all the distributed Temperatures existing along the entire Fiber Optic Cable, until maximum of 10 km length with a Temperature-Resolution until 0.1 °C and a Space-Resolution until 1 meters. Field of Application: Tunnels

## DTS-High Temperature

**DTS•HT:** Distributed Temperatures Sensor - High Temperature is our innovative Fiber Optic based Sensor, able to detect all the distributed Temperatures existing along the entire Fiber Optic Cable, until maximum of 5 km length with a Temperature-Resolution until 0.1 °C a Space-Resolution until 2 meters and an operative Temperature range of 350 °C. Hot-spot detection until a 750°C (but only for a short-time).

Field of Application: Reactor's external surface (Reactor for Gasification Process) - many different areas inside Refinery or Power-Plant where there are high operative Temperatures.

## Working Principle

The measurement principle is based on the optical detection of backscattered light induced by spontaneous Raman processes involving inelastic scattering, and is based on techniques exploiting optical time domain reflectometry (OTDR).

The opto-electronic interrogation unit sends pulses along the sensing fiber, where the pulse duration determines the spatial resolution of measurement, and the back-scattered Raman radiation, carrying information on fiber temperature, is photo-detected with high temporal resolution.

The employed relationship between the Anti-Stokes Raman component, strongly temperature dependent, and the Raman Stokes component, allows to reconstruct the temperature profile along the fiber over distances of tens of kilometers, eliminating the side effects of possible loss variation along the cable, allowing for spatial resolution values of the order of a meter.

The system performs multiple scans of the fiber and a large number of averages while ensuring fast acquisition of the order of few seconds.

The system consists of an opto-electronic interrogation unit and the fiber-optic cable that can contain multiple single-mode and multi-mode fiber, and accompanying accessories such as electrical panels, extension cables, protection boxes.

The sensing element is the optical fiber itself, which is inserted inside properly designed cabling, allowing for an efficient interaction with the surrounding environment and enhancing the fast detection of temperature profiles along the structures to be monitored.

The cable is available in many varieties depending on the operating temperature range and type of installation (ducts, indoors, outdoors, underground, along pipes, and so on). DTS is used for a wide range of applications in strategic sectors such as energy, environment, transport, security, oil and petrochemical industries, wherever it is necessary to detect the temperature in many points distributed over large areas (hot and cold spots), as well as for leakage and micro-leakage automated detection.

There are two measurement configurations, namely single-end and loop configurations.

In the single-end scheme only one fibre-end is connected to the laser, and the light pulses are sent along one direction only; in the loop scheme both fiber-ends are connected to the laser, light pulses are sent alternately in both directions through an optical switch, and the temperature profile is obtained by employing geometric means of the detected Stokes and Anti-Stokes traces along two different directions.

The loop scheme, while potentially decreasing the maximum sensing distance (to one half in case of sensing along linear structures), however, ensures high precision, stability and reliability of the measure and does not require periodic system calibrations.

The sensor system offers the possibility of doubling the maximum distance measurement, in both single-end and loop configurations, by alternately interrogating two different fibers extending in opposite directions, for example along a gas or oil pipeline.

The main advantage of the measuring technique is the ability to perform distributed measurements over distances of several tens of kilometers with spatial resolutions of the order of meters and temperature resolutions of the order of the Celsius degree, with measurement times of few tens of seconds.

In addition, the used cable typically allows for an easy installation, and no active electronic components along the measurement area are required.

Along the cable, the measurement is inherently immune to electromagnetic field interference (EMI), as well as to fiber cable deformations, and is insensitive to moisture and /or corrosion, as well as being fully compatible with the current ATEX regulations.



## Technical Features

Measurement and Control Unit	DTS2000•SD	DTS2000•LD
<b>Misurement Range</b>		
Single-end	0 ÷ 10 km	0 ÷ 25 km
Single-end two way	0 ÷ 20 km	0 ÷ 50 km
Loop	0 ÷ 5 km	0 ÷ 12,5 km
Double Loop	0 ÷ 10 km	0 ÷ 25 km
<b>Optical Fiber Type</b>	Multi-Mode	Multi-Mode
<b>Spatial Resolution</b>	1 m (typical)	2 m (typical)
<b>Cable Temperature Range</b>		
STD Cable	-20 ÷ +80 °C	-20 ÷ +150 °C
High Temperature Cable	-20 ÷ +250 °C	-20 ÷ +300 °C
<b>Temperature Resolution</b>	0.5 °C with 20 s Response Time 0.3 °C with 60 s Response Time	2.5 °C with 35 s Response Time 1.7 °C with 70 s Response Time
<b>Response Time</b>	20 s (typical)	35 s (typical)
<b>Power Supply</b>	90 ÷ 240 Vac	90 ÷ 240 Vac
<b>Operating Conditions</b>		
Operating Temperature	0 ÷ +50 °C	0 ÷ +50 °C
Storage Temperature	-10 ÷ +55 °C	-10 ÷ +55 °C
Relative Humidity	5 ÷ 95% non-condensing	
<b>Dimensions</b>		
Height	220 mm	220 mm
Width	470 mm	470 mm
Depth	431 mm	431 mm
Weight	22 kg	22 kg

## Communication and Alarms

<b>Communication Ports</b>	RS485 Serial with ModBusRTU, Ethernet, optional custom protocols (DPC/ASCII, TCP/IP, others)
<b>Zone Management</b>	Up to 64 Zone programmable alarm zones with length and distance variables start-end area
<b>Types of Alarms</b>	8 types of programmable alarm by zone: absolute value (low, high, critical), variation over zone average (low, high, critical), slope (positive, negative)
<b>Alarms Handing</b>	Up to 16 SPDT relay outputs, max. 250Vac/2Aac, combined with the alarm settings
<b>Self Diagnostics</b>	Continuous self-diagnosis: laser power, fiber length, detection system correct operation, internal temperature. Anomaly signaling through serial output
<b>Optional Modules</b>	Module with 8 analog outputs 4 ÷ 20 mA matched to specific cable locations

## Fiber Optic Cable

The fiber optic sensor is designed to perform distributed temperature measurements over large sensing distances.

The cable can contain up to 8 optical fibers and is built to the customer specific needs. Typically the fibers are enclosed by a buffer tube, followed by a rodent and reinforcement protection in aramid yarns, by intermediate and final protection sheaths with low smoke and zero halogen emission, and by a galvanized steel braiding armor.

The composition of these elements and their sizing vary according to the characteristics of the involved process and application. The different available coating varieties for the optical fiber cable allows to design cables operating at different temperatures (typically up to 80 °C and 150 °C).

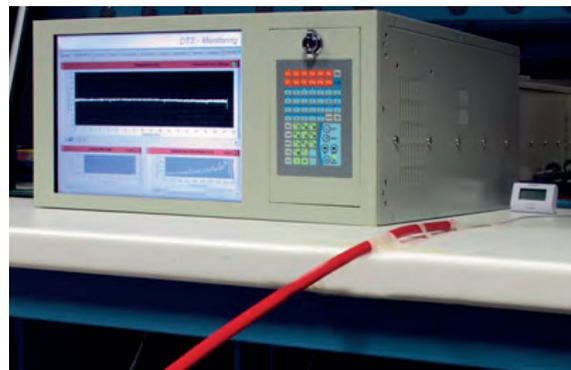
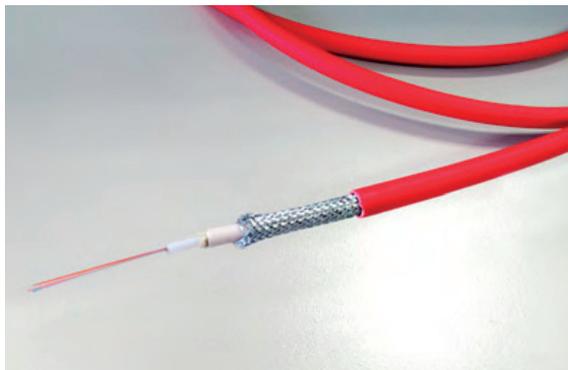
The galvanized steel protection allows for high mechanical and chemical resistance, and the possibility of manufacturing the protection sheaths in polymers with low smoke and zero halogen emission also allows for deployments indoors or within settings having stringent regulatory requirements.

Hence, the sensor system is fully adaptable for to a wide range of possible applications, from monitoring of public structures such as buildings, museums, road tunnels, up to applications in hostile or hazardous environments such as those in the energy, oil and petrochemical sectors.

Fibre-optic cables are normally supplied with 5 km length, and are easily transported with spools. Together with the cable, all the necessary connecting parts are provided, such as cable-holders, connectors, and so forth.

The fiber-optic cables can be repaired or joint together in case of accidental breaks, due to plant requirements, or in order to attain distances greater than 5 km. Junctions are carried out through fusion-splicing and by inserting suitable connectors within properly designed junction boxes.

Such an activity can be directly performed in-field.



## Cable Specification

	STD Cable	High Temperature Cable
<b>Components</b>	Optical fiber, buffering tube made of PBT, reinforcement and rodent protection in aramid yarns (Kevlar), LSZH sheaths, steel braiding armor	Optical fiber, reinforcement and rodent protection in aramid yarns Kevlar, polyamide (PA) sheaths, steel braiding armor
<b>Temperature Range</b>	-20 ÷ +80 °C -20 ÷ +80 °C storage	-20 ÷ +150 °C -20 ÷ +150 °C storage
<b>Max Fiber Optic number</b>	8	8
<b>Cable Diameter</b>	5,2 mm after intermediate sheath 9,0 mm after final sheath	5,2 mm after intermediate sheath 9,0 mm after final sheath
<b>Cable weight</b>	83 kg/km with LSZH sheath	83 kg/km with LSZH sheath
<b>Minimum bend radius</b>	20 times the outer cable diameter	20 times the outer cable diameter
<b>Certifications</b>	CE • LASER pulsed - Class • 1M ATEX	

# ELECTRONIC NEWS IMPIANTI

## companies



### *Main Products*

- Thermal Control System
- Fire Prevention System
- Fiber Optic Sensors
- Continuous Thermocouple  
Linear Sensor
- Acoustic Sensor
- Customized Electronic  
Instruments

### *Industrial Automation for*

- Temperatures
- Monitoring in Industrial  
Processes
- Special Thermocouple

**ELECTRONIC NEWS IMPIANTI S.R.L.**  
Via Marzorati, 13 - 20014 Nerviano (Milano) Italy  
Phone: +39 0331 1550779  
Fax: +39 0331 1351224  
e-mail: [info@elenewsimpianti.it](mailto:info@elenewsimpianti.it)



**ELECTRONIC NEWS  
IMPIANTI**