Distributed Temperature Sensing

Fiber Optic Technologies

DTS
The Company History

ELECTRONIC NEWS is an Italian medium-size company founded in 1978 near Como lake in the north of Italy.

In the first 10 years of activities Electronic News was focused in engineering and production of Heating Control System, Thermal Control System and Electronic Instruments customized for customer’s needs.

In the 1990 ELECTRONIC NEWS started to provide “turnkey solutions” for heating-control / fire-prevention in Oil & Gas and Power Generation markets.

In the 2008 ELECTRONIC NEWS founds Fibersens company in collaboration with Sant Anna Photonic Institute. Fibersens is a spin-off company for developments of fiber optic sensing.

Electronic News today is a System Integrator able to provide many different turnkey solutions as well to engineer and realize customized electronic instruments and sensors.
• Wide Temperature range
• Spatial Resolution down to 1 m
• Temperature Resolution down to 0.1 °C
• Response Time down to 10 seconds
• Distance up 25 km
• Long term Stability
• Immunity to electromagnetic fields
• Cable for high mechanical strength, protection against corrosion
• Possibility to use deployed fiber optic cables
• Simple installation procedures

• Coal Conveyor, Oil, Steam and Gas pipelines
• Chemical and Petrochemical plants and platforms
• Petroleum Industry:
  • Deposits, Pumping Systems
  • Storage Tanks
  • Energy Production Plants
• Road and Rail tunnels
• Civil Applications:
  • Airports, Subways, Shopping Malls

• Distributed Temperature Measurements over large distances
• Leakage and micro-leakage detection
• Fire Monitoring and Prevention
• Intrusion Detection
Oil & Gas

PETROCHEMICAL PLANT
In many chemical plants it’s necessary to check in real time processes temperatures to prevent risk of fire and to optimize plant production efficiency. Our fiber optic linear sensors can be easily installed along all the production-line and detect all the distributed temperatures of the monitored process giving us precious information about the status of the process and of the plant. We developed special fiber-optic sensor that can stand to high temperatures and in the while time provides fast response with a strong sensitivity.

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 top 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 potable tools.

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.

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.
Power Generation

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.

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.

SMART GRID
The increasing demand of electric power is pushing power company-distributor to use their net at its maximum physical-performance increasing risks of over voltage. It becomes necessary to be able to detect temperatures profile along cables to prevent potential hot-spot, fire and to match energy demand with energy supply.
Today, many different energy production-plants of big/medium/small size are entering their energy in the net creating continuous voltage and thermal variation, especially after the introduction of energy produced by renewable sources that are intermittent-sources.
For this reason it becomes very important top set advanced tools to be able to know trend temperatures on the net.

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.
Civil Application

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.

SHIPS

Hot-spot detection on engine room

In the boat the engine-room must be protected and monitored 24 a day. A problem occurring on the engine could generate enormous damages to the boat and consequently to the company itself. Our Linear Sensor can control all the temperatures distributed inside the engine and in all the mechanical gear/device to prevent any over-heating problem.

AIRPORTS

Some airports need to know the distributed temperatures on their runways. The best solutions to do it is to lay underground the DTS fiber optic sensor that with its 25 Km length is able to cover a big area of the runways. Another application is to monitor the hangars in order to prevent fires.
Temperature Detection System and Fire Prevention
Fiber Optic Technologies
Design and Manufacturing of Industrial Control Equipment

Optical Fiber Temperature Monitoring System

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 breaking-trough 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•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 and 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.

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

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.

• 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.
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

<table>
<thead>
<tr>
<th>Measurement and Control Unit</th>
<th>DTS2000-SD</th>
<th>DTS2000-LD</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Misurement Range</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Single-end</td>
<td>0 + 10 km</td>
<td>0 + 25 km</td>
</tr>
<tr>
<td>Single-end two way</td>
<td>0 + 20 km</td>
<td>0 + 50 km</td>
</tr>
<tr>
<td>Loop</td>
<td>0 + 5 km</td>
<td>0 + 12.5 km</td>
</tr>
<tr>
<td>Double Loop</td>
<td>0 + 10 km</td>
<td>0 + 25 km</td>
</tr>
<tr>
<td><strong>Optical Fiber Type</strong></td>
<td>Multi-Mode</td>
<td>Multi-Mode</td>
</tr>
<tr>
<td><strong>Spatial Resolution</strong></td>
<td>1 m (typical)</td>
<td>2 m (typical)</td>
</tr>
<tr>
<td><strong>Cable Temperature Range</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>STD Cable</td>
<td>-20 ÷ +80 °C</td>
<td>-20 ÷ +150 °C</td>
</tr>
<tr>
<td>High Temperature Cable</td>
<td>-20 ÷ +250 °C</td>
<td>-20 ÷ +300 °C</td>
</tr>
<tr>
<td><strong>Temperature Resolution</strong></td>
<td>0.5 °C with 20 s Response Time</td>
<td>2.5 °C with 35 s Response Time</td>
</tr>
<tr>
<td></td>
<td>0.3 °C with 60 s Response Time</td>
<td>1.7 °C with 70 s Response Time</td>
</tr>
<tr>
<td><strong>Response Time</strong></td>
<td>20 s (typical)</td>
<td>35 s (typical)</td>
</tr>
<tr>
<td><strong>Power Supply</strong></td>
<td>90 ÷ 240 Vac</td>
<td>90 ÷ 240 Vac</td>
</tr>
<tr>
<td><strong>Operating Conditions</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Operating Temperature</td>
<td>0 + 50 °C</td>
<td>0 + 50 °C</td>
</tr>
<tr>
<td>Storage Temperature</td>
<td>-10 ÷ +55 °C</td>
<td>-10 ÷ +55 °C</td>
</tr>
<tr>
<td><strong>Relative Humidity</strong></td>
<td>5 ÷ 95% non-condensing</td>
<td>5 ÷ 95% non-condensing</td>
</tr>
<tr>
<td><strong>Dimensions</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Height</td>
<td>220 mm</td>
<td>220 mm</td>
</tr>
<tr>
<td>Width</td>
<td>470 mm</td>
<td>470 mm</td>
</tr>
<tr>
<td>Depth</td>
<td>431 mm</td>
<td>431 mm</td>
</tr>
<tr>
<td>Weight</td>
<td>22 kg</td>
<td>22 kg</td>
</tr>
</tbody>
</table>

Communication and Alarms

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

Such an activity can be directly performed in-field.

Cable Specification

<table>
<thead>
<tr>
<th></th>
<th>STD Cable</th>
<th>High Temperature Cable</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Components</strong></td>
<td>Optical fiber, buffering tube made of PBT, reinforcement and rodent protection in aramid yarns (Kevlar), LSZH sheaths, steel braiding armor</td>
<td>Optical fiber, reinforcement and rodent protection in aramid yarns Kevlar, polyamide (PA) sheaths, steel braiding armor</td>
</tr>
<tr>
<td><strong>Temperature Range</strong></td>
<td>-20 + +80 °C</td>
<td>-20 + +150 °C</td>
</tr>
<tr>
<td></td>
<td>-20 + +80 °C storage</td>
<td>-20 + +150 °C storage</td>
</tr>
<tr>
<td><strong>Max Fiber Optic number</strong></td>
<td>8</td>
<td>8</td>
</tr>
<tr>
<td><strong>Cable Diameter</strong></td>
<td>5,2 mm after intermediate sheath 9,0 mm after final sheath</td>
<td>5,2 mm after intermediate sheath 9,0 mm after final sheath</td>
</tr>
<tr>
<td><strong>Cable weight</strong></td>
<td>83 kg/km with LSZH sheath</td>
<td>83 kg/km with LSZH sheath</td>
</tr>
<tr>
<td><strong>Minimum bend radius</strong></td>
<td>20 times the outer cable diameter</td>
<td>20 times the outer cable diameter</td>
</tr>
<tr>
<td><strong>Certifications</strong></td>
<td>CE • LASER pulsed - Class • 1M ATEX</td>
<td></td>
</tr>
</tbody>
</table>
ELECTRONIC NEWS is certified by UNI EN ISO 9001:2000 and guarantee high quality in all internal processes, as certified by CSICERT. All our electronic instruments are certified as ATEX products.
Markets
- Oil & Gas
- Power Generation
- Tunnels
- Smart Grid

Worldwide
- Europe
- Middle East
- South America
- IRAN
- DUBAI
- BRASILE
- ARGENTINA
- COLOMBIA
- DANIMARCA

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

Instruments Division
- Lenno (CO)

“Turnkey Solutions” Division
- Cernobbio (CO)

Installation and Service Division
- Vado Ligure (SV)

FIBERSENS
R&D in Fiber Optic Sensing
- Pisa