

omnisens securing  
power cable integrity

# Cobra

omnisens   
Securing asset integrity

# Omnisens Cobra Energy Cable Monitoring Solutions

- > Cable load optimization
- > Cable condition monitoring

## WHY MONITOR ENERGY CABLES?

Power engineers are challenged to provide uninterrupted supply at minimal financial and environmental cost, whilst fulfilling regulatory requirements, being Smart Grid compliant and cyber secure.

The condition and performance of power cables, critical to electricity supply, can change during their long service life and these changes, if unnoticed, will result in unplanned outages. Distributed Temperature Sensing (DTS) helps detect these changes before cables fail.

### Cable Condition monitoring

Omnisens Cobra is a fiber optic Distributed Temperature Sensing system (DTS), which detects, locates and profiles small temperature changes along the entire length of a power cable continuously, in real time.

In addition, knowing the actual cable behavior under load can help with decisions regarding investment in the circuit. Cables may still be in good condition long beyond their as-built service life.

### Cable and circuit optimization

To optimize the performance of cables Omnisens Cobra has an optional Dynamic Cable Rating module. Knowing how power cables are reacting to changes in load and their environment, the operator uses the actual data from that cable to make load management decisions.

Feed-in from renewable generation and Smart Grid requirements result in fluctuating loads. Omnisens Cobra provides condition monitoring continuously, in real time, enabling safe operation beyond the steady state current ratings, ensuring the return on investment in the asset.

Driven primarily by the offshore wind farm requirement for longer, lighter cables, data from DTS has informed decisions on reducing cable conductor size.

## WHY CHOOSE OMNISENS COBRA?

Omnisens Cobra is a modular fiber optic distributed monitoring solution. It combines:

- > Omnisens high performance DTS, based on Brillouin or Raman scattering depending on the project requirements. The DTS detects, locates and profiles small temperature changes along the entire length of a power cable continuously, in real time.

Omnisens Raman DTS interrogators provide temperature monitoring of power cables using multimode optical fiber as the sensor. For many cables, particularly shorter direct buried cables, this is an ideal solution.

Omnisens DITEST interrogators are based on Brillouin sensing. The DITEST is a DTS which provides effective monitoring of long cables, or where the sensing fiber experiences significant optical loss, with consistent spatial resolution, using single mode fiber sensors. It detects temperature and/or strain. Due to manufacturing, transport and installation challenges of long cables, the sensing fiber may be placed under tension and strained. The affected cable sections can be successfully monitored for temperature using compensation techniques developed by Omnisens. Whether unintentionally detected or actively monitored for using an appropriate fiber optic sensor design, strain provides another insight into the power cable's condition. Knowing where strain exists or is developing, the operator can mitigate against the effects this may have.

- > Omnisens Map, a customizable graphical user interface, and
- > Dynamic Cable Rating for optimizing cable performance, completes the package.

### How this performance helps decision making

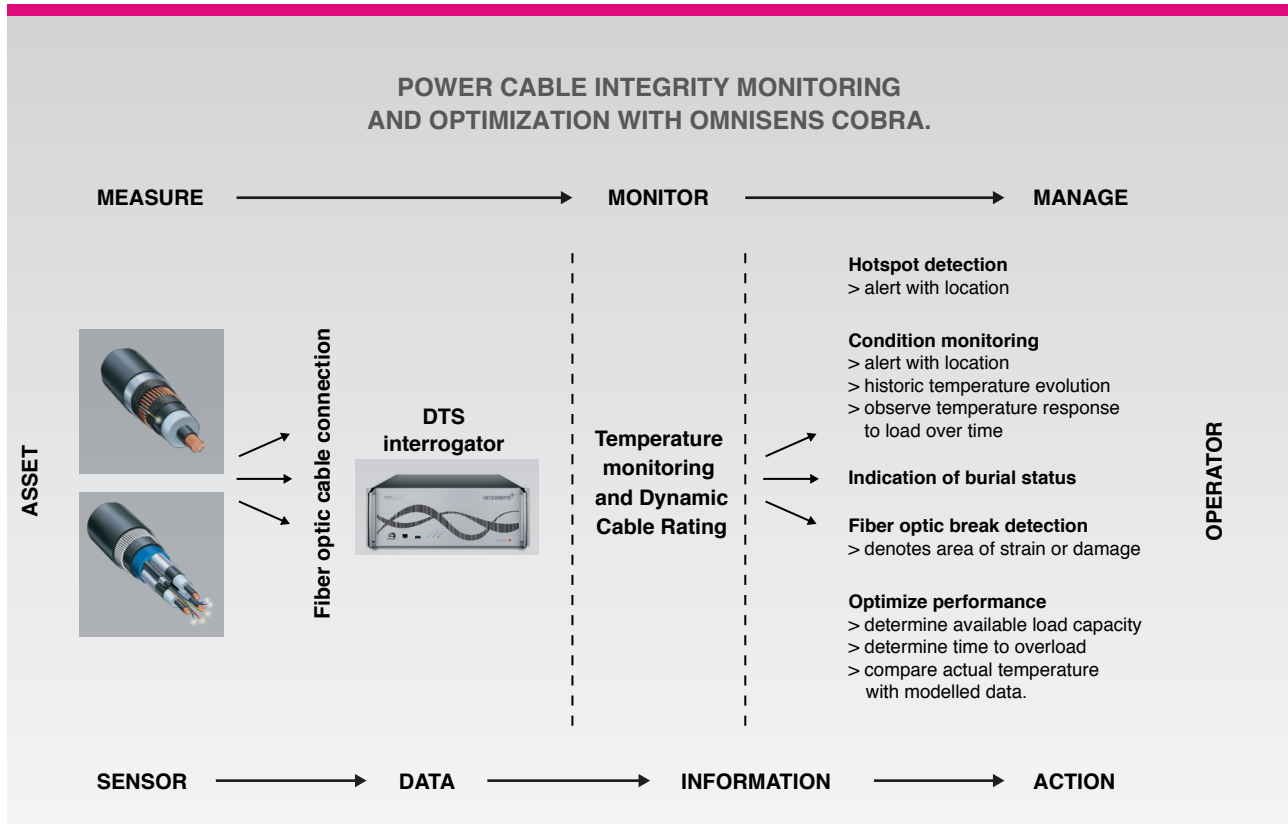
The ability to locate and resolve a small temperature event means that an incipient hot or cold spot which affects as little as 1 m anywhere along the cable can be detected, located and tracked from its earliest appearance, giving the operator time to take action.

Precise temperature resolution means that a change in temperature can be detected and reported quickly.

The speed of detection of small developing events enables the Dynamic Cable Rating system to deliver rapid, reliable extrapolations on which load management decisions can be based. In fact, the Dynamic Cable Rating indicates the actual time remaining for decisions to be made.

The distance range of a single interrogator means that even longer cables can be monitored all along their length. If appropriate, additional interrogators can be added. Developing temperature events can thus be detected, located and investigated.

Exceptional measurement performance, sophisticated monitoring algorithms and optional Dynamic Cable Rating module help operators make timely, informed decisions about their cables and maximize the financial performance of these high fixed-cost items.



*Omnisens Cobra provides high performance, long distance monitoring enabling operators and utilities to optimize their power cables.*

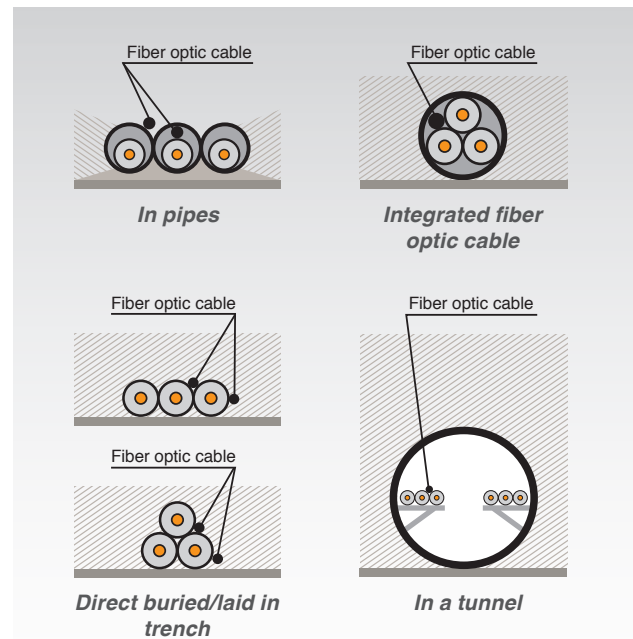
## OMNISSENS COBRA FOR ONSHORE CABLES

### Monitoring cables buried, in ducts or in tunnels

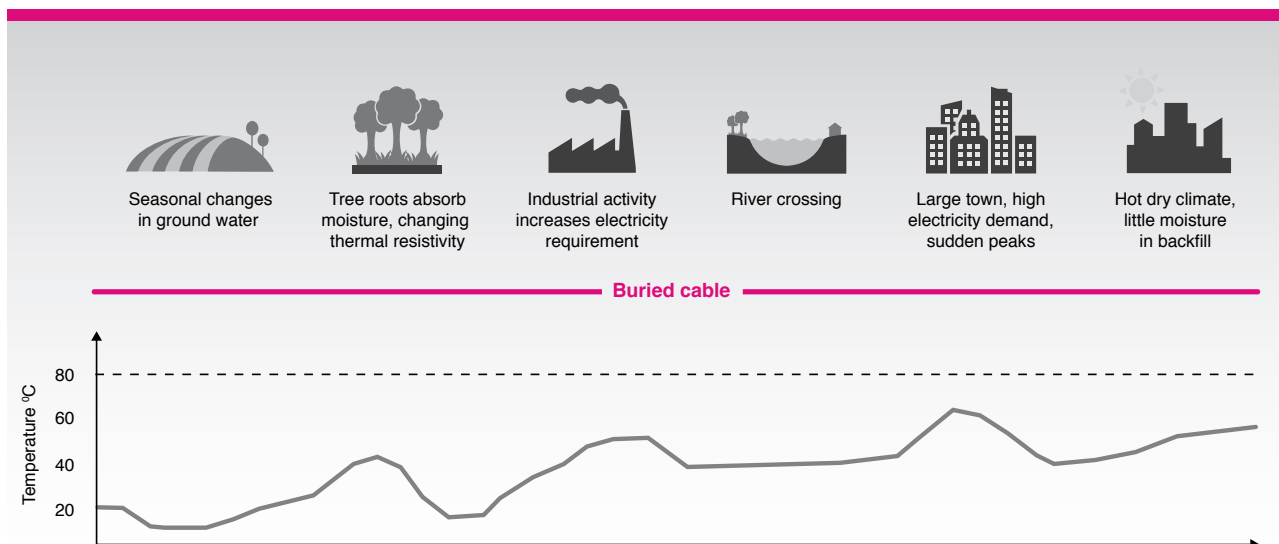
Over time, the soil around a buried cable may dry out, flood, be altered during construction work or by ground movement, resulting in changes to the backfill and thus the cable's ability to dissipate heat. Even cable ducts are subject to damage from construction work. A cable overheating in a tunnel may lead to subsequent catastrophic failure.

For monitoring the temperature of energy cables, the optical fiber sensing cable is either integrated within the energy cable, attached to it, or placed close by. A nearby existing communications cable can also be employed. The fiber sensing cable should comprise strain-free single mode (communications grade) fiber.

Temperature monitoring of cables pinpoints developing temperature events in real time. A visual inspection or other intervention can then be directed to the part of the cable concerned and the risk of subsequent failure greatly reduced. Adding Dynamic Cable Rating, the cable can be safely loaded according to actual temperature, rather than the steady state rating.



*Some typical locations of optical fiber sensing cable in power cable installation.*



*During its > 40 year life a buried power cable faces unforeseen changes in its environment which will affect its thermal profile. Installing cables in pipes or ducts minimizes some of these effects, but the unforeseen still happens.*

## OMNISENS COBRA FOR SUBMARINE CABLES

### Export, array, power-from-shore and interconnector cables

Currents, moving sea and riverbeds, diurnal and seasonal temperature changes as well as fishing, shipping and submarine activities all pose threats to subsea cables.

Using optical fibers within the cable its temperature can be monitored continuously along its length and damage to the cable or changes in its environment can be detected.

With its ability to measure distances of up to 100 km from a single interrogator (solutions are available for longer distances), Omnisens DITEST can be placed some distance from the cable. Housing the interrogator onshore results in easier access for maintenance (no dependence on weather windows, or offshore qualified personnel availability), eliminating offshore capex and reducing opex.

### Cable exposure (un-burial)

The force from currents and storms may result in the exposure of a buried cable. Unsupported, it flexes with the current, accumulates fatigue and subsequently fails. Set to alert at a certain rate of rise or fall in temperature, Omnisens Cobra will indicate the exposed location at an early stage, enabling the operator to investigate and minimize the risk of cable failure.

### Windfarm cables

Cables, both export and inter-array, damaged by strain and inappropriate handling during installation and transport, may fail prematurely. The energy generated by the wind farm can vary dramatically introducing significant thermal stresses. A change in the cable's temperature may be the first indication of impending failure.

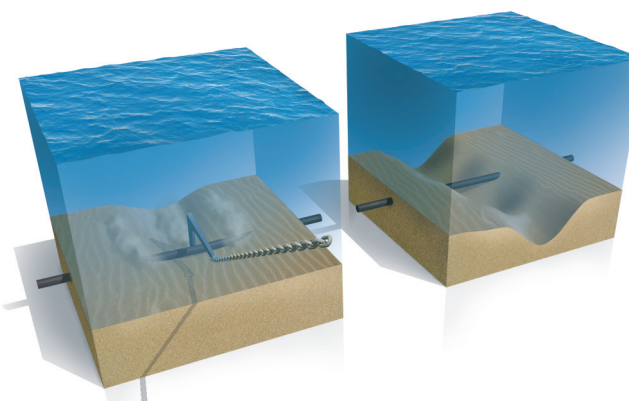
As soon as a change in the temperature is logged by Omnisens Cobra, (a range of alerts and zones is available for this) action can be taken; the load can be adjusted and/or that part of the cable investigated. Rapid detection can mean the difference between reducing current in a circuit and an unplanned outage.

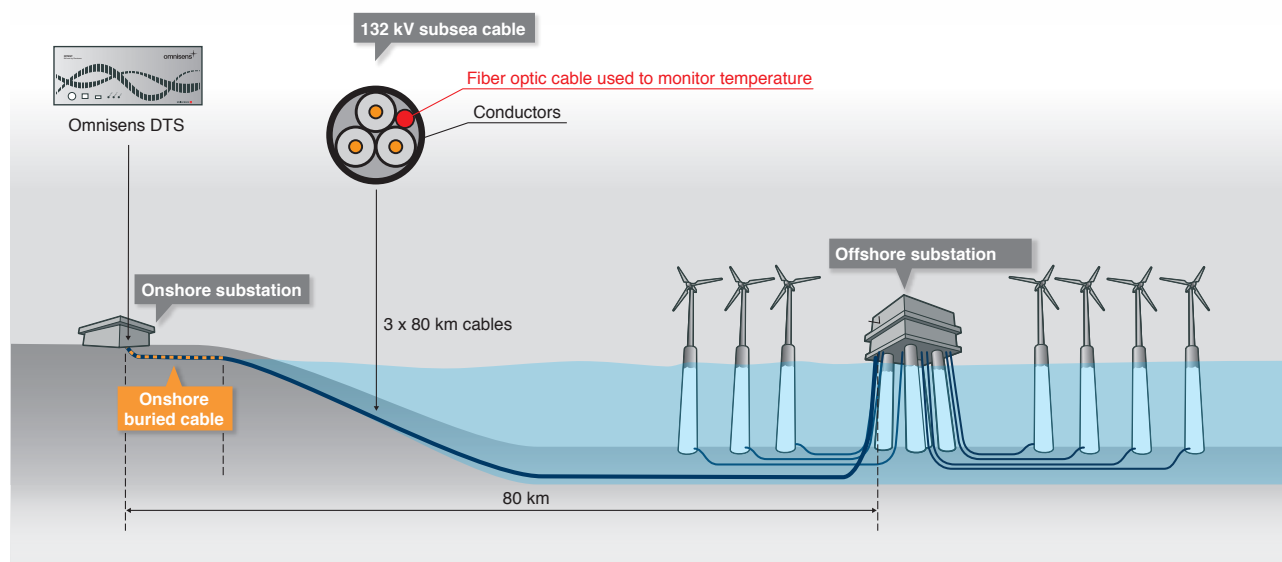
Omnisens Cobra can be extended using the built-in measurement channels or external switch, to include several cables giving the flexibility to monitor additional cables as the wind farm expands.

### Power-from-Shore

The power-from-shore cable includes a dynamic section below the hang-off point. The bend stiffener, component friction and touchdown point protection may contribute to unforeseen effects on the cable's temperature.

Areas of higher temperature can be identified as separate zones in the Cobra system with alerts set accordingly, giving the operator early warning that the maximum operating temperature may be exceeded. This information can also be included in the feedback to the cable model to predict service life.





*Omnisens Cobra's distance range means the cables (array and export) of a wind farm can be monitored from the onshore substation. For larger, more distant windfarms, Omnisens Cobra offers flexibility of location, effective condition monitoring and a precise input for Dynamic Cable Rating.*

### Interconnectors

Interconnectors are highly engineered, prized assets, critical to international electricity trading. Built to withstand the test of time and their environment, they suffer from the effects of currents, tides, fishing and submarine activities.

Omnisens Cobra provides uninterrupted temperature monitoring for interconnectors, with Dynamic Cable Rating to ensure the performance of each cable system is optimized.

## COMPREHENSIVE CABLE MONITORING SOLUTIONS

### Dynamic Cable Rating

The fiber optic temperature monitoring cable is usually integrated within or attached to the power cable, a certain distance away from the conductor. This works well for condition monitoring.

To optimize the cable's performance, Omnisens Cobra has an embedded Dynamic Cable Rating (DCR) option, which establishes the relationship between load and temperature for the power cable and uses this to manage the performance of the cable and provide ratings in emergency situations.

Dynamic Cable Rating uses algorithms based on IEC 60287 Electric cables - Calculation of the current rating and 60853 - Calculation of the cyclic and emergency current rating of cables. The DCR calculates the conductor temperature from that shown by the fiber optic cable, based on the cable construction, electrical design, laying configuration and surrounding conditions.

Knowing the temperature of the conductor and the load, the following predictions can be made:

- > time before maximum temperature is reached, given a permanent or dynamic load pattern and the maximum conductor temperature limit for the cable
- > temperature of the cable at the end of a given period of (over) load
- > maximum ampacity of the cable, given the duration (time) and the allowable temperature during an emergency situation.

To set-up the Dynamic Cable Rating, the operator supplies full details of the cable's construction and installation, for the different route sections, since these affect the cable's temperature. As with all things, the better the quality of the information entered into the model, the more precise will be the outputs, (alerts, temperature profiles). Accurate outputs enable the operator to see a developing event sooner and/or locate it more precisely, allowing more options to be investigated, reducing the risk of unplanned outage.

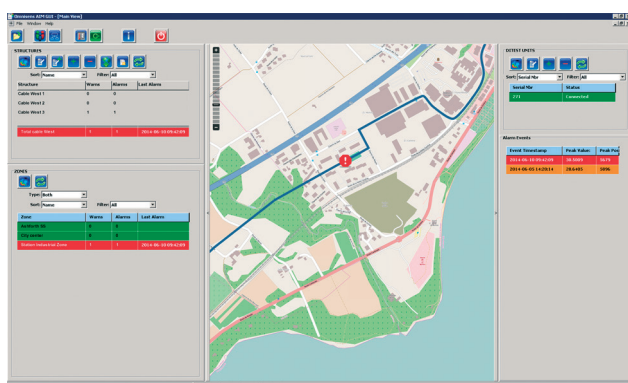
Using Dynamic Cable Rating helps ensure:

- > Flexibility and efficiency: knowing the available capacity in the cable allows the operator to increase the load to within the maximum safe operating conductor temperature, giving them an informed choice of circuit availability and helping get the maximum return from the asset investment.
- > Sustainability: knowing there is enough capacity in the cable to accept new feed-in can mean postponing investment decisions until they are necessary.

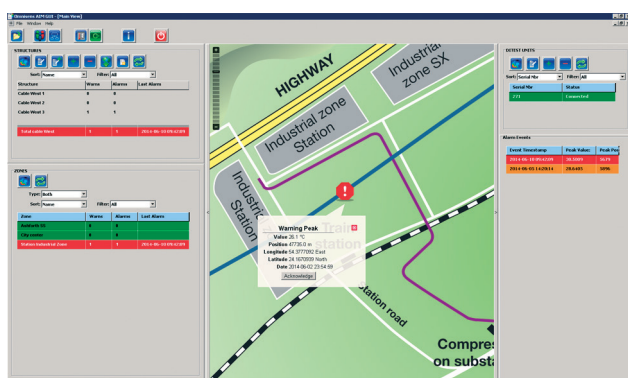
## OMNISENS MAP

Providing a simple ‘see at a glance’ visualization of the entire asset, showing alerts and events, Omnisens Map is an optional module which compliments Cobra.

Information from Omnisens Cobra Dynamic Cable Rating can be integrated into Omnisens Map, eg: position of lowest and highest monthly temperature.



*An event, or events, occurring along the power cable show as alert signals on the graphic representing the asset. The details of the event are shown in a zoom window.*



*Omnisens Map gives a graphical representation of the location of events which prompt an alert. The asset route data is provided by the client and integrated into Cobra by Omnisens. The temperature profiles are also available for analysis.*

**Omnisens Cobra monitors temperature all along the cable. Thanks to its distance range the interrogator can be housed many kilometers from the asset.**

**An optical switch provides extra channels so that several cables can be monitored from the same interrogator. Alerts can be sent to SCADA via TCP or relays. The interrogator is usually housed in the control/instrument room on- or offshore. Portable versions are available for surveys onshore or from a vessel.**

## OMNISENS SERVICE

### Application engineering

Specialists are available to ensure that the Omnisens system corresponds to client requirements, via:

- > Sensing system design, monitoring system tests and validation.
- > Configuration optimization (zone identification and alert thresholds), including system redundancy and communication connectivity (alert and status information)
- > Integration into third party systems, (SCADA).

### Surveys

- > Condition of fiber optic cable pre-, during and post-integration into power cable
- > Temperature of power cable pre-energization, during new circuit construction and testing.

### Commissioning and installation

- > System configuration, zone and alert optimization
- > On-site acceptance testing
- > Remote access set-up and operator training.

### Service contracts

A range of services ensures continuous availability of the monitoring system. These include:

- > On-site service preventive maintenance visit
- > Refresher training and system re-configuration
- > Rapid ‘change-out’ in case of equipment failure or damage.



## OMNISENS COBRA SUMMARY

Omnisens Map, Dynamic Cable Rating and the high performance measuring ability from DITEST combine to provide the complete solution for optimum power cable monitoring.

**Proven:** Omnisens Cobra is a leader in long distance cables sensing, with a track-record of monitoring onshore, interconnector and wind farm cables around the world.

**Performance:** Up to 100 km from a single interrogator unit, without compromising performance. The spatial resolution is set-up during configuration and stays the same along the distance range. High optical budget gives installation margin.

**Sensitivity:** Incipient temperature changes can be detected and localized, giving the operator time to take action.

**Cost effective and flexible:** The available distance range means that the control unit can be located where it suits the operator. If the asset is extended it is likely Omnisens Cobra can be upgraded to monitor it.

**Reliable with reduced risk of false alarms:** The frequency based technique (Brillouin) used in Omnisens DITEST interrogator gives reliable results over the long term. It is immune to measurement drift, (a source of false alarms), and has sufficient power to overcome significant fiber attenuation and connection losses.

**Communication:** status and detected events can be communicated in real time to a range of third party systems. Omnisens follows Information Security Management guidelines to ensure information integrity, availability and traceability.

### TYPICAL PERFORMANCE CRITERIA AT VARIOUS CABLE LENGTHS. (PERFORMANCE CRITERIA ARE INTERDEPENDENT)

Distance range <sup>1</sup> (km)	Spatial resolution <sup>2</sup> (m)	Measurement time <sup>3</sup> (min)	Temperature repeatability <sup>4</sup> (°C at 2 sigma)
10	1	2	< 0,5
20	1	2	< 0,5
30	2	5	< 0,5
50	3	10	< 1,0
75	3	20	< 3,5
100	5	30	< 5,5

<sup>1.</sup> **Distance range:** the maximum distance from the instrument for which the manufacturer will measure and guarantee a measurable standard of performance. For the specified "distance range", all of the other key measurement specifications shall be stated.

<sup>2.</sup> **Spatial resolution:** a temperature event covering the spatial resolution selected for the measurement will be measured with 100% accuracy. If the distance of the temperature event is smaller than the spatial resolution selected, the change will not be measured with the full accuracy.

<sup>3.</sup> **Measurement time:** the period between successive independent temperature measurements, when making continuous measurements on a single fiber. Equivalently, it is the time interval between successive temperature trace timestamps, under these conditions.

<sup>4.</sup> **Temperature repeatability:** the random variation in calculated temperature between successive temperature traces, at a given fiber distance. It is determined from twice the standard deviation of corresponding temperature sample points in each temperature trace, with the fiber held at constant temperature.

## ABOUT OMNISENS

Using fiber optic-based sensing Omnisens offers continuous, reliable monitoring for energy industry assets. A range of solutions is available for early detection and location of events which may threaten the integrity of the asset. These techniques provide condition monitoring, asset optimization and intrusion detection, based on small changes in temperature, strain and vibration. Monitoring techniques include Brillouin-based Distributed Temperature and Strain Sensing (DTSS), which Omnisens pioneered, Raman Distributed Temperature Sensing (DTS), Distributed Acoustic/Vibration Sensing (DAS/DVS) and Fiber Bragg Gratings (FBG).

Based in Switzerland Omnisens operates throughout the world, either directly or through specialized solution providers, via dedicated application, commissioning and customer service teams.

## MISSION

Omnisens provides fiber optic based monitoring solutions for electricity, oil and gas transport, helping customers secure the integrity and optimize the performance of their asset.

## VISION

Recognized for the reliability and performance of their dedicated solutions, Omnisens is seen by industry leaders as an expert and trusted partner in asset integrity monitoring.

**Omnisens**  
www.omnisens.com  
sales@omnisens.com

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