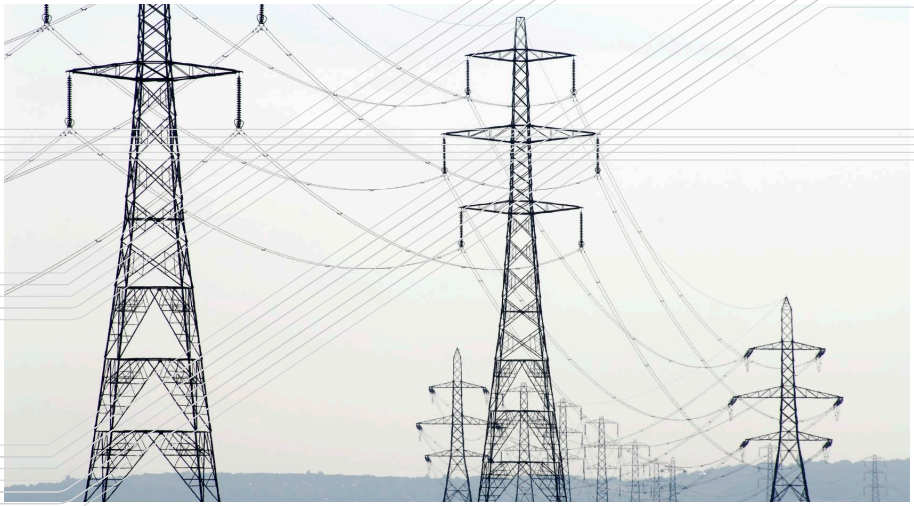


APPLICATION NOTE

DITEST-LTM – ENERGY CABLES & OVERHEADLINES TEMPERATURE MONITORING

Energy

WHY MONITOR ENERGY CABLES ?

To provide electricity without interruption to a growing market is the challenge for Power Engineers. This to be done whilst minimizing costs, environmental effects, and embracing the requirements of this dynamic industry where the life span of an asset may be in excess of 40 years.

The energy industry was the first to recognise the benefits of distributed temperature monitoring using optical fibre, which is ideal for buried cables and overhead lines because:

- The fiber sensor is insensitive to electromagnetic interference (EMI).
- Nearby telecommunications fibers can be used as the sensor.
- The optical fiber sensors have a life expectancy similar to energy cables.
- Fiber sensors placed close to the energy cable monitor the thermal resistivity of the backfill.

The reasons given for monitoring power cables[1] were:

- Hot spot location and monitoring
- To compare installation condition
- Control cooling systems
- Determine circuit rating
- Manage overload operation
- Maximise power capacity.

In summary, monitoring the temperature of an energy cable offers:

- the means to monitor the condition of the cable, since a rise in temperature may indicate a breakdown in insulation, or change in the operating environment of the cable.
- a circuit management input by comparing load to temperature changes, and actual temperature compared to theoretical.
- the ability to postpone investment in the circuit, since if the temperature of the cable is known in relation to load, maintenance or replacement can be scheduled according to actual cable behavior, rather than the predicted replacement date, which is usually sooner.

OMNISENS FEATURES & BENEFITS

- ***40 km monitoring at the highest performance***
- ***Frequency based technique as opposed to intensity based technique for improved measurement accuracy and reliability***
- ***Temperature monitoring on single mode optical fiber***
- ***Strain and deformation monitoring for aerial or buried cables***
- ***Compatible with Dynamic Rating Systems for increased efficiency***
- ***Uses the latest technology which is proven and reliable ensuring maintenance call outs are minimized***

[1] CIGRE Working Group Report 247, published 2002

DITEST-LTM POWER CABLE TEMPERATURE MONITORING SYSTEM

MONITORING ENERGY CABLES AND LINES

'Out of sight' is definitely not 'out of mind' where cables are concerned. These vital assets carry energy around the world, and although 'concealed' below ground or water, they are affected by load variation and changes in the backfill (whether caused by 'burrowing', drying out/ flooding, construction work or ground movement).

For monitoring the temperature of energy cables, the fiber sensing cable is either integrated within the energy cable, attached to it, or placed close by. A nearby communications cable can also be used. The fiber sensor monitors temperature, and so uses a strain-free fiber in the cable sensor, usually in a stainless steel tube.

BURIED CABLES

The fiber optic sensing cable can be placed where most convenient for the cable manufacturer or installer. Its proximity to the conductor is for agreement between the cable supplier and the operator.

A fiber sensor close to the conductor may be preferred for monitoring temperature increases due to load when a Real Time Rating[1] system is considered, whereas one which monitors the ground ambient is just as useful for an understanding of the cable environment.

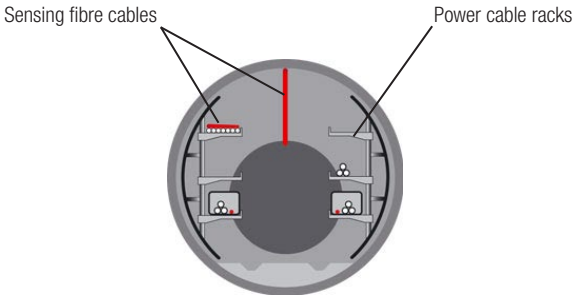
CABLES IN TUNNELS

Temperature monitoring of cables in tunnels not only provides condition monitoring, and Dynamic Rating input. The distance range of the system means that the control unit may be located at a convenient substation, rather than in the tunnel itself.

SUBMARINE CABLES

Until now, limitations of temperature monitoring techniques meant that many submarine cables were only monitored at the shore ends. Omnisens DITEST overcomes this limitation, and can monitor up to 40 km with accuracy maintained along the length of the cable.

OMNISENS DITEST-LTM CAN MONITOR UP TO 40 KM WITH ACCURACY MAINTAINED ALONG THE ENTIRE LENGTH OF THE POWER CABLE.



MONITORING OVERHEAD LINES

Overhead lines provide most of the transmission requirement, and endure the most hostile conditions. Single mode fibers contained in the optical ground wire (OPGW) can be used to monitor the temperature in areas where icing is likely. Extra load can then be applied to the conductors to heat them up and avoid ice forming and the risk of damage to the structure.

Diurnal and seasonal weather changes cause the lines to sag, with the danger of grounding. Sag can be calculated from temperature, but because it uses Brillouin scattering, Omnisens DITEST can also monitor strain directly, offering a valuable tool for overhead line design and operation.

DITEST strain measurement capability can also be exploited to monitor the effect of the power lines induced stresses on the ageing of the communication fibers.

ROV SPECIALTY POWER CABLES

Subsea activities more and more frequently required the use of “work class” Remotely Operated Vehicles (ROV’s) for deep water trenching, cable burial, repair jobs and the recovery of larger objects.

As the operation of ROV’s is progressively moving down to increasing depth, the umbilical’s used to power and control the ROV’s are submitted to challenging conditions during deployment and operation.

The monitoring of umbilical’s temperature is important to guarantee that they are not operated beyond their specifications and that local heating doesn’t damage the cable structure.

Optical fibers integrated in the umbilical’s can be used to perform efficient monitoring provided that the monitoring system is able to cope rotary joints which introduce large varying attenuation.

OMNISENS DITEST-LTM PROVIDES TEMPERATURE MONITORING CAPABILITIES OVER LONG DISTANCES, WHILE MAINTAINING FULL MONITORING PERFORMANCE EVEN IN PRESENCE OF ROTARY JOINTS.

WHAT DOES OMNISENS OFFER ?

Omnisens DITEST offers you more of what you want for Energy Cable Monitoring. The system is engineered for reliability and performance.

DISTANCES OF UP TO 40 KM CAN BE MEASURED WITH A SPATIAL RESOLUTION OF 5 METERS.

Distances over 30 km are measured, with no compromise on performance. Over this distance and using a standard ITU G.652 optical fiber sensor, the system will detect temperature events of 1 m or longer, even with an optical loss of 10 dB along the fiber. This gives a larger margin for error during installation of the sensor.

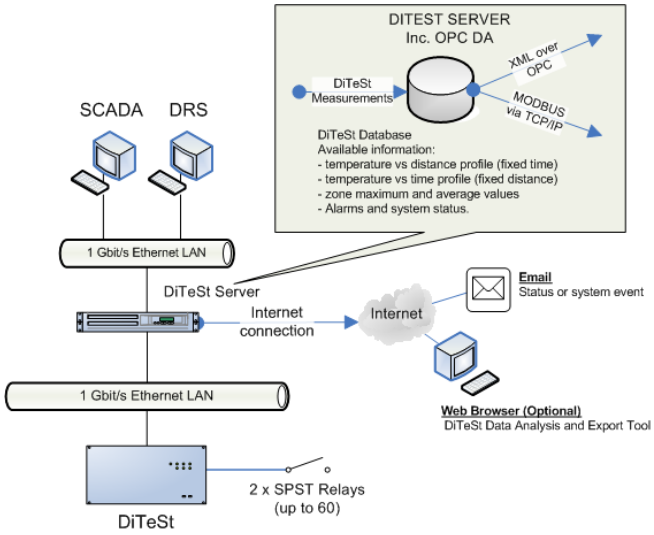
This frequency based technique, when compared to intensity based measurement (e.g. «Raman»), gives more reliable results over the long term, since it is less prone to measurement drift. This drift causes problems over time especially if the temperature moves towards an 'alarm' level, when false alarms will result.

A CUSTOMER FOCUSED TEAM ...

- providing solutions to demanding applications.
- supplying products, service, and project management in pursuance of its commitment to quality, health, safety and environment.
- Advising on the most cost effective solution for each project
- providing training for integrators and users, and after sales support.

DEDICATED INTERFACE

Omnisens DITEST-LTM ssolution is compatible with major Dynamic rating systems (DRS) for improved efficiency of the power cable operation and management.
The system can be connected to SCADA or DRS through OPC DA and Modbus via TCP/IP communication protocols. Temperature profile versus distance and time can be analyzed and transmitted in XML format as well as graphical charts, events and alarms.



REF: AN-ENE-ENG-01

OMNISENS SA - Riond Bosson 3 - 1110 Morges - Switzerland
Tel : +41 21 510 21 21 - Fax :+41 44 274 20 31
email: sales@omnisens.com - www.omnisens.com

OMNISENS DITEST-LTM - SYSTEM PERFORMANCE AND FEATURES

Performance	Sensor configuration	2 single mode fiber @ 1.5 µm wavelength per sensor
	Number of channels	2 (up to 60 upon request)
	Dynamic range (optical budget)	>10 dB
	Acquisition time	15 min for full range and heighest resolution
	Temperature accuracy *	+/- 1°C over entire distance range
	Distance range	30 km with <3 meter spatial resolution 40 km with <5 meter spatial resolution
	Spatial resolution **	1 - 10 m user configurable
System	Communication Interface	1 Gbit/s Ethernet interfaces according to IEEE 802.3, USB2.0, 2 x SPST Relays (up to 60 upon demand)
	Communication protocol	OPC DA, MODBUS over TCP/IP
	Data storage	Internal hard disk (40 GB or more)
	Data format	XML, text files, MS Excel, bitmap plot
	Optical connectors	E-2000 APC
	Enclosure	19" EMC rack cabinet including side panels and loackable front door
	Dimensions (H x W x D)	(42U x 600mm x 800mm)
	Server	DiTeSt server with redundant power supply
	Keyboard and monitor	15" TFT monitor, keyboard with mouse
	UPS	>5 hours of uninterrupted operation (full features available)
	Colors	RAL (in agreement with customer)
	Operating temperature	0 to 40°C
	Storage temperature	-20°C to 60°C
	Power consumption	< 600W (max 1500W during UPS charging)
	Weight	<200 kg
	Protection	IP20
Features	Measurement modes	Automatic unattended measurements with programmable channel sequencing
	Measurement zone	Unlimited (possibility of overlaping)
	Alarms and status	• Max, Average Temperature (K) • Zone Warning (Absolute, Relative, Rise) • Zone Pre-Warning (Absolute, Relative, Rise) • Zone Fiber Break
	Data analysis	Measurement analysis, multiple trace comparison, trends, graphical plots as required for DRS. • temperature vs distance profile (fixed time) • temperature vs time profile (fixed distance) • Alarms and system status
	Remote operation	Remote control, configuration and maintenance via TCP/IP
	Watch dog	Long term operation 24/7 guaranteed by automatic recovery and continuous self diagnosis.
Option	Distance range extension	Compatible with Omnisens DiTeSt remote measurement modules and range extension (DRM and DRR)

* Accuracy is measured with 2 sigma repeatability
** Spatial resolution defines the smallest detectable event along the optical fiber.

Laser safety: Omnisens Ditest products emit invisible infra-red radiation in the range 1550 nm. They are classified to EN 60825-1(2001-03) as Class 1M laser products.

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