



## Application Note

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“ Keeping an eye on every section of even the longest energy cables with Omnisens DITEST LTM. ”

# DITEST™

## ENERGY CABLE MONITORING SOLUTION

> Hot spot detection > Cable load optimization > Cable condition monitoring

### Why monitor energy cables?

To provide an uninterrupted electricity supply to a growing market is the challenge Power Engineers face. All to be done at minimal financial and environmental cost, while obeying the regulatory requirements of this dynamic industry, where the life span of an asset may be in excess of 40 years. HV, EHV and UHV cables are costly, and when buried on land, installed subsea or in tunnels no routine visual inspection is possible. So dramatic are the effects of a failure of these assets that many governments have introduced tough penalties for a power failure or reduction. How then do you know how this valuable asset is behaving over time and in relation to changes in its operation and environment? By monitoring its temperature continuously.

The temperature of a power cable provides at a minimum condition monitoring information, but when the emphasis is on asset performance, temperature monitoring shows how the cable is responding to load, and using a Dynamic Rating

System, allows the load to be managed according to the actual temperature of the cable.

**The energy industry was the first to recognize the benefits of distributed temperature monitoring using optical fiber, which is ideal for buried cables because:**

- > long distances can be measured, along the entire length
- > the fiber sensor is insensitive to electromagnetic interference (EMI)
- > telecommunications fibers near or incorporated in the cable can be employed as the sensor
- > the sensing fibers have a life expectancy similar to energy cables
- > sensing fiber placed close to the energy cable monitor the thermal resistivity of the backfill
- > the temperature data provides real time input for a Dynamic Rating System, enabling the cable operator to optimize the cable load.



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**CIGRE Working Group Report 247 published 2002, gave the reasons for monitoring power cables as:**

- > Hotspot location and monitoring
- > To compare installation condition
- > Control cooling systems
- > Determine circuit rating
- > Manage overload operation
- > Maximize power capacity.

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

- > Condition monitoring 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 tool, by comparing load to temperature changes, and actual temperature compared to theoretical. A Dynamic Rating System can use this data to optimize cable loading.
- > 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.

### **DITEST-LTM Power Cable Temperature Monitoring System**

#### **Monitoring Energy Cables**

'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, changes in the backfill or environment (whether caused by 'burrowing', drying out/ flooding, construction work, or ground movement) and when installed subsea are subject to threats such as dropped objects, anchor drag, etc. which may damage the cable and dramatically change their performance.

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 employed. The fiber sensing cable monitors temperature, and so requires a strain-free fiber in or near the cable, 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 sensing fiber close to the conductor may be preferred for monitoring temperature increases due to load when a Dynamic Rating System is considered, whereas one which monitors the ground ambient gives vital information for an understanding of the cable environment.



#### **Cables in Tunnels**

Whether purpose built or existing, a tunnel provides the ideal location for a power cable, offering access for maintenance and the possibility of visual inspection. Often remote and inaccessible, continuous temperature monitoring is a cost effective option to visual inspection for these tunnels. Damage to cables from third parties (people, machines, animals and even insects) provide an ever-present risk. Once a cable in a tunnel catches fire, it is very difficult to extinguish, and may result in the operator having to find an alternative supply for several days, if not weeks. Temperature monitoring of cables in tunnels pinpoints developing temperature events in real time. A visual inspection or other intervention can be directed to the part of cable concerned, and the risk of subsequent loss greatly reduced. Not only can the operator reduce the risk of loss of supply, but by adding a Dynamic Rating System, the cable can be safely loaded according to actual temperature, rather than an estimated rating.

Thanks to its ability to measure distances of more than 50 km, the Omnisens DITEST offers flexibility in the length of cable that can be monitored using one system, and it can be placed in a substation at some distance from the cable location, which makes it a cost effective and flexible tool for the network operator.

#### **Submarine Cables - Windfarms**

One result of the quest for affordable renewable energy is the construction of on-shore and offshore windfarms. Many off-shore windfarms are constructed at significant distances from the on-shore substation, requiring long export cables. Tides, storms, moving sea- and river-beds, sea temperature changes, fishing, shipping and submarine activities all present challenges for the cable operator. Existing pipelines, cables and other installations can also affect cable temperatures in unexpected ways. The energy produced by the windfarm can vary dramatically, so

#### **Omnisens SA**

Riond Bosson 3, 1110 Morges – Switzerland  
T: +41 21 510 21 21 - F: +41 44 274 20 31  
sales@omnisens.com  
www.omnisens.com



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monitoring the temperature of the cable, all along its length, as accurately as possible is the best way to monitor and therefore manage the cable's operation. As soon as an unplanned change in the temperature is logged (a range of alarms can be used for this) action can be taken; the load can be adjusted and/or that part of the cable can be investigated.



Due to distance limitations of earlier fiber optic temperature monitoring techniques many submarine cables are only monitored at the shore ends, or with limited accuracy. The shore ends are vulnerable, they may be, for example, exposed to direct sunlight or in areas of soil movement, so monitoring them is very useful.

But the risks to the cable are not limited to shore ends. In fact many export cable routes lie in shallow water (less than 100 m), and in areas of dramatic soil migration. A cable may be surrounded by cooling water one day and covered with several meters of mud the next, which will dramatically increase its temperature under the same load. In shallow water areas, the risk of cable being damaged by fishing and shipping activities is also significantly higher. Only by monitoring the entire cable length can such changes in the cable's environment and condition be managed. With the Omnisens DITEST distances of over 50 km can be monitored, with accurate temperature information available every meter along the whole cable length.

Balancing cost with performance while ensuring a secure supply of electricity is another challenge, and here the Omnisens DITEST ability to monitor long distances can reduce the total cost of monitoring. How? To reduce operating costs, many windfarm operators prefer to operate off-shore substations remotely, housing all 'active' operations in the on-shore substation. The power of the Omnisens DITEST to measure over 50 km from one interrogation unit using several measurement channels for each of several cables gives operators the flexibility to achieve this. It also ensures flexibility to add cables and distance as the windfarm expands.

Monitoring with this accuracy along the length of the cable, with the flexibility to house the Omnisens DITEST on-shore offers flexibility, cost effectiveness and greater peace of mind.

### Interconnectors

Interconnectors are highly engineered, prized assets, frequently crossing national borders, and often critical to international electricity trading. Built to withstand the test of time and their environment, they suffer the same challenges as the submarine cables deployed for windfarms.

“ Monitoring long cables helps ensure a secure supply of electricity. Fiber optic temperature monitoring is the perfect way to do this ”

The Omnisens DITEST provides uninterrupted temperature monitoring for these long cables, and there are a wealth of options to ensure that the needs of each project are met.

### A customer focussed team

- > designing solutions for demanding applications, thanks to our dedicated, highly qualified team and their 'can-do' practical approach
- > 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 application and instrument training for integrators and users, and after sales support
- > providing a Data Interpretation service to take the data about the asset and deliver it in a format that gives you the information you need to make operating decisions.

### Dedicated Interface

Omnisens DITEST-LTM solution is compatible with major Dynamic Rating Systems (DRS) for optimizing energy cable operation and management. It is designed to communicate status and detected events in real time to SCADA or third party systems via TCP/IP.



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# “ DITEST will detect and locate a temperature event of 1 meter anywhere along 50 KM cable ”

### Omnisens DITEST Features and Benefits

- > **Long distance temperature monitoring:** Over 50 km from a single interrogator unit, using a standard communications grade optical fiber as a sensor, the Omnisens DITEST will detect temperature events of 1 m or longer, and locate them to within 1 m along the whole cable length.
- > **Proven:** Omnisens DITEST is the first choice for long distance monitoring, and is being used to monitor submarine power cables, subsea umbilicals, on-shore and off-shore pipelines around the world.
- > **Powerful:** Omnisens DITEST can measure with an optical budget of 12 dB along the fiber. This gives a margin for error during installation.
- > **Accurate:** Small temperature changes in the cable can be detected, meaning that action can be taken sooner to prevent an escalation of the problem, helping maintain security of supply.
- > **Reliability:** The system is engineered for reliability and performance, so emergency service visits are rare. It is designed to be remotely accessed for rapid trouble shooting and data interpretation activities.
- > **Cost effective:** Distances over 50 km can be monitored with a single interrogator unit providing temperature information at every meter along the whole cable length. The DITEST system benefits from the developments made for long haul fiber optic telecommunications and can be used in conjunction with dedicated optical amplifiers to extend the monitoring distance range. And if your asset is extended it is likely that the DITEST can be upgraded to monitor it.
- > **Automatic operation:** once the system is commissioned it can left to monitor unattended provided real-time temperature information for efficient temperature monitoring.
- > **Flexible:** The long distances the Omnisens DITEST can monitor mean that the control unit can be located where you want it.
- > **Reduced risk of false alarms:** The frequency based technique (Brillouin) used in Omnisens DITEST gives more reliable results over the long term than, for example Raman based DTS systems, since it is less prone to measurement drift, variation of fiber attenuation and connection losses. This drift causes problems over time especially if the temperature moves towards an ‘alarm’ level, when false alarms will result.

Applications	Benefits
Buried cables	Hotspot detection – real time, over long distances, accurately. Cable condition monitoring Use of Dynamic Cable Rating to optimize cable load
Cables in tunnels	Hotspot detection Cable load optimization with Dynamic Rating System
Windfarm export cables	Hotspot detection Cable temperature monitoring to detect rapidly changing cable environment Performance monitoring and cable load optimization
Interconnectors	Hotspot detection Monitoring of changing cable environment and thermal resistivity Find out how cable temperature responds to load, and use to optimize interconnector

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