



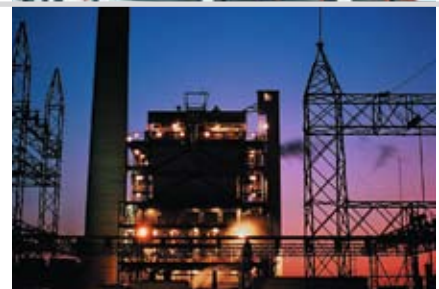
Distributed Temperature Monitoring  
of Energy Transmission and Distribution Systems



Ensuring a Reliable Supply  
of Electrical



Power for Today's World



# Preventive Measures to Avoid Power Outages

As demand for electricity continues to grow, so do the challenges to power companies and power grids. The liberalisation of power supply markets continues apace, resulting in the reorganisation of national and international networks. Events of the past few years – including large-scale blackouts and shortfalls in major markets, and the ongoing addition of alternative sources to existing networks – point up the need for improvements to existing infrastructures. At the same time, there is increased pressure to keep costs to a minimum.

Temperature monitoring is a key factor for the optimisation of underground power transmission and distribution installations. The conductor temperature depends on the load, but other factors such as the thermal soil resistivity, the power line arrangement, adjacent cables and other sources dissipating heat into the surrounding area have an important impact on the performance of the installation.

Up to now, it has been almost impossible to foresee the temperature distribution along the cable route, so that the maximum applicable current load was usually set as a compromise between understanding of operation conditions and risk minimisation.

The availability of industrial Distributed Temperature Sensing (DTS) systems that measure in real time temperatures all along the cable is a first step in moni-

toring the transmission or distribution system capacity. The integrated Dynamic Cable Rating (DCR) or also called Real Time Thermal Rating (RTTR) solution offered by LIOS enables not only to continuously monitor the temperature of a high voltage cable circuit in real time, but to safely utilize the existing network capacity to its maximum. Furthermore it provides the ability to the operator to predict the behaviour of the transmission system upon major changes made to its initial operating conditions.

## Meeting the Demands of a Changing Power Environment

In times where power utilities face growing need of energy – forcing operators to stress the power cables to the physical limit – safety and efficiency becomes more and more important. Undoubtedly, knowledge in real time of cable temperature and thermal behaviour of the cable installation are key to control safety and efficiency of a power distribution network. Regardless of cable design, operational limits or installation practice, the fact is that unforeseeable adverse thermal conditions can and do cause system capacity degradations and service interruptions – especially with fatigue. The monitoring systems by LIOS Technology enable the user to locate any cable hotspot before failure, to dynamically optimize the power load and ensure reliable supplies of electricity by:

- Real time temperature profile measurement.
- Precise localisation of hotspots.

- Multiple alert parameter free configurable for each zone.
- Fibre switch for monitoring different cables resp. phases simultaneously.
- Trend analysis and online interface to accurate rating systems.



## Sensor Cable

### Passive and Maintenance-free Sensors for Your Assets

*LIOS Technology provides the appropriate sensor cable for retrofit or newly built projects. One vital component is a stainless steel or plastic tube that can accommodate multiple optical fibres. The wall thickness of the sheathing of the tube, and the material used to make the sheathing, can be adjusted particularly to the necessary requirements.*

*For retrofit applications we recommend the use of metal free cable easily mountable on the surface of the power cable whereas new installations should gain from the benefit of embedding an appropriate cable into the power cable directly.*

# Technologies Creating Value

## Technologies Creating Value

The LIOS temperature monitoring solution is based on using passive optical fibres as temperature sensors, either integrated directly inside a high voltage cable or mounted externally on the cable insulation. A solution for overhead lines is also available. In this case the optical fibre is integrated into the core of a phase wire of overhead transmission lines (OPPC).

Via joints and high-voltage fibre-optic uncoupling devices, the fibre is linked to an evaluation unit (DTS), where the distributed temperature profile is recorded and further processed. The temperature profiles themselves, or the results/events derived from them, can be transmitted via standard interfaces from the evaluation unit as required, and be either displayed or further processed in real time by PC, PLC or SCADA systems.

## State-of-the-art Temperature Measurement System

The LIOS' DTS technology has been successfully proven in critical applications like fire detection in road and rail tunnels and special hazard buildings, power cable and aerial transmission line monitoring, in oil & gas exploration for permanent down-hole monitoring and for industrial induction furnaces surveillance, where these systems have been equipped in worldwide projects with more than 1500 permanent installations. Most of these applications are safety relevant and require high reliability and

uptime of the sensor system. LIOS current DTS product series was carefully designed and thoroughly tested targeting reliable performance and smooth operation in industrial environments.

This was imposingly endorsed by the latest statistical field analysis, where an excellent mean time between failures (MTBF) figure of 28 years was reached based on field data of the current DTS product series

## Setting Standards for Highly Reliable DTS Performance

High reliability is also a result of the unique optical frequency-domain reflectometry (OFDR) technology of the LIOS DTS systems. In contrast to time-domain technology using pulsed lasers with high peak powers, the LIOS OFDR DTS uses a quasi-continuous laser with low peak power resulting in a nonexistent wear out of the laser unit or any other fatigue of other optical components. The exceptional reliability favors the deployment of the LIOS DTS systems in all remote, safety-relevant and industrial applications.

Key advantages of Raman OFDR distributed temperature sensing (DTS) systems by LIOS Technology:

- Reliable system design with approved key components from the telecom industry  
The semiconductor laser diode tested according Telcordia standard GR-468, with medium lifetime >25 years.



- The OFDR technology enables to provide sophisticated temperature surveillance at commodity prices  
The essential benefits of OFDR technology are the quasi continuous wave mode employed by the laser diode and the narrow-band detection of the optical backscatter signal, whereby a significantly higher signal to noise ratio is achieved compared to conventional pulse technology (OTDR). This technical benefit allows the use of affordable semiconductor laser diodes and electronic assemblies for signal averaging. LIOS' OFDR Raman DTS is classified as a Laser Class 1M Product.
- Invariant spatial resolution along the entire sensor length of 1 m or better even at most remote distances.

# Sophisticated Answers for Modern Power Management

The OFDR technology provides an invariant spatial resolution along the entire sensor length, which ensures to identify and clearly measure atypical hotspots or temperature anomalies at early stages, even at most remote distances. This is in contrast to other measurement principles (e.g. laser pulse principle, OTDR), which are sensitive to dispersion effects and therefore affected by a broadened spatial resolution at longer measurement distances; in other words, the hot spot sensitivity of pulse type measurements degrade with a function of distance.

- Direct link to SCADA systems and flexible data handling  
The embedded communication module of the DTS controller ensures reliable data interfacing on basis of proprietary or customer specific protocols like DNP3, IEC60870-5, POSC WITSML, Modbus (Master/Slave) etc.  
Multiple third party systems can be addressed at the same time. The onboard data storage module buffers up to 72 hours of measurement data and initiates data transfer automatically after the communication link is re-established.
- International Approvals and Certificates – type tested and accredited

In conscious of the strong requirements being made in the safety market LIOS provides a highly proven product based on the compliance with international quality standards recognised by various independent international bodies like VdS, EXAM, FM.

- Impressive track record of more than 1500 installations in permanent operation  
LIOS Technology is the leading industrial DTS manufacturer with certified production and testing procedures including demanding factory acceptance test (FAT) and site acceptance test (SAT) standards.

## Seamless Data Integration

*LIOS DTS systems are perfectly suited for seamless integration into existing or new network or SCADA infrastructures. DTS measurement data, data of point type sensors (like conductor currents) and RTTR calculation outputs (like ampacity predictions) can be directly linked to SCADA and other overall management systems by proven protocol conversion libraries using industry standard protocols, like DNP3, IEC60870-5-104, POSC WITSML, Modbus (Master/Slave) etc. The DTS' communication module provides Ethernet access and comes with on-board storage of measurement data for automatic buffering in case of network break downs.*

*The CHARON\_02 configuration and visualisation software associated with the DTS systems can be adapted to specific requirements and offers numerous options for displaying and processing the recorded measuring data. Its comprehensive database can handle huge amounts of historian measurement data of multiple DTS, point type sensors and RTTR calculation results.*





**The Excellent All-round Solution to Increase Grid Security and Prolong Working Life of Your Facilities**

Distributed temperature sensing is a powerful tool that allows to accurately rate power transmission and distribution assets based on actual field conditions. The easy-to-install, low-maintenance system offers a multitude of advantages. It is especially valuable for dynamic rating, since the accuracy of the temperature modelling can be coupled with the monitoring and the predictive functions of the dynamic rating system.

By enabling dynamic analysis of network structure, it increases the overall safety and reliability of the grid. It facilitates dynamic reactions to transmission requests, resulting in more flexible capacity and revenue management in both the short and long term. And the potential for cost-savings is enormous: Downtimes and blackouts can be avoided, and the need for new lines and upgrades can be greatly reduced.

Customers employing the LIOS Technology integrated real time thermal rating system can

- Increase earnings by activating previously unused resources in existing power lines
- Utilize reserves in extreme situations without having to exceed permissible conductor temperature
- Respond quickly and dynamically to transmission requests by online metering of the grid capacity
- Conduct precisely and in real-time load predictions as new sources of energy are added to the grid
- React quickly to overload conditions





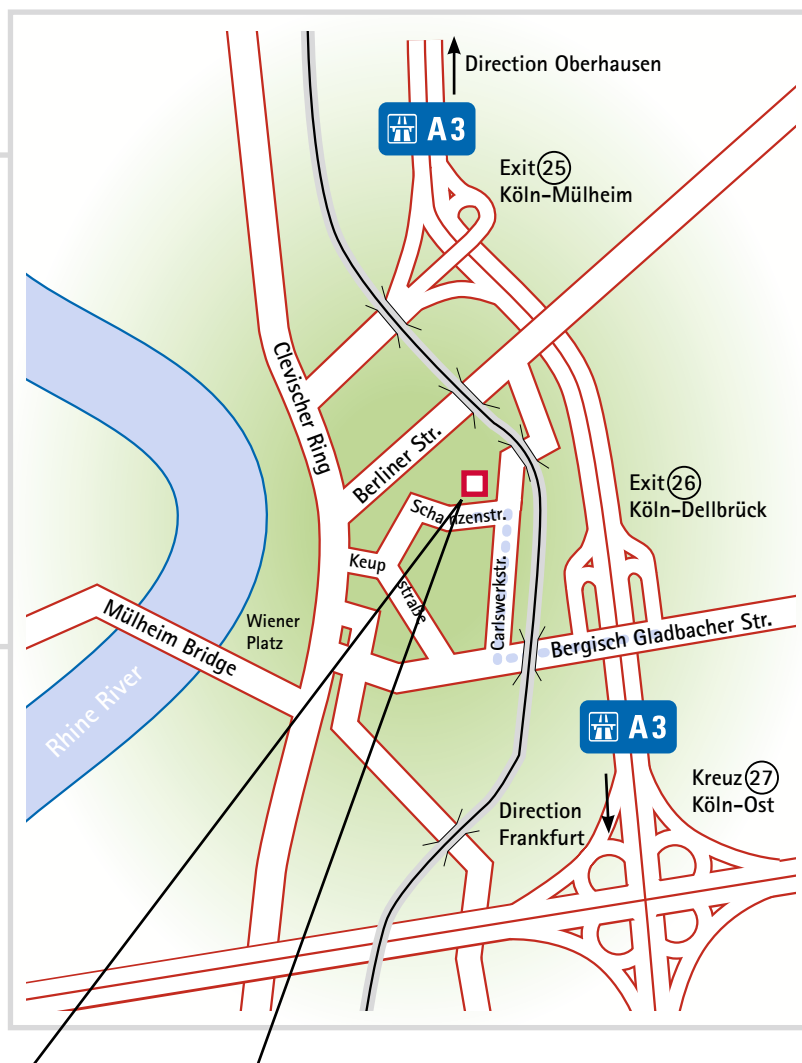
### About us

LIOS Technology GmbH – Linear Optical Sensors is the German based, global leader in the development and supply of state of the art frequency domain based distributed linear heat detection. Starting in 1997 LIOS was the first to introduce a „fiber optical linear heat detection“. With more than 2000 installations worldwide, LIOS sets the benchmark in reliability and track record.



LIOS Thermal Rating

Scan the QR code with your cell phone to learn more about our intelligent condition monitoring solutions.



LIOS Technology GmbH – Linear Optical Sensors  
Schanzenstrasse 39 / Building D9-D13  
51063 Cologne, Germany  
Phone +49 221 99887-0  
Fax +49 221 99887-150

LIOS Technology Inc. – Linear Optical Sensors  
1400 Campus Drive West,  
Morganville, New Jersey 07751, U.S.A.  
Phone +1 732 970 8062  
Fax +1 732 972 4410

E-Mail [info@lios-tech.com](mailto:info@lios-tech.com) | Site [www.lios-tech.com](http://www.lios-tech.com) | [www.thermal-rating.com](http://www.thermal-rating.com)