APPLICATION NOTE

Distributed Temperature Sensing (DTS) for Power Cable Monitoring

Power cables are critical components in electrical transmission and distribution networks, spanning applications from utility grids and renewable energy systems to industrial facilities and infrastructure projects. Ensuring their safe and efficient operation is essential to maintaining system reliability and preventing costly failures.

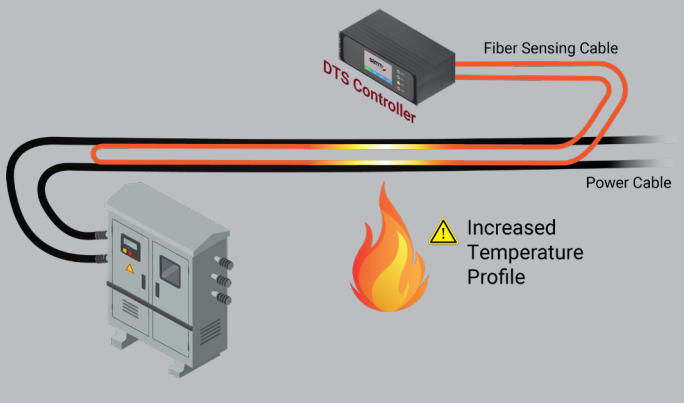
Thermal stress is one of the primary factors affecting cable performance and lifespan. Overloading, insulation degradation, and installation conditions can lead to overheating, increasing the risk of faults or catastrophic failure.

Distributed Temperature Sensing (DTS) uses optical fiber technology to provide continuous, real-time temperature monitoring along the entire length of power cables. This enables operators to optimise performance, detect faults early, and enhance system safety.

Key Challenges

- **Hidden infrastructure:** Underground, subsea, or buried cables are difficult to access
- **Thermal constraints:** Cable capacity is limited by temperature
- **Variable loading:** Fluctuating demand can cause thermal stress
- **Environmental influences:** Soil conditions, ambient temperature, and installation methods impact heat dissipation
- **Aging infrastructure:** Insulation degradation and corroding joints over time increases failure risk
- **Fault detection:** Identifying exact location of issues can be challenging

DTS Technology Overview



Distributed Temperature Sensing (DTS) systems use optical fibers as continuous linear temperature sensors. A DTS control unit sends laser pulses through the fiber and analyses backscattered light (typically Raman scattering) to determine temperature along the fiber.

Key Benefits

- Continuous monitoring over tens of kilometres
- Real-time temperature profiling
- Passive sensing (no power required along cable)
- Immune to electromagnetic interference

System Architecture

A typical DTS deployment for power cable monitoring includes:

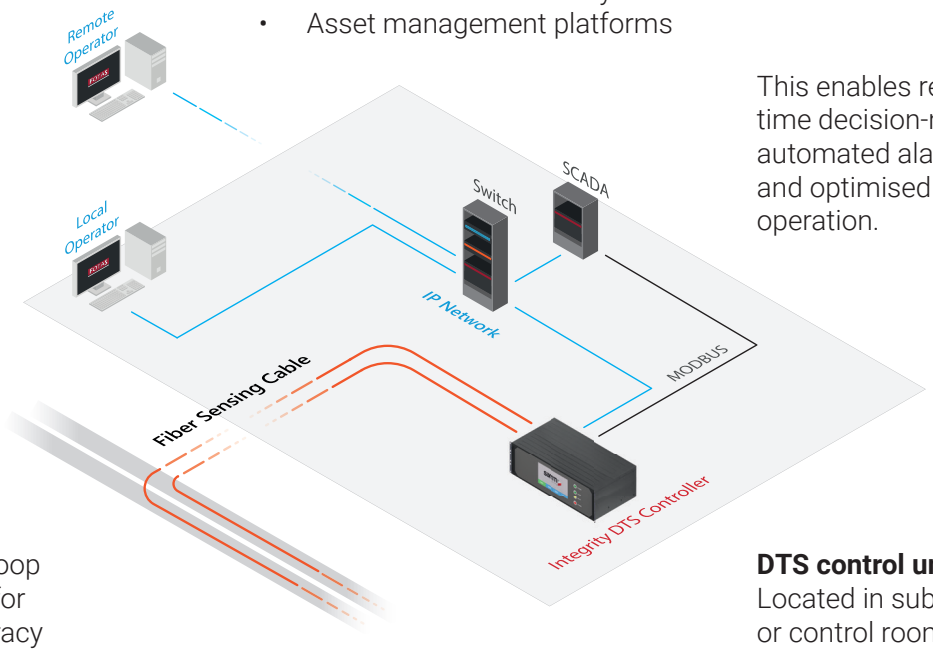
Fiber optic sensing cable: Installed alongside or integrated within the power cable (e.g., within the cable sheath or in adjacent ducts). Typically uses a spare core of the existing fiber optic cable used for SCADA

Redundant configurations: Loop or dual-ended measurement for increased reliability and accuracy

Communication interface: DTS systems can be integrated with:

- SCADA and grid control systems
- Energy management systems (EMS)
- Protection and control systems
- Asset management platforms

This enables real-time decision-making, automated alarms, and optimised network operation.



DTS control unit: Located in substations or control rooms

Key Factors for Successful Deployment

- **Cable integration:** Selection of fiber optic cables compatible with power cable design
- **Thermal coupling:** Ensuring accurate temperature measurement through proper installation
- **Environmental suitability:** Resistant to moisture, pressure, and temperature extremes
- **Routing design:** Optimised placement for reliable monitoring
- **Redundancy:** Dual-ended or loop configurations for critical systems
- **Effective System Design:** Essential to ensure measurement accuracy and long-term performance.

Key Applications

Real-Time Thermal Rating (RTTR) / Dynamic Cable Rating
DTS enables dynamic adjustment of maximum cable current based on actual temperature conditions rather than conservative static assumptions, ensuring:
- Maximises power transfer capacity
- Improves asset utilisation
- Supports grid optimisation and renewable integration

Joint and Termination Monitoring
For these common failure points, DTS enables:
- Continuous monitoring of critical connection points
- Early detection of resistive heating
- Reduced risk of unexpected outages

Fault Detection and Localisation
In the event of a developing fault:
- DTS identifies abnormal temperature rises
- Pinpoints the exact location along the cable
- Reduces troubleshooting time and repair costs

Hot Spot Detection
Localised overheating can occur due to installation defects, insulation damage, poor joints or terminations or external environmental conditions.
- DTS provides precise location of hot spots, allowing targeted maintenance and preventing failures.

Condition Monitoring and Asset Management
Long-term temperature data supports:
- Aging analysis of cable insulation
- Predictive maintenance strategies
- Improved lifecycle management

Subsea and Underground Cable Monitoring
For cables in inaccessible environments:
- Continuous monitoring without physical inspection
- Detection of environmental impacts (e.g., seabed movement, soil drying)
- Enhanced reliability for critical transmission links

Key Benefits

- **Continuous full-length monitoring:** No blind spots along the cable route
- **Increased capacity utilisation:** Through dynamic cable rating
- **Improved reliability:** Early detection of thermal anomalies
- **Reduced downtime:** Faster fault localisation and repair
- **Enhanced safety:** Lower risk of catastrophic cable failure
- **Low maintenance:** Passive sensing with long operational life
- **Scalable solution:** Suitable for distribution and transmission systems