APPLICATION NOTE

Distributed Temperature Sensing (DTS) for Solar PV Installations - Rooftop and Farms

Solar photovoltaic (PV) systems are rapidly expanding across both rooftop installations and large-scale solar farms. As these assets grow in number, size and importance, ensuring their safe, efficient, and reliable operation becomes increasingly critical.

Thermal anomalies such as hot spots, faulty connections, and equipment failures are among the leading causes of operational failures and fire risk in PV systems.

Distributed Temperature Sensing (DTS) using optical fiber technology provides continuous, real-time thermal monitoring across the entire installation.

This enables both early fault detection and improved asset management.

Key Challenges

Utility-Scale Solar Farms

- Large geographic areas often several square kilometres
- High cable density and distributed infrastructure
- Remote locations with limited on-site personnel
- Environmental exposure including temperature extremes, UV, dust, moisture

Rooftop Systems

- Limited access for maintenance and inspection
- Increased fire risk due to proximity to buildings and occupants
- Complex cable routing across confined spaces
- Exposure to varying environmental conditions

Common Challenges

- Early detection of electrical faults and overheating
- Minimising downtime and energy production losses
- Reducing inspection and maintenance costs
- Ensuring compliance with fire and safety regulations

DTS Technology Overview

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

Key Benefits

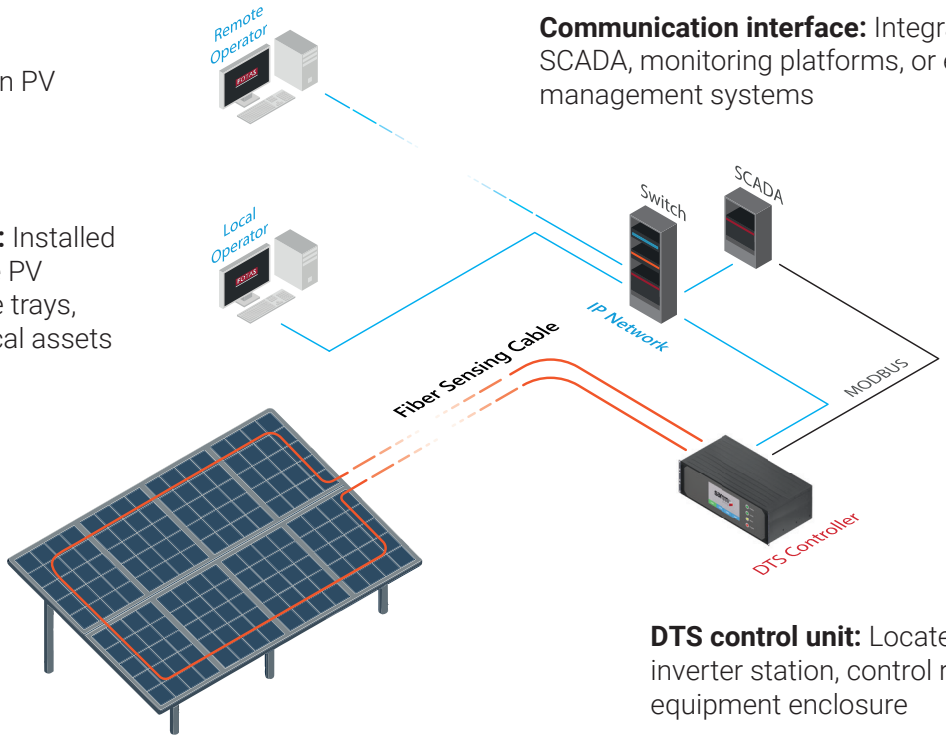
- Continuous temperature monitoring over tens of kilometres of cable
- Real-time monitoring with fast response times providing early indications of a potential fire
- Location of temperature anomaly to 1 metre
- Passive sensing (no power required in the field)
- Immune to electromagnetic interference
- Sensing cable with a design life of 25+ years
- Minimal maintenance requirements

System Architecture

A typical DTS installation in PV applications includes:

Fiber optic sensing cable: Installed along the underside of the PV panels, connections, cable trays, combiner boxes, and critical assets

Network topology: Linear or loop configurations depending on redundancy requirements



Communication interface: Integration with SCADA, monitoring platforms, or energy management systems

DTS control unit: Located in an inverter station, control room, or equipment enclosure

Installation approaches:

- Rooftop: Integrated within cable routing pathways or mounted at the rear of panel rows
- Solar farms: Installed along electrical cables, trench routes, and inverter stations in addition to the PV panels

Key Factors for Successful Deployment

Proper installation ensures accurate temperature measurement and reliable system performance.

- **Cable selection:** UV-resistant, weatherproof, and mechanically robust fiber cables
- **Routing strategy:** Close thermal coupling to monitored assets (e.g., cables, connectors)
- **Environmental protection:** Suitable for outdoor exposure and temperature extremes
- **Zoning and alarm configuration:** Logical segmentation for effective monitoring
- **Redundancy:** Loop configurations for critical installations

Key Applications

Hot Spot Detection in PV panels
Localised heating in PV modules or interconnections can result from cell degradation or mismatch, soiling or shading effects and connector failures.
- DTS enables continuous monitoring along string cabling, identifying abnormal temperature rises before any significant performance loss or failure.

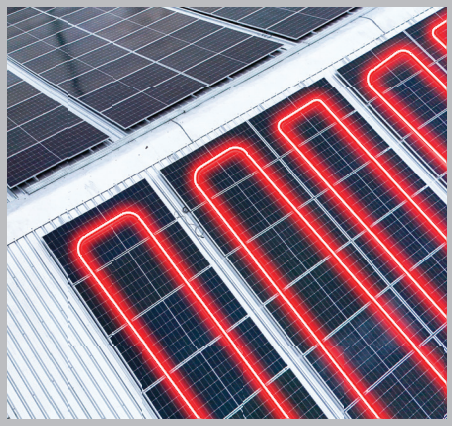
Cable and Connector Monitoring
Electrical faults often originate at DC connectors, junction boxes or cable terminations.
- DTS provides early detection of resistive heating caused by loose or degraded connections, reducing fire risk and preventing system downtime.

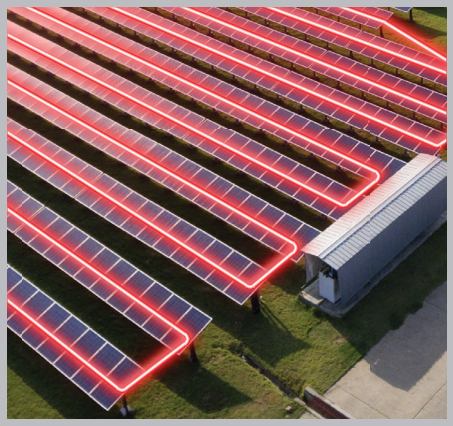
Fire Detection and Prevention
DTS acts as a linear heat detection system across PV installations, and is particularly valuable for rooftop systems where fire spread can impact buildings and occupants. DTS provides:
- Early detection of thermal events before ignition
- Continuous monitoring across large areas
- Rapid localisation of potential fire sources

Combiner Box and Inverter Monitoring
Critical components such as combiner boxes and inverters can be monitored for overheating terminals, load imbalances or cooling system failures.
- Temperature trends help identify developing faults and enable predictive maintenance.

Underground/Trench Cable Monitoring (Solar Farms)
In utility-scale installations, buried or trenched cables are difficult to inspect. DTS enables:
- Detection of overheating due to overload or insulation failure
- Identification of thermal anomalies caused by soil conditions or installation issues
- Continuous monitoring without excavation

Performance Optimisation
Thermal data from DTS can support:
- Identification of underperforming strings
- Correlation of temperature with power output
- Improved system diagnostics and energy yield optimisation





Key Benefits

- **Full asset visibility:** Continuous monitoring across entire installations
- **Early fault detection:** Identification of issues before failure or fire
- **Reduced downtime:** Faster fault localisation and response
- **Enhanced safety:** Lower fire risk for rooftop and field installations
- **Low maintenance:** Passive fiber with long service life
- **Scalability:** Suitable for small rooftop systems and large solar farms
- **Integration-ready:** Compatible with existing monitoring and SCADA systems