APPLICATION NOTE

Optical Fiber Distributed Temperature Sensing (DTS) for Car Parks and EV Charging Infrastructure

Car parks are evolving rapidly as electric vehicles (EVs) become more widely adopted and charging infrastructure is deployed across commercial, residential, retail, transport, and mixed-use developments. While EV adoption supports sustainability goals, it also introduces new fire detection and safety challenges that conventional detection systems may struggle to address.

Modern car parks now contain:

- High vehicle densities
- Enclosed or underground environments
- Limited ventilation
- Increasing electrical infrastructure
- High-power EV charging systems
- Battery energy storage risks
- Extended vehicle dwell times during charging

In these environments, early fire detection is critical for protecting people, infrastructure, and business continuity.

Distributed Temperature Sensing (DTS) using optical fiber technology provides continuous, real-time thermal monitoring across large areas, enabling operators to detect abnormal heat build-up and developing fire conditions at the earliest possible stage.

Supporting EV Fire Response Strategies

As fire regulations evolve to address EV risks, operators increasingly require enhanced thermal monitoring capabilities. DTS technology supports:

- Early incident awareness
- Faster emergency response
- Reduced fire spread risk
- Protection of adjacent vehicles
- Improved operational resilience

Managing High Risk Environments

Conventional Vehicle Fire Risks

Traditional internal combustion engine (ICE) vehicles continue to present fire risks associated with:

- Fuel leaks
- Engine overheating
- Electrical faults
- Arson
- Mechanical failures

Vehicle fires in enclosed car parks can spread rapidly due to close vehicle spacing and restricted smoke ventilation.

Emerging EV Fire Risks

The transition to EVs introduces additional hazards, particularly associated with lithium-ion battery systems and charging infrastructure.

EV Fire Characteristics

Battery failures may initially present as localised overheating before significant smoke generation occurs.

Early thermal detection is therefore increasingly important.

Thermal Runway

Lithium-ion battery failures can result in thermal runaway — a self-sustaining reaction that generates extreme temperatures and potentially reignites after suppression.

Thermal runaway events can:

- Develop rapidly
- Produce very high temperatures
- Generate toxic gases
- Cause reignition hours later
- Spread heat to adjacent vehicles

EV Charging Infrastructure

Charging stations introduce new electrical load concentrations within parking facilities.

Potential risks include:

- Cable overheating
- Connector faults
- Charger component failures
- Arc faults
- Electrical insulation degradation
- Overloaded circuits
- Poor maintenance or installation defects

Fast DC charging systems create particularly high thermal loads and may require enhanced monitoring.

Key Challenges

Challenges with Conventional Detection Technologies

Traditional point-based fire detection systems can face limitations in large or enclosed parking facilities.

Detection Coverage Limitations

Conventional heat or smoke detectors provide only localised detection coverage and may leave blind spots in:

- Long parking aisles
- Ceiling voids
- Cable routes
- Charging infrastructure areas
- Ventilation ducts

Harsh Environmental Conditions

Car parks often experience:

- Dust
- Exhaust contamination
- Humidity
- Temperature fluctuations
- Air movement

These conditions can increase nuisance alarms or reduce detector effectiveness.

Smoke Stratification and Ventilation

Mechanical ventilation systems can dilute or redirect smoke before it reaches ceiling-mounted detectors, delaying alarm activation.

DTS Technology Overview

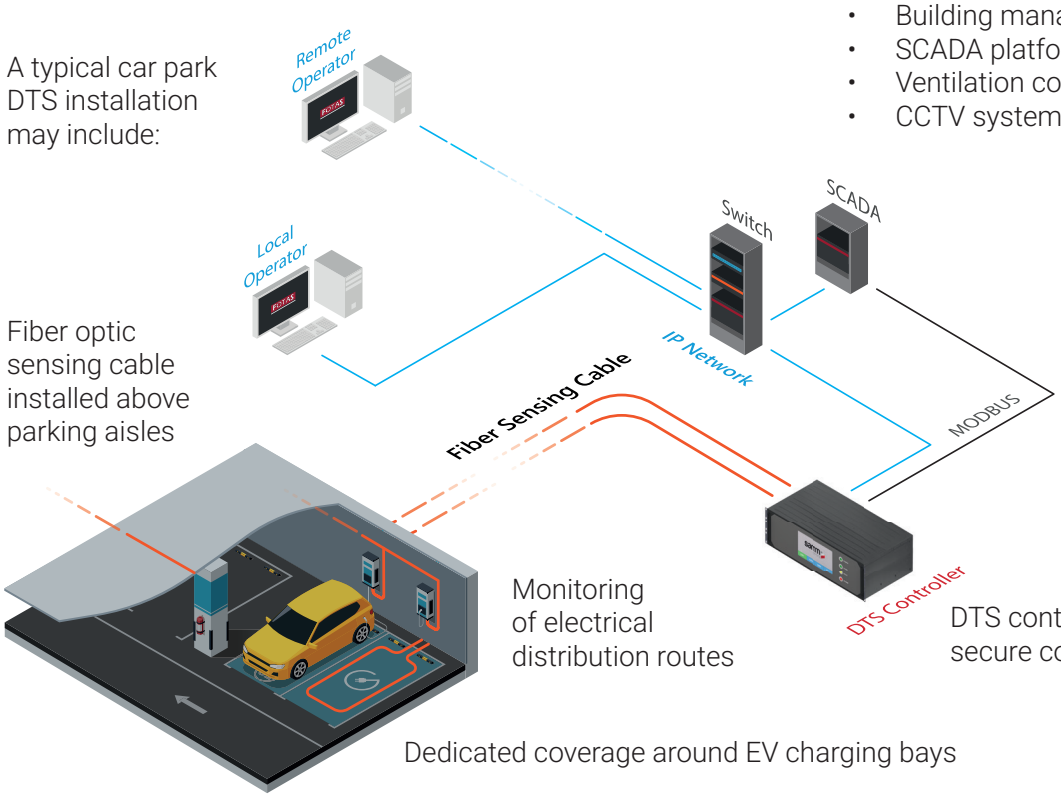
Distributed Temperature Sensing (DTS) systems use standard optical fiber cables as continuous linear heat sensors. Unlike conventional point detectors, DTS provides temperature monitoring continuously along the entire fiber length.

Key Benefits

- Continuous thermal monitoring over many kilometres
- Precise alarm location identification
- Real-time temperature trending
- Immunity to electromagnetic interference
- Operation in harsh environments
- Low maintenance requirements

System Architecture

A typical car park DTS installation may include:



Fiber optic sensing cable installed above parking aisles

Monitoring of electrical distribution routes

DTS control unit located in a secure control room

Dedicated coverage around EV charging bays

DTS systems can integrate with:

- Fire alarm systems
- Building management systems (BMS)
- SCADA platforms
- Ventilation controls
- CCTV systems

A single fiber can protect:

- Parking decks
- EV charging bays
- Cable trays
- Electrical rooms
- Ventilation systems
- Access ramps

Key Factors for Successful Deployment

Fiber Deployment

- Typically, across parking aisles at a minimum spacing distance
- At EV charging locations
- Alongside HV electrical infrastructure

Cable Selection

- Armoured/UV resistant fiber suited for exposed conditions, specialised clamps and brackets
- Protection against moisture, mechanical damage, and vibration
- Design compatible with LSZH (Low Smoke Zero Halogen) requirements

System Design

- Alarm zoning and event classification strategy
- Integration with fire alarm, smoke control systems, BMS/SCADA platforms
- Redundant architecture where required

Key Applications

EV Charging Bay Monitoring
Optical fiber can be installed directly above or adjacent to EV charging spaces to enable earlier intervention before fire escalation by detecting:
- Charger overheating
- Cable hot spots
- Vehicle battery heat anomalies
- Escalating thermal events

Ceiling-Level Area Protection
DTS cables installed across parking aisles provide continuous thermal coverage across large open areas. Benefits include:
- Fast alarm localisation
- Reduced blind spots
- Continuous zone monitoring
- Reliable operation in dusty or humid environments

Ventilation and Escape Route Protection
Monitoring ventilation systems and evacuation routes can support:
- Smoke management system activation
- Safe evacuation
- Firefighter access coordination

Cable Tray and Power Infrastructure Protection
Charging systems require significant power distribution infrastructure. DTS can help identify abnormal heating before electrical failure occurs by monitoring:
- Cable trays
- Switchgear areas
- Transformer rooms
- Power distribution cabinets
- Busbar systems

Key Benefits

Accurate Event Localisation: Operators can quickly identify the precise location of a thermal event, improving emergency response efficiency.

Continuous Linear Coverage: Unlike point detectors optical fiber provides uninterrupted monitoring along the entire protected route.

Reduced Maintenance Requirements: Fiber optic sensing cables contain no electrical components in the field and are resistant to corrosion, moisture and electromagnetic interference.

Scalability: DTS systems can easily scale to support: multi-level car parks, large transport hubs, commercial parking structures and EV charging expansions.

Conclusion

The rise of EV adoption and charging infrastructure is transforming fire safety requirements within parking facilities. Conventional detection approaches alone may not provide the early thermal visibility needed to address emerging risks associated with lithium-ion batteries, high-power charging systems, and increasingly complex electrical infrastructure.

Optical Fiber Distributed Temperature Sensing offers a robust solution for continuous, real-time thermal monitoring across modern car parks. By providing earlier detection, precise event localisation, and reliable operation in harsh environments, DTS technology helps operators improve safety, protect infrastructure, and support business continuity in the next generation of parking facilities.