

Commercial roof-mounted
photovoltaic (PV) systems

SecuriHeat d-LIST

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1 Introduction

More and more organisations around the world are opting to invest in their own freely available sustainable energy source by covering their roofs with solar panels. In a trend that shows no sign of slowing, these rooftop solar photovoltaic (PV) systems are being placed on a wide variety of structures, from new-build factories to historic city centre government buildings. But while many perceive these solar arrays as a low fire risk due to their relatively simple, non-flammable construction, that is in fact not the case. Not only do they present an added risk of fire, but the nature of their position on commercial and government buildings means they have the potential to cause serious damage to building structure as well as significant disruption to business in the event of a fire that is not managed early enough.

Fires around the roof-mounted PV systems can be originated from the failure of DC isolators, inverters, and overheated cables due to poor electrical or connectors installation. Additionally, the presence of PV panels changes the dynamics of a fire involving a roof assembly and increases the fire spread. This can be a major concern, particularly with retrofit systems on existing buildings where the roof can lack appropriate fire resistance treatment. A fire can spread quickly in strong winds and the close proximity of the PV. Ultimately the roof itself may be endangered.

However, fire detection and suppression systems installed inside most buildings are not designed to detect and contain fires from outside the building. Often the only way to detect a fire on the rooftop is by chance visual notifications such as people in a passing vehicle or someone walking outside the building raising the alarm. By the time a fire is established enough to be seen from the ground, it is likely already a major incident requiring full evacuation of the premises and a major firefighting intervention.

An effective fire protection measure is to consider rooftop fire detection when PV systems are installed. Because operations in many large commercial and industrial premises are mission critical or 24/7 continuous processes, a reliable fire protection solution for roof-mounted PV systems can become a crucial part of overall building and life safety, as well as ensuring business continuity and asset protection. A fire detection system can be used to automatically detect fires from roof-mounted PV systems and potentially to actuate suppression systems. However, outdoor ambient conditions, seasonal temperature fluctuations, direct sunlight or reflection, as well as weather elements such as sea salt corrosion are all factors can affect detection performance, service requirements and product lifespan.

Securiton's SecuriHeat d-LIST line-type heat detection system offers a robust, reliable and quick-acting fire detection system well suited for all types of exterior environments. The SecuriHeat d-LIST is an electronic sensor cable system that has been specially designed for EN 54-22 and can be used as an integrating or non-integrating line-type heat detector. This sets the system significantly apart from conventional point-type heat detectors. Other key advantages include its relatively high sensitivity; its real-time system fault self-check and alarm; and the fact that it is free of routine maintenance, fully weather resistant, discreet and easy to install.

The purpose of this Case Study is to provide fire safety and protection consultants, qualified fire system specifiers, design engineers or technicians, with recommendations for the application and use of SecuriHeat d-LIST resettable line-type heat detector (RLTHD) to protect roof-mounted PV systems of varying size and design. It is also suitable for facility management and end-customers alike to gain a high-level insight to cost-effective, fit-for-purpose and fire-engineered fire detection and protection solutions. It offers insight into managing these areas which are as yet not fully covered by prescriptive (Deem-to-Satisfy) fire detection and protection compliance requirements. A key design objective is to enhance fire detection methods to avoid business interruption and mitigate risks from the PV systems through best fire prevention practices.

To facilitate the best risk management practices and reliable emergency response procedures through early intervention and elimination of potential fire incidents, this Case Study touches on:

- Securiton 360° Fire Protection Solution (FACP and ECP¹).
- Securiton software for design, install and maintain, as well as local and remote monitoring.

Where applicable, the Case Study also provides key requirements on Inspection, Testing and Maintenance (ITM) of SecuriHeat RLTHD²; and world-class technical and application support offered by Securiton through its headquarters teams in Europe and its vast global network of local employees and distribution partners.

¹ FACP: Fire Alarm Control Panel, also known as Fire Alarm Systems (FAS) or Fire Indication Panel; FACP is often categorised into Main and Sub panel; Related devices include Mimic Panel and Repeater Panel. ECP: Extinguish Control Panel

² RLTHD: Resettable Line Type Heat Detector

2 Aspects of fire safety and prevention

The global rooftop solar photovoltaic market is estimated to be growing at an impressive compound annual growth rate (CAGR) of 15.70% and is predicted to reach US\$ 434.63 billion by 2032. Among these roof-mounted PV systems, 74% were connected to the grid and 26% were off-grid [1] in 2022. Their deployment spans all residential, industrial and commercial markets. The market growth is also fuelled by ever rising power supply costs while at the same time the cost of PV systems is falling.

In order to successfully protect installed PV systems and the buildings' structure that support their mounting, the nature of the PV systems and the risks and safety implications that they bring must be taken into consideration.

2.1 Roof-Mounted Photovoltaic (PV) Systems

In order to maximise return on investment, roof-mounted PV systems are often designed to maximise the use of all available roof area. Size of individual PV panels varies depending on the number of PV cells (hence the power rating per panel). For example, common 72-cell panels have a typical dimension of (W) 990 mm (39") x 1,956 mm (H) (77") x (D) 36 mm (1.45"), and 96-cell panels of (W) 1,054 mm (41.5") x 1,590 mm (H) (62.6") x (D) 35 mm (1.38").

Roof-mounted PV systems can vary in scale depending on their purpose, available roof surface areas and desire for a higher ROI. The use of solar power has been found feasible for large data centres or various sizes of commercial and industrial applications such as warehouses, storage and distribution centres and large retail outlets. Examples are illustrated in Figure 1 (a).

Such roof top PV systems are mounted either with a single row of a single PV panel height or width with walking space in between or installed one next to another to form a large area of panel surface with little gaps in between. In these types of installations, only limited walking spaces are provided for maintenance service accesses. Spacings between the PV panels and existing roof structures or mechanical fitouts are not standardised for lack of established industry norms and universal codes of practice.

The PV panels themselves may be mounted at a pitch or simply flat in parallel to the roof surface with pre-fabricated steel mounting frames (see Figure 1 (b)). Pitched or flat mount mechanisms come with implications to the installation of fire detection and protection system and potential fire spread characteristics once a fire is ignited.

Obviously, flat mount PV panels can be installed on a pitched roof or vice versa (see Figure 1 (c)).



(a) Various in scale roof-mounted PV panels (left: large data centre; right: mixed use workshop/warehouse/offices at Securiton HQ)



(b) Roof-mounted PV panels (left: pitched mount; right: flat mount)



(c) Pitched panels on a flat roof and flat panels on a pitched roof, Securiton HQ in Zollikofen.

Figure 1 Roof-Mounted Photovoltaic (PV) Systems

2.2 Fire Risk, Consequence and Safety

There are industry codes of practices (e.g. from the Institution of Engineering and Technology [2]) to ensure that a solar PV system is competently installed and safe to operate in compliance with current national and international standards. While the structure of roof-mounted PV systems can be perceived as low risk due to their relatively simple, non-combustible construction and positioning outside of buildings, the actual fire hazards and risks can in fact be significant [3], [4], [5]:

- DC isolator failures and electrical arcing in high DC voltage circuits can be a source of ignition and fire. Although temperature of an electrical arcing varies, it was found sufficient to melt PV panel materials like glass, copper and aluminium. These in turn lead to the combustion of other surrounding materials.

- As more businesses embrace photovoltaic technology, the potential risks associated with electrical components, connectors, wiring and installation errors also escalate. Poor connections, damaged cables, water intrusion in inverters, and faulty components can become the source for short circuits and, eventually, overheating which results in a PV panel fire.
- The presence of PV panels would certainly change the dynamics of a fire involving a roof assembly and increases the fire spread. This can be a major concern, particularly with retrofit systems on existing buildings where the roof can be non-fire rated or lack of appropriate fire resistance treatment. Fire spread due to weather conditions such as strong winds and close proximity of large number of PV panels, can damage or even lead to the collapse of the entire roof structure in a relatively short period of time.
- Fire detection and suppression systems installed inside the buildings are not designed to detect fires outside the buildings. Without specific rooftop fire detection, the only way to detect a fire on the rooftop is by the chance visual notifications such as someone walking outside the building.

In a BRE report [6] where 58 PV fire incidents were analysed, over 90% of the fires involve roof-mounted PV systems. In many cases DC isolators were found to be the probable cause of ignition. Other ignition sources include DC connectors, cables, inverters and on occasions, the PV modules themselves. One year after in a similar report in 2018, it was found 13 of the 80 reported PV panels-related fire incidents resulted in casualties.

The consequences of fires originated at or around roof-mounted PV systems can be significant. During April 2020 and June 2021 [7], solar PV panels on a number of large fulfilment centres of a multinational online retailer caught fire or experienced electrical explosions at least six times. As a result, the company took all of its rooftop PV systems offline pending a detailed investigation. Each fire reportedly cost the company an average of US\$ 2.7 million.

An increasing number of fires involve PV panels' flammability once ignited. According to a report from SFPE Europe [8]:

- In 2009, a fire occurred on the membrane rooftop of a retail store in California, USA damaging 1826 PV modules.
- In 2012, fire associated with solar panels occurred in a warehouse in Goch, Germany, burning approximately 4,000 m² (43,056 ft²) of roof area
- Another large fire incident occurred in 2013 at a food warehouse in New Jersey, USA, where the roof was covered by 7,000 PV modules
- In 2019, the Japanese government warned against the fire risk from rooftop installed PV systems due to the upsurge of fire incidents logged from 2008 to 2017

To improve fire safety for roof-mounted PV systems, there are several design choices that can limit fire spread if ignition occurs. For example, the use a complete system (PV panels, securement, and roof assembly) that has been tested to simulate actual field conditions (FM Global DS 1-15 [3]). While simple coatings may be applied, other appropriate options include the costly replacement of an existing roof with a metal roof, as well as non-combustible materials (such as gypsum cover boards, mineral wool or expanded glass roof insulation) installed directly below single-ply or multi-ply roof covers. The potential for fuel contribution from the underside of the PV panel can be mitigated by using a glass backing, aluminium or fluoropolymer-based back-sheet as passive fire protection measures under the panel.

Traditionally, automatic rooftop fire detection is typically not provided because it had been considered as low loss frequency related to exterior fires. However, the installation of large number of PV panels on the roof changes the risk and hazard profile significantly. With this in mind, insurance company Zurich [4] recommend rooftop fire detection when PV systems are installed. Unlike for inside the building where life and building safety (e.g., NFPA 101 [9] and NFPA 5000 [10]) are prescribed per international and local codes in accordance with relevant building occupancy classification, provisions for automatic fire detection are not prescribed for roof-mounted PV systems. Nevertheless, they represent higher fire hazard and risks and should be considered in terms of life/building safety and business continuity.

With a reliable fire detection system for roof-mounted PV systems, fire incidents can be managed to avoid or minimise operation interruption and damage. Widespread evacuation and power-shutdowns will also be avoided. Even if the fire situation progresses, fire services can be notified automatically and arrive at the scene much earlier.

3 Challenges to Reliable Fire Detection

The primary concerns of fire safety in roof-mounted PV systems are:

- Fires due to increased fire ignition sources on rooftop cannot be detected by fire detection systems typically provided inside buildings.
- De-energising solar power systems is not possible without early detection and intervention. This increases the potential for rapid spread of fire on the rooftop, aided by climate conditions such as wind and dry air.
- The common rack-mounting of the PV panels can trap fire underneath the panels, exuberate flame-induced heat and combustibility of roof coverings, and lead to the collapse of roof structures.
- Once a fire starts spreading beyond the PV panel fire of origin, the difficulty of firefighting efforts will be increased significantly due to dangerous access to the rooftop and inside the building under the affected roof structure.

Even buildings in 24/7 operation, fires on the rooftop can rarely be observed during the early stage of their development. Visibility can be impeded completely if a fire starts under a PV panel and where the roof is mostly flat.

A fire detection system designed to automatically detect fires from roof-mounted PV systems and potentially to actuate suppression systems must be capable of operating reliably in the general outdoor ambient conditions, including seasonal temperature fluctuations, direct sunlight or reflection, and weather elements such as sea salt corrosion. In winters, the temperature could fall to -30°C (-22°F) or lower, and summer temperatures could be well over 40°C (104°F). All of these factors can affect detection performance, service requirements and product lifespan.

While there are practical difficulties in choosing suitable detection products, SecuriHeat d-LIST is an ideal solution to address the key challenges of ensuring a reliable fire detection for rooftop solar panels (see [Table 1](#)), designed as either an integrating or non-integrating line-type heat detector which can always localise a fire exactly (precise detection at the selected sensor spacing).

Challenge	Securiton advantages
Heat dispersion due to outdoor environments	Use of SecuriHeat d-LIST for heat detection, integrated with sprinkler actuation where applicable. A relatively long length of sensing cables (2 x 350 m (1'148 ft)) can be monitored by a single evaluation unit, and it has the sensitivity and flexibility to react to relatively small fires even in an open area.
Wide ambient temperature range	SecuriHeat d-LIST operating temperature range: main detector unit -25°C to +70°C (-13°F to +158°F), sensing cable -40°C to +85°C (-40°F to +185°F) Reinforced cable with strain relief and aluminium foil shielding.
Practical design considerations (including difficult or hazardous ambient conditions)	Small cable diameter and small minimum bending radius with flexible junction box connection for easy install, troubleshooting and services. SecuriHeat d-LIST offers two levels of alert and ('pre-signal' and 'alarm'), facilitating both earlier incident alert to tackle potential fires to minimise damage and disruption, and allowing the fire alarm to be integrated with pre-action sprinklers for timely fire suppression and fire services notification.
Risk-based detection	SecuriHeat d-LIST work with integrated high precision temperature sensors embedded in tough cable for precise monitoring where specific addressable detection and alarm are needed.
Obstructed or difficult access	SecuriHeat d-LIST sensing cables are located underneath the PV panels while the evaluation unit can be installed inside the building or building service rooms on or near the rooftop access areas. Routine service and testing are done from the evaluation unit.
False alarms	SecuriHeat d-LIST adopt unique highly sensitive rate-of-rise detection combined with different alarm thresholds for maximum reliability (algorithm specific and maximum alarm parameter sets).
Low TCO, ongoing services and maintenance	Easy to clean, including with pressure washers. The whole detection system, including the sensing cables requires no or minimal routine maintenance No drift = no re-calibration; performs self-test = no maintenance test required; no limits to cuts & repairs, with no loss of performance

Table 1 Challenges to and solutions for Roof-Mounted PV Systems protection with Reliable Fire Detection

4 Design Codes of Practices

Performance-based Design (PBD) is typically implemented when elements of fire safety and protection system design are not covered in the prescriptive codes. This may be due to unique building structure, environmental conditions, the desire for added detection for early warning, or extended egress considerations [11]. A PBD approach is commonly adopted for either of the following:

- As a means to determine equivalency to a prescriptive code or standard.
- As an approach to achieve broadly defined fire safety goals and objectives.

To select a suitable fire detection system, relevant design and alarm codes must be applied. Examples of these include NFPA 72 [12], BS 5839-1 [13], VdS 2095 [14], and others like AS 1670.1 in Australia [15], NEN 2535 in Netherland [16], R7 in France [17] and DBI 232 in Denmark [18]. Taking into account requirements from all relevant codes and standards, industry code of practices and government regulations [19], [20] for safety, an approach combining risk based and PBD is a fitting fire engineering methodology to devise a suitable fire detection solution to safeguard roof-mounted PV Systems areas.

An adequate fire detection system that automatically alarms local fire services can make a huge difference in minimising the damage that a potential fire can cause. The ability to detect and alert early also allows local building management or facility operators to control the initial outbreak or to remove potential hazards that would help the fire grow. Early detection of an incipient fire can prevent avoidable business interruption and facilitate orderly and safe evacuation as the fire evolves. When a suitable fire detection system can be designed and installed at a low TCO³, the system can achieve building and life safety objectives as well as protection of business assets.

Table 2 illustrates how RLTHD system performance, as well as other design parameters such as environmental conditions and typical applications, are defined. Note that design of SecuriHeat d-LIST in this Case Study is in the context of PBD, response classes and environment groups per EN 54-22 [21]; and temperature classes and range of spacing options per NFPA 72 [12] are applied as design references.

Design Parameters	BS/EN 54-22 [21]		NFPA 72 [12]	
	Response Class	Detection Range °C (°F)	Temperature Class	Response Temperature °C (°F)
Detection Class vs. Detection Range	A1	54-65 (129-149)	Low	38-57
	A2	54-70 (147-158)	Ordinary	58-79
	B	69-85 (156-185)	Intermediate	80-121
	C	84-100 (183-212)	High	122-162
	D	99-115 (210-239)		
	E	114-130 (237-266)		
	F	129-145 (264-293)		
	G	144-160 (291-320)		
Environment Group ⁴	Environment Group	Temperature Range °C (°F)	n.a.	
	(E)1	-5 to +40 (23 to 104)		
	(E)2	-10 to +55 (14 to 131)		
	(E)3	-25 to +70 (-13 to 158)		

Table 2 Design and performance parameters for LTHD per codes and standards

³ TCO: Total Cost of Ownership (of an Early Warning Fire Detection system)

⁴ Sensor element and evaluation unit are Environmental Group III; connection boxes Environmental Group II

5 Optimised Design & Use Case

To address the fire detection needs of roof-mounted PV systems, specific risks must be taken into account together with the operating environments and consistent detection performance. This chapter provides details of optimised SecuriHeat d-LIST RLTHD design and use cases, including design criteria for different application scenarios.

5.1 Design Criteria for SecuriHeat d-List

Being a RLTHD, SecuriHeat detects temperature changes and can alert and alarm almost instantly any potential fire incident or developing fire event. The d-LIST sensing cables represent sealed systems that are immune to dust and moisture. They can resist high pressure washing as well as many common cleaning chemicals, although the latter should be checked on a case-by-case basis.

A summary of SecuriHeat d-LIST products key performance parameters is shown in Table 3 below.

Model	Key performance parameters
SecuriHeat SCU 835 (d-LIST) Classes, sensors and cable length	
Classes	Integrating: A1I, A2I, BI, CI Non-integrating: A1N, A2N, BN, CN
Cable length	SEC-15 cable 2 x 350 m (1'148 ft)
Addressable sensors # (Zone)	2 x 100 sensors (1-64) Sensors embedded in the cable at intervals of 1, 2, 3, 4, 5 or 10 m (3.3, 6.6, 9.9, 13.0, 16.5 and 33.0 ft.), or to bespoke design
Hazardous Areas	SEC 15-Ex II 3G Ex ec IIC T4 Gc II 3D Ex tc IIIB T125°C Dc
Rating and operational data	
Rating	SCU 835 Sensor Control Unit (evaluation unit): IP65 SEC-15 cable: weather-proof fully sealed system
Operating temperature	SCU 835 Sensor Control Unit: -25°C to +70°C (-13°F to +158°F) SEC-15 cable: -40°C to +85°C (-40°F to +185°F) SEC 15-Ex (gas Ex areas): -20°C to +70°C (-4°F to +158°F) SEC 15-Ex (dust Ex areas): -20°C to +80°C (-4°F to +176°F)
Measuring temperature range	SEC-15 cable: -40°C to +120°C (-40°F to +248°F) Temperature resolution of 0.1°C (32.18°F)
Sensing Cable Attributes	Cable Diameter: 15 mm (0.59 inch); Min. Bending Radius: 250 mm (9.8 inch)
Detection and actuation	Maximum temperature and temperature changes (differential or integration algorithm)
# of Relays	4 (16 – REL 835) Built-in (Expanded – Module)
Product Type Approval Standards and compliance level	
EN 54-22:2015+A12020	Integrating and non-integrating line-type heat detector; Response classes: A1N, A2N, BN, CN as well as A1I, A2I, BI, CI
UL 521 (pending); NFPA compliant	Response Classes: LOW, ORDINARY, INTERMEDIATE
DNV & BSH (for marine applications)	Integrating and non-integrating line-type heat detector; Response classes: A1N, A2N, BN, CN as well as A1I, A2I, BI, CI (according to EN 54-22 and DNV-CG-0339)

Table 3 SecuriHeat d-LIST SCU 835 controller and SEC-15 cable

In general, relevant codes and standards for the design of a heat detection system to meet prescriptive requirements are referenced as the basis of design. The sensing cables can be flexibly installed for open areas under the PV panels or placed for localised object protection in likely area of overheating due to electrical faults. The sensor

control units (evaluation units) themselves can be located inside the building, interior access corridors or plant rooms around the roof areas, for easy access with no business interruption.

In addition, surrounding areas may also require other forms of detection or accessories such as MCP. Securiton's other related detection portfolio is listed in Table 4 for reference.

Model	Type	Function ⁵
SecuriSmoke ASD	High sensitivity ASD type smoke detector	Non-hazardous/Hazardous
Smoke Switch LRS	Duct Type (Smoke)	Non-hazardous
Fire Door Control	Open/Close	Non-hazardous
Multi-criteria point type	Smoke with Temperature and/or CO	Non-hazardous
MCP	Manual Call Point	Hazardous
Smoke Detectors	Point type (Smoke)	Hazardous
Temperature Detectors	Point type (Heat)	Hazardous

Table 4 Securiton detection products portfolio

5.2 Application Scenarios

When combining prescriptive and risk-based approaches to design a fit-for-purpose fire detection system for life and building safety, it is important to select advanced Securiton detection product portfolio, including Securiton Early Warning Fire Detection (SecuriSmoke ASD and REK), SecuriBeam LTSD (Line Type Smoke Detector) and SecuriHeat RLTHD. SecuriHeat d-LIST, part of Securiton LHTD product portfolio, is ideal for rooftop areas with PV systems, in outdoor applications where heat detection and alarm control are implemented.

This chapter outlines design recommendations and methods using SecuriHeat d-LIST products to protect exterior rooftop areas with roof-mounted PV systems:

- 1 Risk-based Detection Design
- 2 System Integration Considerations

5.2.1 Risk-based Detection Design

Due to the unique placement characteristics of roof-mounted PV systems, SecuriHeat d-LIST cables are often installed underside the PV panels cover the entire surface of the panel arrays. In addition, for any related equipment, such as DC isolators or inverters, specific object detection points can be provided for localised detection and alarm.

Figure 2 shows the use of SecuriHeat d-LIST sensing cables as rooftop area fire detection:

- (a) d-LIST sensing cables monitoring pitched roof-mounted PV systems;
- (b) d-LIST sensing cables monitoring flat roof-mounted PV systems with inverted wave-shaped layout; and
- (c) Illustration of d-LIST accessories such as connection cable, zone sensor and connection box.

⁵ Products listed as 'Hazardous' or 'Non-hazardous' function are connected to building FACPs such as Securiton SecuriFire Fire Alarm Systems



(a) d-LIST sensing cables layout monitoring pitched Roof-Mounted PV Systems



(b) d-LIST sensing cables layout monitoring flat Roof-Mounted PV Systems (shown during installation work)

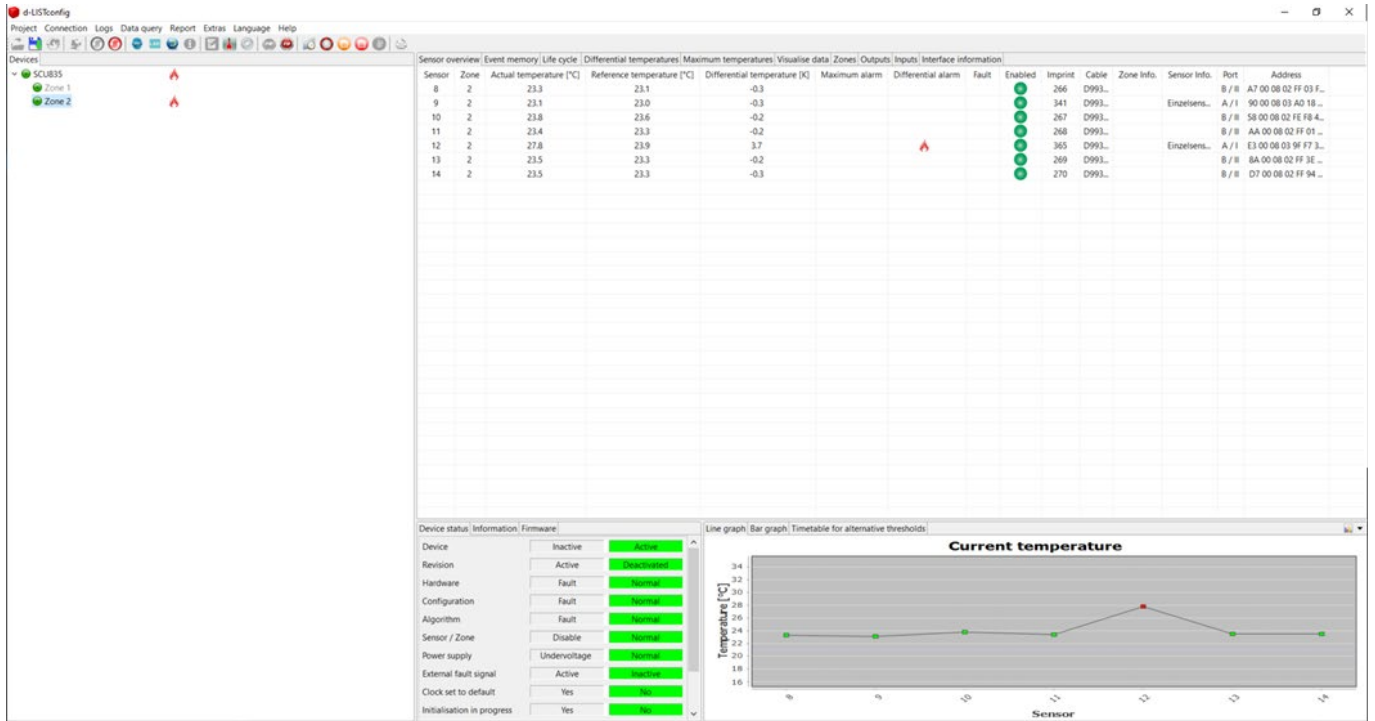
Figure 2 Fire detection placement SecuriHeat d-LIST (risk-based local protection)

Variable	Design recommendation
Spacing	<p>General sensor cables form a single line across the entire length of a single PV panel row if there are big gaps between the panels (Figure 2 (a)). For panels installed close to each other with minimal gaps, sensing cables can be run one for every 2-row or more of PV panels. In this case as illustrated in Figure 2 (b), to maximise the distance between the cables yet also provide optimal detection performance, a square wave-shaped layout may be considered.</p>
Placement	<p>Cables are positioned underneath the PV panels, secured on the inside of the horizontal mounting racks to avoid unintentional damage and exposure to direct sunlight. Wherever practicable, always position the cables under the cover away from direct weather elements such as rain and sunlight.</p>
Orientation	<p>Sensing cables run generally in parallel along the PV panels mounting structure but flexible enough to be bended to go around obstacles, building structure and fittings when needed.</p>
Additional notes	<p>The SecuriHeat d-LIST evaluation unit and the end caps for the sensing cable can be placed well away from the exposed rooftop area.</p> <p>If SecuriHeat d-LIST detector is designed for addressable alarms, sensors embedded in the cable may be at intervals of 1, 2, 3, 4, 5 or 10 m (3.3, 6.6, 9.9, 13.0, 16.5 and 33.0 ft.), or to bespoke design. The manufacturer recommends a spacing be chosen in line with the dimensions of the solar panels being protected, so that one sensor protects either one or two panels, as appropriate.</p> <p>Add branches and connect controllers easily with CBO boxes. This can also be used to repair damaged cable.</p> <p>Choice of Max Alarm, Difference respectively Integration Alarm to enable Pre-signals for early warning</p> <p>Reinforced cable with strain relief and aluminium foil shielded. Flexible cable with sensor positions marked, allow for minimum bending radius of 250 mm (9.8 in.)</p> <p>The cables are fire retardant and halogen free; resistant to water, chemicals, gases and shocks with high EMI immunity.</p> <p>Measuring temperature range: SEC-15 cable: -40°C to +120°C (-40°F to +248°F) temperature resolution of 0.1°C (32.18°F)</p>

5.2.2 System Integration Considerations

Depend on the scale of the Roof-Mounted PV Systems, SecuriHeat d-LIST detectors can be connected to a laptop for easy monitoring and troubleshooting (as shown in Figure 3 (a)). It can also be connected to a building FAS (as illustrated in Figure 3 (b)).

If a pre-action type sprinkler system or a water mist system is used, SecuriHeat d-LIST detector can also be configured to actuate the release of the fire extinguish systems.



(a) d-LIST Config graphical user interface



(b) d-LIST controllers networked via redundant loop to a SecuriFire FAS
Figure 3 System integration considerations for SecuriHeat d-LIST

6 Securiton 360° Fire Protection Solution

Securiton 360° Fire Protection Solution (illustrated in Figure 4 below) is built on its advanced Securiton Fire Alarm Systems (FAS). SecuriFire is not just reliable in operation with its modular, decentralised system architecture, it is also versatile and expandable to cater for current and future needs to connect all approved fire safety devices such as signalling, alarming, display and control units.

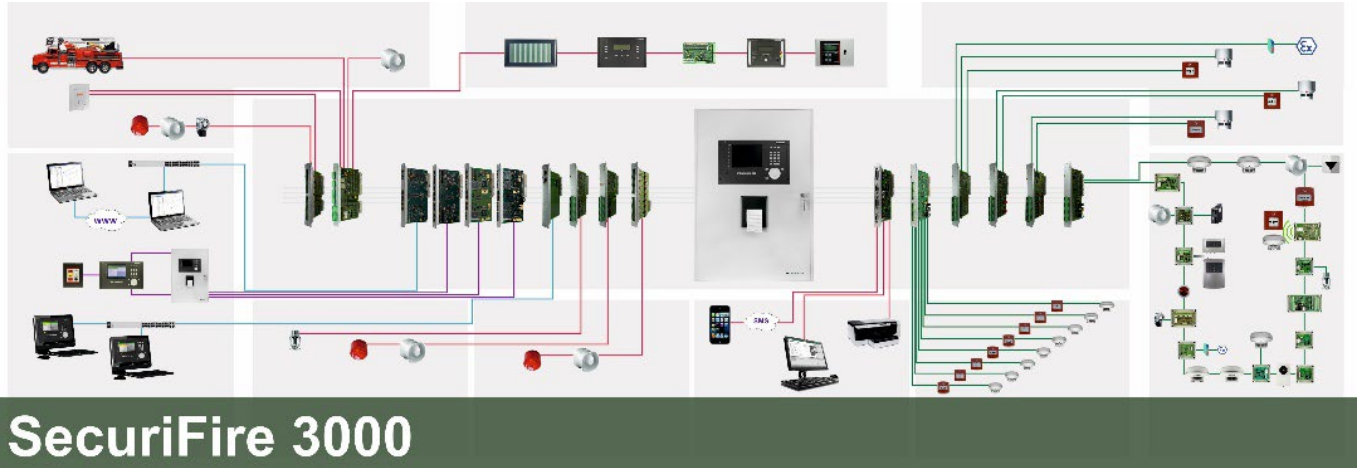


Figure 4 Securiton 360° Fire Protection Solution (FACP and Connections)

SecuriHeat d-LIST controllers are connected via a redundant loop to a SecuriFire FAS. The networked detectors from one or multiple sites can be centrally monitored and managed from a remote location, such as an on-site control room or any authorised off-site location or certified remote monitoring centre.

In general, monitor and manage SecuriHeat d-LIST detectors can be realised with Securiton d-LISTconfig software or through an enterprise BMS software when integrated.

6.1 Features and Benefits

Securiton AG as a whole is certified in accordance with ISO standards 9001, 14001 and 45001 and thus meets globally applicable standards with regard to quality management, environmental management, and occupational health and safety management systems.

Securiton’s SecuriHeat products provide comprehensive line-up for both addressable and non-addressable applications. d-LIST offers unobtrusive, easy to install heat detection that is immune to harsh environments and can easily be cleaned and maintained. It is compatible with the principles of Intrinsically Safe Design and can be used in combination with SecuriSmoke ASD in the most demanding Performance -based Designs.

Summary of benefits of SecuriHeat d-LIST products:

Features	Benefits
Individually assessable sensors	Rapid precise localisation of incipient fires
Sealed cable with choice of sensor spacings	Easy installation, no maintenance required
Extremely durable cables	Operate in extreme environments

6.2 Integrated Verify, Control and Respond

SecuriHeat d-LIST features two levels: the alert ('Pre-signal') and alarm signal ('Alarm'). Typically, an alert from one sensor escalating to an alert from adjacent sensor provides timely alert to an overheating or incipient fire situation, while the alarm signal is used for fire alarm as well as pre-action sprinkler actuation. Table 5 summarises the use of multilevel alarms from SecuriHeat d-LIST.

Level	Signal	Typical use
1	Pre-signal	Verify and control (Power down, manual firefighting with handheld extinguishers)
2	2nd sensor pre-signal	Manually actuate sprinkler system if deem as necessary; call emergency team
3	Alarm	Initiate automatic fire alarm; call fire brigade; automatically initiate sprinkler system if not yet manually activated

Table 5 Alert and alarm levels for LISTEC

6.3 Non-intrusive System Access for ITM

The SecuriHeat d-LIST sensor cable is maintenance free, because the sensors are completely shielded against external influences. In addition, the individual sensors are tested for their function in each measuring cycle. Individual sections of the cable can be replaced easily in case of physical damage.

6.4 Support with Peace of Mind

SecuriHeat is supported by d-LISTconfig software.

Application support includes mainly:

- Partner accreditation program
- Application and field engineering support
- Worldwide reach through a network of partners as well as subsidiaries and investment companies, with branch offices or local employees on all continents.

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