NOVARIS

Application Note
(0015-D90V3)

SIGNAL SURGE PROTECTION FUNCTIONAL SAFETY MANUAL

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1. Introduction

Application and Function

The information in this manual supports the selection and application of surge protection devices (SPD) for instrumentation signals employed in functional safety systems as specified by IEC 61508 and IEC 61511.

The surge protection devices within these standards do not fulfil a distinct safety function, so a comprehensive IEC 61508 functional safety assessment does not apply. Instead, they act as wiring components, facilitating signal connections and terminations while prioritising dependable signal transmission.

Process control systems are susceptible to all three methods of induction of surges: Earth Potential Rise (EPR), Magnetic field and Electric field. EPR is probably the most damaging effect for systems with many outdoor sensors mounted in and around the plant at different locations, whereas electric and magnetic fields can act on the cabling systems even when they are inside a structure. All three effects can generate large voltage differences sufficient to damage the sensors, controls and the controlling equipment. Protection against damage from these effects takes the form of correctly specified SPDs that can keep the system voltages well below the levels where equipment is damaged whilst bypassing the high surge current waveforms simultaneously.

The Novaris signal product series are engineered and verified under AS 1768 and IEC 61643-21 (Low voltage surge protective devices) for signal and communication loop implementation. The signal SPD series prefixed with 'IS-' are certified to be intrinsically safe according to IEC Ex ia IIC T4 and ATEX standards.

The SL, SL2, SL4 and SSP product lines are mounted on DIN rail inside a cabinet or enclosure, safeguarding measurement and control apparatus typically found in control or equipment rooms. These devices generally function similarly across their defined operating ranges. Each module is distinguished by the highest signal voltage it supports under normal conditions, making it easier to select the right SPD for specific signalling requirements.

The SLT/IS-SLT series are designed to protect field-installed equipment, such as level, flow, pressure transmitters, gas detectors and other field devices by fixing directly into the conduit entry points of the instrument housing.

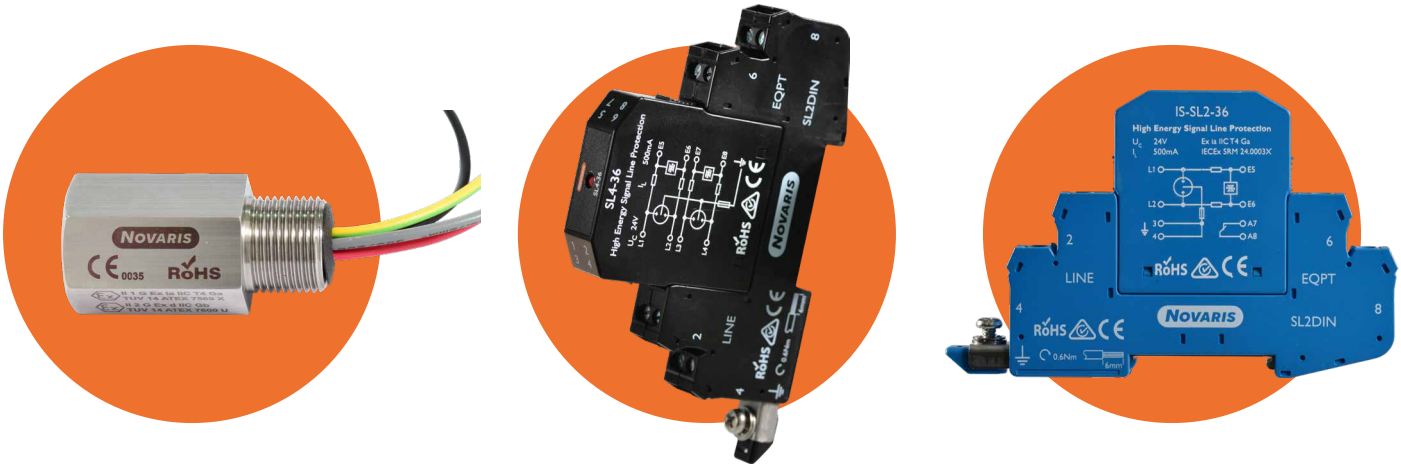


Figure 1. Novaris Signal Surge Protection Range

2. Novaris Signal SPD Series for Field Devices

The Novaris SLT/IS-SLT range provides surge protection for most twisted pair signal cables associated with field instruments and devices, such as level, flow, pressure transmitters, gas detectors, by fixing directly into the conduit entry points of the instrument housing. Novaris 'IS-SLT' products are certified 'Intrinsically Safe' and flameproof according to IEC Ex and ATEX and so may be installed in Ex d rated instruments without loss of integrity. These products are not safety elements but may be used to protect instrument loops designed to achieve Safety Integrity Level of up to SIL3.

Figure 2. IS-SLT Series

IS-SLT3-36-M20 arrangement (3-wire threaded instrument SPD)

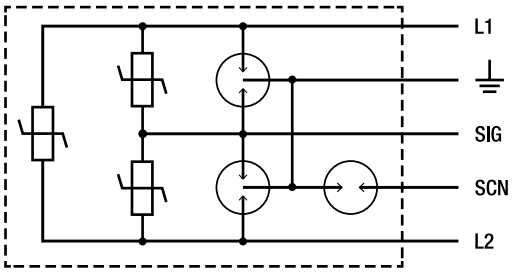


Figure 3. IS-SLT Circuit Arrangement

3. *Novaris Signal SPD Series for Control Equipment*

Novaris Signal series provide surge protection for most twisted pair signalling schemes and are mounted on DIN rail inside a system cabinet or enclosure. The Signal line products contain a multi-stage surge protection circuit for one or two instrument loops and operate passively, drawing no current under standard conditions. Since these SPDs perform a fixed function, there are no operator controls or configuration switches. They are effectively wiring components that pass signals without modification. The installation of each SPD is critical because it governs device performance and determines the impact of any breakdown or failure on the associated signal loop.

The SL / SL2 / SL4 series is designed to protect digital and analogue I/O circuits up to the maximum voltages indicated by the part number. The IS- range in this series is certified to be 'Intrinsically Safe' (according to IEC Ex ia IIC T4 and ATEX) and can be installed in the hazardous zone or the field side of the IS barrier. This not only provides protection for the DCS, SIS, PLC or RTU I/O, but also provides protection for the IS barrier.

All Novaris Signal SPDs that are DIN rail mountable, come with a removable top module that is plugged onto a base module. The base module acts like a terminal block that can be mounted on DIN Rail and provides a way for isolation of the signal whenever required. Hence separate terminal blocks and accessories are not required for such IO loops.

Novaris produces two versions of base modules: a "-G" type with a direct earth connection and an "-EC90" type featuring an isolated ground. The "-EC90" variant uses a 90V DC gas discharge tube in the grounding path. This gas tube remains open circuit in normal conditions, preventing earth leakage and ground loops. When a common mode surge occurs, it briefly conducts to direct surge energy to local ground, then reverts to its open-circuit state. The '-EC90' base option is particularly useful for screen wire terminations especially for SPDs installed in field side cabinets where the floating of screen wires is necessitated. This helps to prevent surges from coupling into the signal loop via cable shields by providing surge discharge capability without compromising isolation.

The below table shows the commonly used Novaris Signal SPD series for Process control environments.

Model Series	Type	Channels	Key Features
SL-xx / IS-SL-xx	Signal SPD	Single	Removable top, no indicator
SL2-xx / IS-SL2-xx	Signal SPD	Single	Removable top, local indicator, changeover contact for remote indication
SL4-xx / IS-SL4-xx	Signal SPD	Dual	Removable top, two independent signal loops, local flag indicator
SLC-36 / IS-SLC-36	Signal & Power SPD	Dual	Removable top, One channel for signal & one for power protection, local indicator
SSP6A & SSP10A	Power SPD	Single	Removable top, DC power SPD. SSP10A - LED power indicator, Local indicator and normally closed contact for remote indication

This safety manual focusses in detail on the following commonly used Novaris signal SPD models:

IS-SL36:
A basic single-channel SPD for signal loops with no monitoring or indicators but with fusible line PCB tracks.

SL2-36:
A single-channel SPD featuring a mechanical flag as visual local indicator and dry contact as remote indicator to detect high-energy surges affecting the SPD.

SL4-36:
A dual-channel SPD with visual local indicator, protecting two independent signal loops within a single enclosure.

SLC-36:
A hybrid SPD that protects both signal and power lines, combining SL2-36 for signal and SSP10A-38 for power in one unit.

SSP10A-38:
A single-channel power SPD for 24V AC/DC power lines, for higher signal load upto 10A.

3.1 IS-SL36 Signal SPD

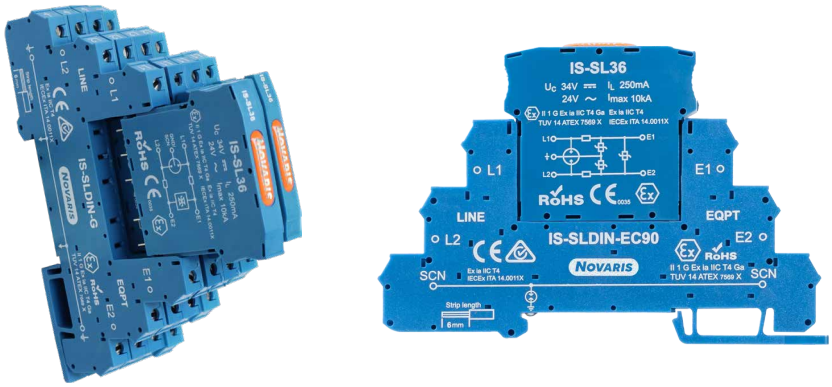


Figure 4. IS-SL Series (Single channel with no indication)

Removable Top Design
In SL and IS-SL series, the design features a removable top module and the base module of the device to act as a terminal block, and the signal loop is interrupted whenever the top module (containing the connectivity and surge protection components) is removed from the base. The plug-in design facilitates simple and rapid replacement and testing – streamlining maintenance without the hassle of detaching the wiring from the terminals. The unique connection pins of the top module reduce systematic errors during installation and servicing, thereby improving safety.

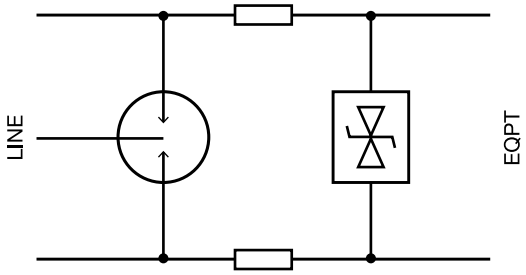


Figure 5. IS-SL Circuit Arrangement

3.2 SL2-36, SL4-36 & SLC-36 Signal SPD

The following are the features for the SL2/SL4/SLC and SSP10A range and their respective IS- range.

Removable Top Design
This feature allows the device to act as a terminal block, and the signal loop is interrupted whenever the top module (containing the connectivity and surge protection components) is removed from the base. It streamlines maintenance by isolating the circuit without the hassle of detaching wiring, thereby improving safety and reducing service time.

Visual Indicator
Unlike in SL/IS-SL range, the SL2/SL4/SLC and SSP10A ranges come with a local indicator of the health status of the SPD. If the device fails, a mechanical flag becomes visibly raised, enabling clear identification and prompting replacement of the affected unit. In the SL2 & IS-SL2 range, a failure alarm is triggered through a voltage free normally closed contact, if either the top module is removed or the device has encountered a failure, providing an extra layer of notification.

'-EC90' type options
SL2 series comes with the option of choosing the '-EC90' type. However, the '-EC90' option does not apply to dual channel SPDs like SL4 and SLC range.

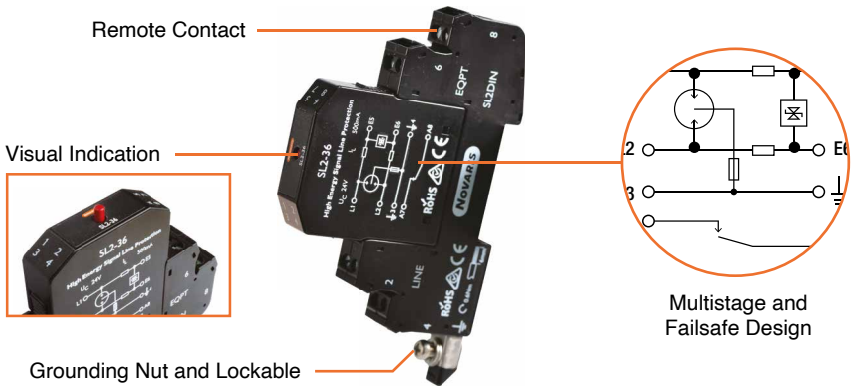


Figure 6. SL2 / IS-SL2 Series Features

3.3 Internal Configurations

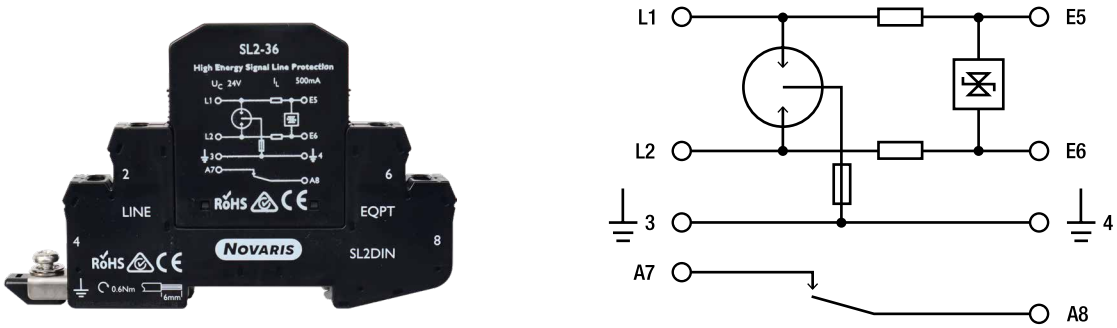


Figure 7. SL2-36 Circuit Arrangement (Single Channel with Local & Remote Indication)

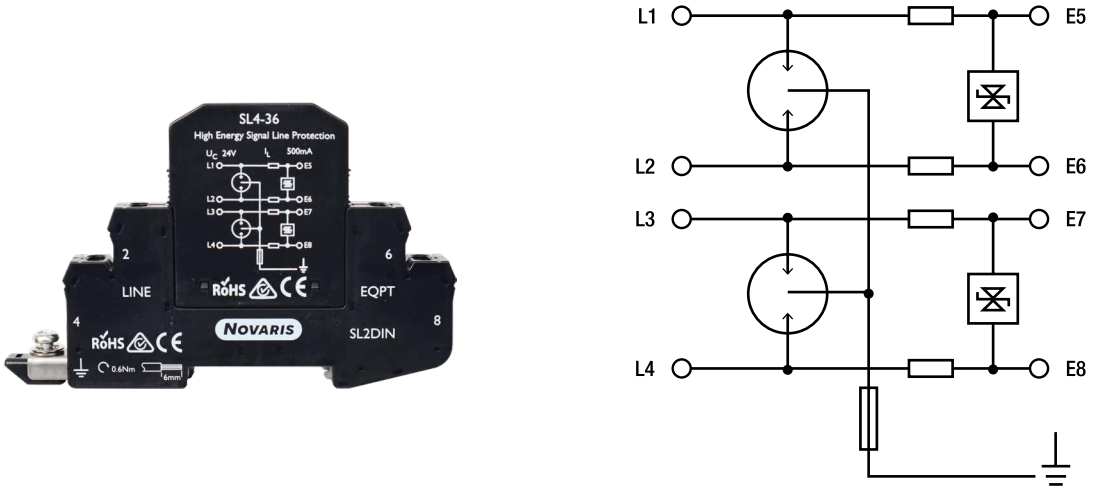


Figure 8. SL4-36 Circuit Arrangement (Dual Channel with Local Indication)

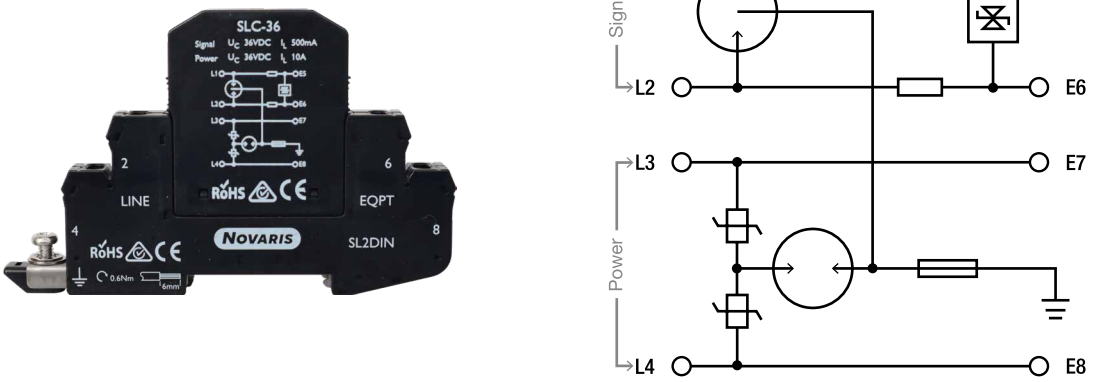


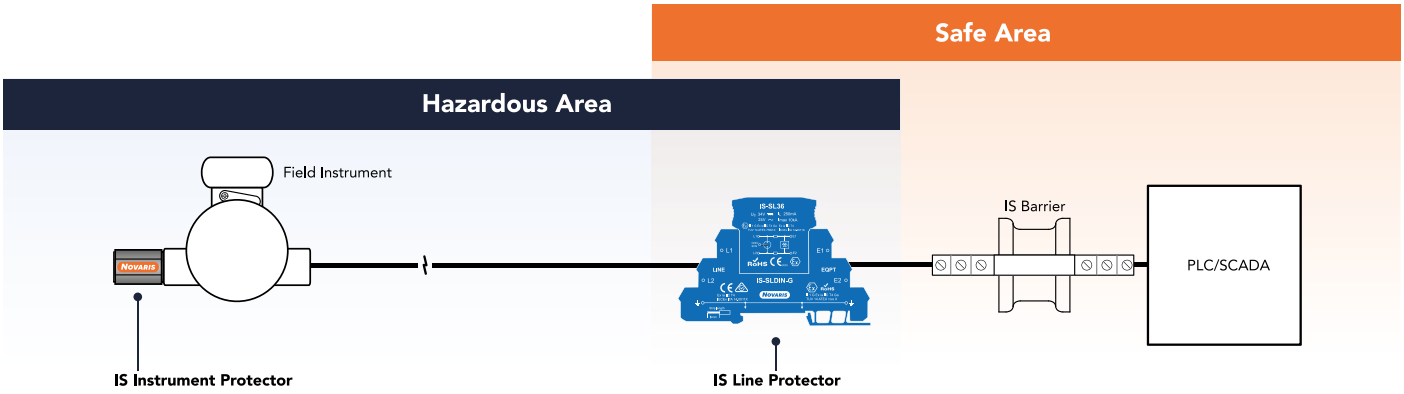
Figure 9. SLC-36 Circuit Arrangement (Power & Signal SPD with Local Indication)

4.1 Use in Functional Safety Applications

Although Surge Protection Devices can serve as protective wiring components within functional safety applications, they do not qualify as 'safety elements' under IEC 61508. These devices limit the energy reaching instrument systems due to external electrical phenomena, such as voltage surges induced by lightning or high voltage switching. Users can consult the failure rate data provided in this manual and incorporate it into a probabilistic model of a Safety Instrumented Function (SIF). This process aids in verifying whether the overall safety instrumented system can achieve the intended Safety Integrity Level (SIL).

4.2 System Configuration Example

An illustrative system configuration is sometimes presented to outline the various interfaces with safety-related system components. While it does not display every detail of the module's internal design, it serves to clarify how the modules should be applied in practice. These products are not safety elements but may be used to protect instrument loops designed to achieve Safety Integrity Level of up to SIL3.



4.3 Protection for Safety PLC

Novaris SL, SL2, SL4, SLC and SSP series modules are connected in line with the signal loop and protect the PLC inputs from detrimental transients and surges. The orange section typically depicts the system's safety-related connection to the logic solver / PLC / SIS. When adopting dual channel modules, it is vital to consider the installation's required integrity: a failure in one channel of a dual channel setup necessitates replacing the entire module, resulting in downtime for both loops. Apart from this difference, single and dual channel units function identically.

4.4 Input / Output Characteristics

In regular operation, Novaris Signal SPD units do not alter or filter the signal; their function is limited to restricting the level of electrical energy.

5. Failure Mode Characteristics

An integral part of the design and application of the Novaris Signal Line protection range is considering the failure mode characteristics. Understanding the modes of failure can give an appreciation of the cause of such failures, identifying potential installation issues and avoid systematic errors.

The Novaris signal line protection devices have been designed to 'fail-safe', minimising possible unsafe failure situations. In Novaris Signal SPD that are connected in series to a signal, there are two stages of protection: a primary stage and a secondary stage. A carefully engineered series impedance is incorporated between the primary GDT (Gas Discharge Tube) and the secondary stages to ensure proper coordination and reliable operation. The secondary stage (often containing Transzorbs/MOVs) is not directly connected to the ground, which prevents common-mode surges or noise from directly reaching the secondary stage without passing through the GDT stage first.

5.1 Overstressed Fault Mode

The overstressed fault mode for the SL/IS-SL range is an open circuit failure mode. In the SL/ IS-SL series the PCB track width within the product has been designed to act as a fusing element. When a surge higher than the Imax of the product is applied, these tracks give way, releasing the load from the circuit where it will remain disconnected until the protection module is replaced. This is to ensure that surges higher than the rating of the surge protection components is not able to reach the load, if the protection components fail. And the failure is immediately detected by the connected logic solver or PLC, prompting the system to transition into a predefined safe state, thereby ensuring a fail-safe response.

For SL2, SL4, SLC, SSP10A range, the mechanical red flag indicator is incorporated as a visual health status indicator. This flag is linked to an internal fuse. In an overstressed fault condition, where the SPD discharges a surge exceeding its rated capacity (Imax), the fuse ruptures and triggers the red flag to pop up, without interrupting the connected signal line. The popped up red flag provides a clear visual indication that the SPD has reached end of life, as it cannot be reset and must be replaced. Notably, the surge is safely discharged prior to fuse operation, confirming that the equipment & signal was protected even as the SPD transitioned into fail-safe state.

5.2 Overvoltage Fault Mode

The overvoltage fault mode for the Novaris signal protection range is a short circuit fault mode. If the device is exposed to a constant over voltage greater than the voltage rating of the device the surge protection components will fail to a short circuit, making the fault immediately detectable by the control or safety system. Such failures typically arise due to incorrect installation or misapplication, rather than random component degradation.

Between the signal lines, the surge protection component (Transzorb/MOV) voltage rating is selected to allow for at least a 10% increase over the maximum recommended operating voltage of the signal protection device. This gives a clear safety margin whilst providing the lowest let through voltage possible, preventing unnecessary signal disturbances while offering robust protection.

Between line and earth, the Novaris signal protection range uses Gas Discharge tube (GDT) protection components to minimise the chance of a short circuit fault from the signal lines to earth.

In the event of a line-to-earth failure, it is advisable to inspect the installation for potential earth potential differences that may contribute to excessive stress on the device. To mitigate risks associated with constant earth potential variations, the use of an IS-SLT type surge protection or IS-SL with '-EC90' base at the remote end of the installation is recommended to provide isolation/ electrical floating.

The Novaris IS-SL range of products are designed to fail in a safe and detectable manner. Any failure in the device results in an immediate interruption of the signal safety loop detected by the connected control/safety system (IS-SL) or by means of visual indication locally on the device (SL2/ SL4/ SSP/ SLC), ensuring that faults do not go unnoticed.

The installation of each SPDs is critical because it governs device performance and determines the impact of any breakdown or failure on the associated signal loop.

6. Selection of Products and Implications

Choosing the appropriate surge protection device depends primarily on factors like its installation point, the signal type and level, and the operational or maintenance demands of the safety instrumented function—rather than the safety attributes of the surge components themselves.

6.1 Determine the Signalling Protocol and Peak Line Voltage

A list of typical signalling protocols and the corresponding Novaris SPD for each use case is available for customers. If the protocol is unknown, the peak signal voltage must be established.

6.2 Select the Clamping Voltage

The clamping voltage of the SPD must exceed the highest signalling voltage to avoid disturbing normal operation whilst still providing ample protection.

Nominal Peak Signal Voltage (V)	Power System (V)	Clamping Voltage (V)
0 - 6	5	7v5
6 - 15	12	18
15 - 30	24	36
30 - 60	48	68

The section below specifies the hardware failure rates for these surge protection devices, tying each potential failure to its influence on the transmitted signal. Equipped with this information, users can evaluate the impact of any such failures on the overall safety instrumented function.

6.3 Determine the Signal Current

- SL / IS-SL models: up to 250mA
- SL2 / SL4 / IS-SL2 / IS-SL4 models: up to 500mA
- SLH2 models: up to 2.5A
- SSP6A models: up to 6A
- SSP10A models: up to 10A

6.4 Select the Signal Frequency / Data Rate

Standard IS-SL/SL2/SL4 units can pass signals up to 60 MHz. For higher frequency or faster data rate needs, the SL485 model is recommended.

Within IEC 61508 and its related standards, surge protection devices are regarded as wiring components, not as safety elements. On their own, they do not fulfil any specific safety function, which makes it impossible to certify them to a particular SIL level individually. However, in a complete safety system, their influence can be evaluated by examining potential failure modes and their effect on overall system integrity.

7. Assessment for use in Functional Safety Applications

- Hardware fault tolerance: 0
- Classified as Type A devices (non-complex with clearly defined failure modes)
- No internal diagnostic functionality

A Failure Mode and Effect Analysis (FMEA) was performed to determine the hardware failure rate of these modules. The results of this analysis are presented below.

7.1 Failure Modes and Rates

Novaris SLT3/ IS-SLT3 Series (Shunt Connected)

Failure Mode	Failure Rate SLT3-36-xx / IS-SLT3-36-xx
Connected signal not affected (λsu)	0
Connected signal interrupted (λsd)	2.00E-07
Errors in connected signal detected (λdd)	9.00E-15
Errors in connected signal undetected (λdu)	9.00E-15

* Signal is driven outside normal operating range of 4/20mA and is detectable by the PLC

Novaris SL / IS-SL Series

Failure Mode	Failure Rate SL36-G / IS-SL36-G
Connected signal not affected (λsu)	9.08E-09
Connected signal interrupted (λsd)	1.65E-08
Errors in connected signal detected (λdd)	3.00E-15
Errors in connected signal undetected (λdu)	3.00E-15

Novaris SL2 / IS-SL2 Series

Failure Mode	Failure Rate SL2-36 / IS-SL2-36
Connected signal not affected (λsu)	21.5E-09
Connected signal interrupted (λsd)	9.45E-09
Errors in connected signal detected (λdd)	1.60E-10
Correct operation (λne)	1.89E-09

Novaris SL4 / IS-SL4 Series

Failure Mode	Failure Rate SL4-36 / IS-SL4-36
Connected signal not affected (λsu)	10.5E-09
Connected signal interrupted (λsd)	18.5E-09
Errors in connected signal detected (λdd)	1.50E-09
Correct operation (λne)	1.00E-09

Novaris SLC (IS-SLC) / SSP10A (IS-SSP10A) Series

Failure Mode	Failure Rate SLC-36 / SSP10A-38
Connected signal not affected (λsu)	20.5E-09
Connected signal interrupted (λsd)	38.5E-09
Errors in connected signal detected (λdd)	1.50E-10
Correct operation (λne)	4.00E-09

7.2 Installation and Operating Conditions

These devices are assumed to be installed, operated, and maintained in accordance with their product specifications, with an average ambient temperature of 40°C. If the average temperature is around 70°C or if significant temperature fluctuations are common, the specified failure rates should be multiplied by an experience-based factor of 2.5.

7.3 Relevance to Safety Instrumented Functions

The data provided here is intended to guide Safety Instrumented Function designers in assessing the influence of these surge protection devices on the performance and availability of instrument loops.
The surge protection devices themselves are not regarded as “safety elements.”

7.4 Electromagnetic Compatibility (EMC)

Novaris surge protection devices are intended for use in typical industrial settings. However, good engineering practice requires that modules be installed in locations where they are not subject to excessive conducted or radiated interference.

Any maintenance or testing should only occur when the field loop is not actively in service. This minimises the risk of transient shifts in the field signal.

7.5 Environmental Considerations

These devices operate effectively in temperatures ranging from -40°C to +70°C and tolerate up to 95% non-condensing relative humidity. They are designed for use in normal industrial environments without excessive vibration, as defined for each product line.

Ensuring reliable operation requires that the devices remain within the prescribed temperature and vibration limits. Abiding by the specified conditions in the product documentation will help maintain long-term reliability.

8. Installation

When installing surge protection devices, two safety considerations are paramount:

- Functional Safety (relevant when used in Safety Instrumented Functions, or SIFs)
- Intrinsic Safety (only pertinent when used in loops requiring intrinsic safety)

If intrinsic safety applies, consult the relevant sections in the instruction manuals or product documentation for guidance on installing interface equipment to satisfy intrinsic safety requirements. In many regions, there are formal codes of practice and industry-specific guidelines that must also be observed.

If these guidelines are properly followed, no extra measures are needed for incorporating the products into functional safety applications.

Except for IS-SLT models, designed specifically for field mounting, modules should be placed in an enclosure rated at least IP54 to protect against dust and moisture. Alternatively, a location providing comparable protection, such as inside a suitable equipment cabinet, is acceptable.

9. Maintenance

Adhering to maintenance and operational guidelines for intrinsically safe equipment in hazardous areas often involves carrying out regular installation audits, as mandated by various codes of practice.

In addition, proof testing the instrumented loop at scheduled intervals established by a safety case assessment ensures ongoing compliance with functional safety requirements. The continuity of the surge protection device (not its surge capability) will be verified as part of overall loop testing during commissioning and throughout the product’s operational life. Removal of the surge device is not needed for these tests.

If a Novaris SPD is identified as faulty at any stage—either during commissioning or routine operation—it should be reported to Novaris. Where applicable, a Return of Goods Agreement (RGA) will be issued, allowing for the device to be returned to the factory for examination. If the product remains within its warranty period, it will be replaced.

10. Technical Assistance & Support

For matters pertaining to technical assistance, installation & operation, maintenance support or warranty, please write to:

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Reference number	Contact person:	Date
PS-26587-24-M	Giorgio Puglia	From 2025-05-26
	E-Mail: g.puglia@tuev-nord.it	Unit 2028-05-25

Subject: Safety signal Surge Protectors models: **IS-SL36-G and IS-SLT3-36-M20**

The purpose of this letter is to clarify the use of surge protective devices in cascade to a safety loop of an instrumented safety function to protect it from surges.

The objective is to protect the instrumented safety function signal from severe voltage oscillation often coming from the earth.

Adding these devices in the safety loop raises the Probability of Failure on Demand of the safety function but these elements fail very rarely so the impact on a possible failure of the functional safety signal result is close to negligible.

An assessment (refer to report no. PS-26587-24-M-01) was conducted with focus on random, systematic faults and common mode failure referring to the standard IEC 61508:2010 parts 1, 2, 4, 6. These SPDs are designed to protect the safe signal of functional safety loop from surges. These surge protection devices do not fulfill a distinct safety function, so a comprehensive IEC 61508 functional safety assessment does not apply.

Best Regards,

Functional Safety and Machinery Expert

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