NOVARIS

The Lightning and Surge Protection Company

CHOOSING SURGE PROTECTION

"Surge protection is not an option -
it is a critical line of defence."

(0067-D11V1)

Risk Assessment

Historically lightning protection was concerned only with the protection of buildings and structures. Since buildings were constructed of masonry and timber. they constituted a significant fire hazard. Traditional lightning protection comprising air terminals, downconductors and earthing systems were developed.

Modern structures containing electrically conductive elements such as metallic roofs, steel frames, metallic cladding and reinforced concrete are inherently self-protecting and the traditional approach is no longer applicable. However this does not remove the need for surge protection on incoming and outgoing electrical services.

As electrical services were introduced into buildings little thought was given to protecting these services against the indirect effects of a lightning strike even though the effects of an indirect strike could often be more damaging than a direct strike to a modern building.

This situation is now recognised in most of the world's lightning protection standards. The IEC standard (IEC62305-2) presents a risk assessment procedure to assess the need for direct and/or indirect lightning protection. The Australian Standard AS1768 provides an Excel spreadsheet to simplify the risk assessment procedure. A typical cover page of this spreadsheet is shown in figure 1.

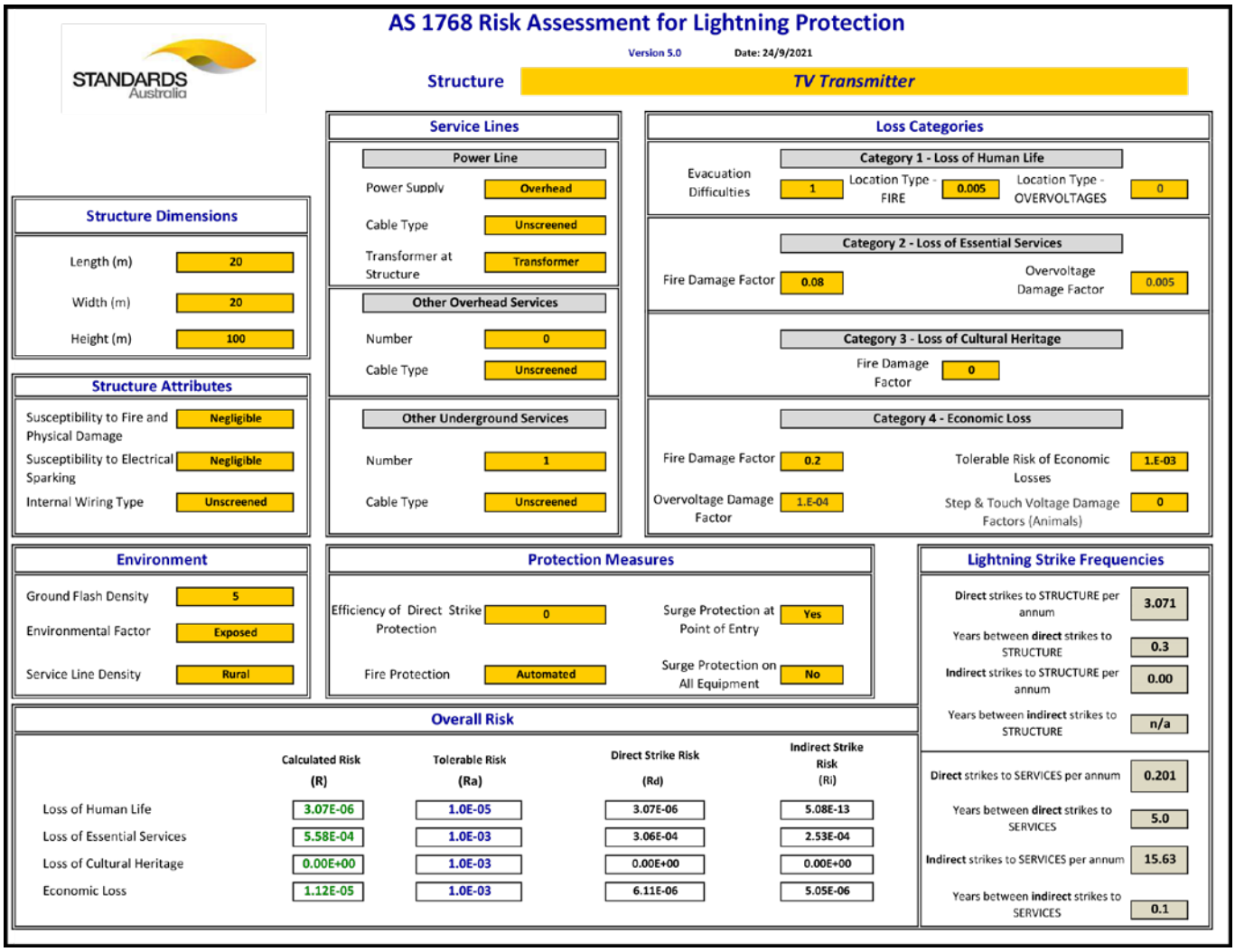


Figure 1. *Risk Assessment from AS1768*

In this example the structure is all steel and therefore self-protecting. The risk assessment determines that only surge protection is required.

Lightning Protection Zones

The risk assessment procedure takes into account four sources of lightning damage and the analysis presents the frequency of these events, shown in the bottom right table in figure 1.

These four sources are:

- **S1** Direct strike to the structure
- **S2** Strike near the structure
- **S3** Direct strike to a service
- **S4** Strike near a service

This is summarised in figure 2 (from both IEC and AS standards)

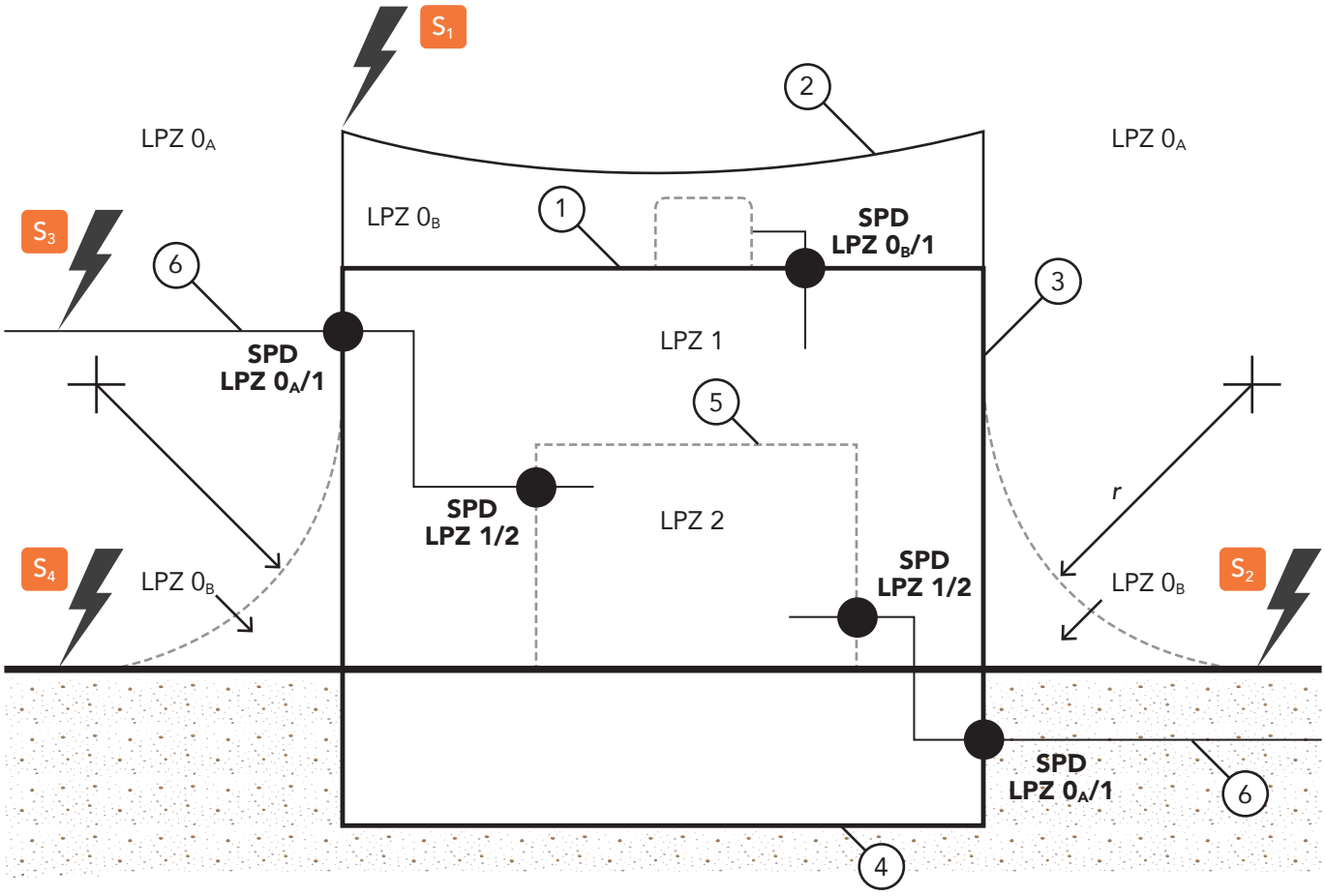


Figure 2. *Sources of Lightning Damage and Lightning Protection Zones*

The risk assessment indicates the need for surge protection whether at the point of entry of services into the structure or further downstream at distribution boards and final circuits and equipment cabinets.
The rating of surge protection devices (SPDs) depends upon their location in the distribution network. Type 1 SPDs are installed in the main switchboard being the boundary of lightning protection zone 0_A ($LPZ0_A$) and the internal distribution wiring in LPZ1. A direct strike to the service or an earth potential rise due to a direct strike to the structure will cause a proportion of the current to flow through the Type 1 SPD.

IEC standards recognise that a direct lightning strike may be modelled by a current waveform with a rise time of 10µs and a decay of 350*µs* (10/350), hence Type 1 SPDs have a 10/350µs rating as well as an 8/20µs rating. After the LPZ0/1 boundary the subsequent current may be modelled by an 8/20µs waveform, hence Type 2 and Type 3 SPDs have an 8/20µs rating.

SPD Selection for LV Power

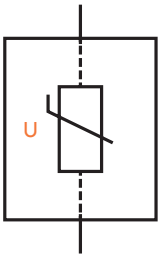
Whilst the risk assessment can provide an indication of the rating of the various SPDs, if the structure is self-protecting this can prove difficult. By identifying the relevant lightning protection zone boundary the rating of the surge protection at that boundary can be determined from Table 1.

Zone Boundary	SPD Location	I_{max} Rating 8/20µs	I_n Rating 8/20µs	I_{imp} Rating 10/350µs
LPZ2/...2	Long final subcircuits, electricity supply outlets	3 - 10kA	2 - 5kA	—
LPZ1/2	Major submains, short final subcircuits and load centres	10 - 50kA	5 - 20kA	—
$LPZ0_B/1$	Service entrance, domestic	50kA	20kA	6.25kA
$LPZ0_A/1$	Service entrance, building fed by overhead or underground service lines, or is an industrial or commercial structure	100kA	40kA	12.5kA
$LPZ0_A/1$	Service entrance, building in a highly exposed lightning area (N_g greater than 2), or fitted with an LPS E.g. mountain top site or tropical regions	200kA	80kA	25kA

Table 1. *Recommended surge ratings – power – derived from AS1768 using standard product surge ratings.*

Surge Protection Technology

Once the surge rating of the SPD has been determined from table 1, the most appropriate SPD technology can be selected.

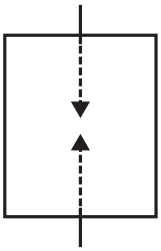


Surge Diverters, SD, SDN, SDD, NSP, NXP (Type 1/2)

Surge diverters are one port shunt connected devices. Novaris surge diverters are voltage clamping devices using metal oxide varistors (MOV). They can be used in all lightning protection zones and have ratings up to 200kA (8/20µs) or 25kA (10/350µs) per phase.

HRC fuses or preferably Novaris surge circuit breakers, SCB, are recommended for overcurrent protection of surge diverters.

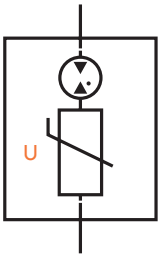
One port surge diverters are most commonly used at main and distribution switchboards in commercial and industrial buildings. Surge diverters are not recommended for installations where sustained overvoltages may be present. Hybrid spark gaps are designed for this purpose.



Spark Gaps, SG (Type 1)

Spark gaps have high surge ratings and are suitable for installation in main switchboards with highly exposed overhead LV power lines in high lightning areas. Spark gaps have a crowbar effect that can cause AC current to flow after being triggered.

This is called follow on current. For this reason, SCBs cannot be used for overcurrent protection of spark gaps. Fuses or circuit breakers must be used.

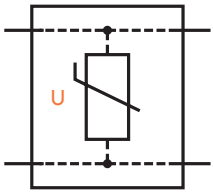


Hybrid Spark Gaps, HSG (Type 1/2)

A hybrid spark gaps combine the advantages of voltage switching and voltage limiting components. They can withstand temporary overvoltages in excess of the line to line supply voltage whilst providing performance almost identical to that of a surge diverter.

They have negligible AC follow on current so may be protected by an SCB.

Hybrid spark gaps can be used in main and distribution switchboards.

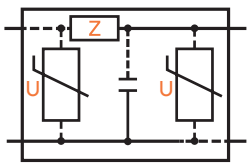


Series Surge Protector, SSP (Type 1/2/3)

Single port SPDs are compromised by the presence of their connecting leads. Typically, voltage drops of 500V per metre can be expected under impulse conditions.

For circuits that are more sensitive the two port SSP provides a means of eliminating the shunt connected leads by being placed in series with the load.

SSPs are suitable for applications such as UPS inputs, rectifiers, VSDs and motors.



Surge Filters, SFH, SFM, SFD (Type 1/2/3)

Surge filters are true two port SPDs offering exceptionally low let-through voltages capable of protecting highly sensitive electronic loads.

They comprise three stages of protection, primary surge protection, series connected low pass filters followed by secondary surge protection. Current ratings range from 6A to 2000A per phase.

They are particularly suited to the protection of data centres, server rooms, communications and cell sites as well as remote telemetry installations.

Type 2/3 surge filters are ideal in equipment cabinets as a final stage of protection.

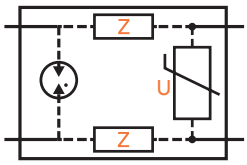
SPD Selection for Signal and Data

Table 2 shows the recommended surge rating for signal and data SPDs related to the lightning protection zone boundary.

Zone Boundary	SPD Location	I_{max} Rating 8/20µs	I_{imp} Rating 10/350µs
LPZ2/...2	Internal marshalling cubicle or equipment cabinet	5kA	—
$LPZ0_B/1$	External signal cables shielded from direct lightning strike	10kA	2.5kA
$LPZ0_A/1$	Point of entry, long overhead or underground signal cables	20kA	5kA
$LPZ0_A/1$	Point of entry signal cables, building in a high lightning area (N_g greater than 2.5), or fitted with an LPS	20kA	5kA

Table 2. *Recommended surge ratings – signal and data – derived from AS1768 using standard product surge ratings.*

Selecting the appropriate SPD requires knowledge of the signal that will pass through the SPD. Generally, signal and data SPDs are two port devices with line and equipment connections.



Two port SPDs are connected in series with the line. Most Novaris process control SPDs incorporate this configuration where alow let through voltage(Up) is required to protect low level signals.

Novaris process control SPDs utilise a combination of voltage switching components (GDT), series impedances and voltage limiting components (MOV, TVS).

When selecting SPDs for process control and data applications, it is important that the signal is not attenuated or lost through the SPD. The following procedure should be followed:

a. Determine the signalling protocol and peak line voltage

Table 3 provides a list of common signalling protocols and the appropriate Novaris SPD for each application. If the protocol is not known, the peak signal voltage must be determined.

b. Select the Clamping Voltage

The clamping voltage of the SPD must be greater than the peak signalling voltage. The following is a guide:

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

SPD Selection for Signal and Data

c. *Determine the signal current*

- SL models are rated at I_L = 250mA
- SL2/4 models are rated at I_L = 500mA
- SLH2 models are rated at I_L = 2.5A
- SSP6A models are rated at I_L = 6A
- SSP10A models are rated at I_L = 10A

For higher current applications, use SFD or IFD surge filters.

d. *Select signal frequency / data rate*

Standard SL/SL2 series will pass signals up to 60MHz.
For higher data rates use the SL485 or RJ45 for Ethernet applications.

e. *Earth isolation*

The normal SL DIN rail base, designated -G, connects the protective earth to the DIN rail to provide a low impedance earth path. If the screen earth of the cable must be isolated use the -EC90 base.
For the SL2 select the -G or -EC90 version.

Table 3. *Novaris Products for Signalling Protocols*

		Novaris Product		
Protocol	**Signal Type**	**High Exposure**	**Low Exposure**	**Field Instrument**
I/O (Analog / Digital <500mA)	± 7VDC, <60MHz	SL2-7v5	SL7v5-G	SLT1-7v5
I/O (Analog / Digital <500mA)	± 16VDC, <60MHz	SL2-18	SL18-G	SLT1-18
I/O (Analog / Digital <500mA)	± 34VDC, <60MHz	SL2-36	SL36-G	SLT1-36
I/O (Analog / Digital <500mA)	± 65VDC, <60MHz	SL2-68	SL68-G	SLT1-68
I/O	0-20mA / 4-20mA	SL2-36	SL36-G	SLT1-36
I/O	RS232	SL4-36	SL36-EC90	SLT3-36
I/O	RS422	SL4-485 + SL1-G90	SL485-EC90 (x2)	SLT4-7v5
I/O	RS485	SL2-485-EC90	SL485-EC90	SLT1-7v5
I/O	1-Wire	SL2-485-EC90	SL485-EC90	SLT1-7v5
I/O (Digital <10A)	2-Wire 24VDC	SSP10A-38	SSP6A-38 (6A)	SLT1-36
I/O (Digital <6A)	4-Wire 24VDC Dual Channel	SSP4-6A-38	SSP4-6A-38	SLT4-36
I/O (Analog / Digital <10A)	3-Wire (Signal, 24VDC Power)	SLC-36	SLC-36	SLT3-36
I/O (Analog / Digital <10A)	4-Wire (Signal, 24VDC power)	SLC-36	SLC-36	SLT4-36

SPD Selection for Signal and Data

		Novaris Product		
Protocol	**Signal Type**	**High Exposure**	**Low Exposure**	**Field Instrument**
I/O (RTD)	2-Wire RTD	SL2-RTD	SL-RTD	SLT1-RTD
I/O (RTD)	3-Wire / 4-Wire RTD	SL4-RTD	SL4-RTD	SLT4-RTD
10 / 100 / 1000T	Ethernet	DRJ45-1CAT6	DRJ45-1CAT6	RJ45-1CAT6-IP67
AS-i	32VDC 1-Pair	SL2-36	SL36-G	SLT1-36
BACnet	ARCNET / Ethernet / BACnet/IP	DRJ45-1CAT6	DRJ45-1CAT6	RJ45-1CAT6-IP67
BACnet	RS-232	SL4-36	SL36-EC90	SLT3-36
BACnet	RS-485	SL2-485-EC90	SL485-EC90	SLT1-7v5
BitBus	RS-485	SL2-485-EC90	SL485-EC90	SLT1-7v5
CAN Bus (Signal)	5VDC 1-Pair	SL2-36	SL36-G	
C-Bus	36VDC 1-Pair	SL2-68	SL68-G	SLT1-68
CC-Link / LT / Safety	RS-485	SL2-485-EC90	SL485-EC90	SLT1-7v5
CC-Link IE Field	Ethernet	DRJ45-1CAT6	DRJ45-1CAT6	RJ45-1CAT6-IP67
CCTV	Power over Ethernet	DRJ45-1CAT6	DRJ45-1CAT6	RJ45-1CAT6-IP67
DALI / DALI 2	Digital Serial Interface	SL2-36	SL36-G	SLT1-36
Data Highway / Plus	RS-485	SL2-485-EC90	SL2-485-EC90	SLT1-7v5
DeviceNet (Signal)	5VDC 1-Pair	SL2-7v5	SL7v5-G	SLT1-7v5
DF1	RS-232	SL4-36	SL36-EC90	SLT3-36
DirectNET	RS-232	SL4-36	SL36-EC90	SLT3-36
DirectNET	RS-485	SL2-485-EC90	SL485-EC90	SLT1-7v5
Dupline (Signal)	5VDC 1-Pair	SL2-7v5	SL7v5-G	SLT1-7v5
Dynalite	DyNet	DRJ45-1CAT6	DRJ45-1CAT6	RJ45-1CAT6-IP67
EtherCAT	Ethernet	DRJ45-1CAT6	DRJ45-1CAT6	RJ45-1CAT6-IP67
Ethernet Global Data	Ethernet	DRJ45-1CAT6	DRJ45-1CAT6	RJ45-1CAT6-IP67
Ethernet Single Pair (SPE)	Single Pair Ethernet	SPE-1	SPE-1	SPE-1
Ethernet Powerlink	Ethernet	DRJ45-1CAT6	DRJ45-1CAT6	RJ45-1CAT6-IP67
FIP Bus	RS-485	SL2-485-EC90	SL485-EC90	SLT1-7v5
FINS	Ethernet	DRJ45-1CAT6	DRJ45-1CAT6	RJ45-1CAT6-IP67
FINS	RS-232	SL4-36	SL36-EC90	SLT3-36

SPD Selection for Signal and Data

		Novaris Product		
Protocol	**Signal Type**	**High Exposure**	**Low Exposure**	**Field Instrument**
FINS	RS-485	SL2-485-EC90	SL485-EC90	SLT1-7v5
FINS	DeviceNet (Signal)	SL2-36	SL36-G	SLT1-36
Fire and Security	12V	SSP10A-14	SSP6A-14-G	
Fire and Security	24V	SSP10A-38	SSP6A-38-G	
FOUNDATION Fieldbus H1	32VDC 1-Pair	SSP10A-38	SSP6A-38-G	SLT1-36
FOUNDATION Fieldbus HSE	Ethernet	DRJ45-1CAT6	DRJ45-1CAT6	RJ45-1CAT6-IP67
GE-SRTP	Ethernet	DRJ45-1CAT6	DRJ45-1CAT6	RJ45-1CAT6-IP67
HART	4-20mA + HF Data	SL2-36	SL36	SLT1-36
HostLink	RS-232	SL4-36	SL36-EC90	SLT3-36
HostLink	RS-422	SL4-485 + SL1-G90	SL485-EC90 (x2)	SLT4-7v5
Interbus	RS-485	SL2-485-EC90	SL485-EC90	SLT1-7v5
KNX	30V, 1.2A DC max, 9.6kb	SSP10A-38	SSP6A-38	SSP6A-38 / SSP10A-38
Load Cell 12V	Wheatstone Bridge	LCP-18	LCP-18	LCP-18
Load Cell 24V	Wheatstone Bridge	LCP-36	LCP-36	LCP-36
MODBUS	RS-485	SL2-485-EC90	SL485-EC90	SLT1-7v5
MODBUS	Ethernet TCP / IP	DRJ45-1CAT6	DRJ45-1CAT6	RJ45-1CAT6-IP67
OPC UA	Ethernet TCP / IP	DRJ45-1CAT6	DRJ45-1CAT6	RJ45-1CAT6-IP67
P-Net	RS-485	SL2-485-EC90	SL485-EC90	SLT1-7v5
PieP	Ethernet	DRJ45-1CAT6	DRJ45-1CAT6	RJ45-1CAT6-IP67
PoE, UPoE, UPoE+	Power over Ethernet	DRJ45-1CAT6	DRJ45-1CAT6	RJ45-1CAT6-IP67
Process Bus (P-Bus)	RS-485	SL2-485-EC90	SL485-EC90	SLT1-7v5
Profibus DP/FMS	RS-485	SL2-485-EC90	SL485-EC90	SLT1-7v5
Profibus PA	32VDC 1-Pair	SL2-36	SL36-G	SLT1-36
Profinet IO	Ethernet	DRJ45-1CAT6	DRJ45-1CAT6	RJ45-1CAT6-IP67
PSTN	POTS	SL-PSTN	KP1/10	MPP-RJxx
S-Bus	32VDC 1-Pair	SL2-36	SL36-G	SLT1-36
SDS	4-Wire (Signal, 24VDC power)	SLC-36	SLC-36	SLT4-36
Sercos III	Ethernet	DRJ45-1CAT6	DRJ45-1CAT6	RJ45-1CAT6-IP67
Sinec H1	Ethernet	DRJ45-1CAT6	DRJ45-1CAT6	RJ45-1CAT6-IP67

SPD Selection for Signal and Data

		Novaris Product		
Protocol	**Signal Type**	**High Exposure**	**Low Exposure**	**Field Instrument**
SynqNet	Ethernet	DRJ45-1CAT6	DRJ45-1CAT6	RJ45-1CAT6-IP67
VDSL	VDSL	MPP-VDSL	MPP-VDSL	MPP-VDSL-IP67

SPD Selection for Signal and Data

Table 4. *Novaris Products for Signalling Protocols – Hazardous Areas*

		Novaris Product - Hazardous Areas		
Protocol	**Signal Type**	**High Exposure**	**Low Exposure**	**Field Instrument**
I/O (Analog / Digital <500mA)	± 7VDC, <60MHz	IS-SL2-7v5	IS-SL7v5-G	IS-SLT1-7v5
I/O (Analog / Digital <500mA)	± 16VDC, <60MHz	IS-SL2-18	IS-SL18-G	IS-SLT1-18
I/O (Analog / Digital <500mA)	± 34VDC, <60MHz	IS-SL2-36	IS-SL36-G	IS-SLT1-36
I/O (Analog / Digital <500mA)	± 65VDC, <60MHz	IS-SL2-68	IS-SL68-G	IS-SLT1-68
I/O	0-20mA / 4-20mA	IS-SL2-36	IS-SL36-G	IS-SLT1-36
I/O	RS232	IS-SL4-36	IS-SL36-EC90	IS-SLT3-36
I/O	RS422	IS-SL4-485 + SL1-G90	IS-SL485-EC90 (x2)	IS-SLT4-7v5
I/O	RS485	IS-SL2-485-EC90	IS-SL485-EC90	IS-SLT1-7v5
I/O	1-Wire	IS-SL2-485-EC90	IS-SL485-EC90	IS-SLT1-7v5
I/O (Digital <10A)	2-Wire 24VDC	IS-SSP10A-38	IS-SSP6A-38 (6A)	IS-SLT1-36
I/O (Analog / Digital <10A)	3-Wire (Signal, 24VDC Power)	IS-SLC-36	IS-SLC-36	IS-SLT3-36
I/O (Analog / Digital <10A)	4-Wire (Signal, 24VDC power)	IS-SLC-36	IS-SLC-36	IS-SLT4-36
I/O (RTD)	2-Wire RTD	IS-SL2-RTD	IS-SL-RTD	IS-SLT1-RTD
I/O (RTD)	3-Wire / 4-Wire RTD	IS-SL4-RTD	IS-SL4-RTD	IS-SLT4-RTD
AS-i	32VDC 1-Pair	IS-SL2-36	IS-SL36-G	IS-SLT1-36
BACnet	RS-232	IS-SL4-36	IS-SL36-EC90	IS-SLT3-36
BACnet	RS-485	IS-SL2-485-EC90	IS-SL485-EC90	IS-SLT1-7v5
BitBus	RS-485	IS-SL2-485-EC90	IS-SL485-EC90	IS-SLT1-7v5
CAN Bus (Signal)	5VDC 1-Pair	IS-SL2-36	IS-SL36-G	
C-Bus	36VDC 1-Pair	IS-SL2-68	IS-SL68-G	IS-SLT1-68
CC-Link / LT / Safety	RS-485	IS-SL2-485-EC90	IS-SL485-EC90	IS-SLT1-7v5
DALI / DALI 2	Digital Serial Interface	IS-SL2-36	IS-SL36-G	IS-SLT1-36
Data Highway / Plus	RS-485	IS-SL2-485-EC90	IS-SL485-EC90	IS-SLT1-7v5
DeviceNet (Signal)	5VDC 1-Pair	IS-SL2-7v5	IS-SL7v5-G	IS-SLT1-7v5

SPD Selection for Signal and Data

		Novaris Product - Hazardous Areas		
Protocol	**Signal Type**	**High Exposure**	**Low Exposure**	**Field Instrument**
DF1	RS-232	IS-SL4-36	IS-SL36-EC90	IS-SLT3-36
DirectNET	RS-232	IS-SL4-36	IS-SL36-EC90	IS-SLT3-36
DirectNET	RS-485	IS-SL2-485-EC90	IS-SL485-EC90	IS-SLT1-7v5
Dupline (Signal)	5VDC 1-Pair	IS-SL2-7v5	IS-SL7v5-G	IS-SLT1-7v5
FIP Bus	RS-485	IS-SL2-485-EC90	IS-SL485-EC90	IS-SLT1-7v5
FINS	RS-232	SL4-36	SL36-EC90	SLT3-36
FINS	RS-485	SL2-485-EC90	SL485-EC90	SLT1-7v5
FINS	DeviceNet (Signal)	SL2-36	SL36-G	SLT1-36
FOUNDATION Fieldbus H1	32VDC 1-Pair	SSP10A-38	SSP6A-38-G	IS-SLT1-36
HART	4-20mA + HF Data	IS-SL2-36	IS-SL36-G	IS-SLT1-36
HostLink	RS-232	IS-SL4-36	IS-SL36-EC90	IS-SLT3-36
HostLink	RS-422	IS-SL4-485 + SL1-G90	IS-SL485-EC90 (x2)	IS-SLT4-7v5
Interbus	RS-485	IS-SL2-485-EC90	IS-SL485-EC90	IS-SLT1-7v5
Load Cell 12V	Wheatstone Bridge	IS-LCP-18	IS-LCP-18	IS-LCP-18
Load Cell 24V	Wheatstone Bridge	IS-LCP-36	IS-LCP-36	IS-LCP-36
MODBUS	RS-485	IS-SL2-485-EC90	IS-SL485-EC90	IS-SLT1-7v5
P-Net	RS-485	IS-SL2-485-EC90	IS-SL485-EC90	IS-SLT1-7v5
Process Bus (P-Bus)	RS-485	IS-SL2-485-EC90	IS-SL485-EC90	IS-SLT1-7v5
Profibus DP/FMS	RS-485	IS-SL2-485-EC90	IS-SL485-EC90	IS-SLT1-7v5
Profibus PA	32VDC 1-Pair	IS-SL2-36	IS-SL36-G	IS-SLT1-36
PSTN	POTS	IS-SL-PSTN		
S-Bus	32VDC 1-Pair	IS-SL2-36	IS-SL36-G	IS-SLT1-36
SDS	4-Wire (Signal, 24VDC power)	IS-SLC-36	IS-SLC-36	IS-SLT4-36

SPD Selection for RF

a. *Options for RF SPDs*

Inline coaxial SPDs containing a gas discharge tube (GDT) are suitable for a wide frequency range (up to 3GHz or 6GHz) but must be chosen with respect to the power on the line if used for transmitting.

Stub type SPDs are used in specialised applications for example where a high passive intermodulation distortion (PIM) is required. Typically this may be around -150dBc.

Spark gap coaxial protectors provide protection for high powered transmitters used for HF radar, FM and TV broadcasting. Typical connectors are EIA flange type.

b. *Identify the connector*

Novaris manufactures a wide range of coaxial SPDs to suit most common connectors and gender variations.

c. *Select the clamping voltage*

The clamping voltage of the SPD must be greater than the peak line voltage. This is particularly important when used for transmitting applications. Knowing the modulation type is important. For example, a 100% amplitude modulated signal will double the peak line voltage.

Product (GDT) Voltage	Max. Power 50 ohms	Max. Power 75 ohms
90V	25W	15W
230V	150W	100W
350V	350W	
600V	1000W	
1000V	2500W	

Spark gap CEIA protectors can operate up to 100KW.

d. *Identify the maximum operating frequency*

3G (to 3GHz) models are available in all standard small format connector types and feature replaceable GDT. These have 50ohm characteristic impedance. Units with F type connectors have 75ohm characteristic impedance.

6G (to 6GHz) models are available in N type, SMA and 4.3-10 with 50ohm characteristic impedance.

Stub type protectors have specific frequency ranges.

CEIA protectors using EIA flange connectors are 50ohm and can operate to 1GHz.

GLOBAL PRESENCE

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