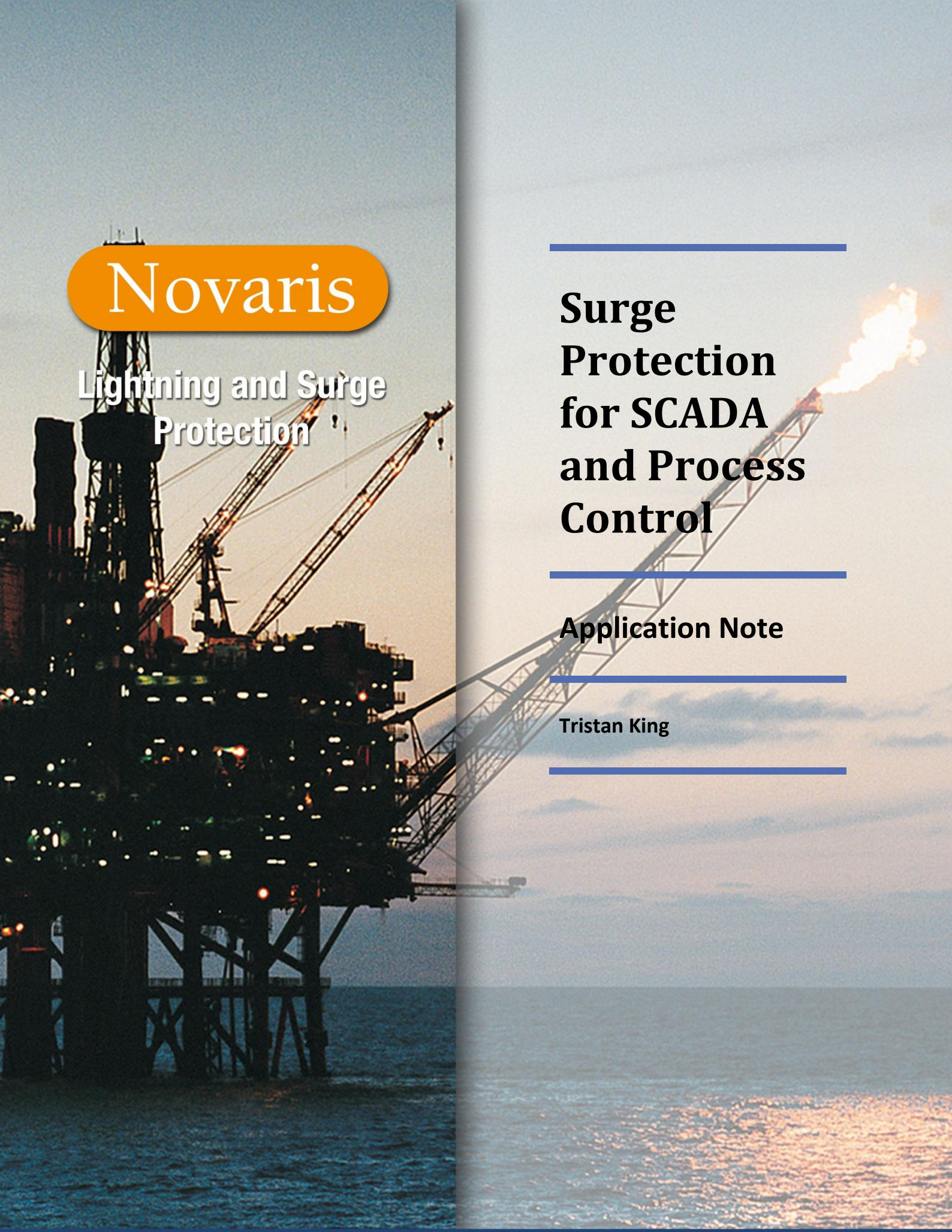

Novaris

Lightning and Surge Protection

# Surge Protection for SCADA and Process Control

## Application Note

Tristan King

## Introduction

SCADA and process control equipment, such as Programmable Logic Controllers (PLCs), Remote Terminal Units (RTUs) and associated switching and metering equipment typically contain sensitive electronics, and therefore are at a high risk of damage in the event of electrical surges. Furthermore, the equipment itself and the downtime necessary to repair and replace damaged equipment can become very costly. When designing a lightning protection system, the SCADA equipment must be given special consideration to minimize the risk of damage and system downtime.

Novaris has engineered a range of products intended to minimize the risk to process control equipment in the event of an electrical surge, whilst not effecting the operation of the equipment. The level of protection provided, and the correct operation of equipment is dependent upon selecting the correct surge protective device (SPD) for the application.

This document is intended to aid in selecting the correct SPD for a variety of different applications commonly found in process control, and to give the designer an idea of where SPDs should be installed. For further information please contact your local Novaris distributor or visit the Novaris website.

## Overview

To provide adequate protection, SPDs are needed at either end of any significant cable run in the system. An SPD, such as a Novaris SLT threaded signal line protectors should be installed into instrument enclosures, utilising a spare gland thread. The PLC or RTU end of the cable run should have an SPD such as a Novaris SL slimline signal line protector fitted, the SPD can replace the marshalling terminals.

For hazardous areas, and in the case of intrinsically safe circuits, the placement of SPDs is very similar to conventional process control, with the added concern of protecting the safety barrier. Novaris intrinsically safe surge protectors should be installed as shown in figure 1.

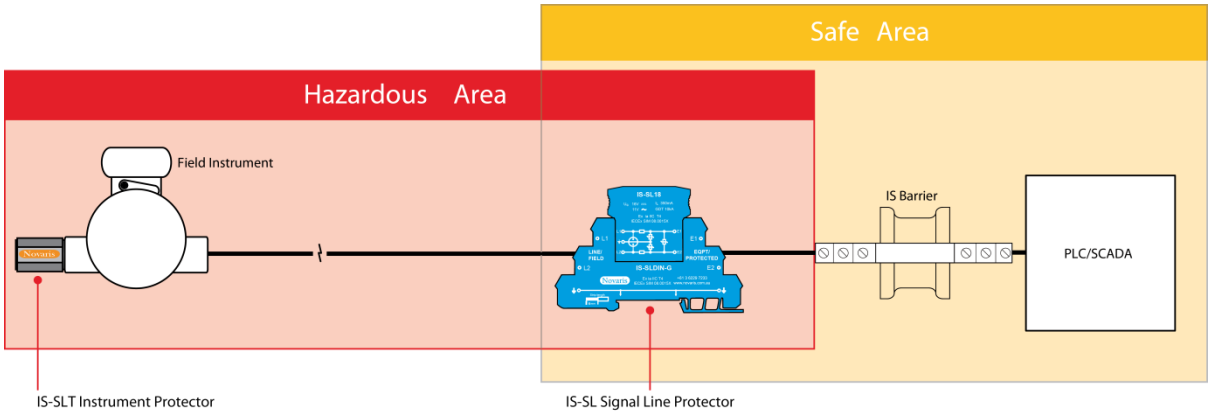


Figure 1: Installation of SPDs for Hazardous areas

Surge protection must also be considered between the PLCs and the supervisory computer system and human machine interface (HMI). As between the PLCs and field instruments, an SPD must be installed at each end of any significant cable run. Novaris SL slimline signal line protectors are suitable for all common signal protocols used in process control.

## Analogue and Digital Inputs / Outputs

Surge protection requirements for analogue and digital inputs / outputs are almost identical. Figure 2 shows how to effectively protect 24V digital inputs and outputs with a current less than 250mA and all low frequency (<250 kHz) ±24V signals.

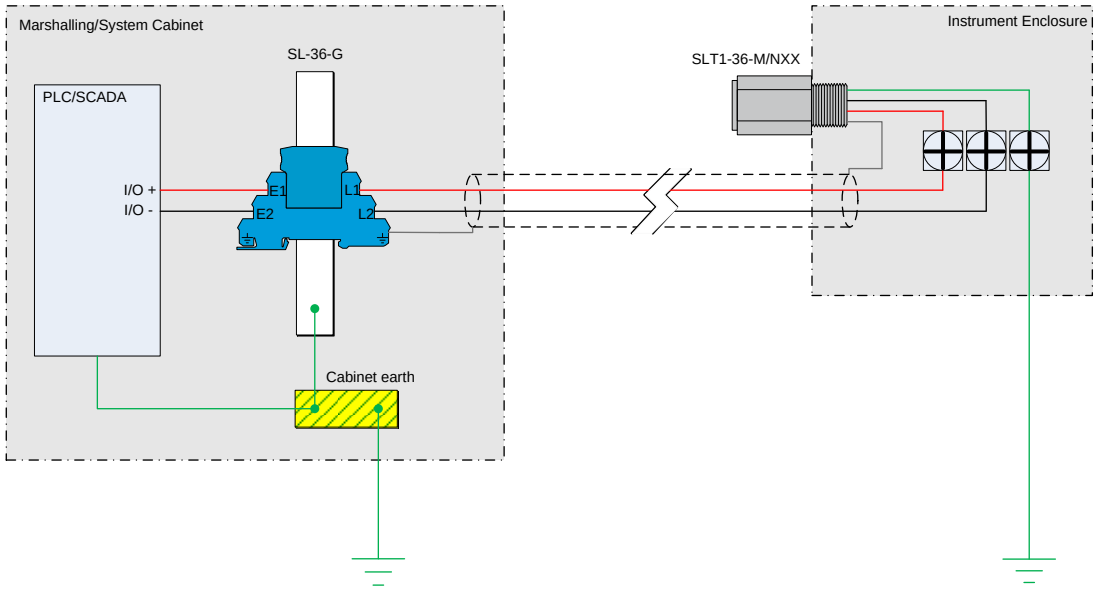


Figure 2: Surge protection for Analogue and Digital I/O with isolated DIN rail

The location and installation of process control SPDs is the same for all voltage ranges from 5V to 110V, however different models of SPD are required.

Refer to Table 1 (page 13) for the applicable surge protection devices.

## Up to 6A Signals

In situations where the current draw is greater than the SL-** series rating of 250mA, the SSP6A range is recommended which will pass up to 6A. Figure 3 shows an installation that can handle up to 6A. The SLTs are a shunt connected device and therefore its use is not dependant on the load current. Refer to Table 1 (page 13) for the applicable surge protection devices.

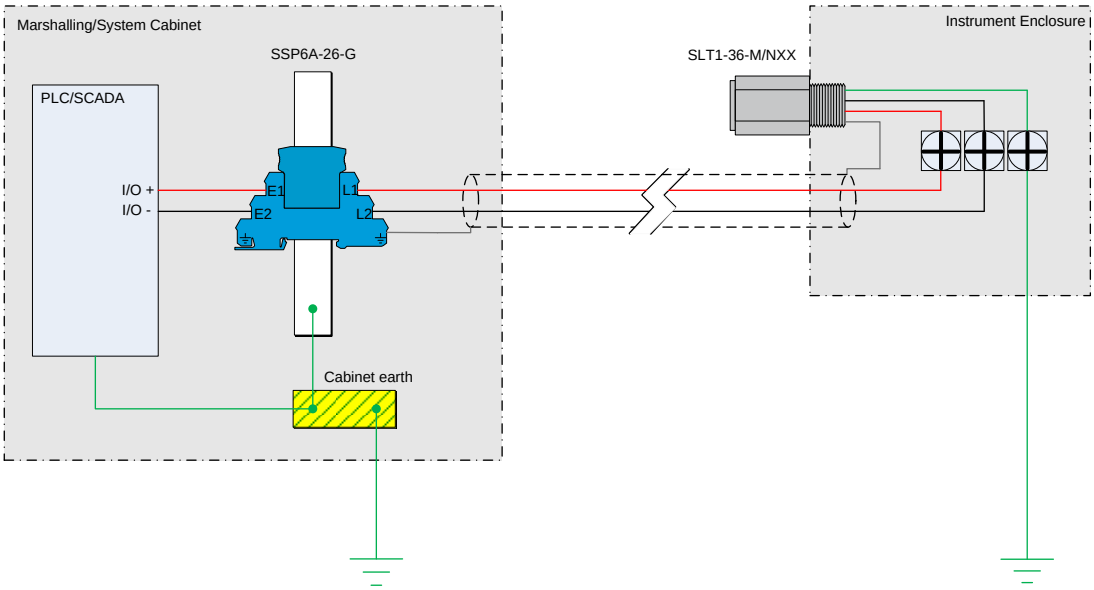


Figure 3: Surge protection for up to 6A current

## 4-20mA

Analogue 4-20mA loop protection is achieved by employing a combination of the SL-420 slimline protector and the SLT1-36-M20 threaded protector as shown in Figure 4. The SL-420 utilises a LED to indicate loop power and surge protection status.

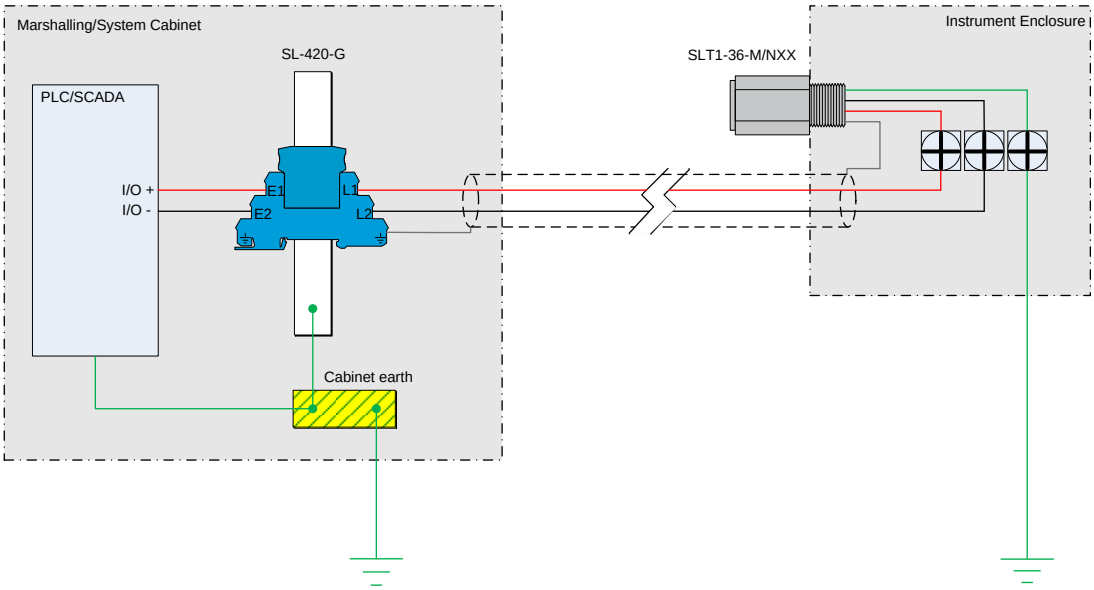


Figure 4: Surge protection for a 4-20mA Loop

## Interposing Relays

Due to the isolation provided by an interposing relay, both the digital output from the PLC and the power source can be protected using a single SPD. The example in Figure 5 shows an SSP protecting the power supply, the digital output on the PLC and the interposing relay.

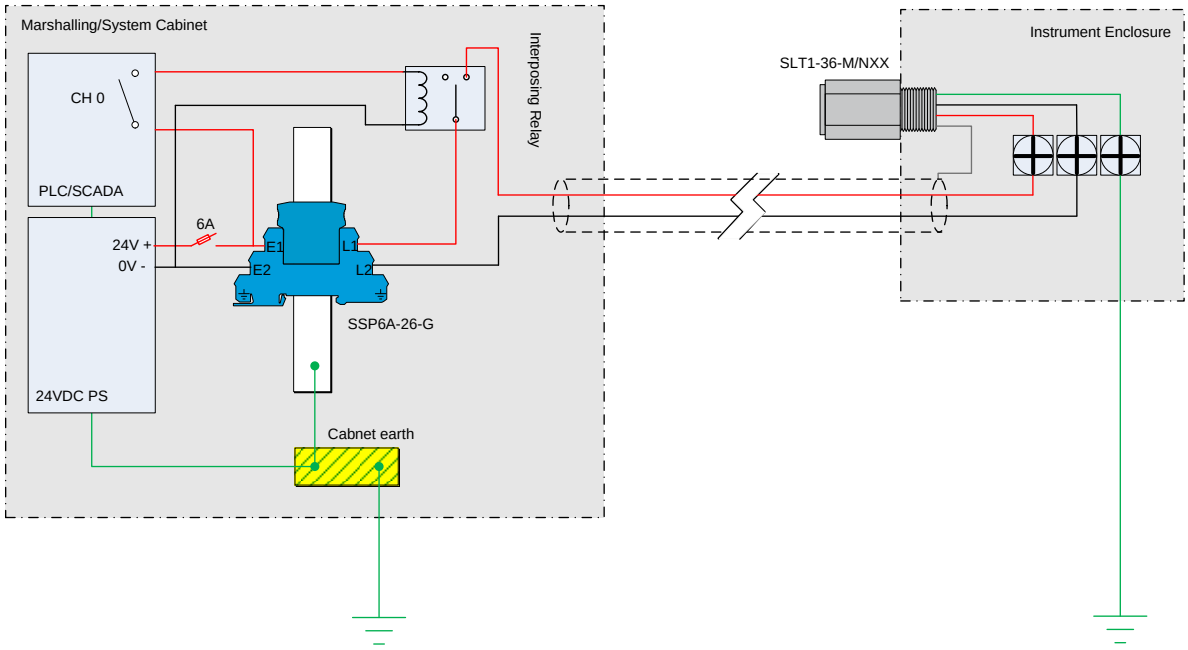


Figure 5: Interposing relay protection

## Residual Temperature Devices

The operation of residual temperature devices is somewhat different to other analogue inputs, in that they work on a change in impedance, and use lower signal levels. There are three common configurations of RTDs, each outlined below with a recommended method of protecting them.

### 4 wire RTD

Figure 6 shows how to effectively protect a 4 wire RTD. Two SL-RTDs are used on the input to the control or PLC, and a SLT4-RTD is installed inside the instrument enclosure. Please refer to the product installation manuals for further detail.

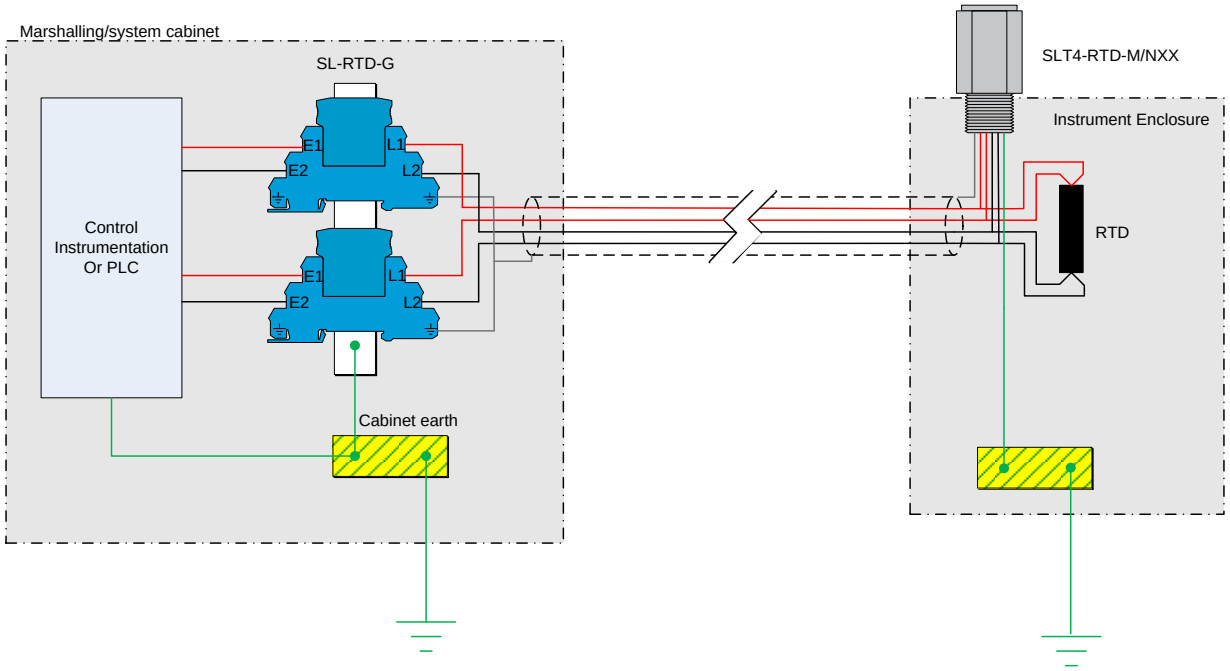


Figure 6: Surge protection wiring for a 4 wire RTD

## 3 wire RTD

Figure 7 shows how to effectively protect a 3 wire RTD. Two SL-RTDs are used on the input to the control or PLC, and a SLT4-RTD is installed inside the instrument enclosure. Please refer to the product installation manuals for further detail.

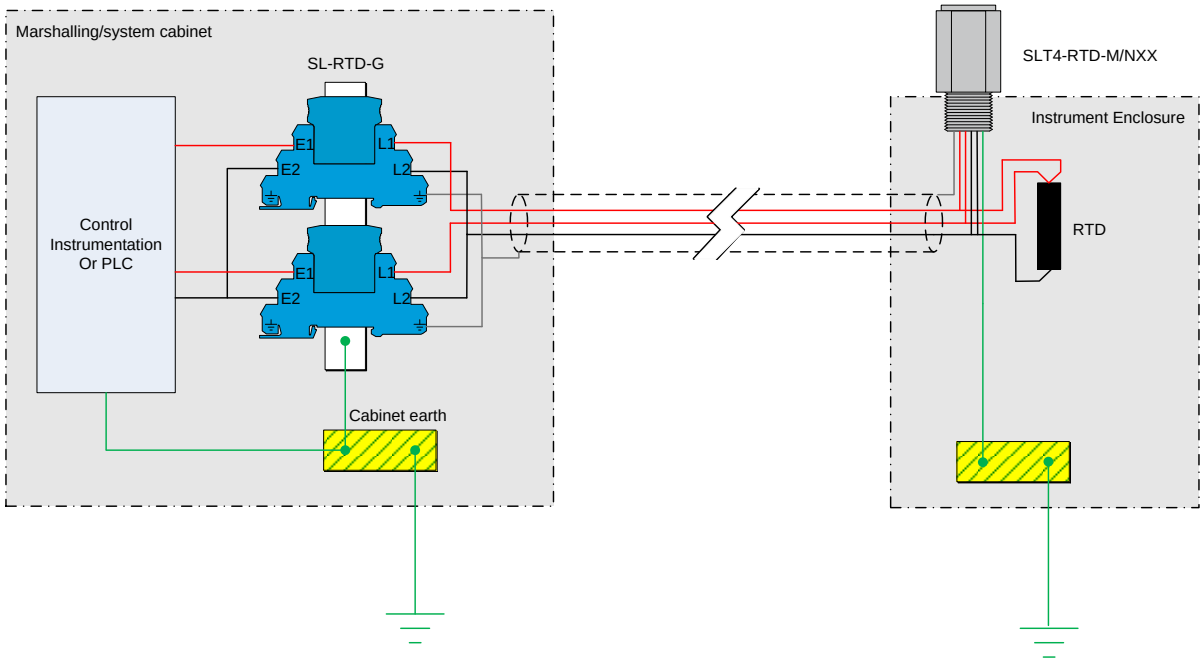


Figure 7: Surge protection wiring for a 3 wire RTD

## 2 wire RTD, 2 wire Thermocouple

Figure 8 shows how to effectively protect a 2 wire RTDor 2 wire thermocouple. An SL-RTD is used on the input to the control or PLC, and a SLT4-RTD is installed inside the instrument enclosure. Please refer to the product installation manuals for further detail.

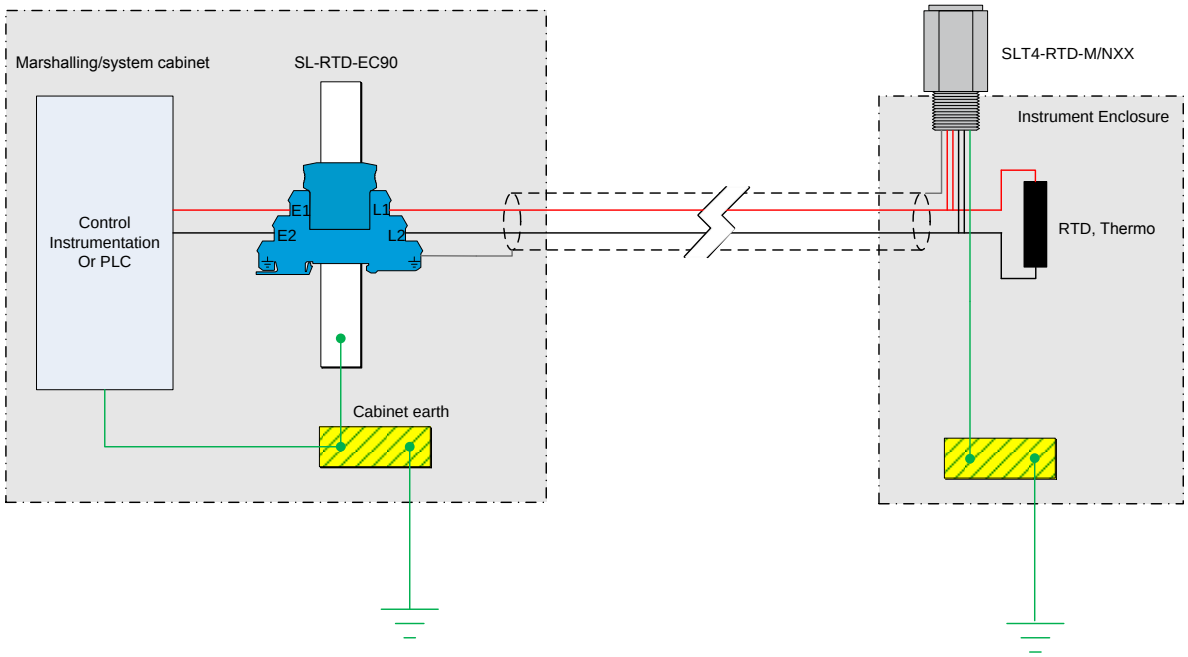


Figure 8: Surge protection wiring for a 2 wire RTD or thermocouple

## HART over 4-20mA Loops

The addition of HART protocol on 4-20mA loops significantly increases the maximum frequency of the signal, and therefore the SPDs need to be capable of passing the signal. Figure 9 shows how to effectively protect combined 4-20mA loops and HART.

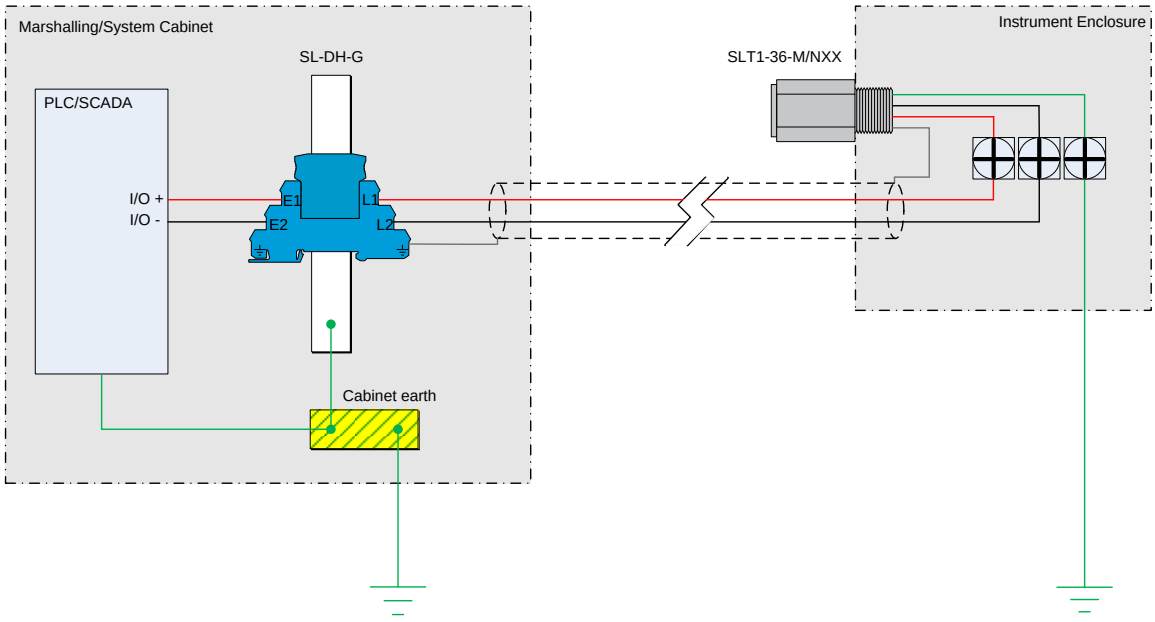


Figure 9: combined 4-20mA & Hart

Multidrop HART may be protected in the same manner, with a Novaris SL-DH or Novaris SLT1-36 at the end of every significant cable run (depending on which model of SPD is easier to install). The termination for multidrop HART will be very similar to HART over 4-20mA loops.

## RS232, RS422 & RS485 Signals

RS232 and RS422/485 signals are significantly faster in nature than other digital I/O signals, and therefore raise the maximum operating frequency. The SPDs used must be capable of passing the higher frequency signal. Surge protection for Profibus or Modbus, should be done in the same manner as the data link layer and physical layer protocol used.

### RS232

Figure 10 shows how to effectively protect a simple three wire signal such as RS232 using Novaris SL-DH SPDs.

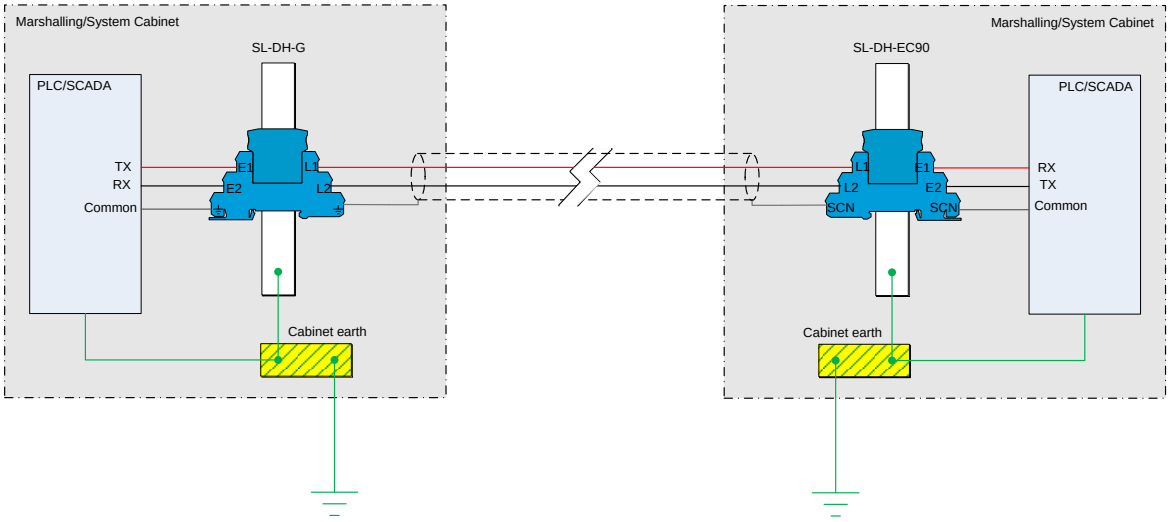


Figure 10: surge protection for RS232

Multidrop RS232 may be protected in the same manner, with a Novaris SL-DH at the end of every significant cable run. The termination for each wire will be very similar to point to point RS232. The multiport RS422 network (figure 10) is equally applicable by substituting SL485-EC90 protectors for SL-DH-EC90.

## RS485

Figure 11 shows how to protect a point to point RS485 signal using Novaris SL485-EC90 surge protectors. Note that only one side of the screen should be terminated to equipment.

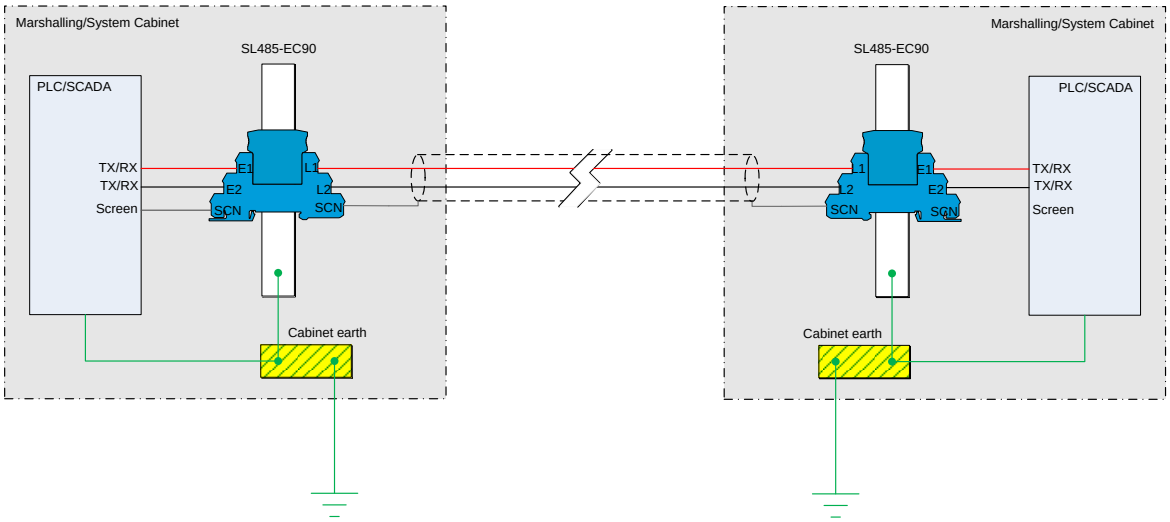


Figure 11: surge protection for RS485

## Multidrop RS485

Multidrop RS485 may be protected in the same manner, with a Novaris SL485-EC90 at the end of every significant cable run. The termination for each wire will be very similar to point to point RS485. Figure 12 shows an example of how a multidrop RS485 network may be configured and how to protect it. Note that only one side of the screen should be terminated to equipment.

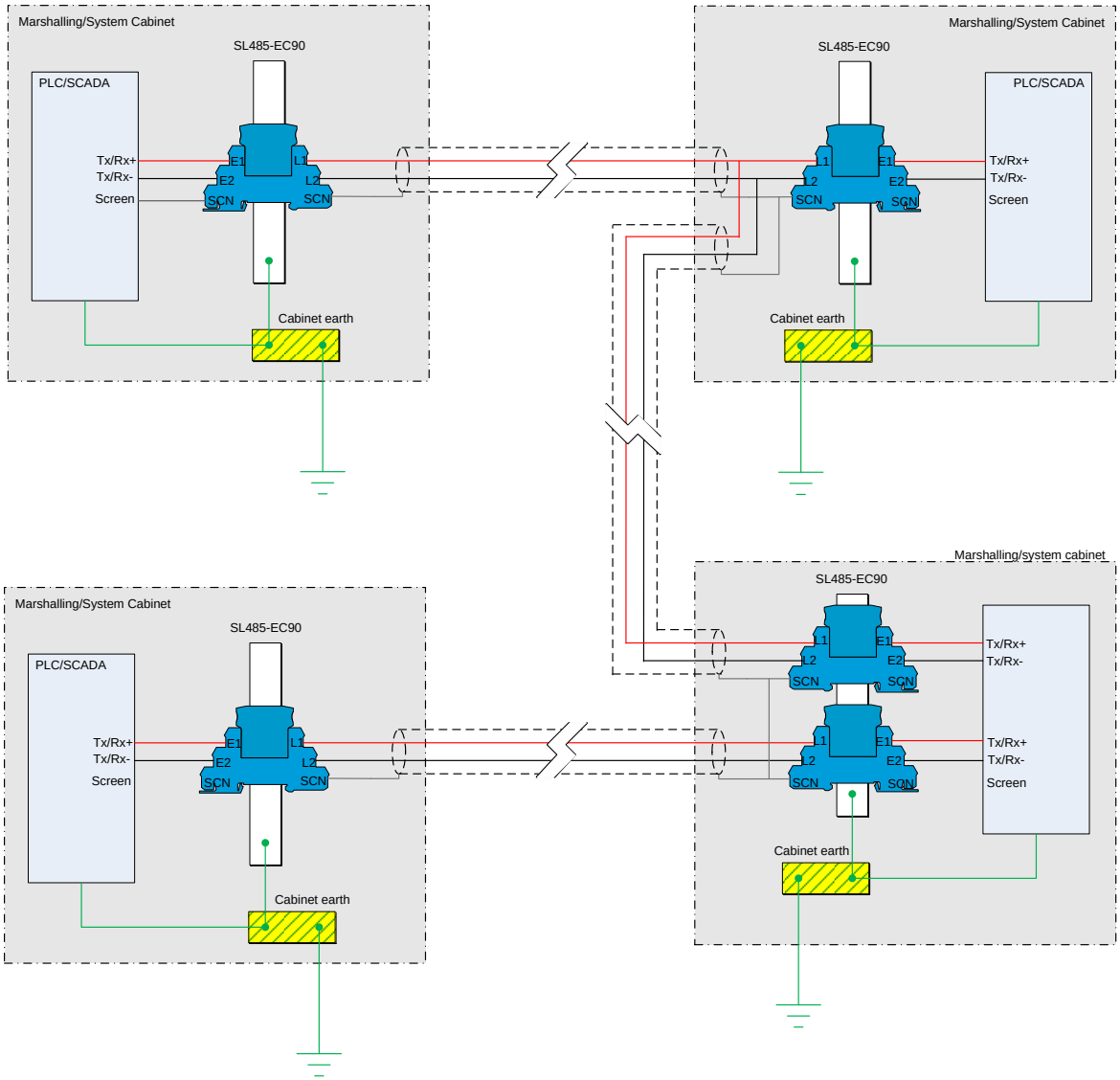


Figure 12: surge protection for Multidrop RS485

## RS422

Figure 13 shows how to protect a point to point RS422 signal using Novaris SL485-EC90 surge protectors. This is a duplication of the RS485 protection. Note that only one side of the screen should be terminated to equipment.

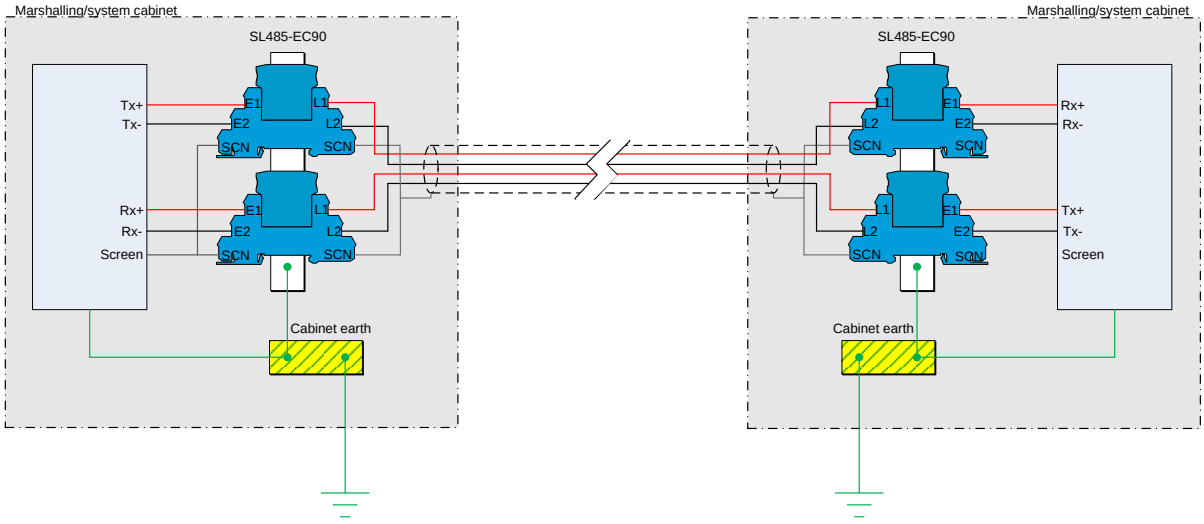


Figure 13: Surge Protection for RS422

Multidrop RS422 may be protected in the same manner, with a Novaris SL485-EC90 (Figure 10) at the end of every significant cable run. The termination for each wire will be very similar to point to point RS422.

## Ethernet & Industrial Ethernet

Industrial Ethernet is becoming increasing popular as the data link layer protocol in process control and SCADA systems, often forming the link between PLCs and RTUs, and the supervisory system and HMI. Surge protection should be considered for all significant cable runs in a network.

Figure 14 shows a cabled network with 4 remote nodes and surge protection. A Novaris UTP-RJ45-24CAT 6 is used to protect the network switch, and Novaris UTP-RJ45-1CAT6 SPDs are used at each remote node. This protection is suitable for any network using a CAT5, CAT5e, CAT6 or PoE physical layer, including Modbus-TCP, PROFINET IO as well as standard local area computer networks.

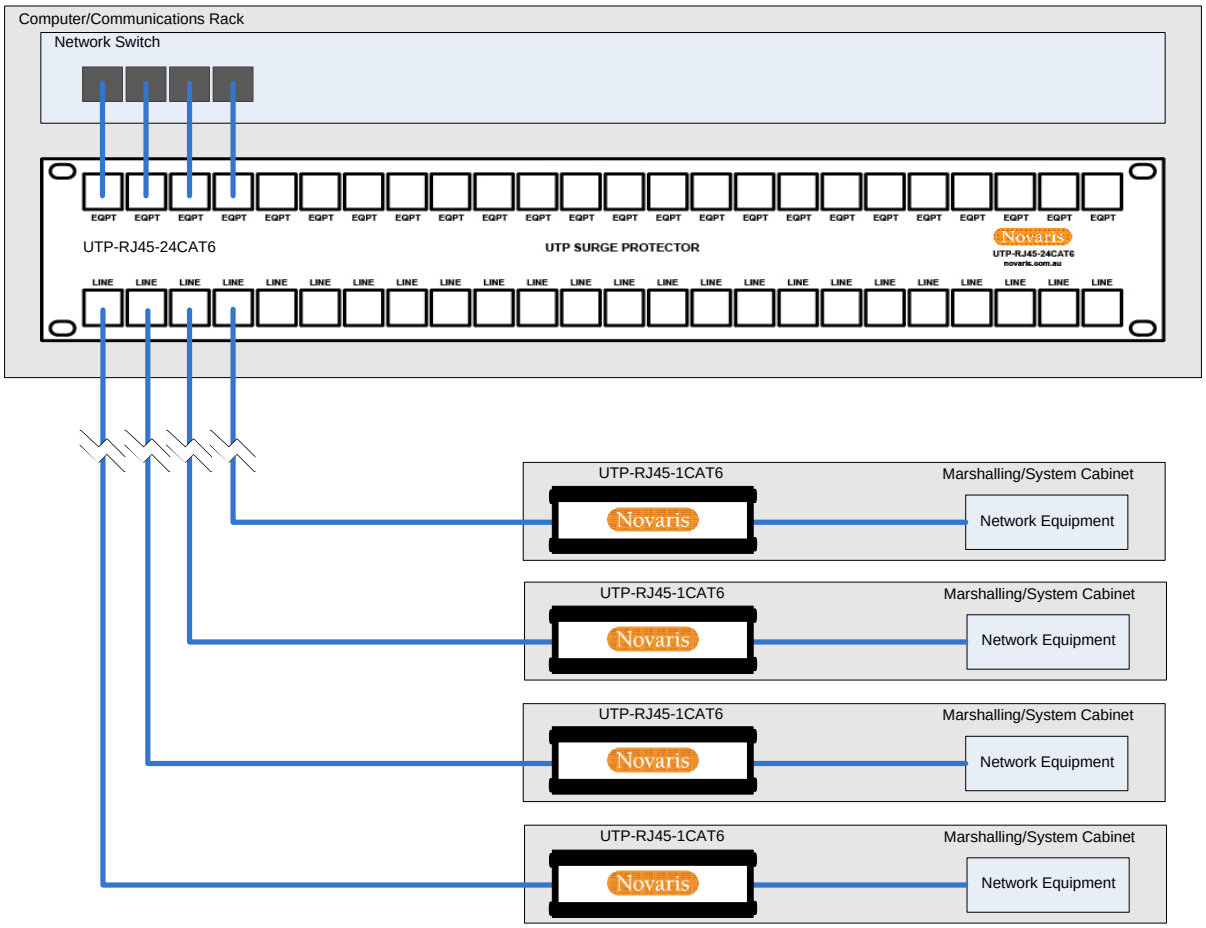


Figure 14: Surge protection for ethernet

It is unnecessary to install surge protection on significant fiber-optic or wireless links, as neither are electrical cabling and therefore are not prone to induced surges.

## Quick Reference

| Signal/Protocol | PLC/Cabinet | Meter/Instrument |
|---|---|---|
| **±5V Analogue or Digital** | SL7V5-G or SSP6A-14-G | SLT1-7V5-M/NXX |
| **±12V Analogue or Digital** | SL18-G or SSP6A-14-G | SLT1-18-M/NXX |
| **±24V Analogue or Digital** | SL36-G or SSP6A-26-G | SLT1-36-M/NXX |
| **±48V Analogue or Digital** | SL68-G or SSP6A-65-G | SLT1-68-M/NXX |
| **±110V Analogue or Digital** | SSP6A-130-G | SDT2-130-M/NXX |
| **4-20mA Loop** | SL-420-G | SLT1-36-M/NXX |
| **4 Wire RTD** | 2 x SL-RTD-G | SLT4-RTD-M/NXX |
| **3 Wire RTD** | 2 x SL-RTD-G | SLT4-RTD-M/NXX |
| **2 Wire RTD** | SL-RTD-G | SLT4-RTD-M/NXX |
| **HART** | SL-DH-G | SLT1-36-M/NXX |
| **RS232** | SL-DH-G | SL-DH-EC90 |
| **RS422** | SL485-EC90 | SL485-EC90 |
| **RS485** | 2 x SL485-EC90 | 2 x SL485-EC90 |
| **Profibus DP** | SL485-EC90 | SL485-EC90 |
| **Profibus PA** | SSP6A-38-G | SSP6A-38-G |
| **Profinet** | UTP-RJ45-24CAT6 | UTP-RJ45-1CAT6 |
| **Modbus** | Check physical layer | Check physical layer |
| **Modbus – TCP** | UTP-RJ45-24CAT6 | UTP-RJ45-1CAT6 |
| **Industrial Ethernet Network** | UTP-RJ45-24CAT6 | UTP-RJ45-1CAT6 |
| **Computer Network (Ethernet)** | UTP-RJ45-24CAT6 | UTP-RJ45-1CAT6 |

**Table 1: Signal protection reference table**

SLTs (Threaded Signal Line Protectors) are manufactured with **M20**, **N12** (1/2” NPT), **N34** (3/4” NPT) and other threads available upon request.

Please consult your local supplier or Novaris for intrinsically safe models of the listed SPDs