

Instruments signal connections Surge Protection Devices

MTL SD Modular range, all versions



FUNCTIONAL SAFETY MANAGEMENT

These products are able to be used within a Safety System conforming to the requirements of IEC 61508:2010. The products are not Safety Elements but may be used to protect instrument loops designed to achieve Safety Integrity Level of up to SIL3.

Eaton Electric Ltd, Luton is a certified Functional Safety Management company meeting the requirements of IEC61508 Part1:clause 6

Surge Protection Devices, type MTL SD Modular



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This manual supports the application of the products in functional safety related loops. It must be used in conjunction with product data sheet and instruction manual to achieve correct installation, commissioning and operation.

In the interest of further technical developments, Eaton reserve the right to make design changes.



1 Introduction

1.1 Application and function

The products covered by this manual are 'Surge Protection' devices which can be located in safe or hazardous areas of a process plant to guard against the indirect effects of lightning or other transient over-voltages on instrumentation signals. They are designed and tested in accordance with IEC 61643-21 (low voltage surge protective devices) for use in signal and communication loops.

The MTL SD Modular surge protectors are intended to be mounted on DIN rail in a cabinet or enclosure, in order to protect measuring and control equipment that is usually located in a control or equipment room.

Each module provides a hybrid surge protection circuit for a single instrument loop. The devices are passive and consume no loop current in normal operation.

There are no configuration switches or operator controls to be set on the surge protection modules. They perform a fixed function, related to the model selected, and can be considered as wiring components that pass the process signals without alteration.



Note:

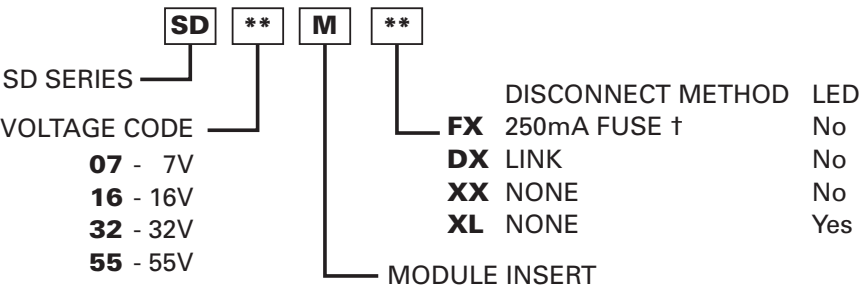
- The information given in this manual is intended to assist in the selection and application of surge protection devices for instrumentation signals that are being used to provide functional safety according to the IEC 61508 and IEC 61511 standards.
- Within the context of these standards the surge protection devices themselves do not perform a defined safety function, and thus a full assessment for functional safety to IEC 61508 would not be relevant. The products are regarded as wiring components, providing connection and termination for the electrical signals, with the key concern being the reliability of the signal transfer through the device.

1.2 Variant Description

The MTL SD Modular range is based on the established SD range of high performance surge protectors. It differs from the SD range in that it includes a replaceable part that contains the active surge protection components. This plugs into a base unit that carries the user wiring connections. Variants are available that allow the pluggable module to be removed (for example, for replacement or testing) without interrupting the I/O signal circuit. Other variants include a diagnostic LED that provides visual indication of degradation of the voltage limiting components which could reduce the effectiveness of the surge protection module, generally after repeated surge events. The diagnostic LED variants are optimised for Analogue Input and Digital Input applications. A further option is the inclusion of a fuse or disconnect link in the pluggable module.

1.3 Model numbering

Pluggable module insert (if ordered separately):

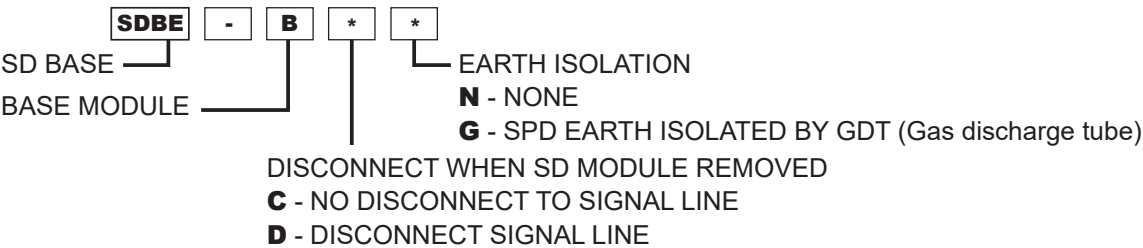


† Fuse option is not ATEX or IECEx certified

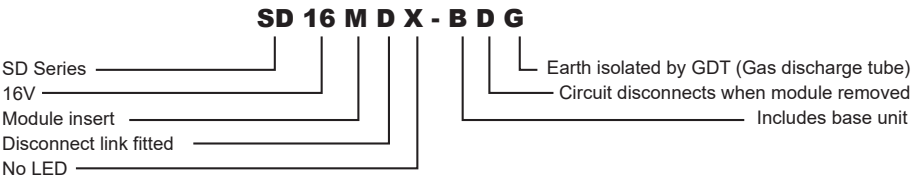
Feed-through module (if ordered separately):



Base module (if ordered separately):



Example of module and base if ordered together:



Typical internal circuit of the SD Modular surge protectors is shown in Figure 1.

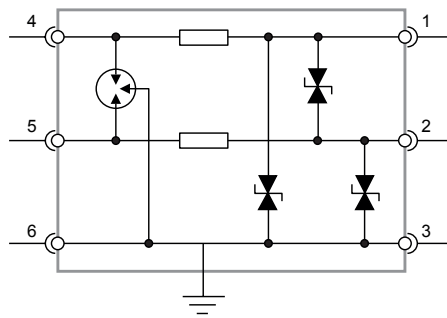


Figure 1

2 System Configuration

The surge protection devices may be used as protective wiring components in functional safety applications, they are passive devices that have no effect on the safety function they are connected to, and hence they are not considered as ‘safety elements’ conforming to the requirements of IEC 61508. As stated previously, the protection devices limit the energy seen by instrument systems as a consequence of external electrical events such as induced surges or voltage transients that arise from lightning strikes or high-voltage switching.

Users of these surge protection devices can use the failure rate information contained in this manual in a probabilistic model of a Safety Instrumented Function (SIF), to determine the achieved Safety Integrity Level (SIL).

The figure below shows an example system configuration and specifies detailed interfaces to the safety-related system components. It does not aim to show all details of the internal module structure, but is intended to support an understanding for the application.

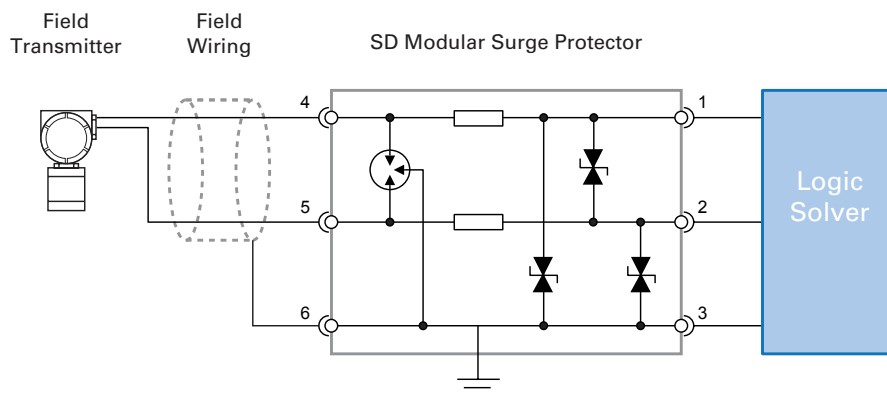


Figure 2

In the above configuration, the MTL SD Modular surge protection module is designed to protect the input into the Logic Solver against damaging transients and surges that are propagated along the field wiring. The blue (shaded) area shows the safety-relevant system connection.

2.1.1 Input/Output Characteristics

The MTL SD Modular surge protectors are passive devices and do not modify or alter the signal in normal operation.

2.1.2 Associated System Components

The surge protectors are wiring components in the signal path between safety-related sensors or other field devices and safety-related instruments or control systems.

3 Selection of product and implications

Surge protection components are used to protect items of electronic hardware such as field instruments or control systems from damage caused by electrical surges. The selection process considers a number of factors such as the probability of a surge event, the topographical distribution of the electrical network, and which hardware items must be protected. Different types of protector must also be selected according to the nature of the I/O signal loop, for example analogue or digital, and input or output. Further details can be found in the product data sheet.

However, where one or more surge protection devices is incorporated in a safety instrumented function (SIF), its effect on the probability that the SIF will not perform its required safety function must be considered. The information given in section 4 of this manual provides the hardware failure rates for the SD Modular range of surge protection devices according to the expected consequence of failures on the signal passing through the device. It is intended that the safety system designer will use this information to assess the effect of such failures on the overall SIF.

4 Assessment for use in functional safety applications

4.1 Failure data

A surge protection device does not perform a specific safety function and is considered as a wiring component within the context of the IEC 61508 standard. Hence it is not appropriate to derive parameters that would normally be associated with an element, such as Safe Failure Fraction or Average Probability of Failure on Demand (PFDavg), or to award an individual device a 'SIL capability'. However, when used as part of a complete safety system, each surge protection module can be assessed with regard to its failure modes and effect on the overall system.

The hardware assessment for the MTL SD Modular range shows that the surge protection devices:

- Have a hardware fault tolerance of 0
- Are classified as Type A devices ("Non-complex" component with well-defined failure modes)
- Have no internal diagnostic elements

The results of a Failure Mode and Effect Analysis (FMEA) are given in Table 1. The FMEA considered the failure rate of each electronic component, probable failure modes, the distribution of such failure modes, and the effects of each failure mode. The FMEA analysis took account of random hardware failures of electronic parts only, and did not consider systematic capability.

Note:

The FMEA analysis considered the random failure rates of components during normal operation of the product only, and in the absence of a surge event. The effects of a surge event on the operation of the surge protection module, or on the I/O signals passed by the module, have not been assessed or quantified. Such effects depend on the magnitude and duration of the surge, and cannot be reliably predicted. It should be understood that a surge protector, where properly installed, increases the availability of the instrumentation system by protecting hardware such as field instruments and the logic solver from surge damage. This is intended to avoid the downtime associated with the replacement of damaged equipment. A surge protector cannot be expected to prevent disturbances to the I/O signals, or any associated nuisance trips, during a surge event.

- The failure rates are stated in FITs (failures per 10⁹ hours)
- The failure rate of all the components was estimated using IEC TR 62380, at an ambient temperature of 40°C. For a higher average temperature of 60°C, or if subject to frequent temperature fluctuation, the failure rates should be multiplied by an experience-based factor of 2.5.

It is assumed that the device is installed, operated and maintained according to the product specification.

The information given here is to help the designer of a Safety Instrumented Function to assess the impact of including surge protection devices on the operation and availability of the instrument loops.

Model numbers SDMXL-BCG, SD**MXL-BDG (Table 1, Column 1)**

Module/base variants with LED, without Fuse or Disconnect Link. All voltages
 Base with earth isolated by GDT. Signal line disconnected/not disconnected options on module removal

Model numbers SD**MXL-BCN, SD**MXL-BDN (Table 1, Column 2)

Module/base variants with LED, without Fuse or Disconnect Link. All voltages
 Base with no earth isolation. Signal line disconnected/not disconnected options on module removal

Model numbers SD**MXX-BCG, SD**MXX-BDG (Table 1, Column 3)

Module/base variants without LED, Fuse or Disconnect Link. All voltages
 Base with earth isolated by GDT. Signal line disconnected/not disconnected options on module removal

Model numbers SD**MXX-BCN, SD**MXX-BDN (Table 1, Column 4)

Module/base variants without LED, Fuse or Disconnect Link. All voltages
 Base with no earth isolation. Signal line disconnected/not disconnected options on module removal

Model numbers SD**MDX-BCG, SD**MDX-BDG (Table 1, Column 5)

Module/base variants without LED, with Disconnect Link. All voltages
 Base with earth isolated by GDT. Signal line disconnected/not disconnected options on module removal

Model numbers SD**MDX-BCN, SD**MDX-BDN (Table 1, Column 6)

Module/base variants without LED, with Disconnect Link. All voltages
 Base with no earth isolation. Signal line disconnected/not disconnected options on module removal

Model numbers SD**MFX-BCG, SD**MFX-BDG (Table 1, Column 7)

Module/base variants without LED, with Fuse. All voltages
 Base with earth isolated by GDT. Signal line disconnected/not disconnected options on module removal

Model numbers SD**MFX-BCN, SD**MFX-BDN (Table 1, Column 8)

Module/base variants without LED, with Fuse. All voltages
 Base with earth isolated by GDT. Signal line disconnected/not disconnected options on module removal

Failure mode	Failure rate (FIT) during normal operation (see Note)							
	1	2	3	4	5	6	7	8
	SD**MXL-BCG, SD**MXL-BDG	SD**MXL-BCN, SD**MXL-BDN	SD**MXX-BCG, SD**MXX-BDG	SD**MXX-BCN, SD**MXX-BDN	SD**MDX-BCG, SD**MDX-BDG	SD**MDX-BCN, SD**MDX-BDN	SD**MFX-BCG, SD**MFX-BDG	SD**MFX-BCN, SD**MFX-BDN
Connected signal not affected	139	135	107	102	107	102	107	102
Connected signal interrupted	119	119	134	135	152	153	170	170
Errors in connected signal	1	1	0	0	0	0	0	0
LED indication fails at low loop currents. Connected signal not affected	74	74	N/A	N/A	N/A	N/A	N/A	N/A
Correct operation (failures have no effect)	102	17	102	18	104	20	106	21

Table 1

4.2 EMC

The surge protection devices are designed for operation in a normal industrial electromagnetic environment but, to support good practice, modules should be mounted such that they are not subjected to undue conducted or radiated interference. See Appendix A for applicable standards and levels.

Any maintenance or other testing activity should only be conducted when the field loop is not in service, to avoid any possibility of introducing a transient change in the field signal.

4.3 Environmental

The MTL SD Modular surge protection devices operate over a temperature range between -40°C and +80°C and at up to 95% relative humidity, noncondensing. A limited temperature range may apply where the devices are used in intrinsically safe applications – refer to the product data sheet.

The devices are intended to be mounted in a normal industrial environment without excessive vibration. See Appendix A for applicable standards and levels.

5 Installation

Installation of the MTL SD Modular surge protectors must be carried out in accordance with the relevant product installation guides, which can be obtained from Eaton's MTL website. In order to avoid systematic errors, the products must not be installed in any location or environment that would cause them to be operated outside their published specification for prolonged periods. For example, the elevation of ambient temperature inside equipment cabinets should be considered, where caused by power dissipation of other equipment. If the modules are installed in field-mounted enclosures, the possibility of internal temperature elevation by solar heating should be taken into account. Care should also be taken to ensure that, where possible, the modules are installed in a secure location, to avoid unauthorised interference or modification.

In order to guard against the effects of dust and water, the modules should be mounted in an enclosure providing at least IP54 ingress protection rating, or the mounting location should provide equivalent protection such as inside an equipment cabinet.

Where the surge protection modules are installed in hazardous area applications, particular attention should be paid to any specific requirements or special conditions of safe use in the installation guides or certificates. Relevant local and international installation standards for hazardous area equipment, such as IEC 60079-14, must also be followed.

Note that correct grounding of surge protectors is essential in order to divert surge currents to earth, without creating damaging potential differences between separate parts of the instrument network. Surge protectors that are wrongly or inadequately grounded may in fact increase the probability of damage in the event of an electrical surge.

6 Maintenance

The primary maintenance requirement for the MTL SD Modular surge protectors in Functional Safety applications is to ensure continuity of the signal lines. Since all module variants are connected in series with the signal circuits, open-circuit failures are likely to be revealed by out-of-range current levels in 4-20mA applications, or by line-fault detection by the Logic Solver in digital applications. Continuity will also be confirmed by proof-testing of the safety instrumented loop, which should be carried out at the intervals determined by safety case assessment. Hence, routine removal of the surge modules for testing is not required.

If an MTL surge protection device is found to be faulty during commissioning or during the normal lifetime of the product, then such failures should be reported to the local MTL office. When appropriate, a Customer Incident Report (CIR) will be raised to enable the return of the unit to the factory for analysis. If the unit is within the warranty period, and the failure is due to defective components or manufacture, then a replacement unit will be provided.

For surge protection devices that are installed in hazardous area applications, the specific maintenance requirements of relevant standards and codes of practice should also be adhered to,

Note:

A feature of the MTL SD Modular surge protectors is that the pluggable module may be removed, to allow the effectiveness of the active surge protection components to be tested using dedicated test equipment such as the MTL Data Surge Tester, model MLDT28500. However, correct functioning of the surge protection components is not essential for the safety function to operate. It is therefore recommended that removal of the pluggable part of MTL SD Modular surge protectors used in safety instrumented functions is only done while the safety system is inactive, for example during a plant shut-down. Although the product variant with type SDBE-BC* “feed-through” base allows replacement of the pluggable module without interruption of the process signal, it is not recommended to remove the module in an operating safety instrumented function.

7 Product life-time

The failure rate data provided in this manual are valid only during the normal service life of the surge protection devices. Typically, for products of this type, the service life is 20 years. Products that are operated beyond their service life will enter the ‘wear-out’ phase of their life-cycle. During this phase, the failure rates and modes of failure are no longer accurately defined by the FIT values stated in this safety manual, meaning that a safety function incorporating the surge protection devices may not achieve its intended Safety Integrity Level (SIL). Products should therefore be replaced before the end of their service life.

8 Appendices

Appendix A: Summary of applicable standards

The appendix lists all standards referred to in the previous sections of this document:

IEC 61508:2010	Functional safety of electrical/electronic/programmable electronic safety related systems, parts 1 and 2 as relevant
IEC 60654-1:1993	Industrial-process measurement and control equipment. Operating conditions. Climatic conditions
EN61643-21+A3:2013	Low voltage surge protective devices- Part 21: Surge protective devices connected to telecommunications and signaling networks – performance requirements and testing methods
EN 61326-1:2013	Electrical equipment for measurement, control and laboratory use –EMC requirements

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