Functional Safety

M-LB-(Ex-)4000-System – Surge Protection Barriers

Manual

SIL

IEC 61508/61511

ISO9001

SIL 3

Your automation, our passion.

PEPPERL+FUCHS

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1 Introduction

1.1 Content of this Document

This document contains information for usage of the device in functional safety-related applications. You need this information to use your product throughout the applicable stages of the product life cycle. These can include the following:

- Product identification
- Delivery, transport, and storage
- Mounting and installation
- Commissioning and operation
- Maintenance and repair
- Troubleshooting
- Dismounting
- Disposal

Note

This document does not substitute the instruction manual.

Note

For full information on the product, refer to the instruction manual and further documentation on the Internet at www.pepperl-fuchs.com.

Note

For specific device information such as the year of construction, scan the QR code on the device. As an alternative, enter the serial number in the serial number search at www.pepperl-fuchs.com.

The documentation consists of the following parts:

- Present document
- Instruction manual
- Manual
- Datasheet

Additionally, the following parts may belong to the documentation, if applicable:

- EU-type examination certificate
- EU declaration of conformity
- Attestation of conformity
- Certificates
- Control drawings
- FMEDA report
- Assessment report
- Additional documents

For more information about Pepperl+Fuchs products with functional safety, see www.pepperl-fuchs.com/sil.

1.2 Safety Information

Target Group, Personnel

Responsibility for planning, assembly, commissioning, operation, maintenance, and dismounting lies with the plant operator.

Only appropriately trained and qualified personnel may carry out mounting, installation, commissioning, operation, maintenance, and dismounting of the product. The personnel must have read and understood the instruction manual and the further documentation.

Intended Use

The device is only approved for appropriate and intended use. Ignoring these instructions will void any warranty and absolve the manufacturer from any liability.

The device is developed, manufactured and tested according to the relevant safety standards.

Use the device only

- for the application described
- with specified environmental conditions
- with devices that are suitable for this safety application

Improper Use

Protection of the personnel and the plant is not ensured if the device is not used according to its intended use.

1.3 Symbols Used

This document contains symbols for the identification of warning messages and of informative messages.

Warning Messages

You will find warning messages, whenever dangers may arise from your actions.
It is mandatory that you observe these warning messages for your personal safety and in order to avoid property damage.

Depending on the risk level, the warning messages are displayed in descending order as follows:

Danger!

This symbol indicates an imminent danger.

Non-observance will result in personal injury or death.

Warning!

This symbol indicates a possible fault or danger.

Non-observance may cause personal injury or serious property damage.

Caution!

This symbol indicates a possible fault.

Non-observance could interrupt the device and any connected systems and plants, or result in their complete failure.

Informative Symbols

Note

This symbol brings important information to your attention.

Action

This symbol indicates a paragraph with instructions. You are prompted to perform an action or a sequence of actions.

2 Product Description

2.1 Function

This manual describes solely the safety function and safe state of the surge protection barrier as part of the surge protection system.

Danger!

Danger to life from wrong usage of the device

The protection of the safety loop against overvoltage is **not the safety function** of the surge protection barrier.

The surge protection barrier protects applications and equipment against voltage surges caused by lightning or switching operations.
The statement concerning the safety function of the surge protection barrier solely describes the effect on safety loops in which the barrier is installed. The barrier acts in the safety loops as a simple pass through element.

Surge Protection Barrier M-LB-42**(.M)

The device limits induced transients of different causes, e. g. lightning or switching operations. The limitation is achieved by diverting the current to earth and limiting the signal loop voltage during the duration of the overvoltage pulse.

The device consists of base module and protection module.The protection module can be replaced without tools.

The device has a status indication at the front.

The device is mounted on a 35 mm DIN mounting rail according to EN 60715.

The DIN mounting rail is used to attach the device in the switch cabinet and is responsible for grounding the surge protection barriers. The DIN rail mounting ensures a grounding connection with the lowest possible resistance of the device.

Surge Protection Barrier M-LB-Ex-42**(.M)

The device limits induced transients of different causes, e. g. lightning or switching operations. The limitation is achieved by diverting the current to earth and limiting the signal loop voltage during the duration of the overvoltage pulse.

The device is used for intrinsic safety applications.

The device consists of base module and protection module.The protection module can be replaced without tools.

The device has a status indication at the front.

The device is mounted on a 35 mm DIN mounting rail according to EN 60715.

The DIN mounting rail is used to attach the device in the switch cabinet and is responsible for grounding the surge protection barriers. The DIN rail mounting ensures a grounding connection with the lowest possible resistance of the device.

2.2 Interfaces

The device has the following interfaces.

- Safety relevant interfaces: protected signal lines
- Non-safety relevant interfaces: status indication

Note

For corresponding connections see datasheet.

2.3 Marking

Pepperl+Fuchs Group Lilienthalstraße 200, 68307 Mannheim, Germany
Internet: www.pepperl-fuchs.com

Surge protection barriers M-LB-42**(.M), M-LB-Ex-42**(.M)	Up to SIL 3

The *-marked letters of the type code are placeholders for versions of the device.

2.4 Standards and Directives for Functional Safety

Device specific standards and directives

Functional safety	IEC/EN 61508, part 2, edition 2010: Functional safety of electrical/electronic/programmable electronic safety-related systems (manufacturer)

System-specific standards and directives

Functional safety	IEC 61511-1:2016+COR1:2016+A1:2017 EN 61511-1:2017+A1:2017 Functional safety – Safety instrumented systems for the process industry sector (user)

3 Planning

3.1 System Structure

3.1.1 Low Demand Mode of Operation

If there are two control loops, one for the standard operation and another one for the functional safety, then usually the demand rate for the safety loop is assumed to be less than once per year.

The relevant safety parameters to be verified are:

- the PFD_{avg} value (average **P**robability of dangerous **F**ailure on **D**emand) and the T_1 value (proof test interval that has a direct impact on the PFD_{avg} value)
- the SFF value (**S**afe **F**ailure **F**raction)
- the HFT architecture (**H**ardware **F**ault **T**olerance)

3.1.2 High Demand or Continuous Mode of Operation

If there is only one safety loop, which combines the standard operation and safety-related operation, then usually the demand rate for this safety loop is assumed to be higher than once per year.

The relevant safety parameters to be verified are:

- the PFH value (**P**robability of dangerous **F**ailure per **H**our)
- Fault reaction time of the safety system
- the SFF value (**S**afe **F**ailure **F**raction)
- the HFT architecture (**H**ardware **F**ault **T**olerance)

3.1.3 Safe Failure Fraction

The safe failure fraction describes the ratio of all safe failures and dangerous detected failures to the total failure rate.

$SFF = (\lambda_s + \lambda_{dd}) / (\lambda_s + \lambda_{dd} + \lambda_{du})$

A safe failure fraction as defined in IEC/EN 61508 is only relevant for elements or (sub)systems in a complete safety loop. The device under consideration is always part of a safety loop but is not regarded as a complete element or subsystem.

For calculating the SIL of a safety loop it is necessary to evaluate the safe failure fraction of the elements and subsystems, but not of a single device.

Nevertheless the SFF of the device is given in this document for reference.

3.2 Assumptions

The following assumptions have been made during the FMEDA:

- The device will be used under average industrial ambient conditions comparable to the classification **stationary mounted** according to MIL-HDBK-217F.

  Alternatively, operating stress conditions typical of an industrial field environment similar to IEC/EN 60654-1 Class C with an average temperature over a long period of time of 40 °C may be assumed. For a higher average temperature of 60 °C, the failure rates must be multiplied by a factor of 2.5 based on experience. A similar factor must be used if frequent temperature fluctuations are expected.
- External power supply failure rates are not included.
- Propagation of failures is not relevant.
- Failure rates are constant, wear is not considered.
- The control loop has a hardware fault tolerance of **0** and it is a type **A** device. A SFF value for this device is not given, since this value has to be calculated in conjunction with the connected field device, as described in the following section.

Application

The surge protection barrier and the connected device (field device, isolator or actuator) have to be considered in combination. The PFD_{avg}/PFH budget of the device categories in the entire safety loop is:

- Actuator (valve) 40 %
- Transmitter (sensor) 25 %
- Isolator 10 %

As an overview for the SIL2 or SIL3 safety loop this means:

Device category	SIL 2		SIL 3	
	PFH	PFD_{avg}	PFH	PFD_{avg}
Total	10^{-6}	10^{-2}	10^{-7}	10^{-3}
Actuator (40 %)	4×10^{-7}	4×10^{-3}	4×10^{-8}	4×10^{-4}
Transmitter (25 %)	2.5×10^{-7}	2.5×10^{-3}	2.5×10^{-8}	2.5×10^{-4}
Isolator (10 %)	10^{-7}	10^{-3}	10^{-8}	10^{-4}

Table 3.1 Overview PFD_{avg}/PFH budget

3.3 Safety Function and Safe State

The safety function of the surge protection barriers depends on the signal loop to which it is attached. The interference on safety relevant signals (e. g. 4 mA to 20 mA analog signal) that pass through the devices was evaluated.

Observe the PFH/PFD_{avg} values in the functional safety manual and the specified calculation rules. The devices fulfil the requirements for SIL 3 and can be used to pass safety relevant signals through in applications up to SIL 3.

The surge protection barriers limit induced transients of different causes, e. g. lightning or switching operations. This protection function itself is not the safety function of the device.

Safe State

The safe state depends on the application. There are 6 different applications:

- Digital input (NAMUR signal)

  Lead breakage and short circuit are out of range and counted as safe failures.
- Digital output (de-energized to safe – DTS)

  Lead breakage and short circuit interrupt the energy transfer to the field and are counted as safe failures.
- Analog input (4 mA to 20 mA)

  Lead breakage and short circuit are out of range and counted as safe failures.
- Analog output (4 mA to 20 mA)

  Lead breakage and short circuit interrupt the energy transfer to the field and are counted as safe failures.
- Resistance thermometer (RTD)

  Measurement current = 200 µA (i. e. KFD2-UT2-1)
  - R ≤ 3137 Ω (Pt1000 at 600 °C)
  - R ≥ 60 Ω (Pt100 at -100 °C)
  Wire resistance = 35 Ω (1000 m total and 0.5 mm^2 Cu)

  Lead breakage and short circuit are out of range and counted as safe failures.
- Thermocouple (TC)
  - U ≤ 80 mV (type E at 1000 K)
  - U ≥ -10 mV (type E at -270 K)

  Lead breakage and short circuit lead to plausible temperature readings and were rated dangerous undetected. Special values apply, . If you are using a signal converter with line fault detection, the values for standard 2-wire applications apply.

For the evaluation, all deviations from the input signal were rated as dangerous undetected, if the deviations are

- greater than the specified leakage current or
- greater than the 1 Ω line resistance.

The user must observe the valid range for the signals in the application and react accordingly if this range is left.

The values given in the following table are calculated for 2-wire applications as field devices are usually connected by more than one wire. For the calculation, add the numbers from the respective column to the numbers given for the safety loop. They are already summarized for the respective application.

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Safety Function

The safety function of the surge protection barrier is to behave like a piece of copper wire, passing through the process signal without being altered.

Reaction Time

The reaction time is < 1 ms.

Note

The fault indication output is not safety relevant.

Note

See corresponding datasheets for further information.

3.4 Characteristic Safety Values

M-LB-4224, M-LB-4244, M-LB-4254

Parameters	Characteristic values	
Assessment type	FMEDA report	
Device type	A	
Mode of operation	Low demand mode or high demand mode	
Safety function [1]	Pass through the signal	
SIL [2]	3	
Analysis	Analysis 1 [3]	Analysis 2 [4]
λ_{sd}	0 FIT	0 FIT
λ_{su}	3 FIT	3 FIT
λ_{dd}	0 FIT	7 FIT
λ_{du}	10 FIT	3 FIT
$\lambda_{no\ effect}$	37 FIT	37 FIT
$\lambda_{no\ part}$	1 FIT	1 FIT
$\lambda_{total\ (safety\ function)}$	13 FIT	13 FIT
MTBF [5]	2269 years	2269 years

Table 3.2

1 The safe state of the surge protection barrier depend on the application.

2 The maximum safety integrity level of the safety loop in which the device might be used depends on the performance values of the whole safety loop or the elements of the safety loop. See application examples section.

3 Analysis 1 represents a worst case analysis.

4 Analysis 2 represents an analysis with the assumption that lead short circuits and short circuits to ground are detectable or do not have an effect.

5 acc. to SN29500. This value includes failures which are not part of the safety function/MTTR = 24 h.

M-LB-4222, M-LB-4242, M-LB-4252

Parameters	Characteristic values	
Assessment type	FMEDA report	
Device type	A	
Mode of operation	Low demand mode or high demand mode	
Safety function [1]	Pass through the signal	
SIL [2]	3	
Analysis	Analysis 1 [3]	Analysis 2 [4]
λ_{sd}	0 FIT	0 FIT
λ_{su}	3 FIT	3 FIT
λ_{dd}	0 FIT	2 FIT
λ_{du}	10 FIT	8 FIT
$\lambda_{no\ effect}$	37 FIT	37 FIT
$\lambda_{no\ part}$	1 FIT	1 FIT
$\lambda_{total\ (safety\ function)}$	13 FIT	13 FIT
MTBF [5]	2269 years	2269 years

Table 3.3

1 The safe state of the surge protection barrier depend on the application.

2 The maximum safety integrity level of the safety loop in which the device might be used depends on the performance values of the whole safety loop or the elements of the safety loop. See application examples section.

3 Analysis 1 represents a worst case analysis.

4 Analysis 2 represents an analysis with the assumption that lead short circuits and short circuits to ground are detectable or do not have an effect.

5 acc. to SN29500. This value includes failures which are not part of the safety function/MTTR = 24 h.

M-LB-4212

Parameters	Characteristic values	
Assessment type	FMEDA report	
Device type	A	
Mode of operation	Low demand mode or high demand mode	
Safety function [1]	Pass through the signal	
SIL [2]	3	
Analysis	Analysis 1 [3]	Analysis 2 [4]
λ_{sd}	0 FIT	0 FIT
λ_{su}	3 FIT	3 FIT
λ_{dd}	0 FIT	13 FIT
λ_{du}	16 FIT	3 FIT
$\lambda_{no\ effect}$	44 FIT	44 FIT
$\lambda_{no\ part}$	1 FIT	1 FIT
$\lambda_{total\ (safety\ function)}$	19 FIT	19 FIT
MTBF [5]	1803 years	1803 years

Table 3.4

1. The safe state of the surge protection barrier depend on the application.
2. The maximum safety integrity level of the safety loop in which the device might be used depends on the performance values of the whole safety loop or the elements of the safety loop. See application examples section.
3. Analysis 1 represents a worst case analysis.
4. Analysis 2 represents an analysis with the assumption that lead short circuits and short circuits to ground are detectable or do not have an effect.
5. acc. to SN29500. This value includes failures which are not part of the safety function/MTTR = 24 h.

M-LB-4214

Parameters	Characteristic values	
Assessment type	FMEDA report	
Device type	A	
Mode of operation	Low demand mode or high demand mode	
Safety function [1]	Pass through the signal	
SIL [2]	3	
Analysis	Analysis 1 [3]	Analysis 2 [4]
λ_{sd}	0 FIT	0 FIT
λ_{su}	3 FIT	3 FIT
λ_{dd}	0 FIT	17 FIT
λ_{du}	20 FIT	3 FIT
$\lambda_{no\ effect}$	48 FIT	48 FIT
$\lambda_{no\ part}$	1 FIT	2 FIT
$\lambda_{total\ (safety\ function)}$	23 FIT	23 FIT
MTBF [5]	1601 years	1601 years

Table 3.5

1 The safe state of the surge protection barrier depend on the application.
2 The maximum safety integrity level of the safety loop in which the device might be used depends on the performance values of the whole safety loop or the elements of the safety loop. See application examples section.
3 Analysis 1 represents a worst case analysis.
4 Analysis 2 represents an analysis with the assumption that lead short circuits and short circuits to ground are detectable or do not have an effect.
5 acc. to SN29500. This value includes failures which are not part of the safety function/MTTR = 24 h.

M-LB-Ex-4242

Parameters	Characteristic values	
Assessment type	FMEDA report	
Device type	A	
Mode of operation	Low demand mode or high demand mode	
Safety function [1]	Pass through the signal	
SIL [2]	3	
Analysis	Analysis 1 [3]	Analysis 2 [4]
λ_{sd}	0 FIT	0 FIT
λ_{su}	3 FIT	3 FIT
λ_{dd}	0 FIT	6 FIT
λ_{du}	10 FIT	4 FIT
$\lambda_{no\ effect}$	54 FIT	54 FIT
$\lambda_{no\ part}$	1 FIT	1 FIT
$\lambda_{total\ (safety\ function)}$	13 FIT	13 FIT
MTBF [5]	1696 years	1696 years

Table 3.6

1 The safe state of the surge protection barrier depend on the application.

2 The maximum safety integrity level of the safety loop in which the device might be used depends on the performance values of the whole safety loop or the elements of the safety loop. See application examples section.

3 Analysis 1 represents a worst case analysis.

4 Analysis 2 represents an analysis with the assumption that lead short circuits and short circuits to ground are detectable or do not have an effect.

5 nach SN29500. Dieser Wert enthält Ausfälle, die nicht Teil der Sicherheitsfunktion sind/MTTR = 24 h.

M-LB-4272

Parameters	Characteristic values	
Assessment type	FMEDA report	
Device type	A	
Mode of operation	Low demand mode or high demand mode	
Safety function [1]	Pass through the signal	
SIL [2]	3	
Analysis	Analysis 1 [3]	Analysis 2 [4]
λ_{sd}	0 FIT	0 FIT
λ_{su}	2 FIT	2 FIT
λ_{dd}	0 FIT	2 FIT
λ_{du}	4 FIT	2 FIT
$\lambda_{no\ effect}$	36 FIT	36 FIT
$\lambda_{no\ part}$	1 FIT	1 FIT
$\lambda_{total\ (safety\ function)}$	6 FIT	6 FIT
MTBF [5]	2686 years	2686 years

Table 3.7

1 The safe state of the surge protection barrier depend on the application.

2 The maximum safety integrity level of the safety loop in which the device might be used depends on the performance values of the whole safety loop or the elements of the safety loop. See application examples section.

3 Analysis 1 represents a worst case analysis.

4 Analysis 2 represents an analysis with the assumption that lead short circuits and short circuits to ground are detectable or do not have an effect.

5 acc. to SN29500. This value includes failures which are not part of the safety function/MTTR = 24 h.

M-LB-4282

Parameters	Characteristic values	
Assessment type	FMEDA report	
Device type	A	
Mode of operation	Low demand mode or high demand mode	
Safety function [1]	Pass through the signal	
SIL [2]	3	
Analysis	Analysis 1 [3]	Analysis 2 [4]
λ_{sd}	0 FIT	0 FIT
λ_{su}	2 FIT	2 FIT
λ_{dd}	0 FIT	4 FIT
λ_{du}	6 FIT	2 FIT
$\lambda_{no\ effect}$	42 FIT	42 FIT
$\lambda_{no\ part}$	1 FIT	1 FIT
$\lambda_{total\ (safety\ function)}$	8 FIT	8 FIT
MTBF [5]	2261 years	2261 years

Table 3.8

1 The safe state of the surge protection barrier depend on the application.

2 The maximum safety integrity level of the safety loop in which the device might be used depends on the performance values of the whole safety loop or the elements of the safety loop. See application examples section.

3 Analysis 1 represents a worst case analysis.

4 Analysis 2 represents an analysis with the assumption that lead short circuits and short circuits to ground are detectable or do not have an effect.

5 acc. to SN29500. This value includes failures which are not part of the safety function/MTTR = 24 h.

The characteristic safety values like PFD, PFH, SFF, HFT and T_1 are taken from the FMEDA report. Observe that PFD and T_1 are related to each other.

The function of the devices has to be checked within the proof test interval (T_1).

3.5 Useful Lifetime

Although a constant failure rate is assumed by the probabilistic estimation this only applies provided that the useful lifetime of components is not exceeded. Beyond this useful lifetime, the result of the probabilistic estimation is meaningless as the probability of failure significantly increases with time. The useful lifetime is highly dependent on the component itself and its operating conditions – temperature in particular. For example, electrolytic capacitors can be very sensitive to the operating temperature.

This assumption of a constant failure rate is based on the bathtub curve, which shows the typical behavior for electronic components.

Therefore it is obvious that failure calculation is only valid for components that have this constant domain and that the validity of the calculation is limited to the useful lifetime of each component.

It is assumed that early failures are detected to a huge percentage during the installation and therefore the assumption of a constant failure rate during the useful lifetime is valid.

However, according to IEC/EN 61508-2, a useful lifetime, based on general experience, should be assumed. Experience has shown that the useful lifetime often lies within a range period of about 8 to 12 years.

As noted in DIN EN 61508-2:2011 note N3, appropriate measures taken by the manufacturer and plant operator can extend the useful lifetime.

Our experience has shown that the useful lifetime of a Pepperl+Fuchs product can be higher if the ambient conditions support a long life time, for example if the ambient temperature is significantly below the maximum ambient temperature.

Please note that the useful lifetime refers to the (constant) failure rate of the device. The effective life time can deviate from this.

The estimated useful lifetime is greater than the warranty period prescribed by law or the manufacturer's guarantee period. However, this does not result in an extension of the warranty or guarantee services. Failure to reach the estimated useful lifetime is not a material defect.

4 Mounting and Installation

Mounting and Installing the Device

1. Observe the safety instructions in the instruction manual.
2. Observe the information in the manual.
3. Observe the requirements for the safety loop.
4. Connect the device only to devices that are suitable for this safety application.
5. Check the safety function to ensure the expected output behavior.

4.1 Mounting

Mounting and Grounding the Device

1. Mount the device on a 35 mm x 7.5 mm DIN mounting rail according to EN 60715.
2. Ground the device via the DIN mounting rail.

4.2 Configuration

A configuration of the device is not necessary and not possible.

5 Operation

Danger!

Danger to life from missing safety function

If the safety loop is put out of service, the safety function is no longer guaranteed.

- Do not deactivate the device.
- Do not bypass the safety function.
- Do not repair, modify, or manipulate the device.

Operating the device

1. Observe the safety instruction in the instruction manual.
2. Observe the information in the manual.
3. Use the device only with devices that are suitable for this safety application.
4. Correct any occurring safe failures within 24 hours. Take measures to maintain the safety function while the device is being repaired.

5.1 Proof Test

According to IEC/EN 61508-2 a recurring proof test shall be undertaken to reveal potential dangerous failures that are not detected otherwise.

Check the function of the subsystem at periodic intervals depending on the applied PFD_{avg} in accordance with the characteristic safety values. See chapter 3.4.

It is under the responsibility of the plant operator to define the type of proof test and the interval time period.

Equipment required:

- 2 digital multimeter with an accuracy of 0.1 %
- Variable power supply 0 V DC to 50 V DC and current limitation

Proof Test Procedure

1. Put out of service the entire safety loop. Protect the application by means of other measures.
2. Prepare a test set-up, see following figures.
3. Test the device, see following tables.
4. After the test, reset the device to the original settings.

Leakage Current Measurement

Device	Step no.	Measurement	Expected result
M-LB-4212(.M)	1 2 3	6 V AC or 8.5 V DC between terminals 1' and 2' 6 V AC or 8.5 V DC between terminal 1' and ground 6 V AC or 8.5 V DC between terminal 2' and ground	Leakage current below 10 µA Leakage current below 10 nA Leakage current below 10 nA
M-LB-4214(.M)	1 2 3	6 V AC or 8.5 V DC between terminals 1' and 2' 6 V AC or 8.5 V DC between terminal 1' and ground 6 V AC or 8.5 V DC between terminal 2' and ground	Leakage current below 5 µA
M-LB-4222(.M)	1 2 3	10.6 V AC or 15 V DC between terminals 1' and 2' 10.6 V AC or 15 V DC between terminal 1' and ground 10.6 V AC or 15 V DC between terminal 2' and ground	Leakage current below 30 µA Leakage current below 10 nA Leakage current below 10 nA
M-LB-4224(.M)	1 2 3	10.6 V AC or 15 V DC between terminals 1' and 2' 10.6 V AC or 15 V DC between terminal 1' and ground 10.6 V AC or 15 V DC between terminal 2' and ground	Leakage current below 10 nA Leakage current below 70 nA Leakage current below 70 nA
M-LB-(Ex)-4242(.M)	1 2 3	25.4 V AC or 36 V DC between terminals 1' and 2' 25.4 V AC or 36 V DC between terminal 1' and ground 25.4 V AC or 36 V DC between terminal 2' and ground	Leakage current below 30 µA Leakage current below 10 nA Leakage current below 10 nA
M-LB-4244(.M)	1 2 3	23.3 V AC or 33 V DC between terminals 1' and 2' 23.3 V AC or 33 V DC between terminal 1' and ground 23.3 V AC or 33 V DC between terminal 2' and ground	Leakage current below 10 nA Leakage current below 70 nA Leakage current below 70 nA
M-LB-4252(.M)	1 2 3	39.6 V AC or 56 V DC between terminals 1' and 2' 39.6 V AC or 56 V DC between terminal 1' and ground 39.6 V AC or 56 V DC between terminal 2' and ground	Leakage current below 30 µA Leakage current below 10 nA Leakage current below 10 nA
M-LB-4254(.M)	1 2 3	38.1 V AC or 54 V DC between terminals 1' and 2' 38.1 V AC or 54 V DC between terminal 1' and ground 38.1 V AC or 54 V DC between terminal 2' and ground	Leakage current below 20 nA Leakage current below 100 nA Leakage current below 100 nA
M-LB-4272(.M)	1 2 3	127 V AC or 180 V DC between terminals 1' and 2' 127 V AC or 180 V DC between terminal 1' and ground 127 V AC or 180 V DC between terminal 2' and ground	Leakage current below 50 nA

Device	Step no.	Measurement	Expected result
M-LB-4282(.M)	1 2 3	250 V AC or 320 V DC between terminals 1' and 2' 250 V AC or 320 V DC between terminal 1' and ground 250 V AC or 320 V DC between terminal 2' and ground	Leakage current below 50 nA

Table 5.1

Resistance Measurement

Device	Step no.	Measurement	Expected result
M-LB-4212(.M) M-LB-4214(.M) M-LB-4222(.M) M-LB-4224(.M) M-LB-(Ex)-4242(.M) M-LB-4244(.M) M-LB-4252(.M) M-LB-4254(.M)	1 2	Resistance between terminals 1 and 1' Resistance between terminals 2 and 2'	Resistance approx. 1 Ω

Table 5.2

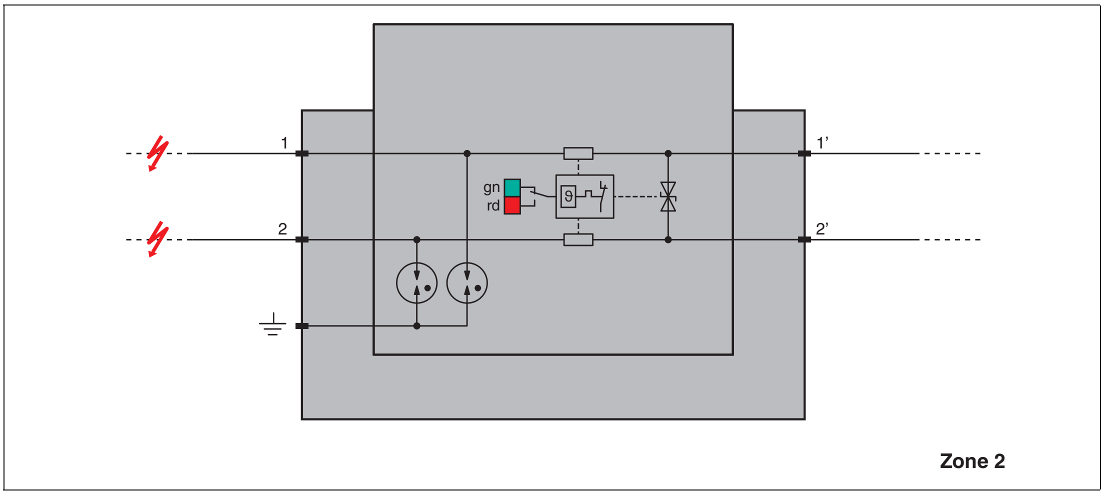

Figure 5.1 Proof test set-up for M-LB-4222(.M), M-LB-4242(.M), M-LB-4252(.M)

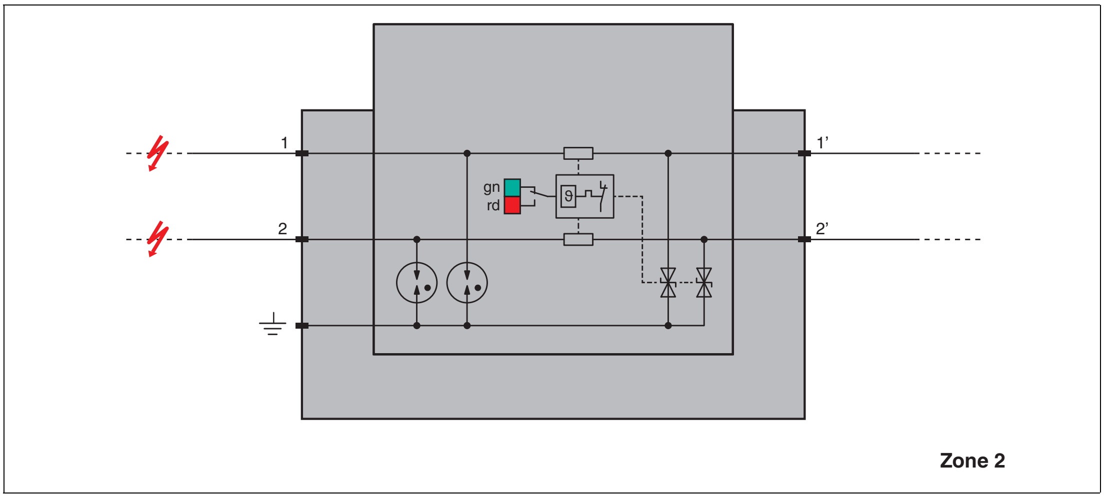

Figure 5.2 Proof test set-up for M-LB-4224(.M), M-LB-4244(.M), M-LB-4254(.M)

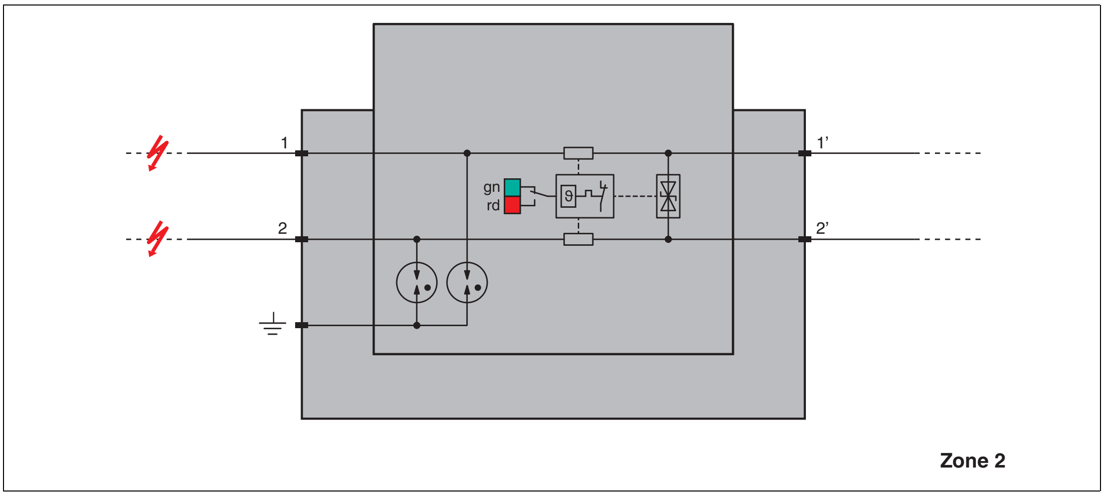

Figure 5.3 Proof test set-up for M-LB-4212(.M)

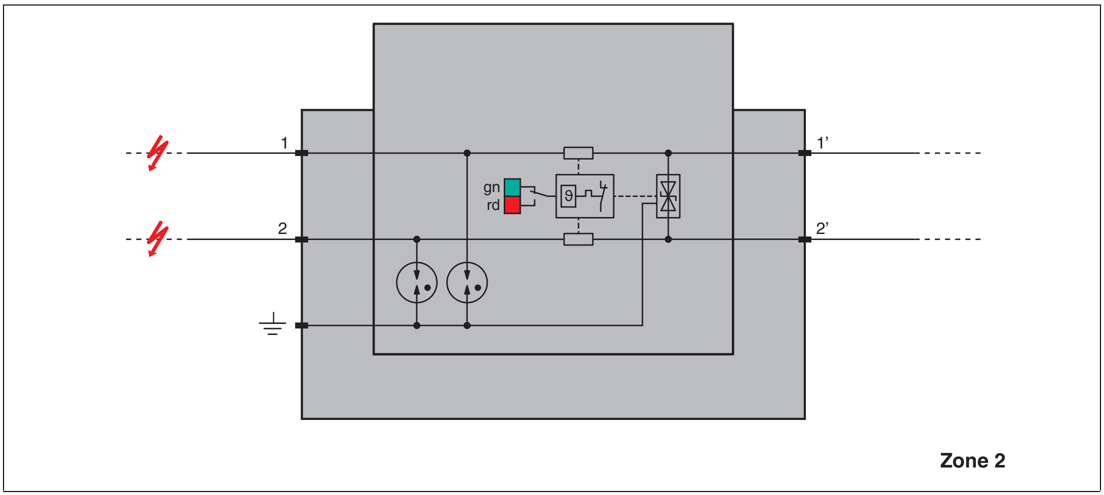

Figure 5.4 Proof test set-up for M-LB-4214(.M)

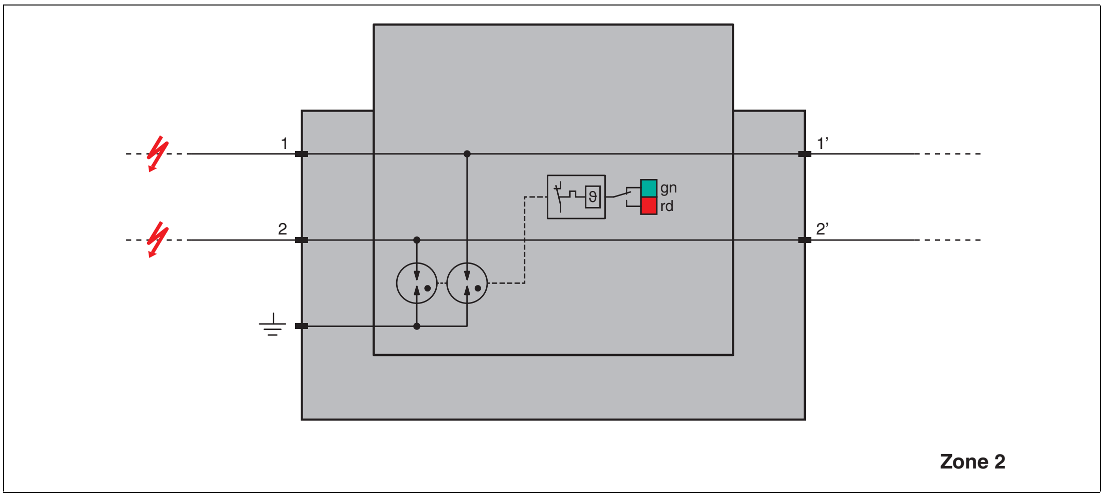

Figure 5.5 Proof test set-up for M-LB-4272(.M)

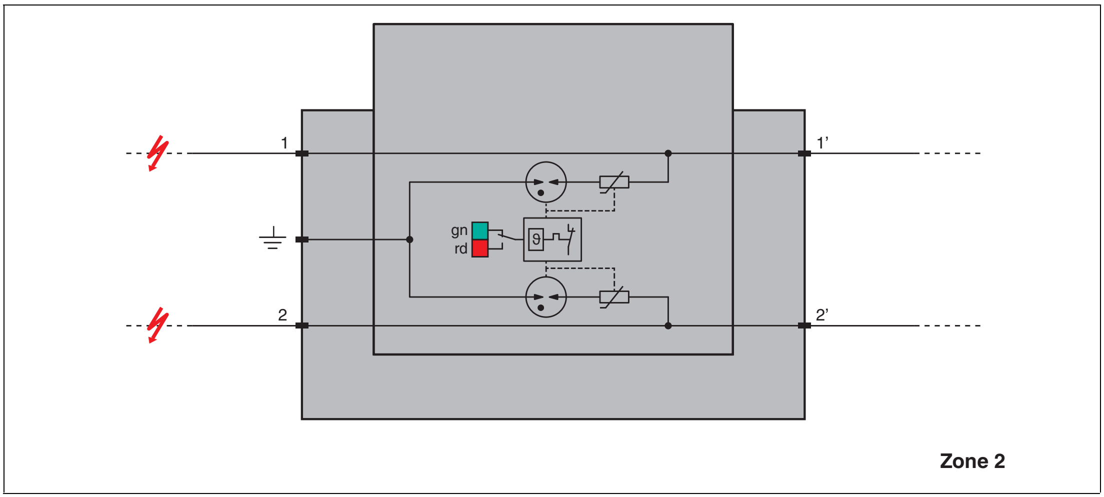

Figure 5.6 Proof test set-up for M-LB-4282(.M)

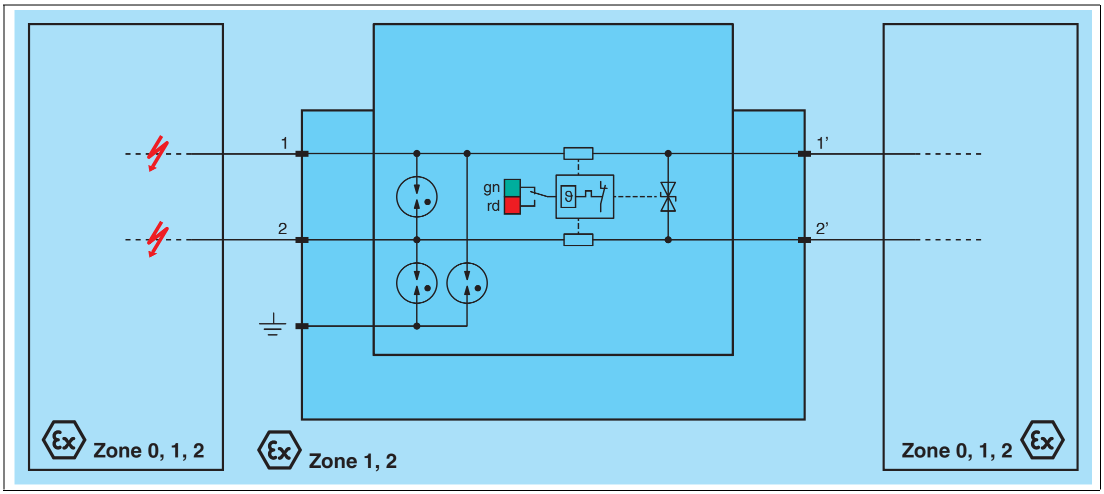

Figure 5.7 Proof test set-up for M-LB-Ex-4242(.M)

6 Maintenance and Repair

Danger!

Danger to life from missing safety function

Changes to the device or a defect of the device can lead to device malfunction. The function of the device and the safety function is no longer guaranteed.

Do not repair, modify, or manipulate the device.

Maintaining, Repairing or Replacing the Device

In case of maintenance, repair or replacement of the device, proceed as follows:

1. Implement appropriate maintenance procedures for regular maintenance of the safety loop.
2. While the device is maintained, repaired or replaced, the safety function does not work. Take appropriate measures to protect personnel and equipment while the safety function is not available.
   Secure the application against accidental restart.
3. Do not repair a defective device. A defective device must only be repaired by the manufacturer.
4. If there is a defect, always replace the device with an original device.

Reporting Device Failure

If you use the device in a safety loop according to IEC/EN 61508, it is required to inform the device manufacturer about possible systematic failures.

Report all failures in the safety function that are due to functional limitations or a loss of device function – especially in the case of possible dangerous failures.

In these cases, contact your local sales partner or the Pepperl+Fuchs technical sales support (service line).

It is not necessary to report failures in the safety function that are due to external influences or damage.

7 List of Abbreviations

ESD	**E**mergency **S**hut**d**own
FIT	**F**ailure **I**n **T**ime in 10^{-9} 1/h
FMEDA	**F**ailure **M**ode, **E**ffects, and **D**iagnostics **A**nalysis
λ_{s}	Probability of safe failure
λ_{dd}	Probability of dangerous detected failure
λ_{du}	Probability of dangerous undetected failure
$\lambda_{no\ effect}$	Probability of failures of components in the safety loop that have no effect on the safety function.
$\lambda_{not\ part}$	Probability of failure of components that are not in the safety loop
$\lambda_{total\ (safety\ function)}$	Probability of failure of components that are in the safety loop
HFT	**H**ardware **F**ault **T**olerance
MTBF	**M**ean **T**ime **B**etween **F**ailures
MTTR	**M**ean **T**ime **T**o **R**estoration
PCS	**P**rocess **C**ontrol **S**ystem
PFD$_{avg}$	Average **P**robability of dangerous **F**ailure on **D**emand
PFH	Average frequency of dangerous failure per hour
PLC	**P**rogrammable **L**ogic **C**ontroller
PTC	**P**roof **T**est **C**overage
SC	**S**ystematic **C**apability
SFF	**S**afe **F**ailure **F**raction
SIF	**S**afety **I**nstrumented **F**unction
SIL	**S**afety **I**ntegrity **L**evel
SIS	**S**afety **I**nstrumented **S**ystem
T_1	Proof Test Interval

Your automation, our passion.

Explosion Protection

- Intrinsic Safety Barriers
- Signal Conditioners
- FieldConnex® Fieldbus
- Remote I/O Systems
- Electrical Ex Equipment
- Purge and Pressurization
- Industrial HMI
- Mobile Computing and Communications
- HART Interface Solutions
- Surge Protection
- Wireless Solutions
- Level Measurement

Industrial Sensors

- Proximity Sensors
- Photoelectric Sensors
- Industrial Vision
- Ultrasonic Sensors
- Rotary Encoders
- Positioning Systems
- Inclination and Acceleration Sensors
- Fieldbus Modules
- AS-Interface
- Identification Systems
- Displays and Signal Processing
- Connectivity

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