

# MACX MCR-SL-(2)I-2)I-ILP(-SP)

Passive isolator, one and two channel

Data sheet  
106893\_en\_01

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## 1 Description

The single- or dual-channel input loop powered 2-way isolator with plug-in connection technology is used for the electrical isolation and filtering of analog signals.

The device allows operation on active sensor technology with a supply voltage of 6 V ... 30 V DC.

The device is powered via the current loop of the sensor. Therefore, no additional power supply is necessary.

Input signal = output signal: 0(4) mA ... 20 mA

The measurement signal is transferred 1:1.

### Features

- 2-wire passive isolators for electrical isolation and filtering of standard analog signals.
- Supplied by an input loop
- 2.9 V voltage drop
- Up to SIL 3 according to IEC/EN 61508
- 2-way electrical isolation
- Plug-in connection terminal blocks, either screw or spring-cage connection technology (Push-in technology)
- Installation in Ex zone 2 permitted
- Housing width of 12.5 mm



Make sure you always use the latest documentation.  
It can be downloaded from the product at [phoenixcontact.net/products](http://phoenixcontact.net/products).



This document is valid for the products listed in the "Ordering data".

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### 3 Ordering data

Description	Type	Order No.	Pcs./Pkt.
Single-channel input loop-powered 2-way isolator with plug-in connection technology for the electrical isolation of analog signals. Input signal = output signal: 0(4) mA ... 20 mA. Screw connection technology.	MACX MCR-SL-I-I-ILP	2905278	1
Single-channel input loop-powered 2-way isolator with plug-in connection technology for the electrical isolation of analog signals. Input signal = output signal: 0(4) mA ... 20 mA. Push-in connection technology.	MACX MCR-SL-I-I-ILP-SP	2905279	1
Two-channel input loop-powered 2-way isolator with plug-in connection technology for the electrical isolation of analog signals. Input signal = output signal: 0(4) mA ... 20 mA. Screw connection technology.	MACX MCR-SL-2I-2I-ILP	2905280	1
Two-channel input loop-powered 2-way isolator with plug-in connection technology for the electrical isolation of analog signals. Input signal = output signal: 0(4) mA ... 20 mA. Push-in connection technology.	MACX MCR-SL-2I-2I-ILP-SP	2905281	1

### 4 Technical data

Input data	
Description of the input	Current input
Configurable/programmable	no
Max. voltage input signal	< 30.5 V
Current input signal	0 mA ... 20 mA 4 mA ... 20 mA
Input voltage limitation	30.5 V
Voltage dissipation	2.9 V (I = 20 mA)
Step response (10-90%)	5 ms (500 Ω load)
Output	
Output description	Current output
Configurable/programmable	no
Output signal maximum voltage	27.5 V
Current output signal	0 mA ... 20 mA 4 mA ... 20 mA
Transmission Behavior	1:1 to input signal
Load/output load current output	≤ 1375 Ω (I = 20 mA)
Residual ripple	< 10 mV <sub>rms</sub> (500 Ω load)
Supply	
Supply voltage range	no separate supply voltage necessary
General data	
Maximum transmission error	≤ 0.1 % (of final value)
Maximum temperature coefficient	≤ 0.002 %/K (of measured value / 100 Ω load)
Degree of protection	IP20
Flammability rating according to UL 94	V0
Overvoltage category	II
Pollution degree	2
Dimensions W/H/D	12.5 mm / 99 mm / 114.5 mm ( MACX MCR-SL-I-I-ILP ) 12.5 mm / 99 mm / 114.5 mm ( MACX MCR-SL-I-I-ILP-SP )
Type of housing	PA 66 green

Connection data	Screw connection	Push-in connection
Conductor cross section, solid	0.2 mm <sup>2</sup> ... 2.5 mm <sup>2</sup>	0.2 mm <sup>2</sup> ... 1.5 mm <sup>2</sup>
Conductor cross section, flexible	0.2 mm <sup>2</sup> ... 2.5 mm <sup>2</sup>	0.2 mm <sup>2</sup> ... 1.5 mm <sup>2</sup>
Conductor cross section AWG	24 ... 14	24 ... 16
Stripping length	7 mm	8 mm
Tightening torque	0.5 Nm ... 0.6 Nm	
Diameter Test socket in the connector	2.3 mm	2.3 mm

Ambient conditions	
Ambient temperature (operation)	-40 °C ... 85 °C
Ambient temperature (storage/transport)	-40 °C ... 85 °C
Permissible humidity (operation)	5 % ... 95 % (non-condensing)
Maximum altitude for use above sea level	< 2000 m

Electrical isolation	
Input/output/power supply	
Rated insulation voltage (overvoltage category II; pollution degree 2, safe isolation as per EN 61010-1)	300 V <sub>rms</sub>
50 Hz, 1 min., test voltage	2.5 kV

**Conformance with EMC directive 2004/108/EC and for low-voltage directive 2006/95/EC**  
 Noise immunity according to EN 61326-1

Conformance / approvals	
ATEX	Ⓔ II 3 G Ex nA IIC T4 Gc X
UL, USA / Canada	UL 61010 Listed Class I, Div. 2, Groups A, B, C, D T4 Class I, Zone 2, Group IIC T4
Functional Safety in accordance with IEC 61508 ( 968/FSP 1200.00/15 )	to SIL 3

## 5 Safety notes

### 5.1 Installation notes

- The category 3 device is suitable for installation in the zone 2 potentially explosive area. It fulfills the requirements of EN 60079-0:2012+A11:2013 and EN 60079-15:2010.
- Installation, operation, and maintenance may only be carried out by qualified electricians. Follow the installation instructions as described. When installing and operating the device, the applicable regulations and safety directives (including national safety directives), as well as generally approved technical regulations, must be observed. The safety data is provided in this package slip and on the certificates (conformity assessment, additional approvals where applicable).
- The device must not be opened or modified. Do not repair the device yourself, replace it with an equivalent device. Repairs may only be carried out by the manufacturer. The manufacturer is not liable for damage resulting from violation.
- The IP20 protection (IEC 60529/EN 60529) of the device is intended for use in a clean and dry environment. The device must not be subject to mechanical strain and/or thermal loads, which exceed the limits described.
- The device must be stopped if it is damaged, has been subjected to an impermissible load, stored incorrectly, or if it malfunctions.
- The device is not designed for use in potentially dust-explosive atmospheres. If dust is present, installation must take place in a suitable and approved housing (at least IP54) that meets the requirements of EN 60079-31. The specified surface temperature of the housing must be observed.
- The device complies with the EMC regulations for industrial areas (EMC class A). When using the device in residential areas, it may cause radio interference.

### 5.2 Installation in the Ex area (zone 2)

- Observe the specified conditions for use in potentially explosive areas! Install the device in a suitable approved housing (with a minimum of IP54 protection) that meets the requirements of EN 60079-15. Observe the requirements of EN 60079-14.
- Only devices which are designed for operation in Ex zone 2 and are suitable for the conditions at the installation location may be connected to the circuits in the Ex zone.
- In potentially explosive areas, terminals may only be snapped onto or off the DIN rail connector and wires may only be connected or disconnected when the power is switched off.
- The device must be stopped and immediately removed from the Ex area if it is damaged, was subject to an impermissible load, stored incorrectly or if it malfunctions.

### 5.3 UL Notes

#### PROCESS CONTROL EQUIPMENT FOR HAZARDOUS LOCATIONS 31ZN

- 1 Suitable for use in class 1, division 2, groups A, B, C and D hazardous locations, or nonhazardous locations only.
- 2 WARNING - EXPLOSION HAZARD: Do not disconnect equipment while the circuit is live or unless the area is known to be free of ignitable concentrations.
- 3 WARNING - EXPLOSION HAZARD: Substitution of any components may impair suitability for Class I, Division 2.

## 6 Installation

### 6.1 Connection notes



**WARNING: Electrical danger due to improper installation**

Observe the connection notes for safe installation in accordance with EN/UL 61010-1:

- Provide a switch/circuit breaker close to the device, which is labeled as the disconnecting device for this device.
- Provide overcurrent protection ( $I \leq 16 \text{ A}$ ) within the installation.
- To protect the device against mechanical or electrical damage, install it in a suitable housing with appropriate degree of protection as per IEC 60529.
- During installation, servicing, and maintenance work, disconnect the device from all effective power sources, provided you are not dealing with SELV or PELV circuits.
- If the device is not used as described in the documentation, the intended protection can be negatively affected.
- Thanks to its housing, the device has basic insulation to the neighboring devices, for 300 Veff. If several devices are installed next to each other, this has to be taken into account, and additional insulation has to be installed if necessary! If the neighboring device is equipped with basic insulation, no additional insulation is necessary.
- The voltages present at the input and output are extra-low voltages (ELV). Depending on the application, dangerous voltage ( $> 30 \text{ V}$ ) to ground could occur at the input and output. The supply voltage could be a dangerous voltage, depending on the application. All connections are safely electrically isolated from each other.

### 6.2 Electrostatic discharge



**NOTE: Electrostatic discharge**

The device contains components that can be damaged or destroyed by electrostatic discharge. When handling the device, observe the necessary safety precautions against electrostatic discharge (ESD) according to EN 61340-5-1 and IEC 61340-5-1.

### 6.3 Structure

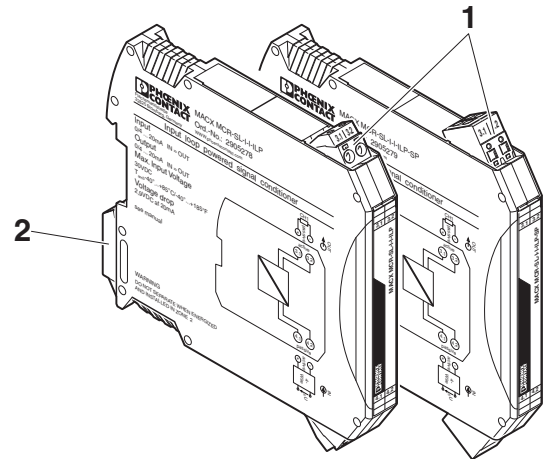


Figure 1 Structure

- 1 COMBICON plug-in, screw, or push-in connection terminal with integrated test socket
- 2 Snap-on foot for DIN rail mounting

**6.4 Basic circuit diagram with connection terminal blocks**

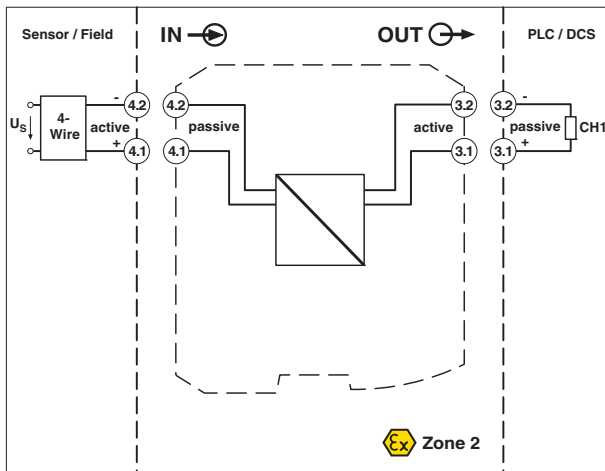


Figure 2 Single-channel

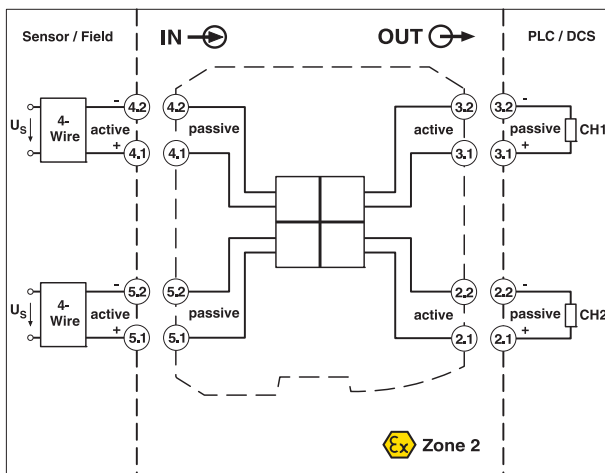


Figure 3 Two-channel

**6.5 Power supply**

An ME 6,2 TBUS-2 DIN rail connector (Order No. 2869728) is used to supply active devices. A DIN rail connector is not required to operate this passive device.

This device can be snapped onto a DIN rail connector – an electrically conductive connection is not established. This means that you do not need to disconnect an existing DIN rail connector element connection.

**6.6 Dimensions**

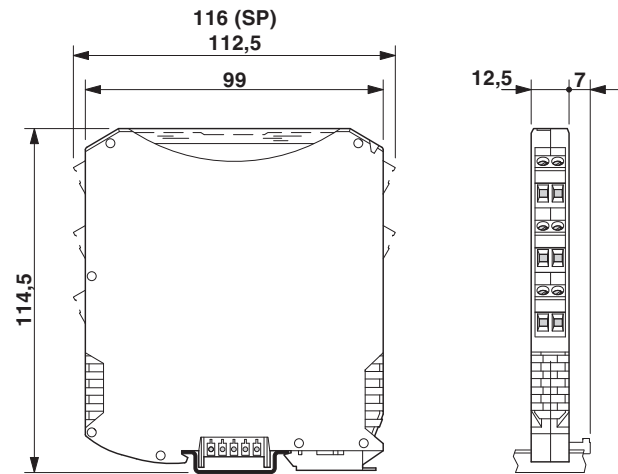


Figure 4 Dimensions

### 6.7 Assembly

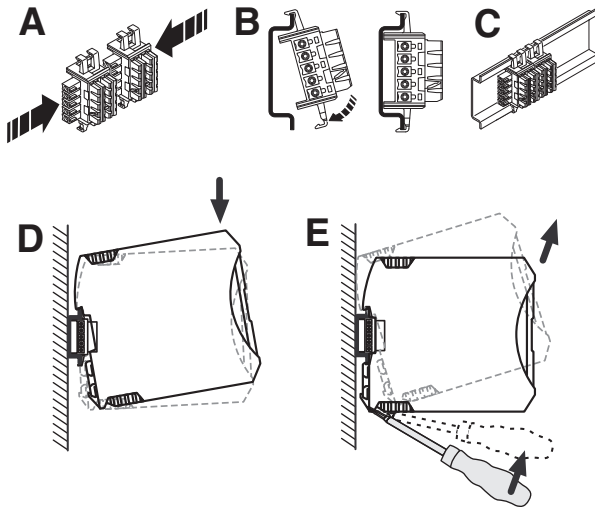


Figure 5 Mounting and removing

The device can be snapped onto all 35 mm DIN rails according to EN 60715.

An ME 6,2 TBUS-2 DIN rail connector (Order No. 2869728) is used to supply active devices. A DIN rail connector is not required to operate this passive device.

This device can be snapped onto a DIN rail connector – an electrically conductive connection is not established. This means that you do not need to disconnect an existing DIN rail connector element connection.

### 6.8 Connecting the cables

#### Screw connection:

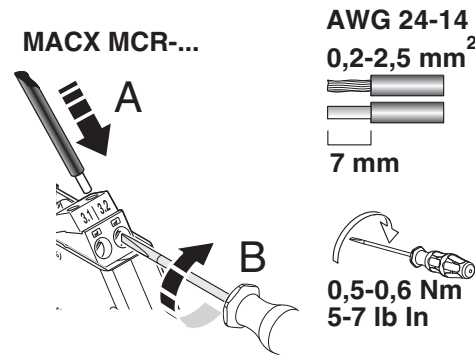


Figure 6 Screw connection

- Strip the wire by approximately 7 mm and crimp ferrules to the end of the wires.
- Insert the wire into the corresponding connection terminal block.
- Use a screwdriver to tighten the screw in the opening above the connection terminal block.  
Tightening torque: 0.6 Nm

#### Push-in connection:

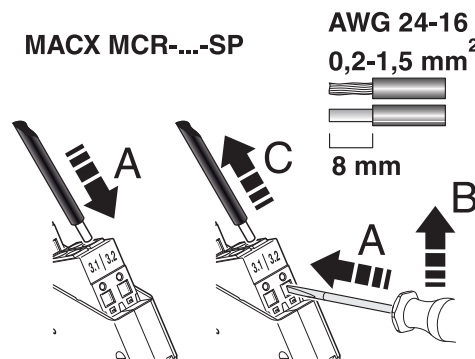


Figure 7 Push-in connection

- Strip the wire by approximately 8 mm and crimp ferrules to the end of the wires.
- Insert the wire into the corresponding connection terminal block.
- Push in the pushbutton with a screwdriver to release.

### 6.9 Startup

- Before startup, check that the device is operating and wired correctly.



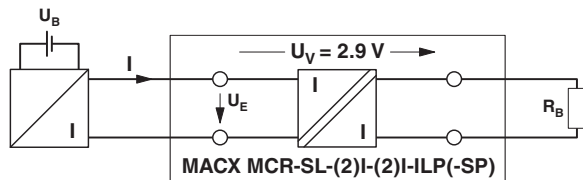
## 7 Method of operation

The passive isolator draws the power required for isolation from the input signal.

When using passive isolators, make sure that the current sourcing voltage of the measuring transducer  $U_B$  is sufficient to drive the maximum current of 20 mA via the passive isolator with a voltage drop  $U_V = 2.9$  V and load  $R_B$ .

This means:

$$U_B \geq U_E = 2.9 \text{ V} + 20 \text{ mA} \times R_B$$



## 8 Safety-related applications

The following notes apply for the devices:

Designation	Order No.
MACX MCR-I-I-ILP	2905278
MACX MCR-I-I-ILP-SP	2905279
MACX MCR-2I-2I-ILP	2905280
MACX MCR-2I-2I-ILP-SP	2905281

The devices listed above are certified in compliance with DIN EN 61508-1:2010 and DIN EN 61508-2:2010. Test certificate: 968/FSP 1200.00/15

The devices are TÜV-certified.

### 8.1 Safety function

The defined safety function for the devices applies for the input signal range of 4 ... 20 mA.

The device transfers a measuring signal of 4 ... 20 mA – electrically isolated – into an output signal of 4 ... 20 mA with a tolerance of 2%. The input signals are transferred in a linear 1:1 ratio.

The fault signal is defined for the ranges between <3.6 mA and >21 mA.

The analog output signal has to be evaluated using a downstream logic unit.

In the case of a two-channel, redundant application (1oo2), you must compare the values and establish a safe state when exceeding a certain tolerance.

### 8.2 Operating mode

Operating mode in accordance with EN 61508: "low requirement rate" or "high requirement rate" (six requirements per minute maximum)

### 8.3 Relevant standards

The device can be used in safety-related applications up to SIL 3 (systematic suitability SC3). The standards which are relevant to the intended purpose, such as EN 61508 and EN 62061, must be applied.

## 8.4 Safety integrity requirements

### 8.4.1 Error rates

- Type A device (according to EN 61508-2)
- Safety integrity level (SIL) 3
- Operating mode 4 ... 20 mA
- $MTTF_D$  221 a
- MTTR 72 h
- Ambient temperature 40°C

### 8.4.2 Load $\leq 700 \Omega$

Failure rate in FIT

$\lambda_{Total}$	$\lambda_S$	$\lambda_D$	$\lambda_{SD}$	$\lambda_{DU}$	$\lambda_{DD}$	SFF	$DC_D$
103,2	101.7	1.5	0	1.5	0	98.6%	0 %

The MTBF is 1,106 years.

### PFH/PFD values

T [PROOF]	1 year	2 years	3 years
$PFD_{1001}$	$6,6 \cdot 10^{-6}$	$1,3 \cdot 10^{-5}$	$2 \cdot 10^{-5}$
$PFH_{1001}$	$1,5 \cdot 10^{-9}$	$1,5 \cdot 10^{-9}$	$1,5 \cdot 10^{-9}$
$PFD_{1002}$	$6,6 \cdot 10^{-7}$	$1,3 \cdot 10^{-6}$	$2 \cdot 10^{-6}$
$PFH_{1002}$	$1,5 \cdot 10^{-10}$	$1,5 \cdot 10^{-10}$	$1,5 \cdot 10^{-10}$

### 8.4.3 Load $> 700 \Omega$

Failure rate in FIT

$\lambda_{Total}$	$\lambda_S$	$\lambda_D$	$\lambda_{SD}$	$\lambda_{DU}$	$\lambda_{DD}$	SFF	$DC_D$
103,2	94.2	9	0	9	0	91.3%	0 %

The MTBF is 1,106 years.

### PFH/PFD values

T [PROOF]	1 year	2 years	3 years
$PFD_{1001}$	$4 \cdot 10^{-5}$	$7.9 \cdot 10^{-5}$	$1.2 \cdot 10^{-4}$
$PFH_{1001}$	$9 \cdot 10^{-9}$	$9 \cdot 10^{-9}$	$9 \cdot 10^{-9}$
$PFD_{1002}$	$4 \cdot 10^{-6}$	$7.9 \cdot 10^{-6}$	$1.2 \cdot 10^{-5}$
$PFH_{1002}$	$9 \cdot 10^{-10}$	$9 \cdot 10^{-10}$	$9 \cdot 10^{-10}$

## 8.5 Conditions

- The failure rates of the components used remain constant throughout the period of use.
- The propagation of errors by the device in the system is not taken into consideration.
- The repair time (replacement) should be eight hours.
- The failure rates of the external power supply are not taken into consideration.
- The average temperature at which the device is to be used is +40°C.
- The specified error rates are based on an ambient temperature of +40°C.

## 8.6 Installation and startup



**NOTE:** Installation, operation, and maintenance may only be carried out by professionals.

During installation, observe the instructions in the package slip:

Designation	MNR No.
PACKB.MACX MCR-SL-(2)I-(2)I-ILP(-SP)	9071251

The package slip is supplied with the device. It can also be downloaded at: [phoenixcontact.net/products](http://phoenixcontact.net/products).

Lockable housing with IP54 protection is recommended for the installation of the devices.

- Connect the device according to the installation notes.
- Make sure that the connected sensor and measuring transducer correspond to the intended configuration.
- Check that the device operates correctly with the measuring transducer and sensor connected.
- A calibrated sensor simulator and a calibrated digital multimeter may be required in order to check the device with the measuring transducer connected.
- Start up the safety circuit and check that it operates correctly.

### 8.7 Notes on operation

The output signal of the passive isolator in normal, uninterrupted mode is within the range of 3.6 ... 21 mA. If a fault or error occurs during operation, the connected safety-related controller establishes that a measured value is outside of normal operation and initiates appropriate measures. As it cannot be established whether the error was caused by the passive isolator or by the devices connected upstream of the passive isolator, you must check the entire safety loop from the sensor to the output of the passive isolator.

After being switched off and on again, the required voltages are established in the device. Signal transmission is then performed without further action.

### 8.8 Recurring checks

The function of the entire safety loop must be checked regularly according to IEC/EN 61508 and IEC/EN 61511.

The intervals for checking are specified by the intervals of each individual device within the safety loop.

It is the operator's responsibility to select the type of checks and the checking intervals in the specified time period.

Checking must be carried out in such a way that the correct function of the safety equipment in conjunction with all components can be verified.

#### Possible procedure for recurring checks for discovering dangerous and undetected device failures

A calibrated simulator (0/4 ... 20 mA current) or a sensor simulator and one or ideally two calibrated digital multimeters are required in order to check the devices.

1. Take appropriate steps to prevent incorrect use.
2. Disconnect the safety circuit from further processing.
3. Connect the current simulator to the input of the repeater power supply/signal conditioner, or the sensor simulator to the input of the measuring transducer.
4. Connect the digital multimeters to the input and output of the repeater power supply/signal conditioner.
5. At the input of the device, set a signal in the range from 4 ... 20 mA or at the input of the connected measuring transducer, set a suitable signal with the sensor simulator.
6. Measure the current in the repeater power supply/signal conditioner. The output must be set to the same value.
7. Setting  $\leq 3.6$  mA or  $> 21$  mA verifies that the subsequent processing can detect signals that are out of range and evaluate them accordingly. If the output value deviates from the input value by more than 3 times the specified class accuracy rating, the device should be checked. In the event of an error, the device should be replaced with an equivalent device.
8. Restore the safety circuit to full functionality.
9. Resume normal operation.

### 8.9 Repair

The devices have a long service life, are protected against malfunctions, and are maintenance-free.

However, if a device should fail, send it back to Phoenix Contact immediately. The type of malfunction and possible cause must also be stated.

Please use the original packaging or other suitable safe packaging when sending devices back for repairs or recalibration.

Phoenix Contact GmbH & Co. KG  
Abteilung Service und Reparatur  
Flachmarktstr. 8  
32825 Blomberg  
GERMANY

## 8.10 Standards

The devices are developed and tested according to the following standards:

IEC/EN 61508-1	Functional Safety of electrical/electronic/programmable electronic safety-related systems - Part 1: General requirements
IEC/EN 61508-2	Functional Safety of electrical/electronic/programmable electronic safety-related systems - Part 2: Requirements for electrical/electronic/programmable electronic safety-related systems
IEC/EN 61326-1	Electrical equipment for measurement, control and laboratory use - EMC requirements
IEC/EN 61326-3-2	Electrical equipment for measurement, control and laboratory use - EMC requirements - Part 3-2: Immunity requirements for safety-related systems and for equipment intended to perform safety-related functions (Functional Safety) - Industrial applications with specified electromagnetic environment
IEC/EN 61511	Functional safety - Safety instrumented systems for the process industry sector

## 8.11 Abbreviations

Abbreviation		Meaning
DC <sub>D</sub>	Diagnostic coverage of dangerous failures	Diagnostic coverage of dangerous failures: $DC_D = \lambda_{DD} / (\lambda_{DU} + \lambda_{DD})$
DC <sub>S</sub>	Diagnostic coverage of safe failures	Diagnostic coverage of safe failures: $DC_S = \lambda_{SD} / (\lambda_{SU} + \lambda_{SD})$
FIT	Failure in time	1 FIT = 1 failure/10 <sup>9</sup> h
HFT	Hardware fault tolerance	Hardware fault tolerance: ability of a function unit to continue with the execution of a demanded function despite existing faults or deviations
$\lambda_D$	Rate of dangerous failures	Proportion of dangerous failures per hour
$\lambda_{DD}$	Rate of dangerous detected failures	Proportion of detected dangerous failures per hour
$\lambda_{DU}$	Rate of dangerous undetected failures	Proportion of undetected dangerous failures per hour
$\lambda_S$	Rate of safe failures	Proportion of safe failures per hour
$\lambda_{SD}$	Rate of safe detectable failures	Proportion of detectable safe failures per hour
$\lambda_{SU}$	Rate of safe undetectable failures	Proportion of undetectable safe failures per hour
MTBF	Mean time between failures	Mean time between consecutive failures
PFD <sub>avg</sub>	Average probability of failure on demand	Average probability of dangerous failure on demand of a safety function
PFH	Probability of a dangerous failure per hour	Probability of failure per hour for the safety function
PL	Performance level	The performance level indicates the capability of safety-related parts of a control system to carry out a safety function in foreseeable conditions (PL: a, b, c, d, e)
SFF	Safe failure fraction	Proportion of safe failures: proportion of failures without the potential to set the safety-related system to a dangerous or impermissible function state
SIL	Safety integrity level	International standard IEC 61508 defines four discrete safety integrity levels (SIL 1 to 4). Each level corresponds to a probability range for the failure of a safety function. The higher the safety integrity level of safety-related systems, the lower the probability that the demanded safety functions will not be performed.