

Electromagnetic Interferences

Interpretation ISO 13849-1, Annex L



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- Specialist in pneumatics
- Specialist in electrical engineering
- Specialist for the programming of control systems and safety switching devices

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1 General

1.1 Objectives of this Document

- This document provides possible interpretations of the requirements of Annex L of ISO 13849-1.
- The requirements are described in simpler language and, where necessary, supplemented.
- For Festo products, where possible, it is indicated how these requirements are met and where the evidence can be found.

1.2 General notes

- The given interpretations must always be assessed on an application-specific basis to determine whether they are applicable and complete.
- The circuits shown are schematic principle diagrams that, for the sake of clarity and brevity, cannot be exhaustive. They are recommendations and do not exclude other possible solutions.
- The Application Note ➤ [100565 Electromagnetic Immunity \(EMI\) for safety-related circuits according to ISO 13849](#) can contribute to understanding this document.

2 Scope of Annex L

Electromagnetic interferences (EMI) can disturb and damage controls and automation systems. Currents and voltages generated by various events (e.g., lightning strikes, switching operations, short circuits, etc.) cause overvoltage and electromagnetic disturbances (after IEC 60204-1, H.2). These shall not lead to common-cause failures or failures in safety circuits.

Not all components fall within the scope of Annex L. Only components that can be affected by or can cause electromagnetic disturbances need to be considered. According to the ↗ [Guide to the Application of the EMC Directive 2014/30/EU](#) (19.12.2018), three groups can be distinguished:

1. Components without electrical and/or electronic parts

Components that do not contain electrical or electronic parts do not cause electromagnetic disturbances and are not affected by such disturbances during operation. Therefore, these components are not subject to the requirements of Annex L (according to ↗ [Guide to the Application of the EMC Directive 2014/30/EU](#) (19.12.2018), section 1.4.1).

Examples include pneumatic drives, pneumatically actuated valves, axis mechanics, hoses.

2. Components that cannot cause or be affected by electromagnetic disturbances

Components that, by their nature, cannot cause electromagnetic disturbances and are not susceptible to them are not subject to the requirements of Annex L.

This includes the following components, provided they do not contain active electronic parts:

- Cables, connectors, adapters;
- Components with only resistive loads without switching devices, e.g., braking resistors;
- Batteries and accumulators (without active electronic circuits);
- Induction motors without electronic circuits;
- Switches without active electronic parts;
- Electromagnetic relays without active electronic parts;
- Solenoid valves without hold-current reduction;
- Fuses without active electronic parts.

(according to ↗ [Guide to the Application of the EMC Directive 2014/30/EU](#) (19.12.2018), section 1.4.4)

Notes

- Cables can act as coupling paths and must be taken into account when implementing measures from Annex L. This depends on the devices connected to the cables.

3. Components that can cause or be affected by electromagnetic disturbances

All components with active electronic parts fall within the scope of Annex L. These components must also meet the requirements of IEC 61000-6-2. This confirmation is indicated by Festo in the declaration of conformity for the EMC Directive 2014/30/EU, e.g., for solenoid valves with holding-current reduction ↗ [VMPA](#).

Measures from Annex L should be considered especially when using components from the last group and when routing cables.

3 Overview

To assess electromagnetic interferences (EMI) according to ISO 13849-1, Annex L, there are four paths with requirements that allow a sufficient assessment:

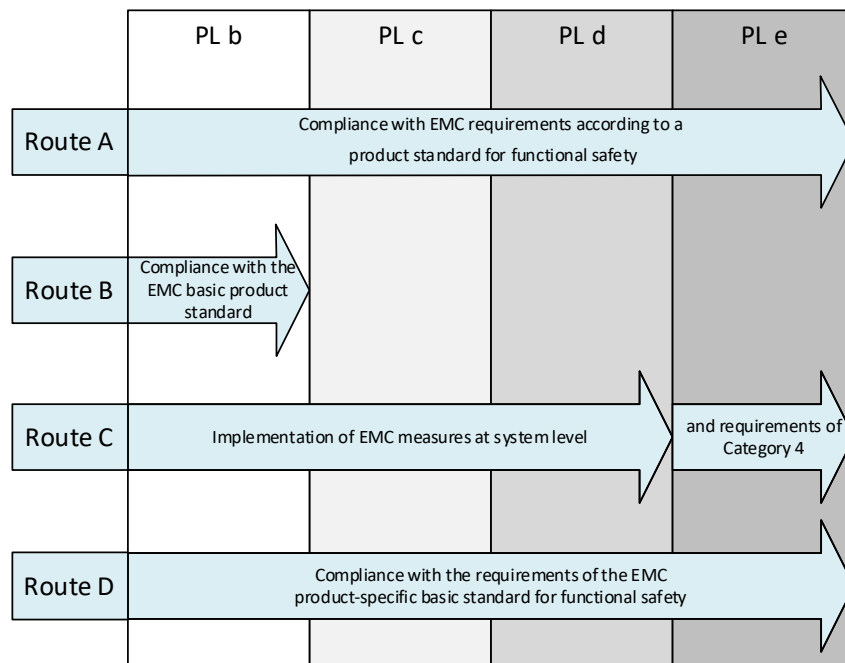


Figure 1 Overview of routes for electromagnetic interferences (EMI)

4 Route A: Product standard for functional safety

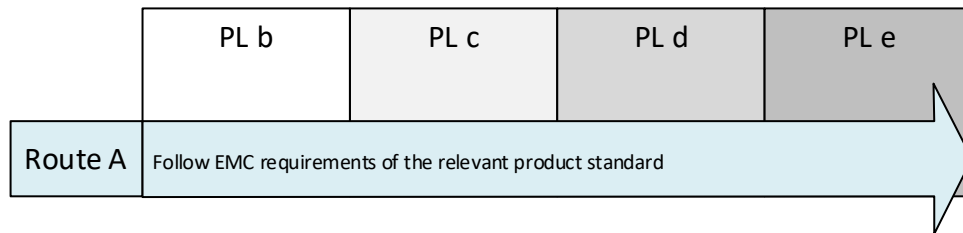


Figure 2 Route A: Product standard for functional safety

If a product is designed and manufactured to a functional safety standard, that product meets the EMC requirements for functional safety applications. Standards that meet these requirements are:

- IEC 60947-5-3:2013-08 - Low-voltage switchgear and controlgear - Part 5-3: Control circuit devices and switching elements - Requirements for proximity devices with defined behavior under fault conditions (PDDb)
- IEC 61000-6-7:2014-10 - Electromagnetic compatibility (EMC) - Part 6-7: Generic standards - Immunity requirements for equipment intended to perform functions in a safety-related system (functional safety) in industrial locations
- IEC 61131-6:2012-10 - Programmable controllers - Part 6: Functional safety (EN 61131-6:2012-11, DIN EN 61131-6:2013-10)
- IEC 61326-3-2:2017-05 - 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 61800-5-2:2016-04 - Adjustable speed electrical power drive systems - Part 5-2: Safety requirements – Functional (EN 61800-5-2:2017-04, DIN EN 61800-5-2:2017-11)

This route is characterized by the fact that the higher EMC requirements for functional safety are met at product level.

4.1 Festo products that meet a product standard for functional safety

Festo has issued a declaration of conformity for the following products, which confirms compliance with the EN 61800 5 2 standard

- CMMT-AS, please see declaration of conformity E-M-R ➔ [8189310-17107957, 2023-12-15](#).

Important note

- When using these products, the requirements of the user information (at least assembly, maintenance and operating instructions) must be strictly adhered to.

5 Route B: EMC generic standard for industrial environments IEC 61000-6-2

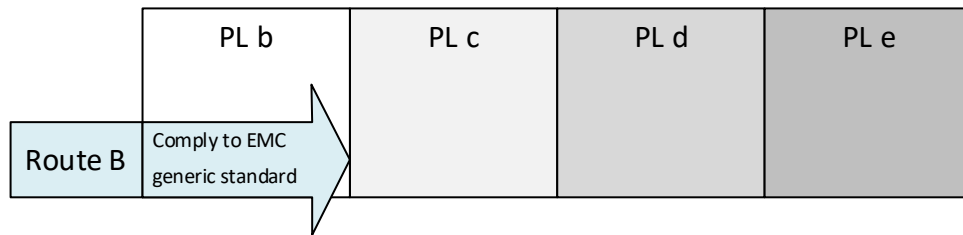


Figure 3 EMC generic standard for industrial environments IEC 61000-6-2

If a product is designed and manufactured according to an immunity standard for industrial environments, this product only meets the EMC requirements for applications with functional safety up to PL b. The following standard can be applied for this:

- IEC 61000-6-2 Electromagnetic compatibility - Part 6-2: Generic standards - Interference immunity for industrial areas

This route is characterized by the fact that the EMC requirements are met at product level.

5.1 Festo products that meet an EMC generic standard

At Festo, almost all products with active electronics meet this generic standard. This is stated in the declaration of conformity for the EMC directive, e.g. for solenoid valves ➔ [VMPA](#).

Important note

- When using these products, the requirements of the user information (at least assembly, maintenance and operating instructions) must be strictly adhered to.

6 Route C: Realization of EMC measures on system level

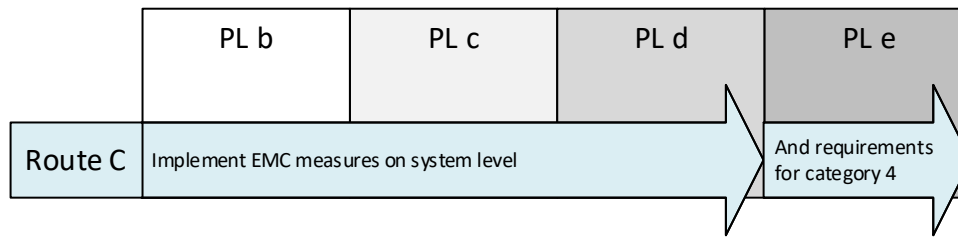


Figure 4 Route C: EMC measures on system level

If no adequate measures for immunity to electromagnetic interference are possible or implemented at product level, path C can be selected. Here, measures are implemented at system level and evaluated with points. Depending on the PL, a certain number of points must be achieved to ensure that a sufficient number of measures have been implemented.

The measures specified in this path overlap with the measures required on the basis of the EMC Directive 2014/30/EU and its harmonized standards.

We therefore always recommend taking EMC measures into account when designing a machine. There are guidelines from various manufacturers that describe this. Based on IEC 60204-1, Annex H, there is a guide for safety circuits in the application note [100565 Electromagnetic Interferences \(EMI\)](#).

6.1 Assessment according to Annex L with table L.1

The measures for achieving electromagnetic compatibility are divided into the following sections in Table L.1:

- Safety-related sensors and their wire harness
- Safety-related I/O system (central or decentral or integrated in the PLC)
- PLC as part of the SRP/CS
- Safety-related actuator and their wire harness
- Other components and wiring with relevant disturbance level
- Engineering, programming, training, field observation
- Power supply of the SRP/CS

The implementation of each technical measure is awarded a certain number of points. If a technical measure is not relevant, the score can be taken into account in the calculation. The following points must be achieved:

- For category B and 1: at least 230 points
- For categories 2, 3 and 4: at least 280 points

Important notes

- For PL e, the requirements of category 4, in particular resistance to faults and their detection, must also be met.
- For some specifications and measures, an interpretation is given of how the specifications can be evaluated in relation to safety circuits. Further information on the area of application of a requirement may be provided.

6.2 Safety-related sensors and their wire harness

Interpretation

- “Safety-related sensors” are all inputs of a safety circuit that contain active electrical components and can be sources of interference or interference sinks. These include light curtains, encoders, electronic pressure sensors, rotary encoders, etc.
- Pushbuttons, switches, limit switches, pressure switches, etc. that operate electromechanically do not fall under this definition, see also section "2 Scope of application of Annex L".

No.		Score	Source
	Safety-related sensors and their wire harness		
1	Application of the measures described in IEC 60204-1:2016+AMD1: 2021, Annex H and/or IEC 61800-3 (hr)	10	ISO 13849-1, Table L.1

Specified standards

- IEC 60204-1 - Safety of machinery - Electrical equipment of machines - Part 1: General requirements
- IEC 61800-3 - Adjustable speed electrical power drive systems - Part 3: EMC requirements and specific test methods for PDS and machine tools

Implementation

- The required measures are described in application note ↗ [100565 Electromagnetic Interferences \(EMI\)](#).
- The implementation of these measures is also necessary for compliance with the requirements of the EMC Directive 2014/30/EU and its harmonized standards and should always be implemented.

No.		Score	Source
	Safety-related sensors and their wire harness		
2	Analog voltage signals, angle encoder shielded and either grounded or twisted cables, or both, for sensors and safety-related input/output-signals (cable shields are contacted all-around and flat contacted in low impedance close to the components) (hr)	20	ISO 13849-1, Table L.1

Definition

- **Angle encoders** measure the angle of rotation of rotating objects with high precision and output this as an analog signal.
- **Sensors** are electronic devices that determine a measured value of the environment.

Area of application

- This measure must be strictly observed for analog voltage signals.
- For sensors with current signals, binary signals, or digital signals, this measure is recommended.

Implementation

- Shielded cables must be used for analog voltage signals and should be earthed at both ends.
- If interference nevertheless occurs, an impermissible leakage current flows via the cable shield. In this case, the preferred measures are to install a protective earth conductor running in parallel or to connect all system components to each other with low impedance and to connect them to the protective earth conductor.
- The necessary measures are described in application note ↗ [100565 Electromagnetic Interferences \(EMI\)](#).

- As a rule, manufacturers of devices with analog voltage signals provide corresponding installation instructions and recommendations for the cables to be used.

Note

- Shielded cables must always be earthed. The choice between earthed or twisted cables in the standard text is not permitted.

No.		Score	Source
	Safety-related sensors and their wire harness		
3	Harnesses and wiring of low voltage DC between components is in twisted pair cabling	10	ISO 13849-1, Table L.1

Definition

- Low-voltage DC power supply is usually a PELV power supply with 24 VDC.

Area of application

- Electrical supply of safety-related sensors that have separate ports for the supply of direct current. These are e.g. light curtains, measuring systems, etc.
- This is also recommended for the load and logic supply of electrical components in the safety circuit.

Implementation

- If single wires are used for the port of the direct current supply, these wires must be twisted.
- If flexible sheathed cables are used, the wires are normally already twisted.
- If flexible jacketed cables are used, the cores are usually already twisted. Further information can be found in section “3.4.2 Twisted Conductors” of the Application Note [↗ 100565 Electromagnetic Interferences \(EMI\)](#).

6.3 Safety-related I/O system (centralized or decentralized or integrated in the PLC)

Interpretation

- The safety-related I/O system comprises all digital and analog inputs and outputs of the safety switching device. These can be present in the safety switching device or arranged decentral.

No.		Score	Source
	Safety-related IO system (central or decentral or integrated in the PLC)		
4	installed in a shielded and bonded cabinet or components in a shielded and bonded housing (hr)	20	ISO 13849-1, Table L.1

Implementation

- Safety switching devices with their inputs/outputs are installed in metal switch cabinets that provide sufficient shielding and are adequately earthed.
- Decentralized I/O systems should have a metal housing, the housing of which must be connected to the protective conductor.
- Decentralized I/O systems with plastic housings must be installed in a metal switch cabinet that is connected to the protective earth conductor.

No.		Score	Source
	PLC as part of SRP/CS		
7	Category 3/4 for PLr d/e with diverse PLC in the same enclosure separated with sufficient distance in accordance with the manufacture installation instruction	10	ISO 13849-1, Table L.1

Area of application

- This measure is only applicable if two functional PLCs are used in the safety circuit.

Implementation

- If the two functional PLCs are installed in a control cabinet, the requirements of the manufacturer's assembly and installation instructions must be observed.
- A sufficient distance must be maintained between these PLCs to prevent mutual interference due to electromagnetic effects.
- The required measures are described in section “3.5 Construction and Installation of the Control Cabinet” in Application Note [↗ 100565 Electromagnetic Interferences \(EMI\)](#).

No.		Score	Source
	PLC as part of SRP/CS		
8	Category 3/4 for PLr d/e with redundant PLC in different enclosures	20	ISO 13849-1, Table L.1

Area of application

- This measure is only applicable if two functional PLCs are used in the safety circuit.

Implementation

- If the two functional PLCs are installed in two separate metal control cabinets.
- The two functional PLCs are installed in a control cabinet in different areas that are separated from each other by a distance or shielding plates.

Note

- The “different enclosures” measure is only effective if the enclosures are made of metal and are earthed.

No.		Score	Source
	PLC as part of SRP/CS		
9	Category 3/4 for PLr d/e with diverse channels (e.g. PLC and discrete logic) or using safety PLC	20	ISO 13849-1, Table L.1

Definition

- Safety PLC is used here as a synonym for all devices certified for logic functions in safety circuits. This includes safety PLCs, safety relays or other certified safety devices with logic functions.

Scope of application

- This measure is only to be implemented for categories 3 or 4 or PLr d or e.

- This measure is only applicable if two diverse channels are used to implement the logic, e.g. one channel with a PLC, the second channel with a discrete logic circuit.
- Safety circuits with a safety switching device.

Implementation with diverse channels

With the measures against CCF according to ISO 13849-1, section F.3.2, diversity can already be implemented (shortened to the points relevant to the logic):

- different technologies/design or physical principles are used, e.g.:
 - the first channel electronic or programmable electronic and the second channel electromechanical hardwired;
 - ...
- ...
- different components, e.g. from different manufacturers (not just branded differently);
- ...

Implementation with safety switching device

- The use of a safety switching device certified for logic functions is required.

6.5 Safety-related actuator and their wire harness

Interpretation

- Safety-related actuators are all power switching elements (outputs) of the safety switch that can be disturbed by electromagnetic processes.

No.		Score	Source
	Safety-related actuator and their wire harness		
10	application of the measures described in IEC 60204-1:2016+AMD1: 2021, Annex H and/or usage of IEC 61800-3(hr)	10	ISO 13849-1, Table L.1

Specified standards

- IEC 60204-1 - Safety of machinery - Electrical equipment of machines - Part 1: General requirements
- IEC 61800-3 - Adjustable speed electrical power drive systems - Part 3: EMC requirements including specific test methods for drive systems and machine tools

Implementation

- The required measures are described in section application note ➔ [100565 Electromagnetic Interferences \(EMI\)](#).
- The implementation of these measures is also necessary for compliance with the requirements of the EMC Directive 2014/30/EU and its harmonized standards and should always be implemented.

6.6 Other components and wiring with relevant disturbance level

Interpretation

- **Components with significant disturbance levels** are essentially power electronics devices (e.g. servo drive controllers, rectifier systems, power supply units for DC power supply, converters in DC chargers and photovoltaic systems), dimmers, fluorescent lamps, electric motors with non-linear current-voltage characteristics, etc.
- **Wiring with significant disturbance levels** are cables that lead to or from components with significant interference levels.

No.		Score	Source
	Other components and wiring with relevant disturbance level		
11	Shielded and bonded cables for motors or sinewave filter between motor and inverter or equivalent measures in accordance with the manufacture installation instruction where applicable (hr)	20	ISO 13849-1, Table L.1

Interpretations

- Motors are stepper and servo motors that are controlled via a frequency inverter or servo drive controller.
- Inverters are frequency inverters or servo drive controllers.

Implementation

- Shielded and earthed cables must be used for the motor cables. If necessary, an additional sine filter is required. This must be specified in the manufacturer's user information (assembly, installation and operating instructions).
- A declaration of conformity for the EMC Directive 2014/30/EC with the harmonized standard EN 61800-3 (IEC 61800-3) should be available for servo drive systems. The requirements in the manufacturer's user information (assembly, installation and operating instructions) must be implemented.
- The following Festo servo drive controllers meet these requirements
 - CMMT-AS: EN IEC 61800-3 complied with (see declaration of conformity [8190446-17108459, 2023-02-06](#))
 - CMMP-AS: EN IEC 61800-3 complied with (see declaration of conformity [5691201, 2022-06-14](#))
 - CMMT-ST: EN IEC 61800-3, EN 61800-5-2 complied with (see declaration of conformity [8192910-17109645, 2023-05-16](#))
 - CMMS-ST: EN IEC 61800-3 complied with (see declaration of conformity [5630119, 2021-08-18](#))

Notes

- Required filters are usually built into the servo drive controllers.
- Additional filters may be required for certain installation situations.

No.		Score	Source
	Other components and wiring with relevant disturbance level		
12	RF-filter, overvoltage and transient protection (e.g. filter, transient-voltage suppression diode, optocoupler, ferrites) for safety-related input signals in accordance with the manufacture installation instruction where applicable (hr)	20	ISO 13849-1, Table L.1

Area of application

- In the application area are all devices, components, and cables with interference levels that can affect safety-related circuits.
- These devices and components include, among others, servo drives, power supplies, inductors, transformers, and valve solenoids.
- Wiring with relevant interference levels includes, for example, motor cables, mains cables, and cables to inductive components.

Implementation for servo drive controllers

If the manufacturer confirms that the servo drive controllers meet the requirements of EN 61800-5-2 and/or IEC 61800-3, the requirements and measures in the operating instructions must be complied with or implemented. The following Festo servo drive controllers meet these requirements

- CMMT-AS: EN IEC 61800-3 complied with (see declaration of conformity ↗ [8190446-17108459, 2023-02-06](#))
- CMMP-AS: EN IEC 61800-3 complied with (see declaration of conformity ↗ [5691201, 2022-06-14](#))
- CMMT-ST: EN IEC 61800-3, EN 61800-5-2 complied with (see declaration of conformity ↗ [8192910-17109645, 2023-05-16](#))
- CMMS-ST: EN IEC 61800-3 complied with (see declaration of conformity ↗ [5630119, 2021-08-18](#))

Notes

- Required filters are usually built into the servo drive controllers.
- Additional filters may be required for certain installation situations.

Implementation for valve solenoids

- If the basic safety principle “Transient suppression” (ISO 13849-2, Table D.1) is implemented, this measure is fulfilled. See application note ↗ [100568](#).

No.		Score	Source
	Other components and wiring with relevant disturbance level		
13	EMI filters (as per manufacturers installation instructions or specifically intended for the application) for power mains (e.g. overvoltage and transient protection)	20	ISO 13849-1, Table L.1

Area of application

- A machine is always connected to the power grid of a building. The machine must fit into the building's overvoltage and transient protection concept.

Implementation

- The machine must be integrated into the building's lightning protection concept in accordance with DIN EN 62305. A surge protective device in accordance with HD 60364-5-53 must be provided for this purpose (SPD, type 3), see section “3.1 Overvoltage protection” in application note ↗ [100565 Electromagnetic Interferences \(EMI\)](#).
- It must be checked whether the installation of filters is prescribed for individual components of the machine in its user information.
- Whether additional filters are required when porting a machine to the mains can only be determined by measurement or testing.

No.		Score	Source
	Other components and wiring with relevant disturbance level		
14	application of the measures described in IEC 60204-1:2016+AMD1: 2021, Annex H and/or usage of IEC 61800-3	10	ISO 13849-1, Table L.1

Specified standards

- IEC 60204-1 - Safety of machinery - Electrical equipment of machines - Part 1: General requirements

- IEC 61800-3 - Adjustable speed electrical power drive systems - Part 3: EMC requirements including specific test methods for drive systems and machine tools

Implementation

- The required measures are described in section application note ↗ [100565 Electromagnetic Interferences \(EMI\)](#).
- The implementation of these measures is also necessary for compliance with the requirements of the EMC Directive 2014/30/EU and its harmonized standards and should always be implemented.

6.7 Engineering, programming, training, field observation

Interpretations

- “Training” here means that a documented qualification for electromagnetic influences on safety circuits has been completed.
- “Field observations” here means that feedback from customers and our own service technicians is analyzed with regard to electromagnetic influences that can lead to malfunctions and faults in the safety circuit. These must be evaluated and suitable measures taken if necessary.

No.		Score	Source
	Engineering, programming, training, field observation		
15	all components fulfil at minimum the requirements against EMI generic standards IEC 61000-6-2 (mentioned in manufacturers documentation) (hr)	30	ISO 13849-1, Table L.1

Scope of application

- Please refer to section “2 Scope of application of Annex L”. Not all products with electrical and electronic components fall within the scope of this requirement.

Implementation

- All components with active electronic parts must meet the requirements of IEC 61000-6-2. At Festo, this confirmation is specified in the declaration of conformity for the EMC Directive 2014/30/EU, e.g. for solenoid valves ↗ [VMPA](#).

No.		Score	Source
	Engineering, programming, training, field observation		
16	risk analysis for EMI (see example in Table L.2) and risk assessment with a final report	20	ISO 13849-1, Table L.1

Implementation

- The preparation of an EMC analysis, an EMC plan, and an EMC risk assessment is required. The standard IEC 61000-1-2 describes the process and requirements for this.

No.		Score	Source
	Engineering, programming, training, field observation		
17	diverse redundant channels	20	ISO 13849-1, Table L.1

Scope of application

- This measure is only relevant for categories 2, 3 and 4.

Implementation

- The measures against CCF according to ISO 13849-1, section F.3.2, are sufficient. Only measures that can lead to an improvement in resistance to electromagnetic interference are relevant. These include
 - Different technologies/design or physical principles are used, for example:
 - first channel electronic or programmable electronic and second channel electromechanical hardwired;
 - different initiation of safety function for each channel (e.g. position, pressure, temperature);
 - ...
 - Sensing elements employ different measurement principles (e.g. digital and analogue) or physical principles (e.g. distance, pressure or temperature);
 - Different components, e.g. of different manufacturers (not re-badged);
 - Different loads, e.g. contact/valve of one channel switches without load, contact/valve in the second channel switches under load.

No.		Score	Source
	Engineering, programming, training, field observation		
18	Separation of EMI sources and sensitive components, e.g. • separate routing and location of power lines and signal lines; • separate metal cabinets for power electronics and low power electronics; • following the instructions by the manufacturer; if no instructions are available use distance ≥ 20 cm between power components and sensitive components or alternatively use shielded and bonded components in shorter distance with field experience of low EMI influences.	30	ISO 13849-1, Table L.1

Implementation

- The required measures are described in application note [↗ 100565 Electromagnetic Interferences \(EMI\)](#).
- The implementation of these measures is also necessary for compliance with the requirements of the EMC Directive 2014/30/EU and its harmonized standards and should always be implemented.

No.		Score	Source
	Engineering, programming, training, field observation		
19	software/firmware with diagnostic on component or system level, e.g. by plausibility checks, data cross monitoring in case of redundancy, self-tests	20	ISO 13849-1, Table L.1

Objective

- To recognize the effects of electromagnetic interference so that a safe condition can be established.

Implementation

- Each safety function is monitored with a diagnostic measure. This is already provided for in the safety circuit for categories 2, 3 and 4.
- A diagnostic measure must also be provided for categories B and 1. This can also be carried out by a functional controller. If a fault is detected with these diagnostic functions, a safe state can be requested via the safety circuit.

No.		Score	Source
	Engineering, programming, training, field observation		
20	designers have experience or have been trained (with training documentation, e.g. certificate of training) to understand the causes and consequences of EMI	20	ISO 13849-1, Table L.1

Area of application

- The designers and developers of the safety circuit are trained in the field of electromagnetic compatibility. After this training, they know the causes and consequences of electromagnetic interference, know possible measures to counteract the causes and how to apply them.
- The training must also teach them how to carry out an EMC analysis, draw up an EMC plan and carry out an EMC risk assessment.
- More effective measures against electromagnetic interference should be taken for safety circuits than for a functional control system.

Implementation

- Designers and developers are trained and take a test. A certificate is issued to prove that the designers or developers have successfully passed this qualification measure.

No.		Score	Source
	Engineering, programming, training, field observation		
21	reuse of a specific functional safety system design previously used in a similar electromagnetic environment and found to be highly reliable without known EMI issues	30	ISO 13849-1, Table L.1

Area of application

- A safety circuit has been fully developed, validated and documented. In practice, it has been shown that no EMC problems have occurred.
- Please consider the definition “Field observation” in section → “6.7 Engineering, programming, training, field observation.”

Implementation

- An existing safety circuit with an identical structure is used. It may be possible to remove and add safety-related inputs if these correspond to the existing solution.

6.8 Power supply of the SRP/CS

No.		Score	Source
	Power supply of the SRP/CS		
22	low voltage AC or DC power supplies with insulated transformers related to IEC 61558-2-16, and/or SELV supplies related to IEC 60950-1, IEC 62368-1 and/or SELV or PELV supplies related to EN 50178	20	ISO 13849-1, Table L.1

Notes on the specified standards

The following standards for power supplies are listed:

- EN 50178 - Equipment of power installations with electronic apparatus
- IEC 62368-1 - Audio/video, information and communication technology equipment - Part 1: Safety requirements
- IEC 60950-1 - Information technology equipment - Safety - Part 1: General requirements
- IEC 61558-2-16 - Safety of transformers, reactors, power supply units and combinations thereof - Part 2-16: Particular requirements and tests for switching power supplies and transformers for general purpose switching power supplies

Some of these standards are no longer harmonized under the Low Voltage Directive 2014/35/EU and some are not internationally recognized. According to the 2019 ZVEI guide “Selection of safety standards for power supplies”, the following standard is recommended for industrial control cabinets

- IEC 61010-2-201 - Safety requirements for electrical equipment for measurement, control and laboratory use - Part 2-201: Particular requirements for control equipment

Area of application

- Relevant for all safety circuits, regardless of the category.
- Only the power supply of the safety circuit is considered here.

Implementation

- The power supply for the safety circuit is provided by a safety transformer, PELV or SELV power supply unit. The functional control may be carried out via the same power supply.
- The permissible power supplies are
 - PELV power supply units in accordance with EN IEC 61010-2-201
 - Control transformer with separate windings in accordance with IEC 61558-2-16
 - SELV power supply units in accordance with EN IEC 61010-2-201

No.		Score	Source
	Power supply of the SRP/CS		
23	Redundant PLC with separate switching power supply for the SRP/CS of channel 1/2	10	ISO 13849-1, Table L.1

Interpretations

- Two functional PLCs (one in each channel) are regarded as “redundant PLCs”. See section → “6.4 PLC as part of SRP/CS.”

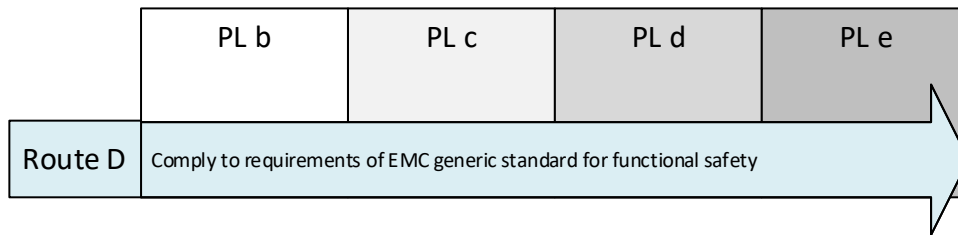
Area of application

- Only relevant for safety circuits with category 2, 3 or 4.
- Only relevant if two functional PLCs (one in each channel) are used.
- If a safety switching device is used, this measure is not relevant. However, a separate PELV or SELV power supply unit is also recommended for the safety circuit in this case.

Implementation

- A separate PELV or SELV power supply unit is used for the safety circuit.
- The permissible switched-mode power supply units are
 - PELV power supply units in accordance with EN IEC 61010-2-201
 - SELV power supply unit in accordance with EN IEC 61010-2-201

7 Path D: Generic standard for functional safety IEC 61000-6-7



If no adequate measures for immunity to electromagnetic interference are possible or implemented at product level, path D can also be selected. In this case, measures and tests are implemented at system level in accordance with one of the following standards:

- IEC 61000-6-7 - Electromagnetic compatibility (EMC) - Part 6-7: Generic standards - Immunity requirements for equipment intended to perform functions in a safety-related system (functional safety) in industrial locations
- IEC 61326-3-1 - Electrical equipment for measurement, control and laboratory use - EMC requirements - Part 3-1: Immunity requirements for safety-related systems and for equipment intended to perform safety-related functions (functional safety) - General industrial applications

Notes

- These measures and tests relate to the safety circuit and not to the complete machine.

8 Used Literature

8.1 Cited Documents from Festo

- [1] [100565 Electromagnetic Immunity \(EMI\) for safety-related circuits according to ISO 13849](#)

8.2 Standards

- [2] DIN EN ISO 4414:2011-04 – Pneumatic fluid power - General rules and safety requirements for systems and their components (ISO 4414:2010); German version EN ISO 4414:2010
- [3] ISO 5598:2020-01 – Fluid power systems and components - Vocabulary
- [4] DIN EN ISO 12100:2011-03 - Safety of machinery - General principles for design - Risk assessment and risk reduction (ISO 12100:2010); German version EN ISO 12100:2010
- [5] DIN EN ISO 13849-1:2023-12 – Safety of machinery - Safety-related parts of control systems - Part 1: General principles for design (ISO 13849-1:2023); German version EN ISO 13849-1:2023
- [6] DIN EN ISO 13849-2:2013-02 – Safety of machinery - Safety-related parts of control systems - Part 2: Validation (ISO 13849-2:2012); German version EN ISO 13849-2:2012
- [7] ISO 19973-1:2015-08 - Pneumatic fluid power - Assessment of component reliability by testing - Part 1: General procedures
- [8] VDMA 24584:2022-06 – Safety functions of regulated and unregulated (fluid) mechanical systems; German Version
- [9] DIN EN 50178:1998-04 - Electronic equipment for use in power installations; German version EN 50178:1997
- [10] DIN EN 61000-1-2:2017-07 - Electromagnetic compatibility (EMC) - Part 1-2: General - Methodology for the achievement of functional safety of electrical and electronic systems including equipment with regard to electromagnetic phenomena (IEC 61000-1-2:2016); German version EN 61000-1-2:2016
- [11] DIN EN 61000-6-7:2015-12 - Electromagnetic compatibility (EMC) - Part 6-7: Generic standards - Immunity requirements for equipment intended to perform functions in a safety-related system (functional safety) in industrial locations (IEC 61000-6-7:2014); German version EN 61000-6-7:2015
- [12] DIN EN IEC 61010-2-201:2025-11 - Safety requirements for electrical equipment for measurement, control, and laboratory use - Part 2-201: Particular requirements for control equipment (IEC 61010-2-201:2024); German version EN IEC 61010-2-201:2024
- [13] DIN EN 61131-6:2013-10 - Programmable controllers - Part 6: Functional safety (IEC 61131-6:2012); German version EN 61131-6:2012
- [14] DIN EN IEC 61326-3-2:2019-10 - 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 61326-3-2:2017); German version EN IEC 61326-3-2:2018
- [15] DIN EN 60204-1:2026-06 - Safety of machinery - Electrical equipment of machines - Part 1: General requirements (IEC 60204-1:2016, modified + AMD1:2021); German version EN 60204-1:2018 + A1:2025
- [16] DIN EN 60950-1:2014-08 - Information technology equipment - Safety - Part 1: General requirements (IEC 60950-1:2005, modified + Cor.:2006 + A1:2009, modified + A1:2009/Cor.:2012 + A2:2013, modified); German version EN 60950-1:2006 + A11:2009 + A1:2010 + A12:2011 + AC:2011 + A2:2013
- [17] DIN EN 60947-5-3:2014-12 - Low-voltage switchgear and controlgear - Part 5-3: Control circuit devices and switching elements - Requirements for proximity devices with defined behavior under fault conditions (PDDb) (IEC 60947-5-3:2013); German version EN 60947-5-3:2013
- [18] DIN EN 61326-3-1:2018-04 - Electrical equipment for measurement, control and laboratory use - EMC requirements - Part 3-1: Immunity requirements for safety-related systems and for equipment intended to perform safety-related functions (functional safety) - General industrial applications (IEC 61326-3-1:2017); German version EN 61326-3-1:2017
- [19] DIN EN 61508:2011-02 - Functional safety of electrical/electronic/programmable electronic safety-related systems (IEC 61508:2010); German version EN 61508:2010
- [20] DIN EN 61508-4:2011-02 - Functional safety of electrical/electronic/programmable electronic safety-related systems - Part 4: Definitions and abbreviations (IEC 61508-4:2010); German version EN 61508-4:2010
- [21] DIN EN 61511:2019-02 - Functional safety - Safety instrumented systems for the process industry sector - (IEC 61511:2016); German version EN 61511:2017
- [22] DIN EN IEC 61558-2-16:2025-10 – Safety of transformers, reactors, power supply units and combinations thereof - Part 2-16: Particular requirements and tests for switch mode power supply units and transformers for switch mode power supply units for general applications (IEC 61558-2-16:2021 + COR1:2023); German version EN IEC 61558-2-16:2025

- [23] DIN EN IEC 61800-3:2024-04 - Adjustable speed electrical power drive systems - Part 3: EMC requirements and specific test methods for PDS and machine tools (IEC 61800-3:2022); German version EN IEC 61800-3:2023
- [24] DIN EN IEC 62061:2023-02 - Safety of machinery - Functional safety of safety-related control systems (IEC 62061:2021); German version EN IEC 62061:2021
- [25] DIN EN 61800-5-2:2017-11 - Adjustable speed electrical power drive systems - Part 5-2: Safety requirements - Functional (IEC 61800-5-2:2016); German version EN 61800-5-2:2017
- [26] DIN EN IEC 62368-1:2025-01 – Audio/video, information and communication technology equipment - Part 1: Safety requirements (IEC 62368-1:2023, modified); German version EN IEC 62368-1:2024 + A11:2024

8.3 Legal Regulations

- [27] Machinery Directive: Directive 2006/42/EC of the European Parliament and of the Council of 17 May 2006 on machinery, and amending Directive 95/16/EC (recast)
- [28] Machinery Regulation: Regulation (EU) 2023/1230 of the European Parliament and of the Council of 14 June 2023 on machinery and repealing Directive 2006/42/EC of the European Parliament and of the Council and Council Directive 73/361/EEC
- [29] EMC Directive: Directive 2014/30/EU of the European Parliament and of the Council of 26 February 2014 on the harmonization of the laws of the Member States relating to electromagnetic compatibility

9 Information about the Document

9.1 General Information

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Title	Electromagnetic Interferences
Subtitle	Interpretation ISO 13849-1, Annex L

9.2 Revision History

Ver.	Date	Ed.	Chapter	Description of Change/Impact
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9.3 Approval/Release of the Document

Role	Signature
Release	

9.4 Period of Validity

Document is valid until 2031-07-21 or until one of the documents used or the required relevant base are changed.



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