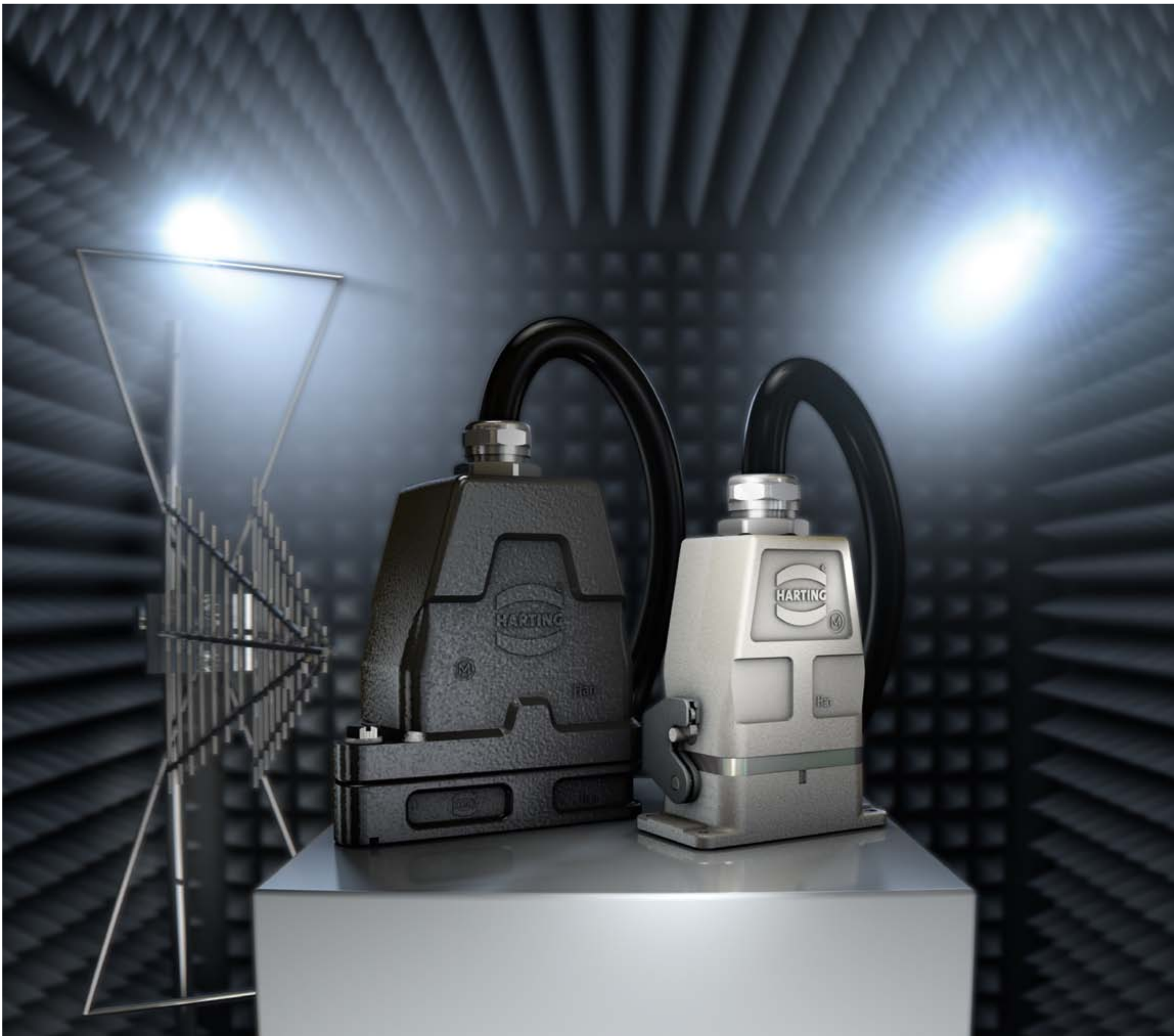

HARTING EMC

Electromagnetic Compatibility for Industrial Interfaces

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People | Power | Partnership

Contents

Electromagnetic compatibility (EMC) in the industry

Industrial machinery and equipment are becoming more and more complex and automated. Applications must control numerous high-performance actuators, and must transmit and process an increasing number of sensitive signals.

In order to function in harsh industrial environments, machinery and equipment must feature proven reliability and availability. To ensure these two key qualities, it is important that machinery and equipment are properly designed for optimal electromagnetic compatibility (EMC); this means that limits must be maintained for interference emission and immunity. The EMC Directive (Directive 2004/108/EC) defines the framework for the EMC levels of machinery and equipment.

The reliability and availability of electrical equipment in harsh industrial environments is only ensured when the components are installed in an EMC-compliant manner.

The significance of **EMC**

According to the European Directive, EMC is specified as:

“The ability of a device, equipment or system to function satisfactorily within its electromagnetic surroundings, without causing electromagnetic interference that would affect anything in the surrounding environment, equipment or systems.”

Two different situations should be noted here with respect to electromagnetic interference:

- A device, equipment, or system which affects the environment (via emission).
- A device, equipment, or system which is affected by the environment (interference immunity).

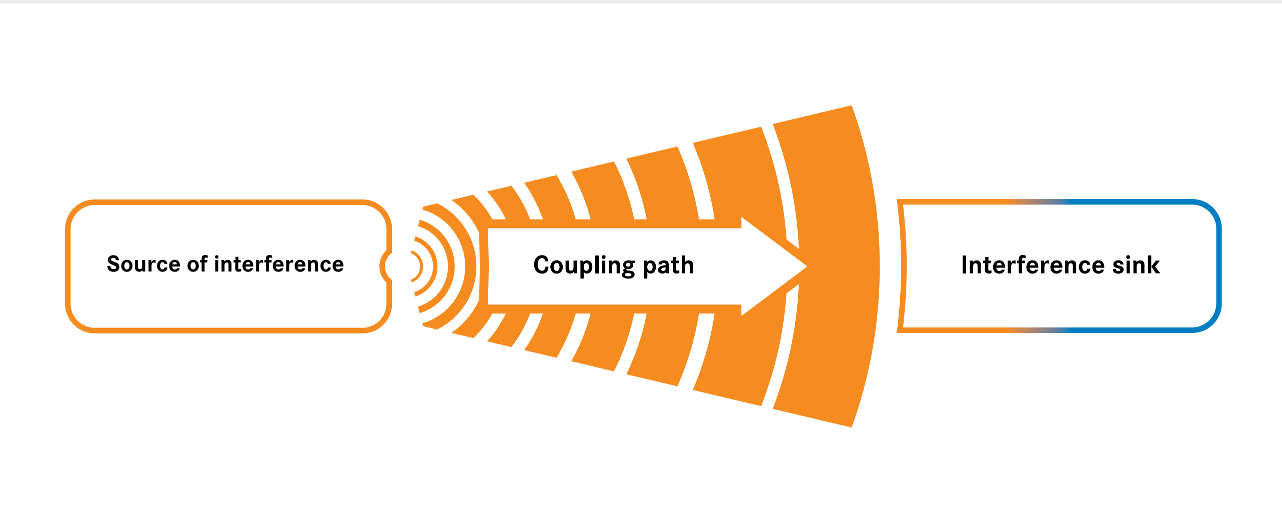
The emitting system is the source of interference. The system that is being affected by the emissions is referred to as the interference sink. The path of electromagnetic energy as it is transmitted between the source and sink is referred to as coupling.

Possible coupling paths include:

- electrical cables (power cables, data cables, bus cables or control cables)
- magnetic, electric or electromagnetic fields

This first type of path is referred to as cable-based interference; the second path is referred to as field-coupled interference.

Schematic diagram of the coupling path



HARTING connectors
for industrial applications

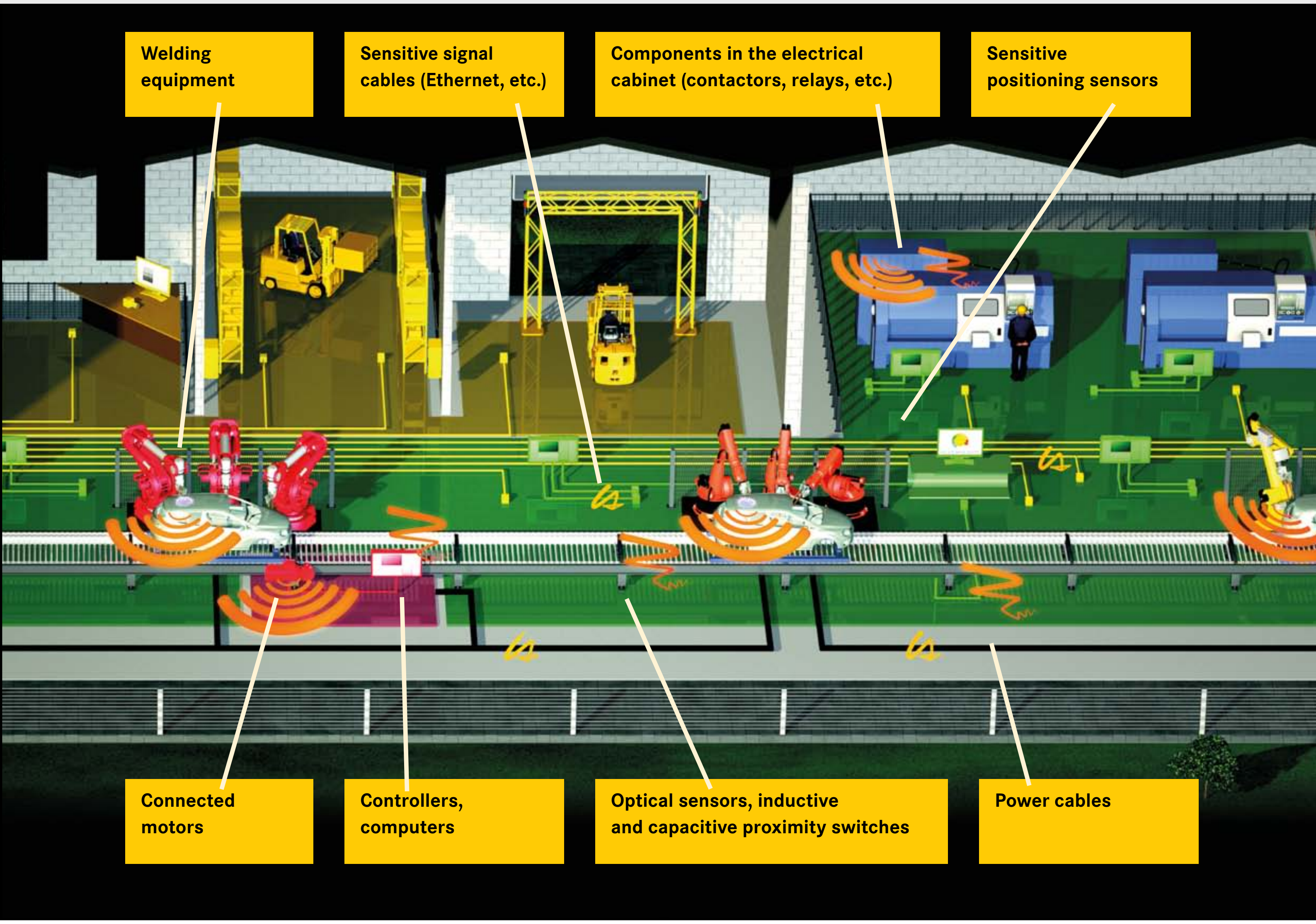
Electrical and electronic devices, equipment and systems which contain electrical or electronic components are all within the scope of this EMC Directive. The CE mark is used to indicate conformity with the directive.

As passive electromechanical components, connectors do not fall within the scope of the EMC Directive and are thus not designated with the CE mark.

However connectors may be components within cable assemblies, machinery, equipment and controllers which themselves are required to have the CE mark.

Thus, the EMC performance of the individual connector and of the connector in combination with the other components is a key quality factor.

Connector applications in industrial environments which are prone or sensitive to interference

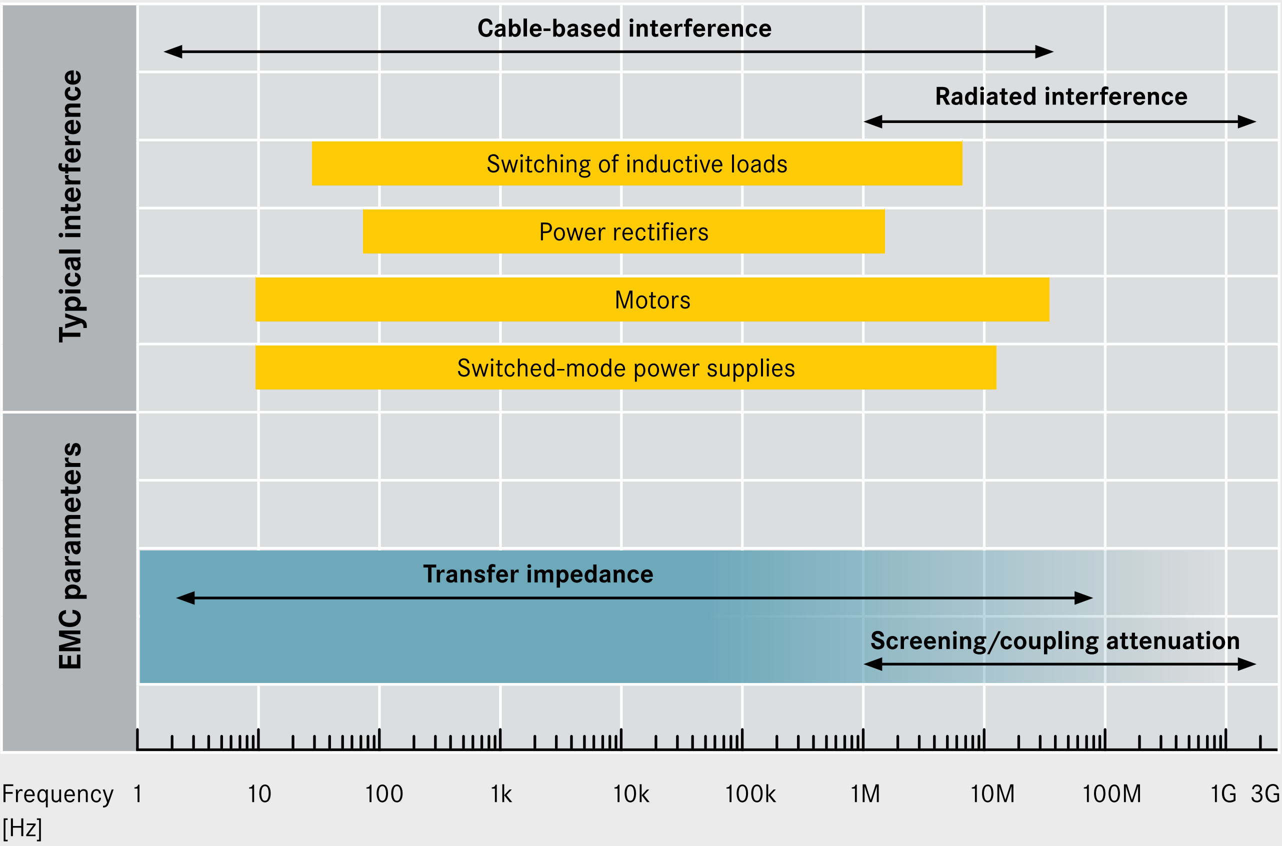


EMC characteristics of connectors

The shielding effect is the key factor when assessing a connector's EMC characteristics. It can be described using the:

- Transfer impedance
- Screening attenuation / coupling attenuation

Interfering sources and their frequency range



The transfer impedance is used as a criterion for evaluating connectors:

- The transfer impedance (also referred to as the coupling resistance) has established itself as a measure for assessing a connector's EMC characteristics. It is a useful indicator because it describes the EMC characteristics in a frequency range that is particularly critical for EMC disturbances (e.g. for bursts and electrostatic discharge).
- The transfer impedance of connectors can be determined using the "parallel wire" or the "triaxial" method. The normalized measurement results from both methods can then be compared.

EMC testing standards
and their comparability

The transfer impedances of HARTING connectors are in compliance with the requirements of BS EN 50467: “Railway applications – Vehicles – Electrical connectors, requirements and test methods”. This standard requires measuring the transfer impedance according to IEC 60512-23-7.

Common testing standards for EMC connector measurements, in comparison

Current testing standard	**Test object**		**EMC parameters**				
	Connector	Cable	Transfer impedance		Screening attenuation / coupling attenuation		
			Measurement method		Measurement method		
			Parallel wire	Triaxial pipe	Parallel wire	Triaxial pipe	Absorbing clamp
IEC 60512-23-7[1]	■		■		■		
IEC 60512-23-3[2]	■		■		■		
IEC 60512-26-100[2]	■			■			
VG 95214-11[3]	■	■	■				
VG 95214-12[3]	■	■		■			
VG 95214-13[3]	■	■				■	
DIN EN 50289-1-6[4]		■	■	■		■	
DIN EN 50289-1-14...16[4]		■					■
IEC 62153-4-3[5]		■		■			
IEC 62153-4-5[5]		■					■
IEC 62153-4-6[5]		■	■				
IEC 62153-4-7[5]	■	■		■		■	
IEC 62153-4-11[5]	■						■
IEC 62153-4-12[5]	■						■
→			The measurement results can be compared.		The measurement results are specific to your particular process and are not comparable.		

1) **Test specification for HARTING EMC connectors: IEC 60512:** Connectors for electronic equipment – Tests and measurements: -23-7: Screening and filtering tests. Test 23g: Effective transfer impedance of connectors

2) IEC 60512-23-3: Test 23c: Shielding effects for connectors and accessories; -26-100: Measurement setup, testing configuration, reference configuration and measuring methods for connectors in compliance with IEC 60603-7, tests 26a to 26g

3) VG 95214: Test of components -11: Measuring methods for transfer impedance and screening attenuation, transfer impedance of screened components (line-injection method, KS 11 B), -12: Triaxial methods KS 12 B and 22 B KS (conductive gaskets), -13: Triaxial method KS 13 B

4) DIN EN 50289: Communication cables – Specifications for test methods: -1-6: Electrical test methods; Electromagnetic performance; -1-14: Electrical test methods – Coupling attenuation or screening attenuation of connecting hardware

5) IEC 62153-4-1 to -4-15: Metallic communication cable test methods

Optimal EMC-Performance

In order to ensure optimal EMC performance, it is important to consider the entire system (including the cable and cable clamp) rather than just the connector. The following considerations are also important:

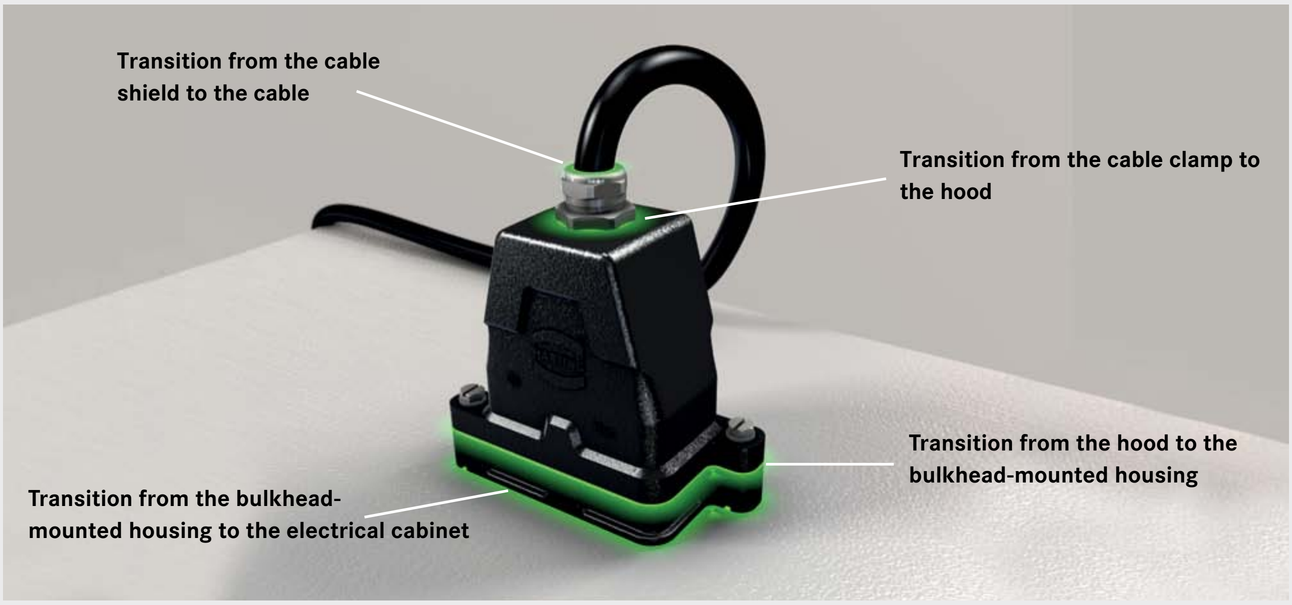
- The effects of EMC upon a system should already be taken into account during the design phase. Sufficient reserve shielding steps should be implemented in the design. Subsequent post-design corrections generally require more effort and lead to higher costs.

- The weakest component within an assembly determines the assembly's overall EMC performance. For example, using a high-quality connector in combination with a non-EMC-compliant cable clamp will not deliver a good EMC performance, since the weakest link (in this case, the clamp) will reduce overall performance.

- Design or technical errors during the installation of individual components can seriously damage the entire system so that the system is no longer compliant with the EMC Directive. Such errors include:
  - a selective non-continuous application of the shielding braid from twisting or the "pigtail" effect,
  - surfaces insulated from the electrical cabinet,
  - or a missing EMC clamp.

A continuous, homogeneous transmission of the shielding screen will ensure optimal EMC performance for the connector. The transitions between the different connector components are the critical factors (see illustration).

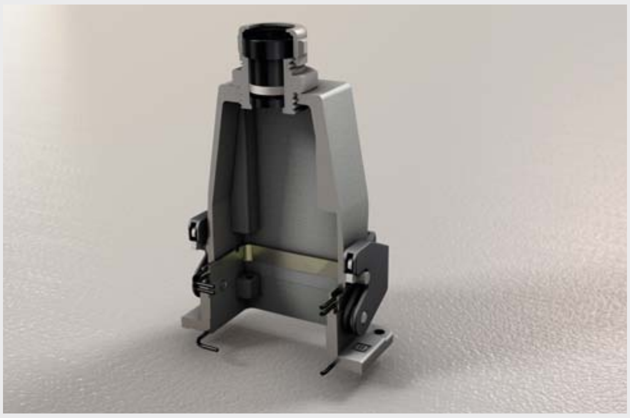
Key points for EMC shielding



The homogeneous shielding screen is interrupted at these transitions. The best EMC performance, however, is insured when these junctures are overlapping. They should also cover a large area, be of low impedance and cover the entire 360°.

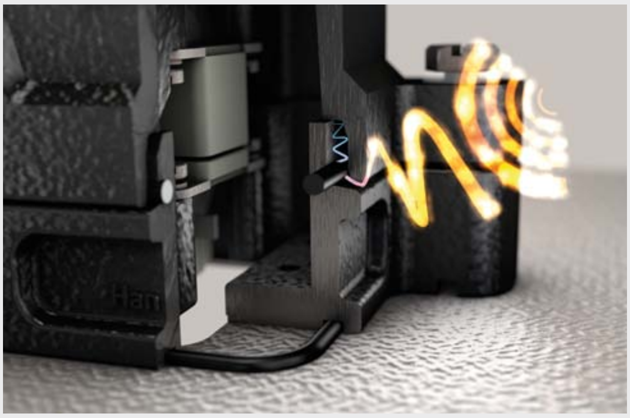
HARTING connectors – the optimal EMC interface

HARTING EMC housings provide excellent shield transitions and thus provide the perfect EMC-optimized platform for reliable industrial solutions.
They feature:



A 360° wide-area contact

A continuous, metallic-conductive 360° contact which enables a continuous and homogeneous shielding screen transmission.



A pronounced labyrinth structure

The optimized labyrinth structure ensures the best performance. Any interference fields (emitted or received) are weakened substantially as they are reflected in this labyrinth structure.

A sturdy design

The heavy-duty design of the HARTING connectors make them perfect for use in extremely demanding industrial applications.

RoHS-compliant materials

HARTING connectors contain no environmentally harmful substances and are thus compliant with RoHS.

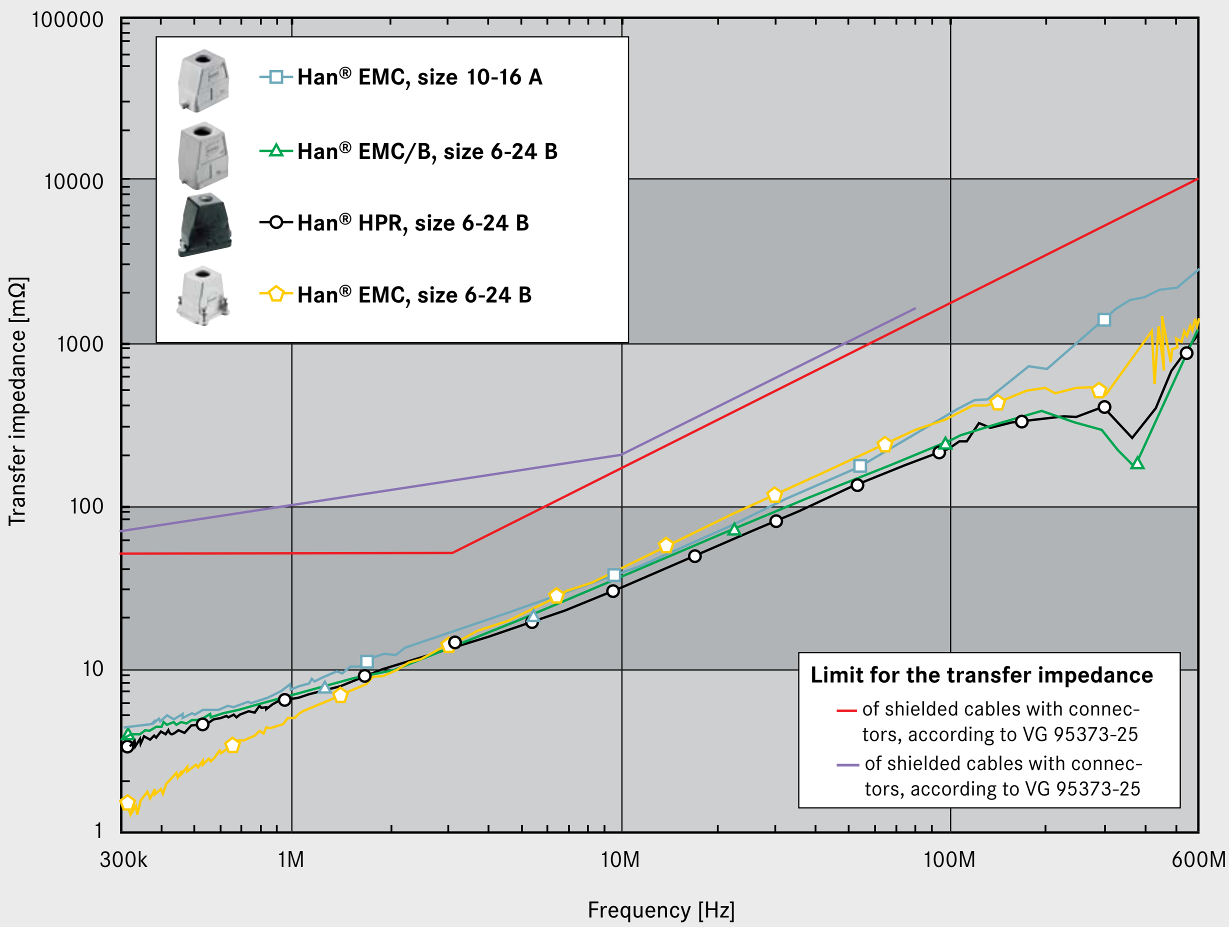
EMC effectiveness of
Han® connector housings

The transfer impedances of HARTING connectors are in compliance with the requirements of BS EN 50467: “Railway applications – Vehicles – Electrical connectors, requirements and test methods”. According to requirement 6.2.1, a transfer impedance measurement is required in compliance with IEC 60512-23-7: “Connectors for electronic equipment – testing and measuring methods”.

Since neither of these two standards specifies limits for the transfer impedance, HARTING sets its own standards in order to evaluate the measurements qualitatively. The limits we use for transfer impedance come from the standard VG 95373-25: “Limits for couplings and shields for shielded cables and connectors”, and the cabling standards ISO/IEC 11801: “Information technology – Generic on-site cabling”.

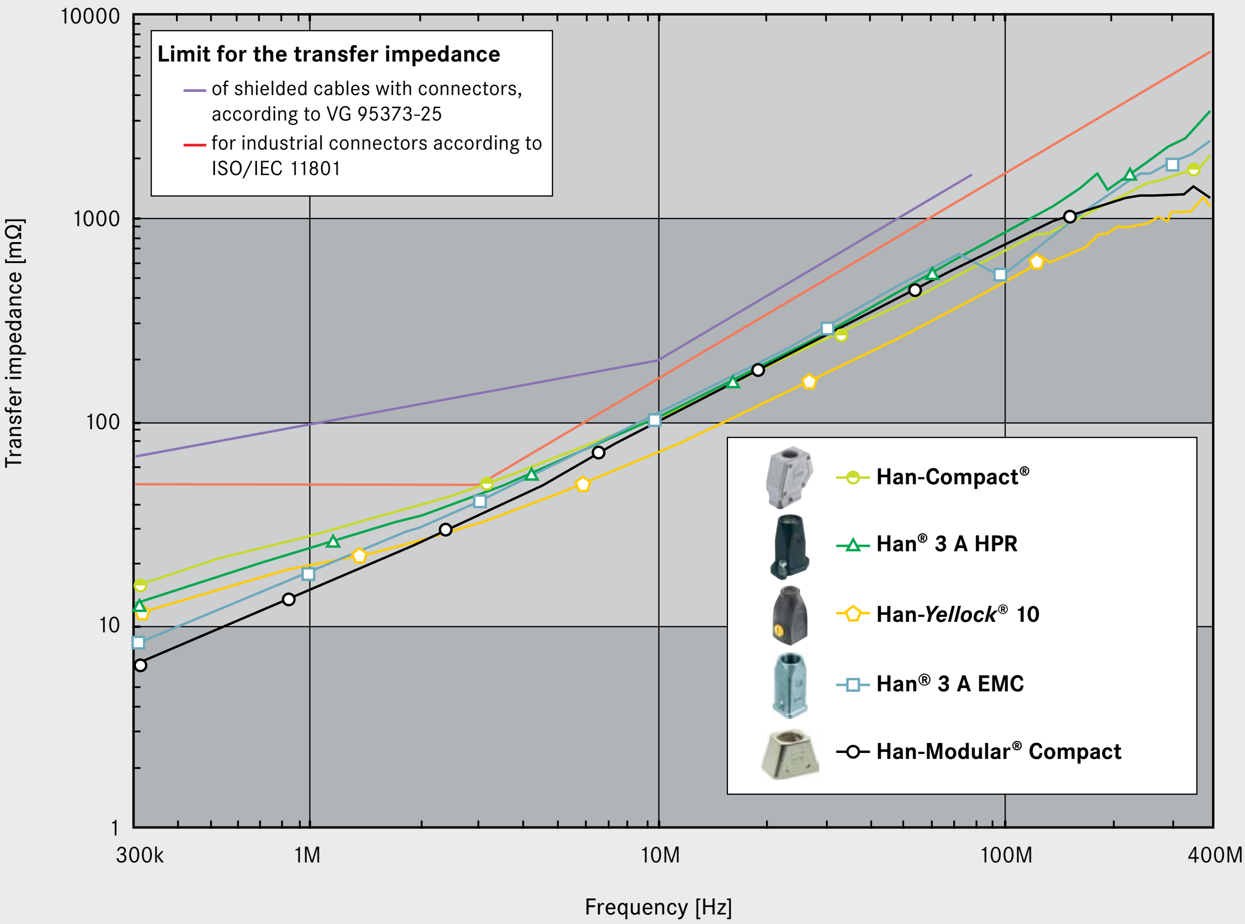
Test results: The tested HARTING housings measured well below the normative limits; they thus provide excellent EMC performance, and are particularly well suited for industrial applications.

Transfer impedance of the Han® EMC and the Han® HPR connector housings*



* Test run according to DIN EN 60512-23-3, parallel wire method

Transfer impedance of the Han® 3 A EMC and other Han® connector housings*



* Test run according to DIN EN 60512-23-3, parallel wire method

Han® connector housings with outstanding EMC performance

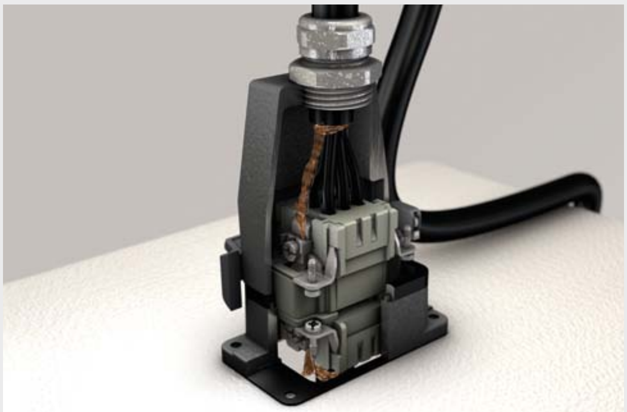
Han® EMC	Han® 3 A EMC
Han® HPR	Han® 3 A HPR
Han® EMC/B	Han-Modular® Compact
Han-*Yellock*® 10	Han-Compact®

Standard housings and
EMC applications

In real-world applications, interfaces with standard housings often use a twisted screening braid for the shielding transfer.

This is carried out using the PE contact. The following illustration shows an example of this.

Standard housing: Shielding transition with twisted screening braid

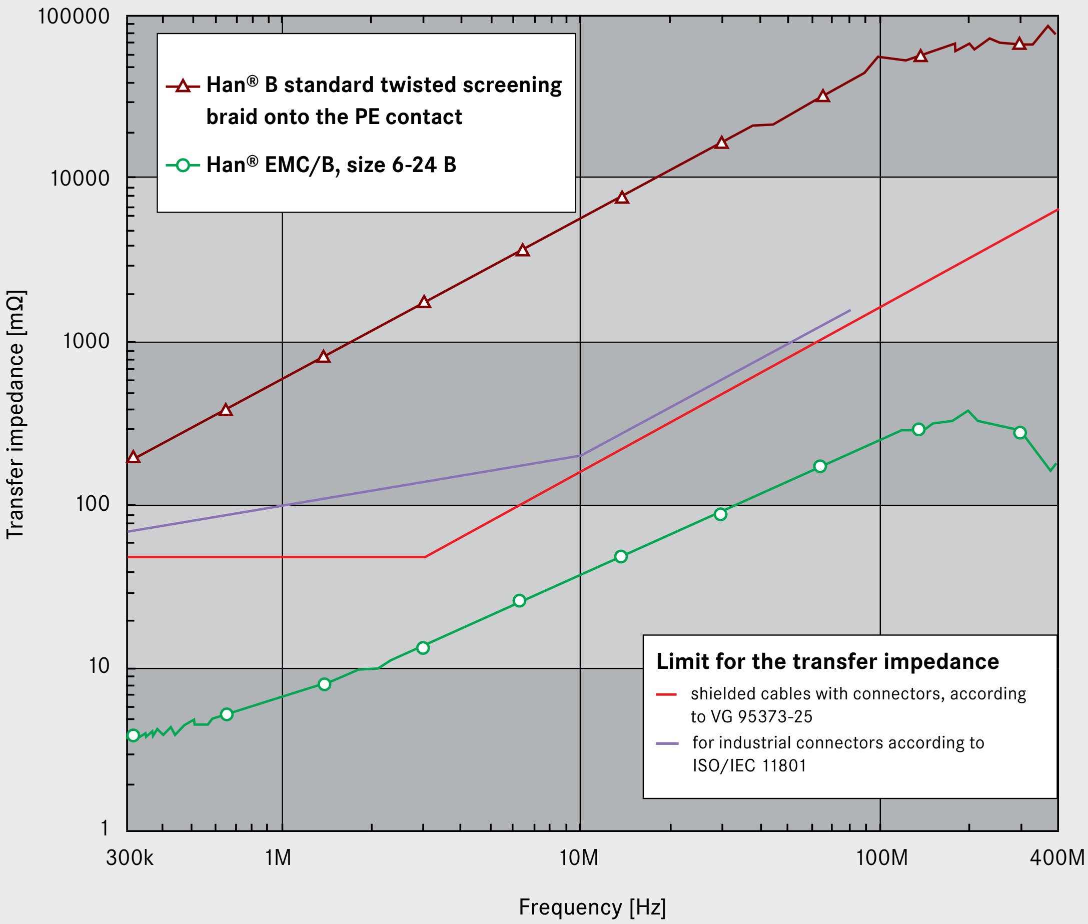


The variant shown here is not suitable for demanding EMC applications because it provides:

- no wide-area 360° contact
- no labyrinth structure

This assessment is based on measurements conducted by HARTING on standard connectors and EMC connectors. The following illustration (on p.13) shows the different EMC influences upon standard and special connector housings.

EMC performance of standard and special connector housings*



* Test run according to DIN EN 60512-23-3, parallel wire method

The transfer impedance measurements confirm that the variant with the selective non-continuous shielding via the PE contact is (in contrast to the EMC housing) not within the normative limits throughout the entire range. It is therefore not recommended for EMC applications in industrial environments.

HARTING recommends using special function-optimized EMC connectors to provide the best EMC shielding for radiation-sensitive areas.

Glossary

Burst: A high-frequency, quickly rising, low-energy interference pulse caused by the switching of inductive loads. It can cause errors in analogue measurement signals and can also cause computers to crash.

ESD: Electrostatic discharge: An electrostatic discharge between materials with different potentials. A discharge may result in a high voltage pulse being applied to an electrical device, resulting in damage or destruction of semiconductors.

EMC cable clamp: A metallic cable clamp which provides not only strain relief and sealing, but also enables an optimal contact to be established between the cable shield and the housing.

Galvanic coupling: A coupling via common impedances, whereby different circuits use a common ground (earthing) cable

Capacitance coupling: Coupling via electric fields, where adjacent cables have different potentials

Coupling: The interrelationship between circuits, whereby energy is transmitted from one circuit to the other. In connection with EMC, coupling is used to describe the transmission of electromagnetic energy between the interference source and the interference sink.

Coupling attenuation: A criterion for assessing the shield effect of symmetrical, “electrically long” components: It is calculated from the screening attenuation and the component’s asymmetric (common mode) attenuation.

Coupling resistance: Refer to transfer impedance

Line-injection method: Refer to parallel wire method

Parallel wire method: Normative method for measuring the transfer impedance

Screening attenuation: Criterion for assessing the shielding effect of “electrically long” components, in conjunction with the EMC characteristics of cables and connectors

Interference source: The source of the disturbance

Interference sink: An electrical equipment or device whose function can be influenced by interference

Transfer impedance: Criterion for assessing the shielding effect of passive “electrically short” components

Triaxial method: Normative method for measuring the transfer impedance and/or screening attenuation

Asymmetric attenuation: Criterion for assessing the stranding of the wire pairs during symmetric transmission

Corporate Technology **Services**

Corporate Technology Services (CTS) is an accredited laboratory responsible for the testing and certification of electro-mechanical and electronic transmission system characteristics of products.

This laboratory is accredited according to DIN EN ISO/IEC 17025. They conduct testing for electro-mechanical components, electronic and fibre-optic transmission systems, dimensions and material properties, as well as EMC testing for CE-mark certification. They support product development with their product certifications, innovative enabling technologies and technical consulting.

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Coupling resistance, triaxial pipe

Signal integrity

ElectroMagnetic Compatibility

- EMC interference emission
- EMC interference immunity
- Testing of RFID system components

Signal integrity

- Analysis over time and frequency ranges
- Transfer impedance (coupling resistance), screening attenuation, coupling attenuation

EMC measurement device

Anechoic chamber, EMC interference emission

More detailed information about the testing domains and tasks of Corporate Technology Services can be found at:
www.harting.com/produkt-center/qualitaetsmanagement/corporate-technology-service/

Pushing Performance

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