How does a Machine Builder deal with EMC

Schaffner
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21/11/2023

de Nederlandse EMC-ESD Vereniging
EMC-ESD Event 2023

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Hotel van der Valk Vianen
Dinsdag 21 november

Agenda

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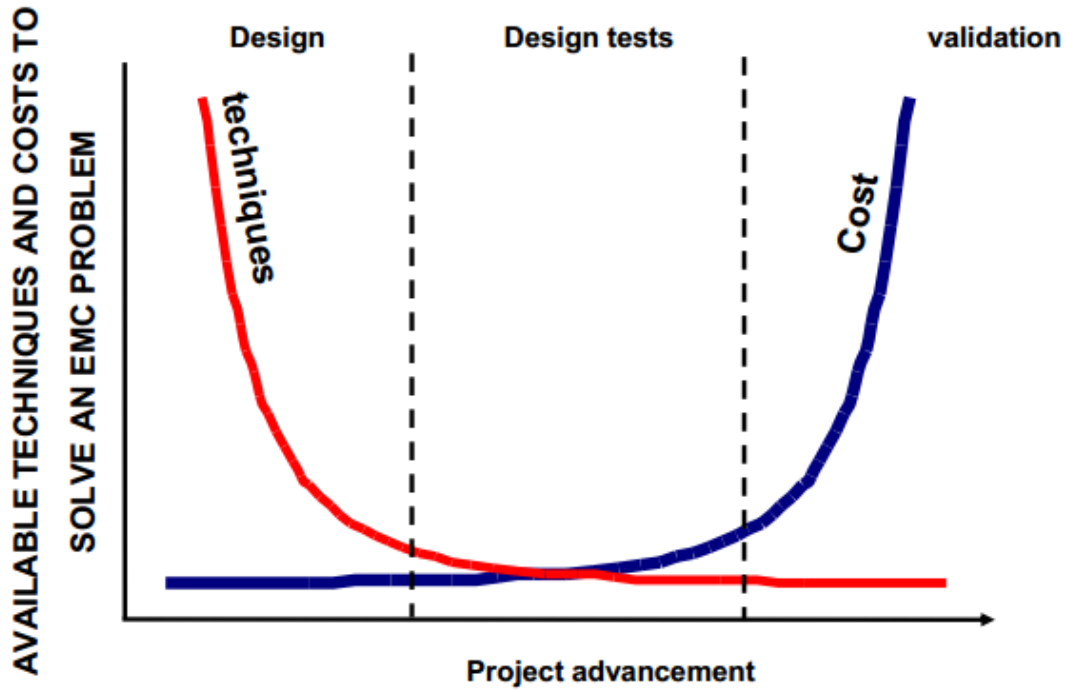
EMC Challenges for machine integrator

- Insure compatibility between system and environment
- Meet the certifications requirements (EC marking, CB certification, etc.)
- Optimize the design costs..



RoHS CE

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How to handle COTS: example EC marking

- Integrating EC COTS does not mean that the Machine will have EC marking
- Why?
- EMC does not rely only on equipment! The environment is very important

- Two steps are necessary:
- 1- Choose COTS with appropriate certifications
- 2- Optimize cabling and earthing

EMC Compliance Analysis for COTS

Declaration of conformity CE

EMC Test Report

- Compliant
- GAP Analysis
- Non-compliant

- In some industrial fields (railway systems, installations, etc.) this risk analysis of COTS is very important

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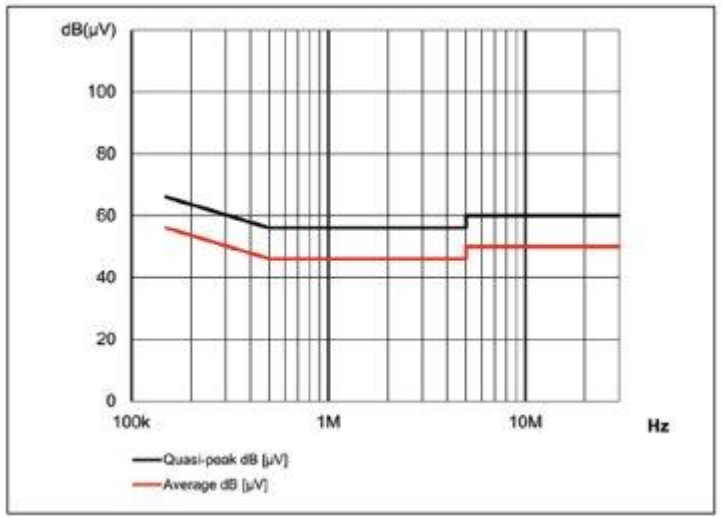
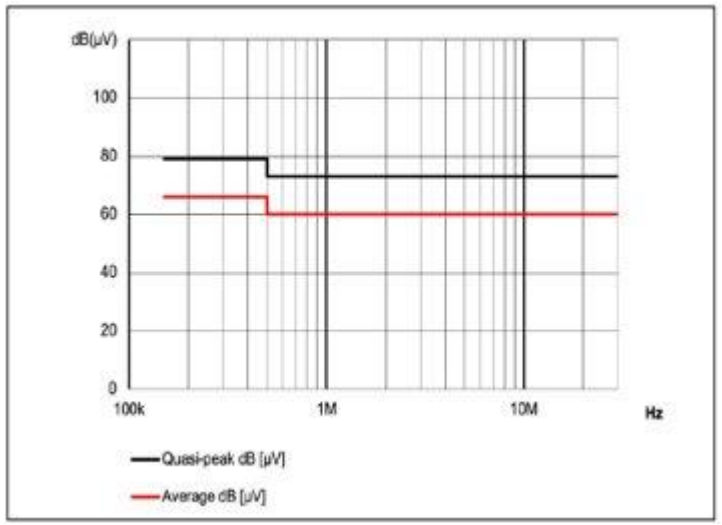
GAP Analysis

- Comparing the mentioned standards in the EC declaration with the EMC target (product standard)
- Complementary tests are needed in certain cases



Emission limit for equipment in residential environments



Emission limit for equipment industrial environments

- Other parameters shall be taken in consideration in certain cases (example: leakage current for medical devices and load impedance for power supplies)

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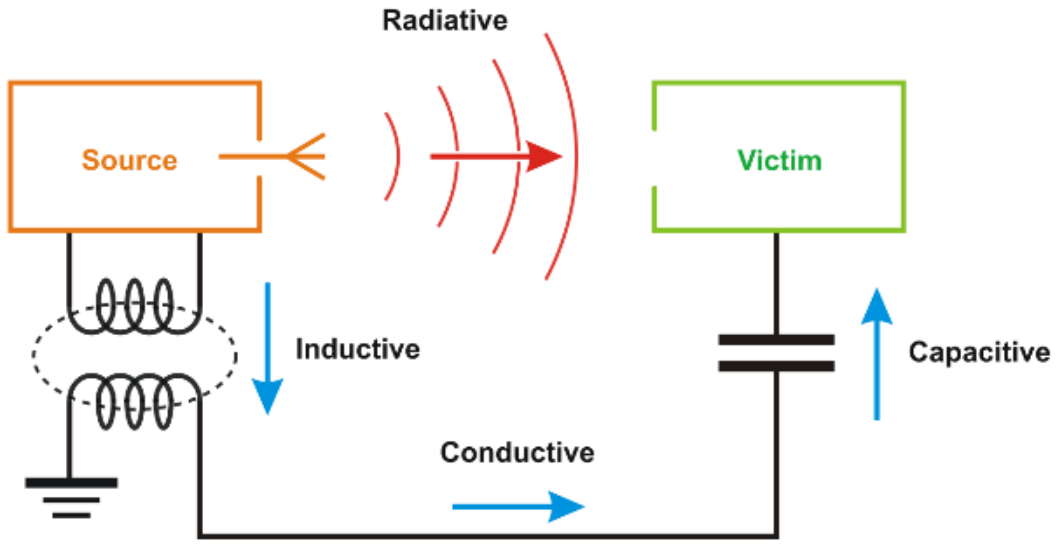
EMI Coupling

Conductive coupling (Galvanic coupling) can generate Common-mode - or Differential-mode noise.

Induction can be of two kinds, electrical induction and magnetic induction. It is common to refer to electrical induction as *capacitive coupling*, and to magnetic induction as *inductive coupling*.

Inductive coupling occurs when a varying magnetic field exists between two parallel conductors inducing a change in voltage along the receiving conductor.

Capacitive coupling occurs when a varying electric field exists between two adjacent conductors, inducing a change in voltage across the gap.



Radiative coupling or **electromagnetic coupling** occurs when the source emits or radiates an electromagnetic waves propagating across the open space and is picked up or received by the victim -> High frequency phenomena.

Note: radiated noise can also create conductive noise and vice versa !

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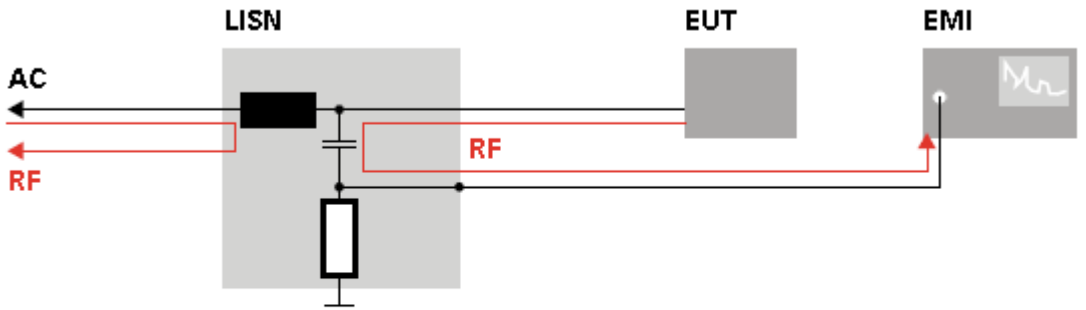
Applicable tests for different frequency ranges

Harmonics	LF Range	Conducted RF Range	Conducted RF Range	Radiated RF Range	Radiated RF Range
50Hz … 2/2.5 kHz	**2/2.5 … 9 kHz**	**9 … 150 kHz**	**150 kHz … 30 MHz**	**30 MHz … 1/2/3 GHz**	**> 3 GHz**
60Hz … 2.4/3 kHz	2.4/3 … 9 kHz			*	

Regulated range		**Regulated range for some products**	
Unregulated range	*	**Upper limit depends on product**	



LISN Line impedance stabilization network

EUT Equipment under test

EMI EMI receiver

Measurement principle for line-conducted voltage measurements

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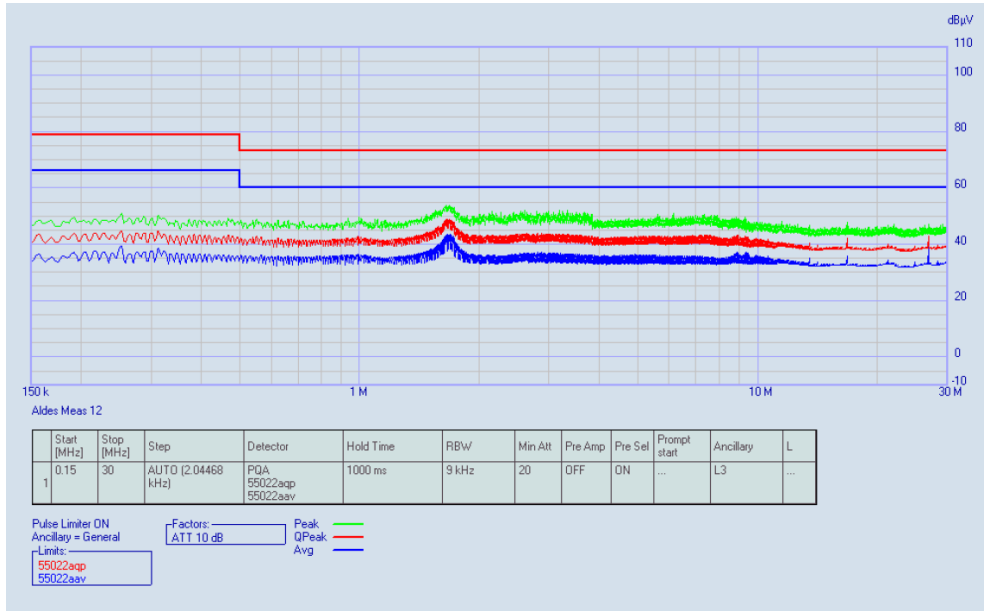
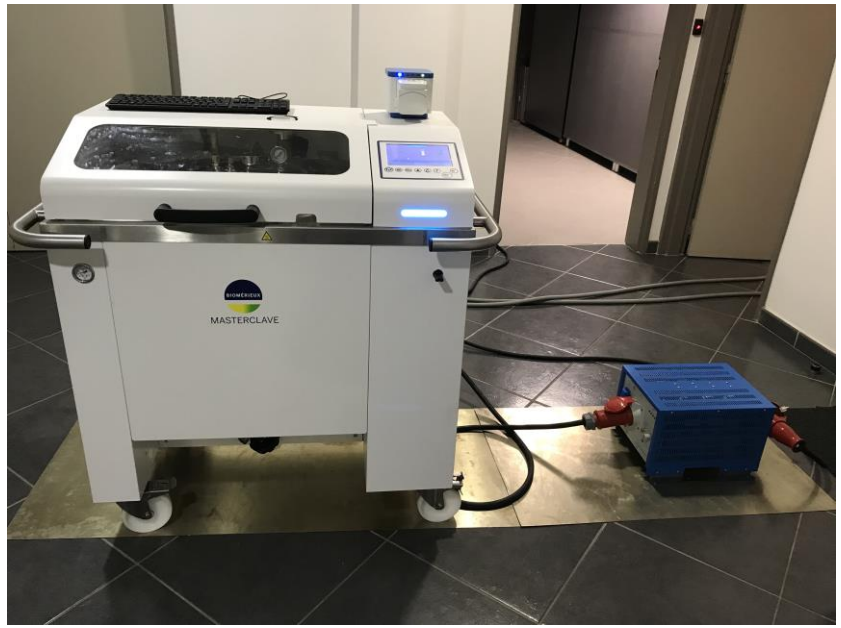
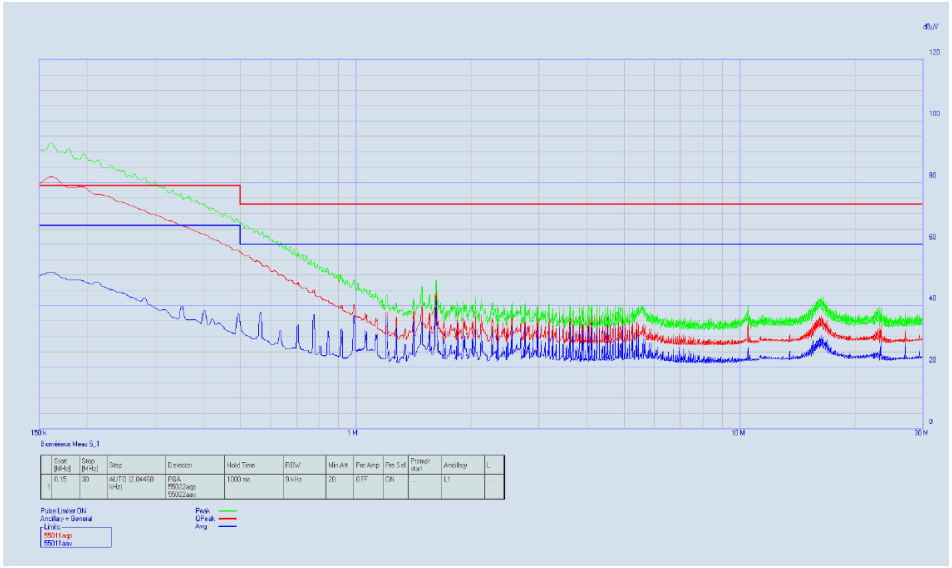
Filtering: from EMI to EMC







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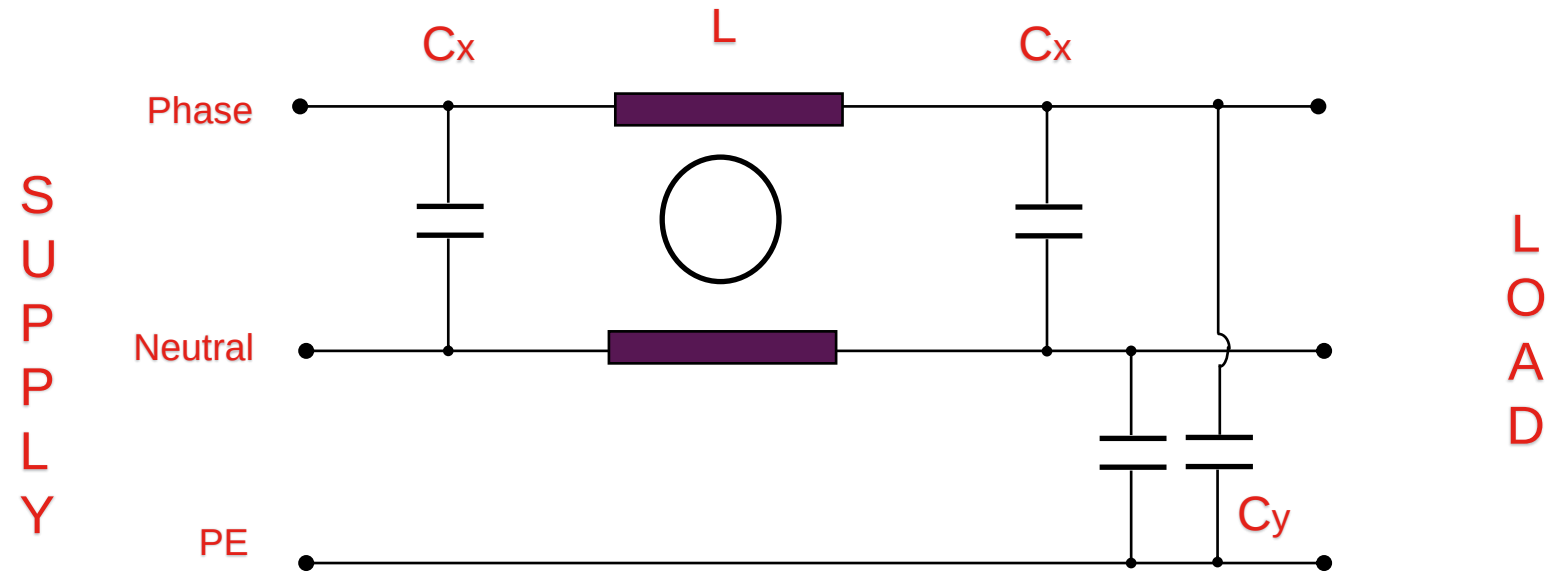
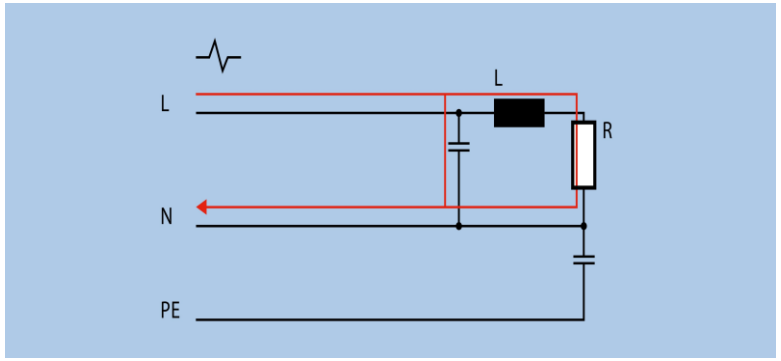
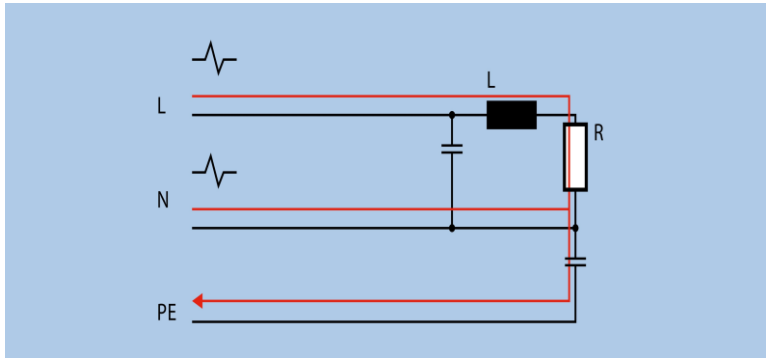
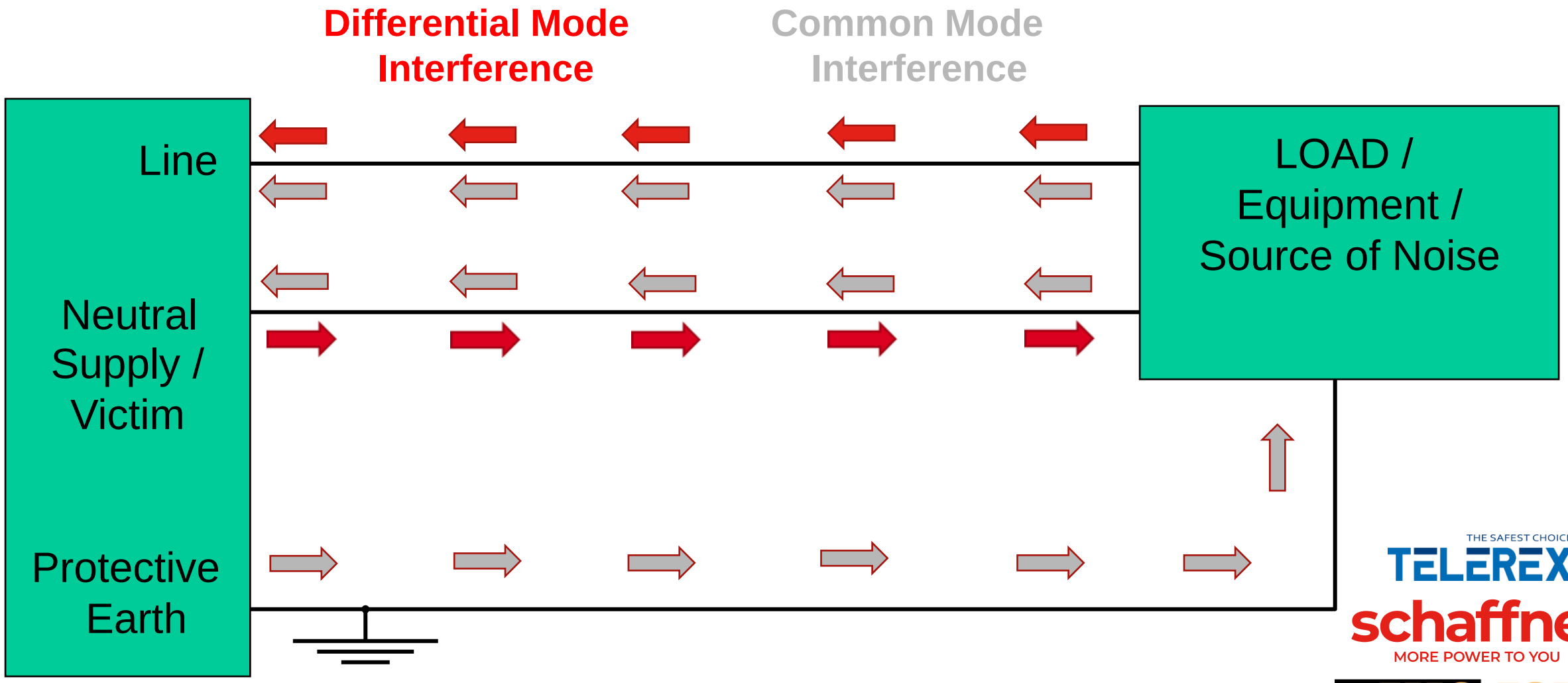
Filtering: operating mode







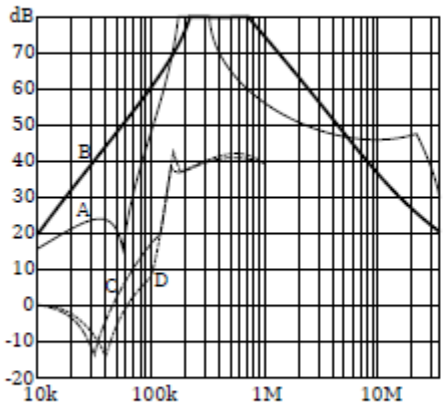
Common Mode and differential Mode



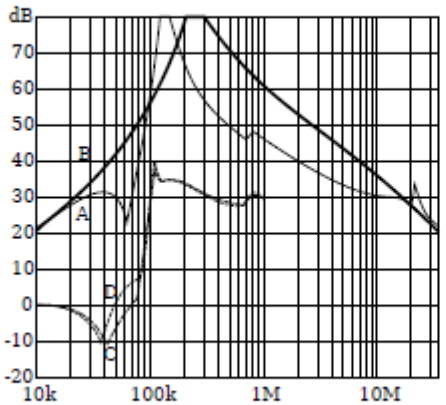
Filtering and impedance

- Attenuation (or insertion loss) is communicated for both common mode and differential mode.
- Refer to the graphics of unbalanced impedance (0,1Ω/100 Ω or 100 Ω / 0,1Ω)
- → this configuration is more representative of real system

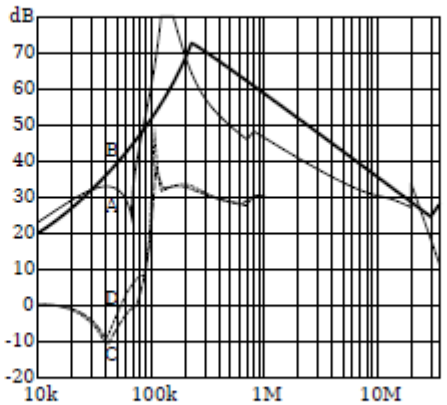
Per CISPR 17; A=50 Ω/50 Ω sym; B=50 Ω/50 Ω asym; C=0.1 Ω/100 Ω sym; D=100 Ω/0.1 Ω sym



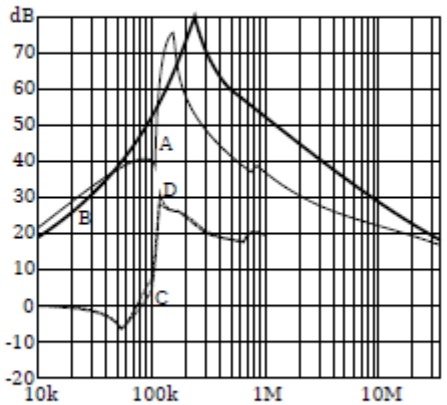
35 to 80 A types



110 and 150 A types

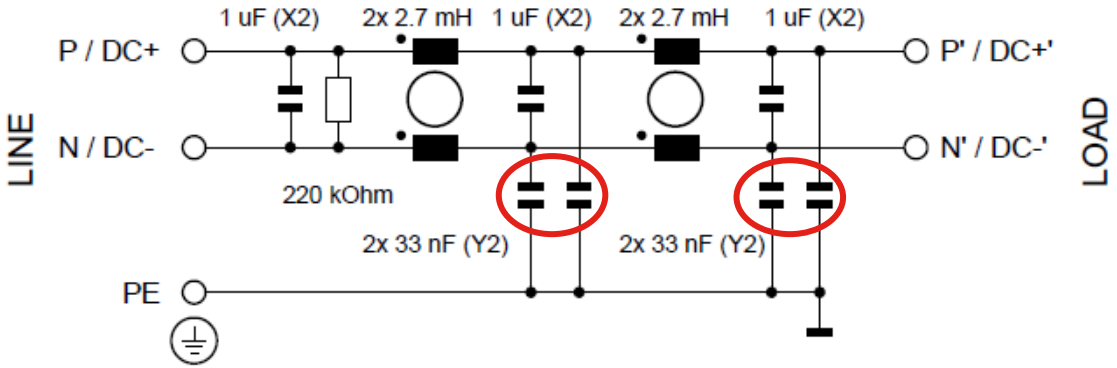


200 A types



230 and 300 A types

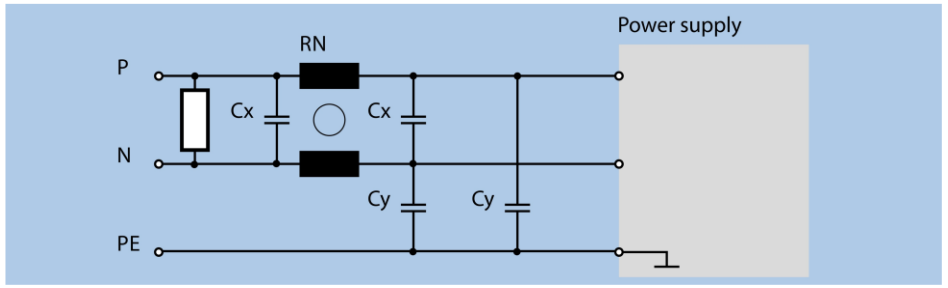
Leakage current

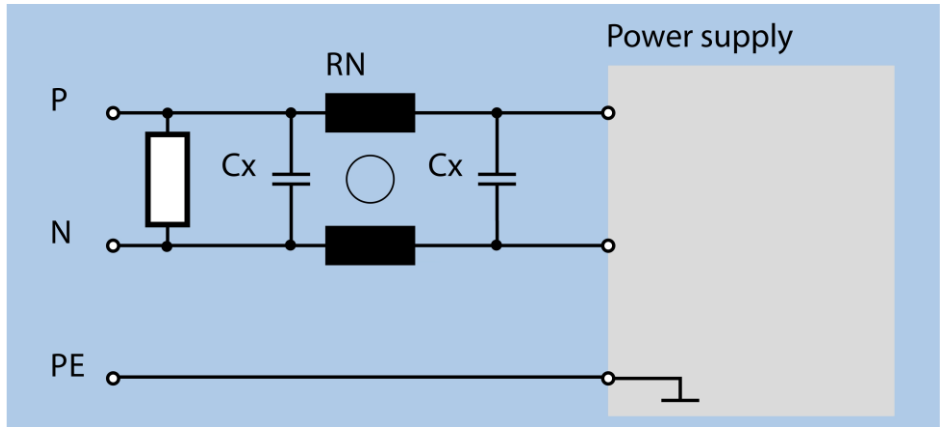


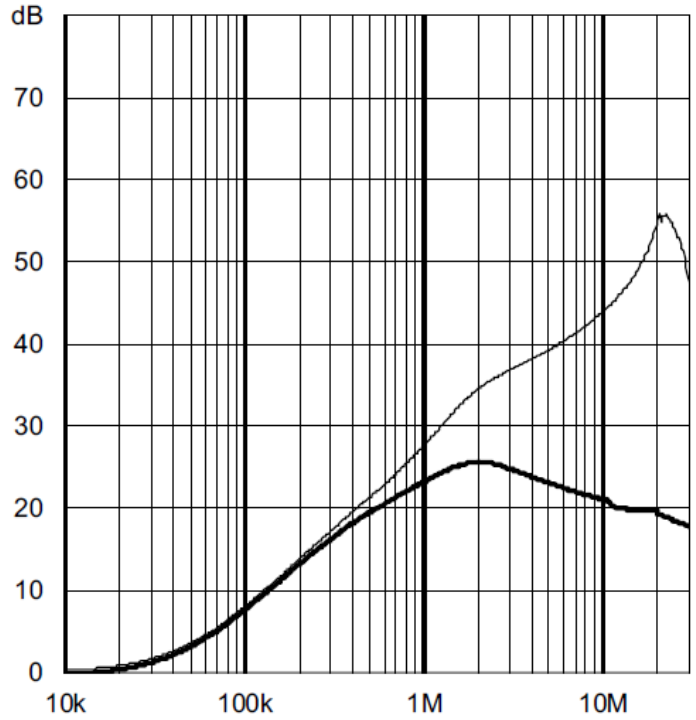
$$I_{LK} = 2\pi \times f_R \times U_R \times C_y$$

- Electrical Safety Standards (medical devices, laboratory equipment, etc.) can have certain requirement about leakage current.
- The filter should be designed according to these requirements

Filtering performance and leakage current







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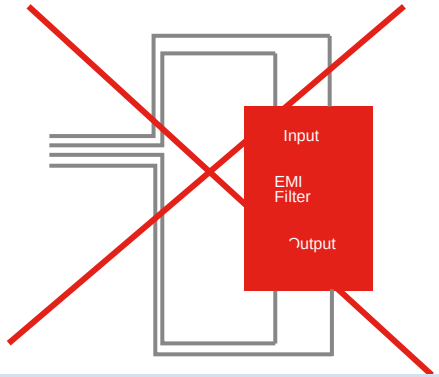
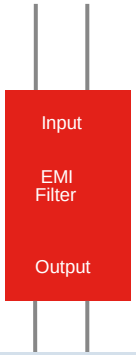
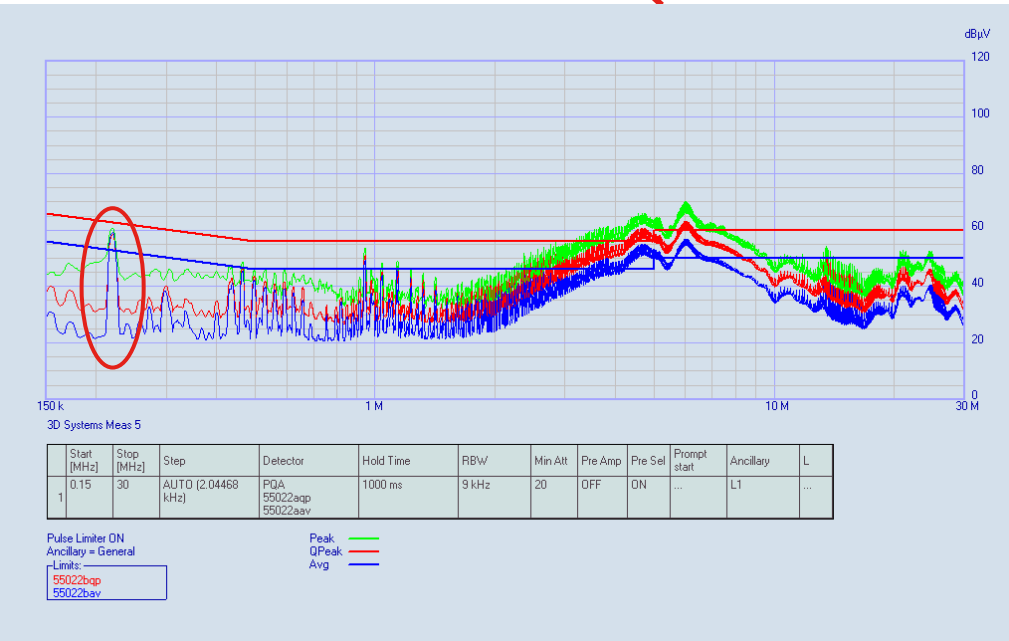
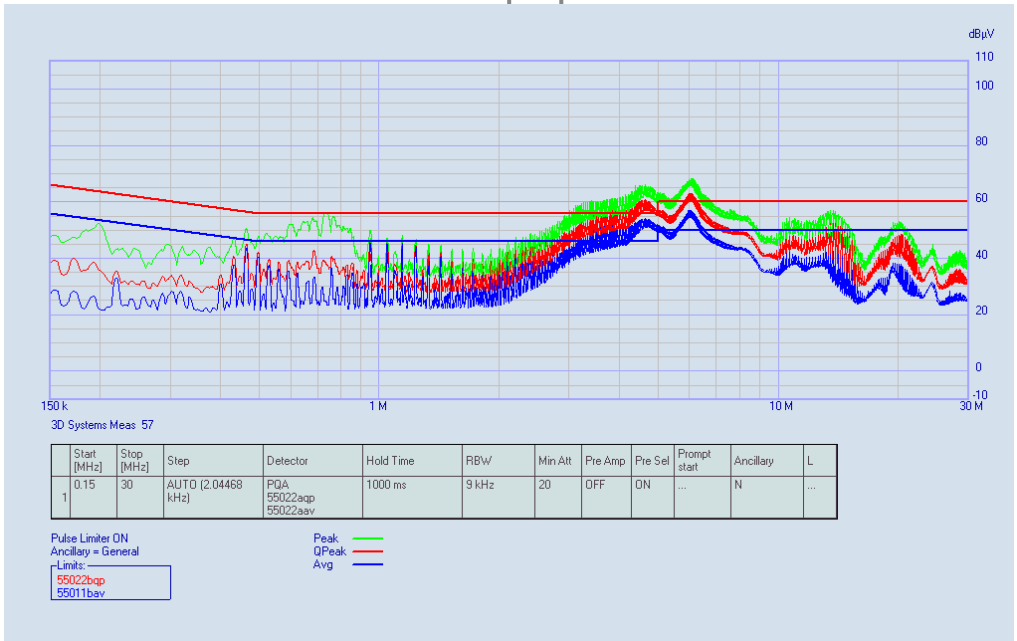
How to install a filter?

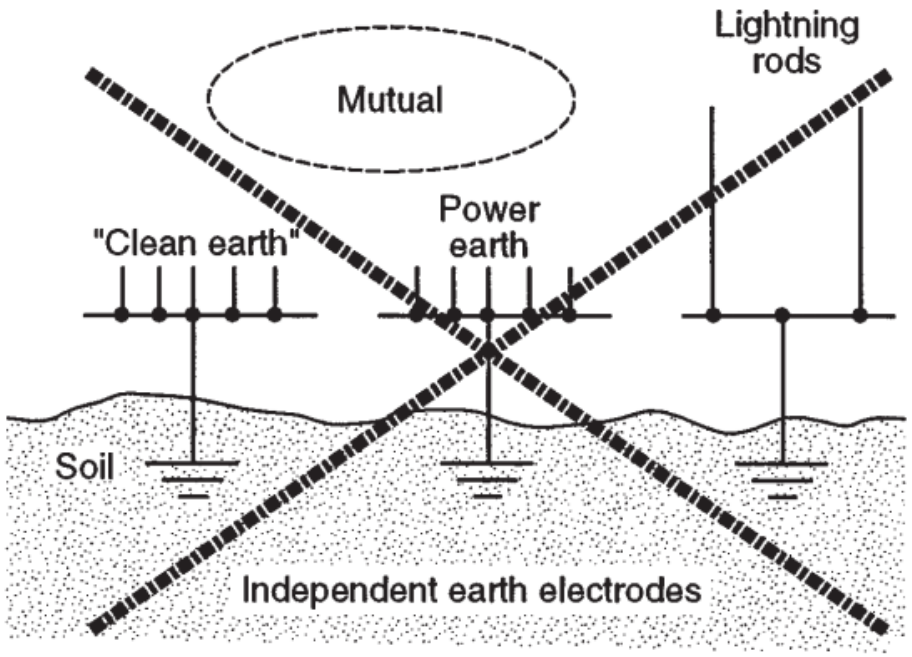


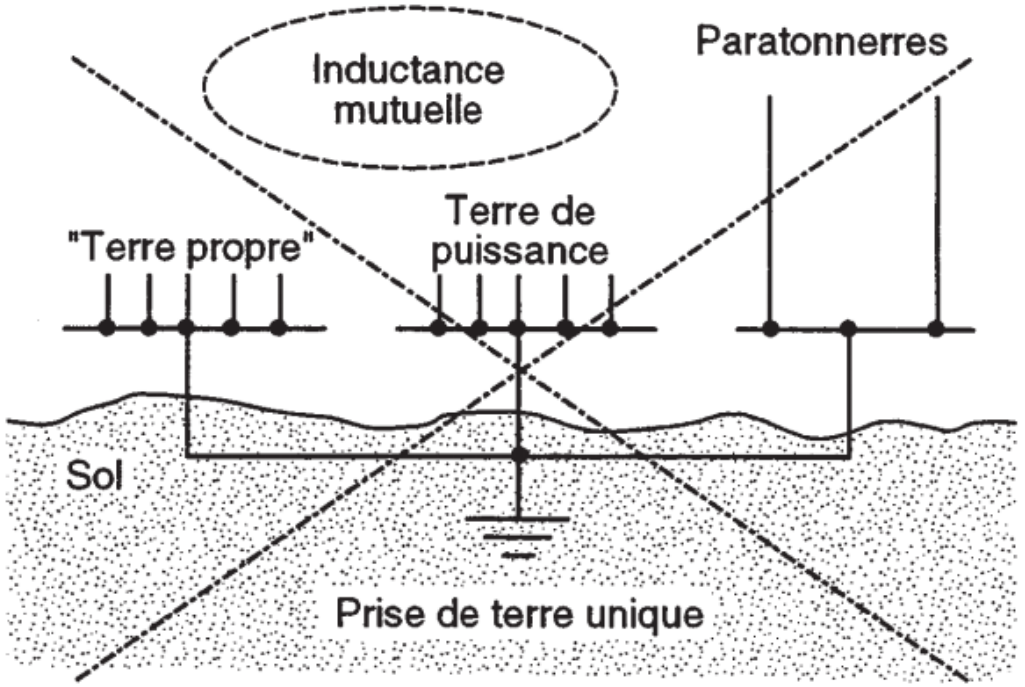






Earthing: Dos and don’ts

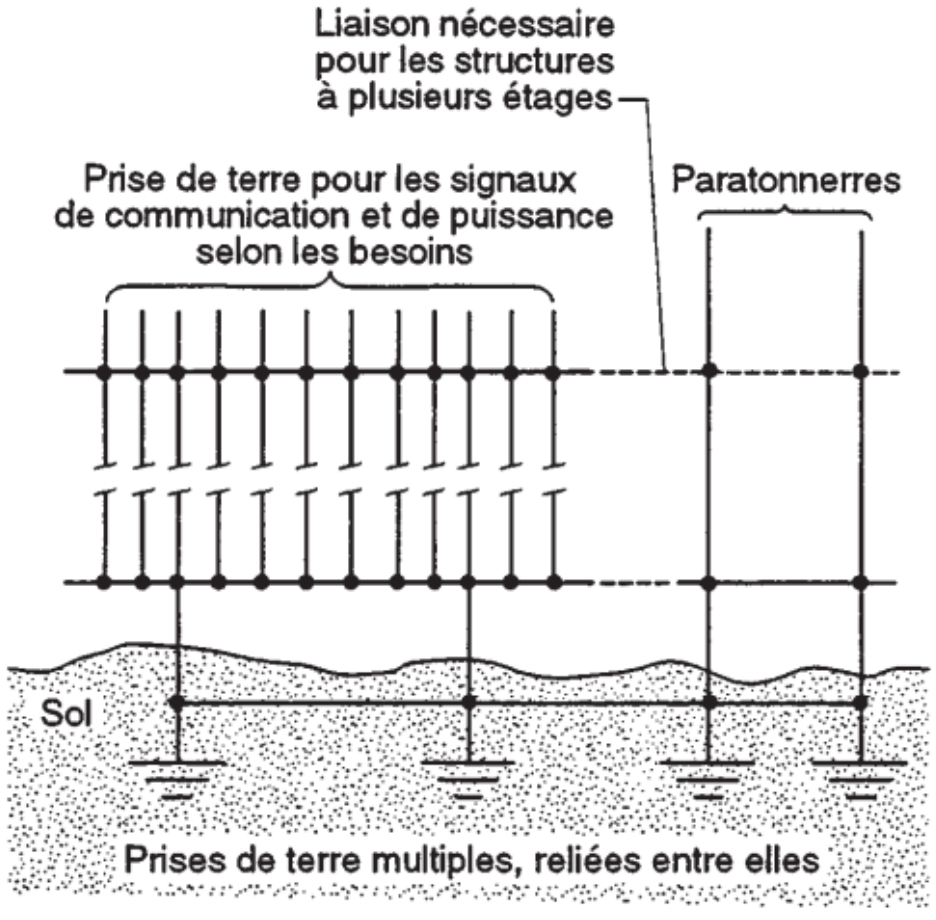


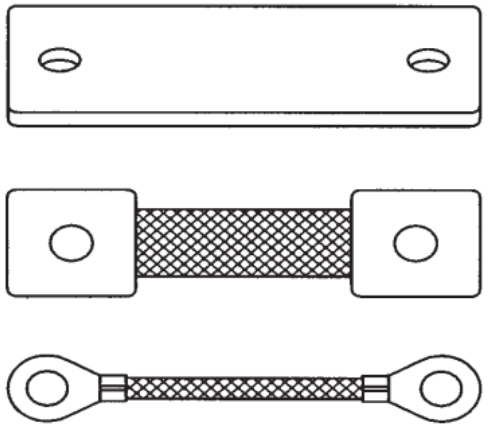


- Difference in potential between the different references

- Mutual inductance in HF

How to optimize earthing





EMC installation guidelines

- For more information, refer to technical note EN61000-5-2

Do	Don’t
Make cables as short as possible	Make loops with cables
Seperate power cables and communication cables	Paint metallic chassis
Use a large ground strap or copper bar for earthing	Cross talk phenomenon

Q&A

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Dinsdag 21 november

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