



KONFERENCJA

EMC FOR BUSINESS

PRAKTYCY DLA PRAKTYKÓW

11-12.10.2018



Kompatybilność Elektromagnetyczna
w przemyśle na przykładzie systemów
sterowania silnikami

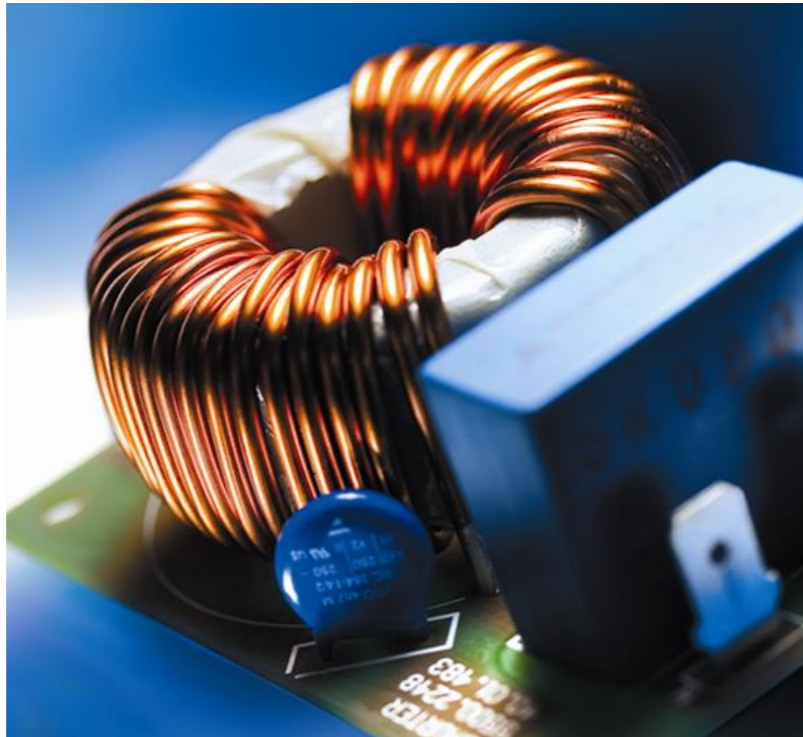
 **SCHURTER**
ELECTRONIC COMPONENTS

Herbert Blum - SCHURTER

Product Manager EMC

EMC for Business 2018 – praktycy dla praktyków – www.emc4b.com

EMC Emissions in the Machine Industry



EMC Emissions in the Machine Industry

- > European Directives
- > European requirements
- > US requirements
- > Applicable Standard EN55011
- > Applicable Standard FCC Title 47, Part 15
- > Practical Examples



Basic Requirements European Directives

>The basic requirements for EMC are laid down in the European directives:

- | | |
|-------------------------|------------|
| - Machines directive | 2006/42/EC |
| - Low voltage directive | 2014/35/EU |
| - EMC directive | 2014/30/EU |
| - Atex directive | 2014/34/EU |



Basic Requirements Machines Directive

- >Chapter 1.5.2 Static Electricity: Machines must be designed and manufactured in a manner such that any dangerous electrostatic discharges are avoided....
- >Chapter 1.5.10 Radiation: Unwanted radiation emissions from a machine must be prevented or reduced to a level such that these have no harmful effects on human life.
- >Chapter 1.5.11 External Radiation: Machines must be designed and manufactured in a manner such that their function is not impaired by external radiation.



Basic Requirements EMC Directive 2014/30/EU

>Chapter 1: Protection requirements

Equipment shall be so designed and manufactured, having regard to the state of the art, so as to ensure that:

a) the electromagnetic disturbance generated does not exceed the level above which radio and telecommunications equipment or other equipment cannot operate as intended;

=> Emission

b) it has a level of immunity to the electromagnetic disturbance to be expected in its intended use, which allows it to operate without unacceptable degradation of its intended use.

=> Immunity



Basic Requirements EMC Directive 2014/30/EU

>Article 13: Fixed installations

(2) Where there are indications of non-compliance of the fixed installation, in particular where there are complaints about disturbances being generated by the installation, the competent authorities of the Member State concerned may request evidence of compliance of the fixed installation and, when appropriate, initiate an assessment.

If it is ascertained that a fixed installation does not fulfil the requirements, the competent authorities can issue an injunction for the taking of suitable measures to ensure conformity with the protection requirements of Appendix 1 Chapter 1 **(Slide no. 5)**.



Basic Requirements EMC Directive vs. Machines Directive

- >EMC is to be taken into consideration with the safety and security of machines.
- >EMC product requirements are legally binding and defined in the EMC directive.
- >EMC requirements can also be found in other directives, e.g., in the machines directive.



Basic Requirements Indices in the EMC Directive

- > (13) Harmonised standards reflect the generally acknowledged state of the art as regards electromagnetic compatibility matters in the European Union. It is thus in the interest of the functioning of the internal market to have standards for the electromagnetic compatibility of equipment which have been harmonised at Community level. **Once the reference to such a standard has been published in the Official Journal of the European Union, compliance with it should raise a presumption of conformity** with the relevant essential requirements, although other means of demonstrating such conformity should be permitted. Compliance with a harmonised standard means conformity with its provisions and demonstration thereof by the methods the harmonised standard describes or refers to.



Basic Requirements Listing in the Official European

(Publication des titres et des références des normes harmonisées au titre de la directive)

(2010/C 306/01)

OEN ⁽¹⁾	Référence et titre de la norme harmonisée (et document de référence)	Référence de la norme remplacée	Date de cessation de la présomption de conformité de la norme remplacée Note 1
CEN	EN 617:2001 Equipements et systèmes de manutention continue - Prescriptions de sécurité et de CEM pour les équipements de stockage des produits en vrac en silos, soutes, réservoirs et trémies		

the reference



Basic Requirements Listing in the Official European Journal

Link to the Official European Journal (updated daily):

<http://eur-lex.europa.eu/de/index.htm>

The screenshot shows the EUR-Lex website interface. At the top, there is a search bar with the query 'emc' and a search button. Below the search bar, there are navigation tabs for 'Home', 'Official Journal', 'EU law and related documents', 'National law', 'Legislative procedures', and 'More'. The main content area displays search results for 'emc'. On the left, there are filters for 'By domain', 'By subdomain', 'By year of document', 'By type of procedure', and 'By author'. The search criteria section shows 'Search for: emc, Search language: English'. The results list includes two entries: 'Regulation (EU) No 168/2013 of the European Parliament and of the Council of 15 January 2013 on the approval and market surveillance of two- or three-wheel vehicles and quadricycles' and 'Regulation (EU) No 1286/2013 of the European Parliament and of the Council of 11 December 2013 establishing an action programme to improve the operation of taxation systems in the European Union for the period 2014-2020 (Fiscalis 2020) and repealing Decision No 1482/2007/EC'. The first result is selected and expanded, showing details such as the OJ reference, direct text access, CELEX number, and author information.

Basic Requirements Application of the Testing Standards

- >The manufacturer is responsible for knowing and applying the standards necessary for his system .
- >Should there be no product standards available for the conformity part, the following generic standards are to be used :

IEC61000-6-1	Domestic and business premises	Immunity
IEC61000-6-2	Industrial premises	Immunity
IEC61000-6-3	Domestic and business premises	Emission
IEC61000-6-4	Industrial premises	Emission



Basic Requirements Application of the Testing Standards

- >If a product standard exists, this should be used.
- >For emissions of fixtures and fittings in the machine industry, EN55011: 2009 is normally used.

IEC61000-6-1	Domestic and business premises	Immunity
IEC61000-6-2	Industrial premises	Immunity
IEC61000-6-3	Domestic and business premises	Emission EN55011
IEC61000-6-4	Industrial premises	Emission EN55011







Applicable Standard EN55011:2015

Actual status

- > **Industrial, scientific and medical devices – radio disturbance – limiting values and measurement procedures (IEC/CISPR 11:2015, modified); German text EN 55011:2016**
- > The EN 55011:2015 has adopted the 6th edition of the International standard IEC/CISPR 11 (edition 2015) with common European modifications.



EN55011 Classification of ISM Devices

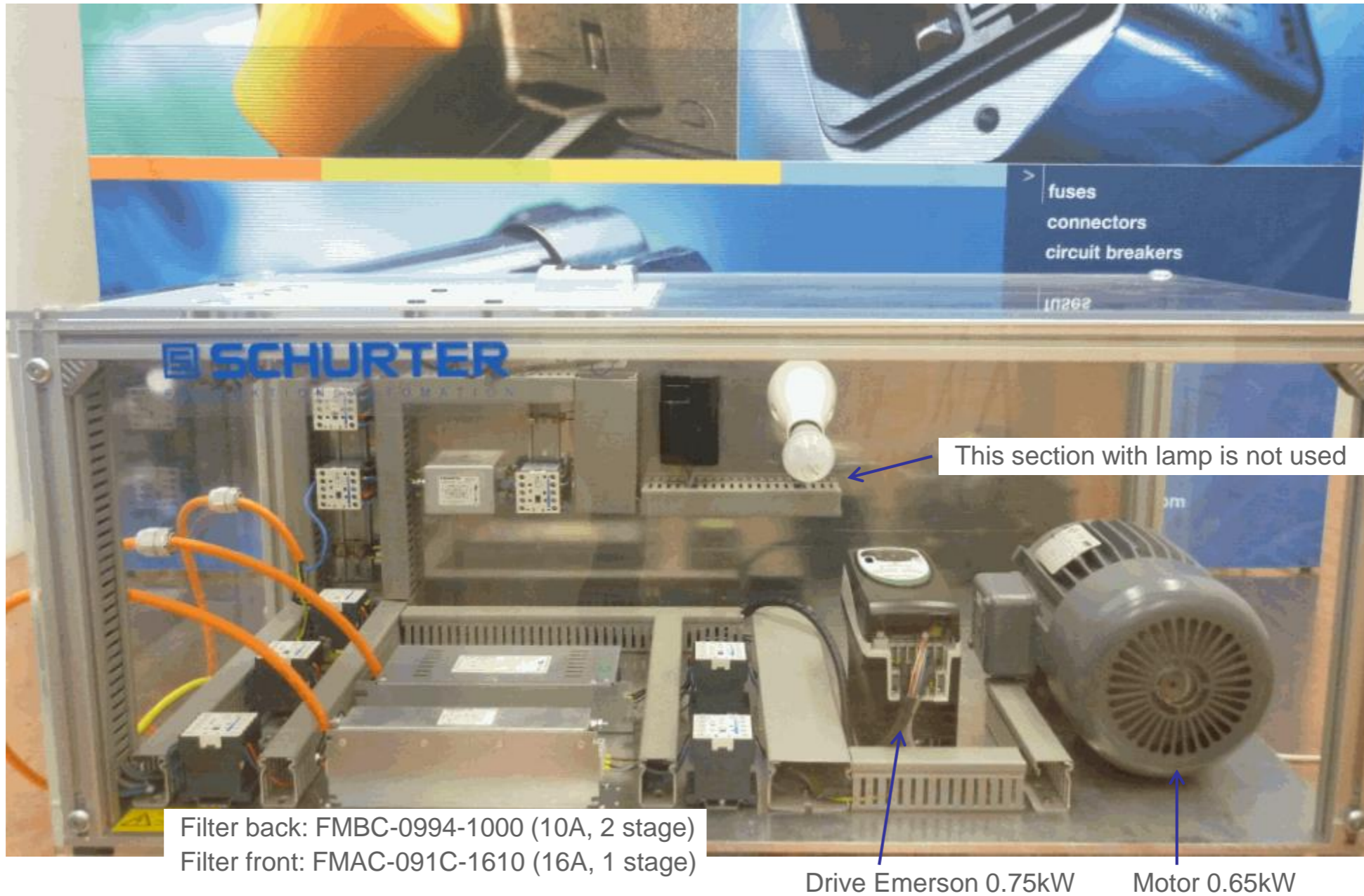
	Group 1 all other ISM devices	Group 2 ISM devices with HF effective energy 9kHz – 400GHz
Class A	<p>Industry Example: Machine tool controls</p> 	<p>Industry Example: EI. Welding machines Erosion machines</p> 
Class B	<p>Domestic / office premises Example: Laboratory equipment Medical-scientific equipment</p> 	<p>Domestic / office premises Examples: Microwave devices Induction cookers Dielectric heaters Medical equipment with HF application</p> 



Applicable Standard EN55011 Measurement Setup Emission

- > Measurement of the disturbance voltage at the mains supply connection with a network simulation according to CISPR16.2 (150kHz – 30MHz)
- > Measurement of the disturbance radiation with an antenna at a distance of 3m or 10m (30MHz – 1GHz)





Filter back: FMBC-0994-1000 (10A, 2 stage)
Filter front: FMAC-091C-1610 (16A, 1 stage)

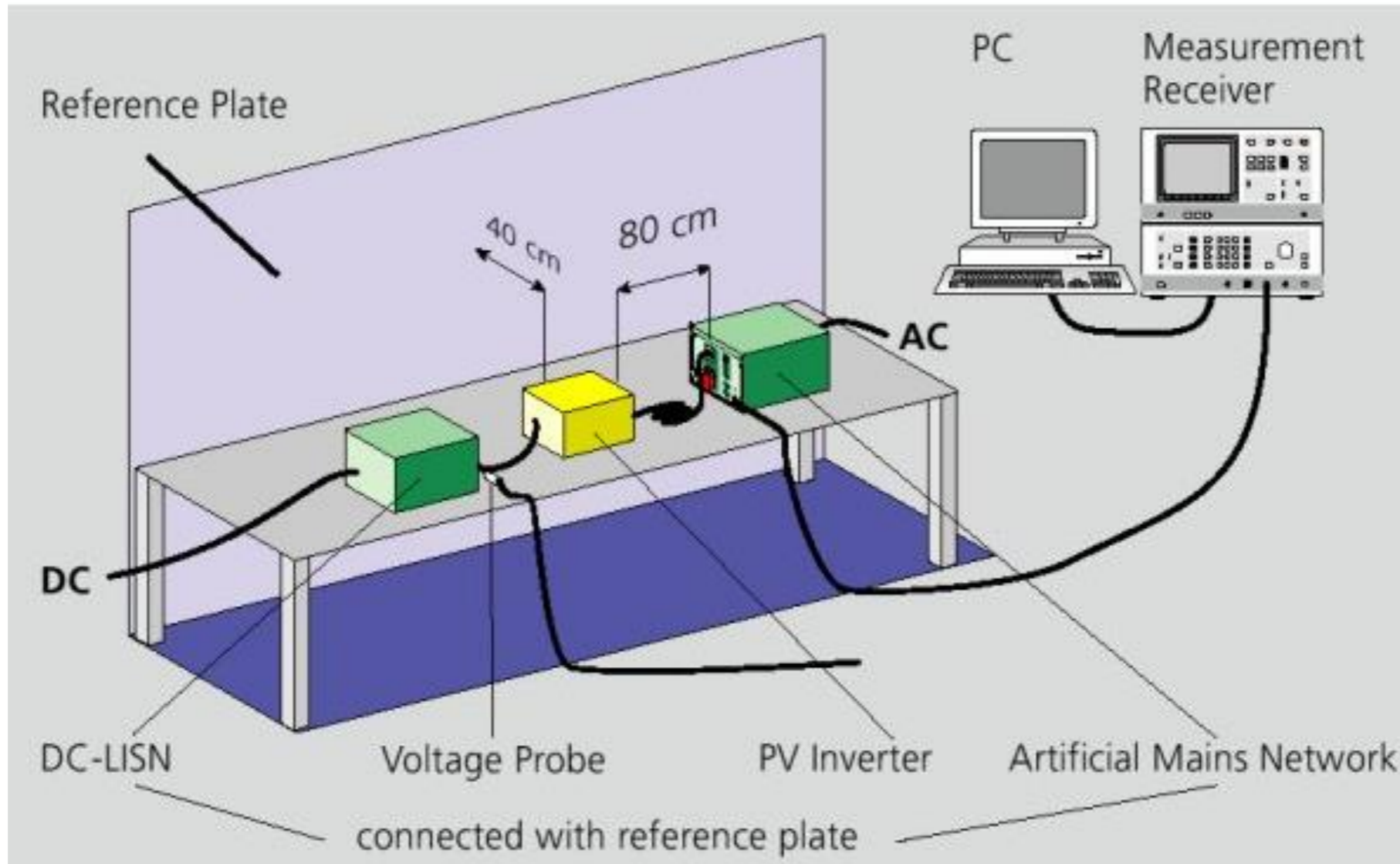
Drive Emerson 0.75kW

Motor 0.65kW

This section with lamp is not used



- > Set up according IEC/EN 55011 Conducted emission





Spectrum Analyzer

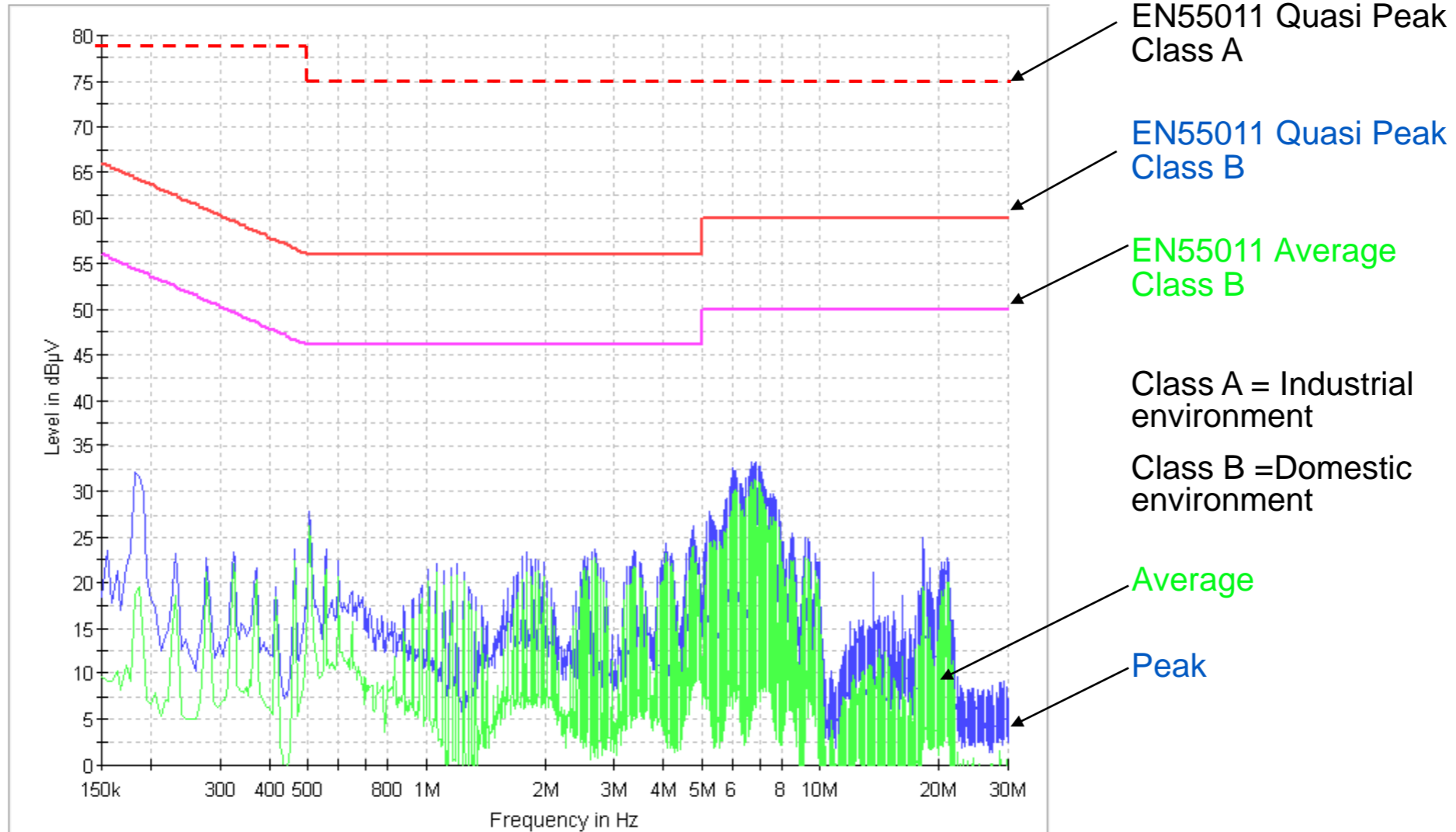
LISN

Device under test

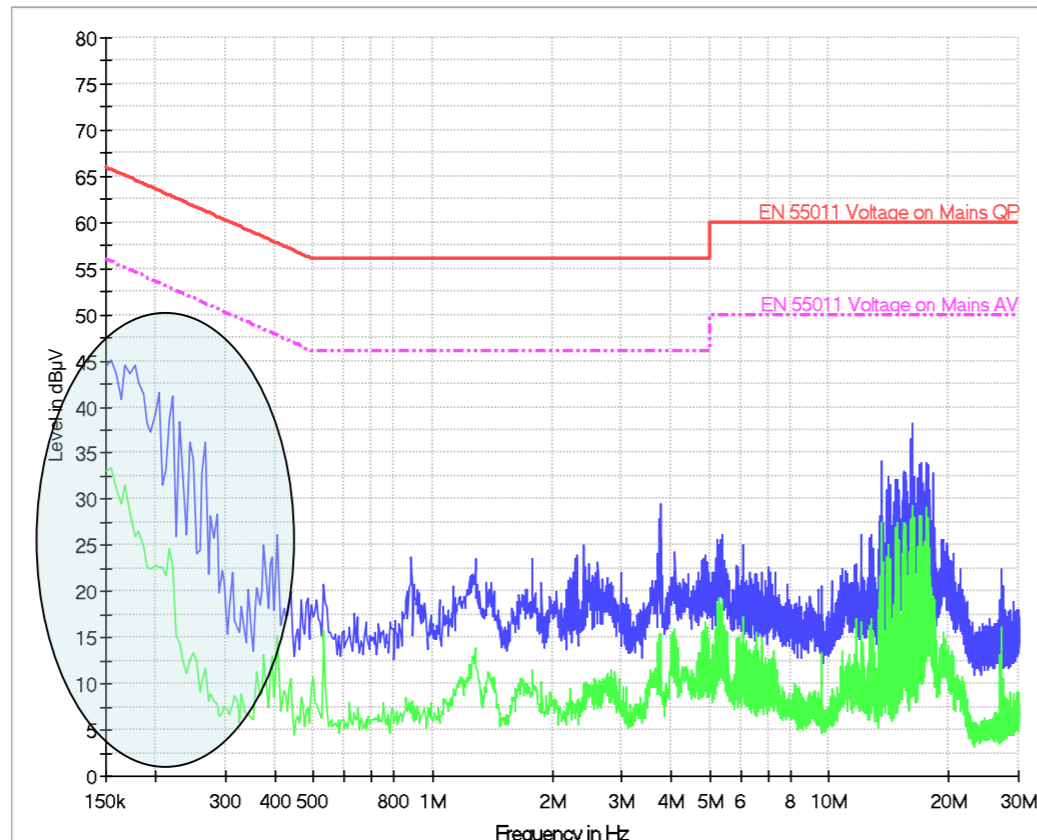
Ground plane solid copper
on floor and wall



Limiting values



Measurement of the base level in an industrial environment

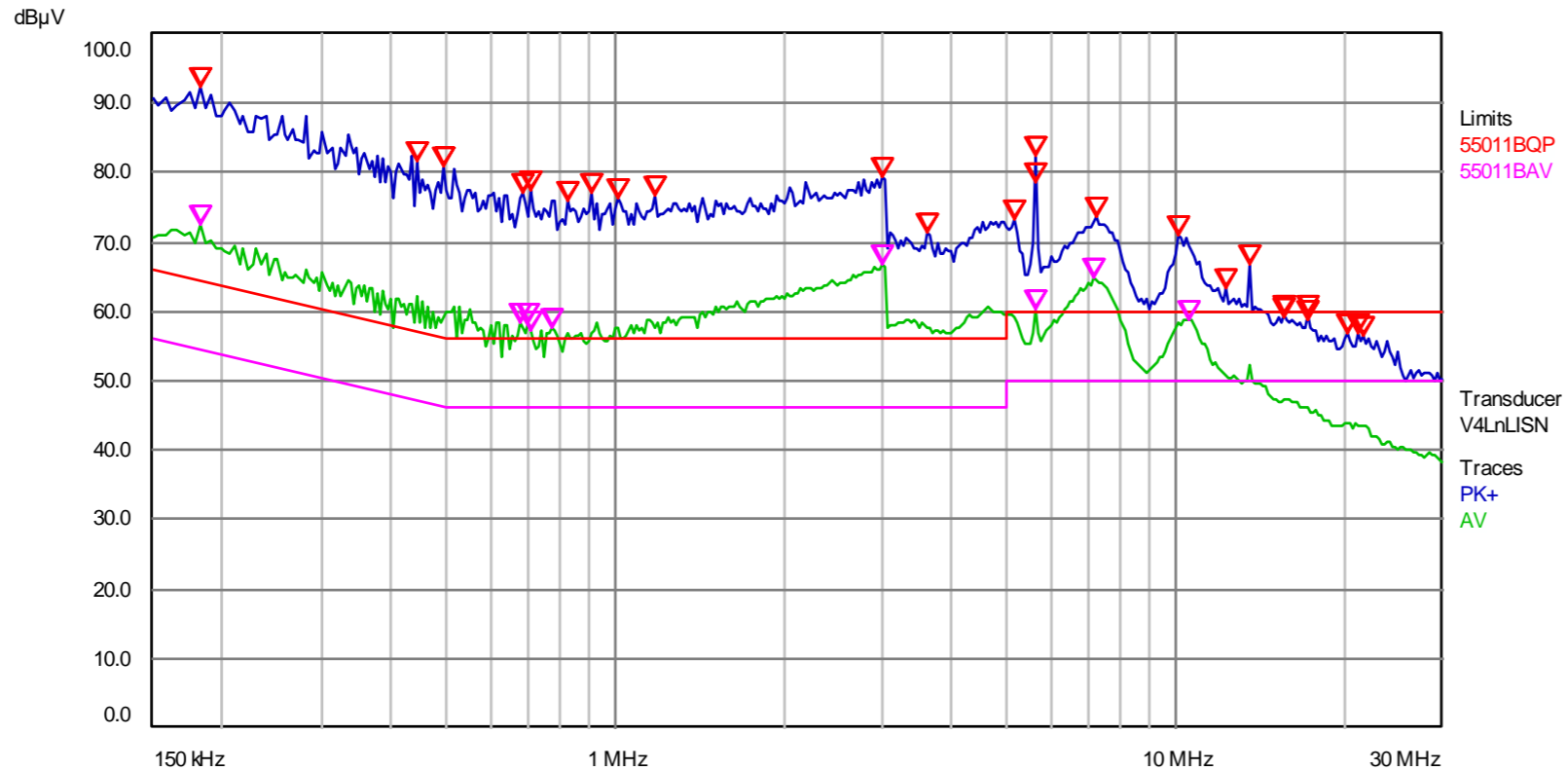


Despite the network simulation, the test system displays a high level of disturbance in the 150-200kHz range

The measurement should therefore be carried out in a testing chamber better suited for the purpose.

The test setup is tested to limiting values class B.

Measurement 0 without any filter

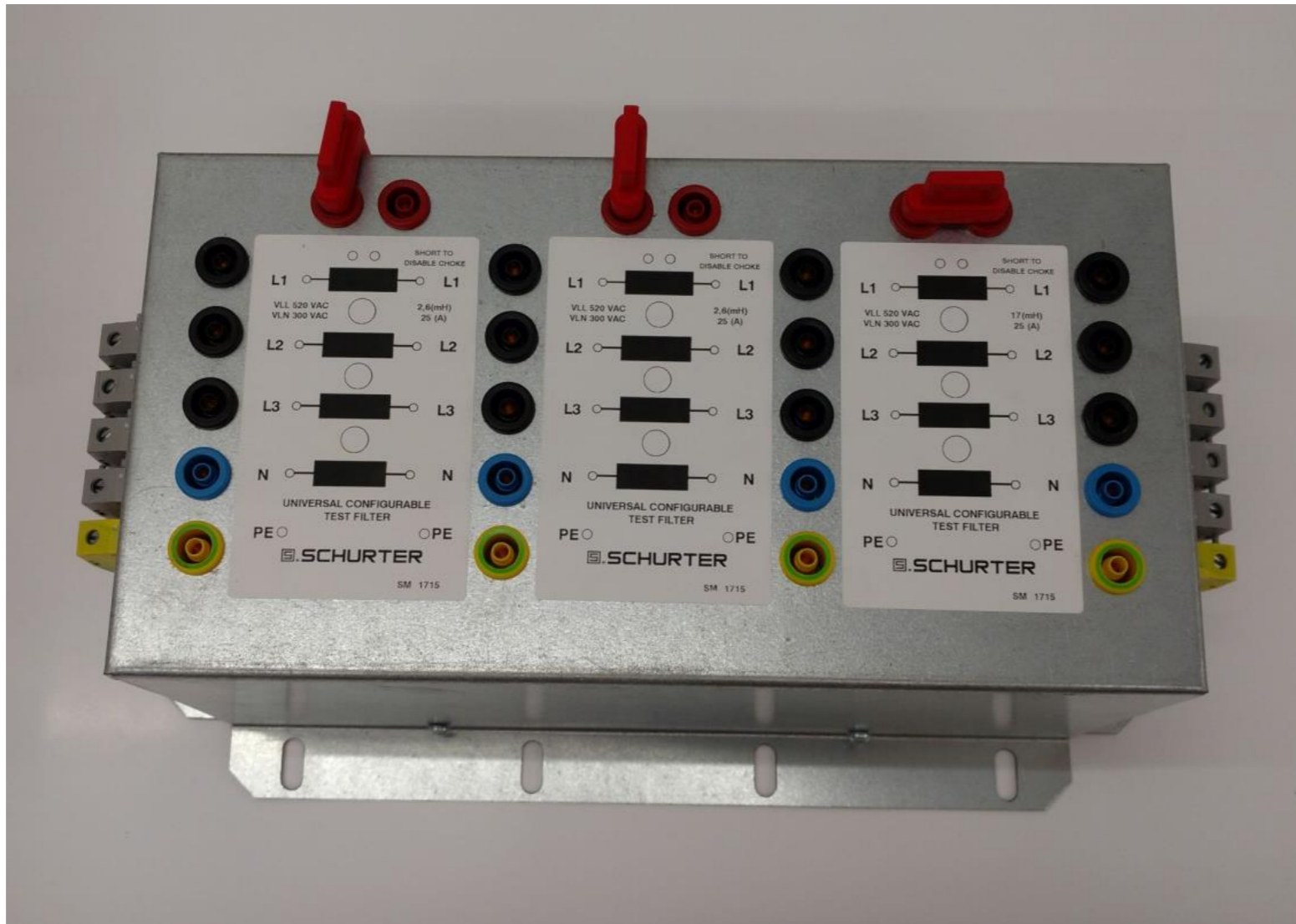


Peak
Average

Noise level on a wide frequency range over the limits!



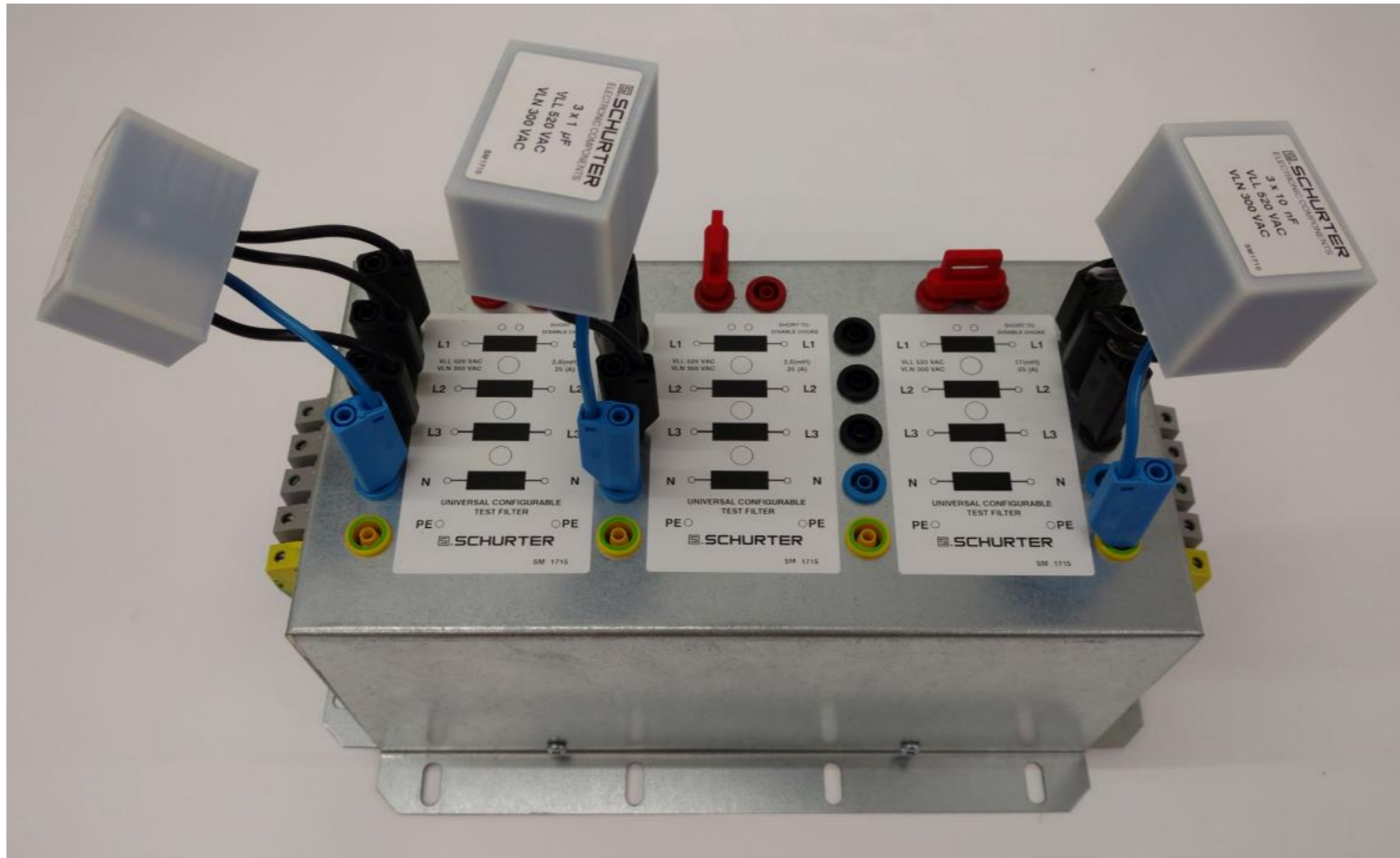
Universal Configurable Test Filter



- > Universal filter for training and measurements
3 phases 760V,
25 / 50A
- > 3x common mode chokes with magnetically short bars
- > 4x connectors for various capacitors in X or Y mode



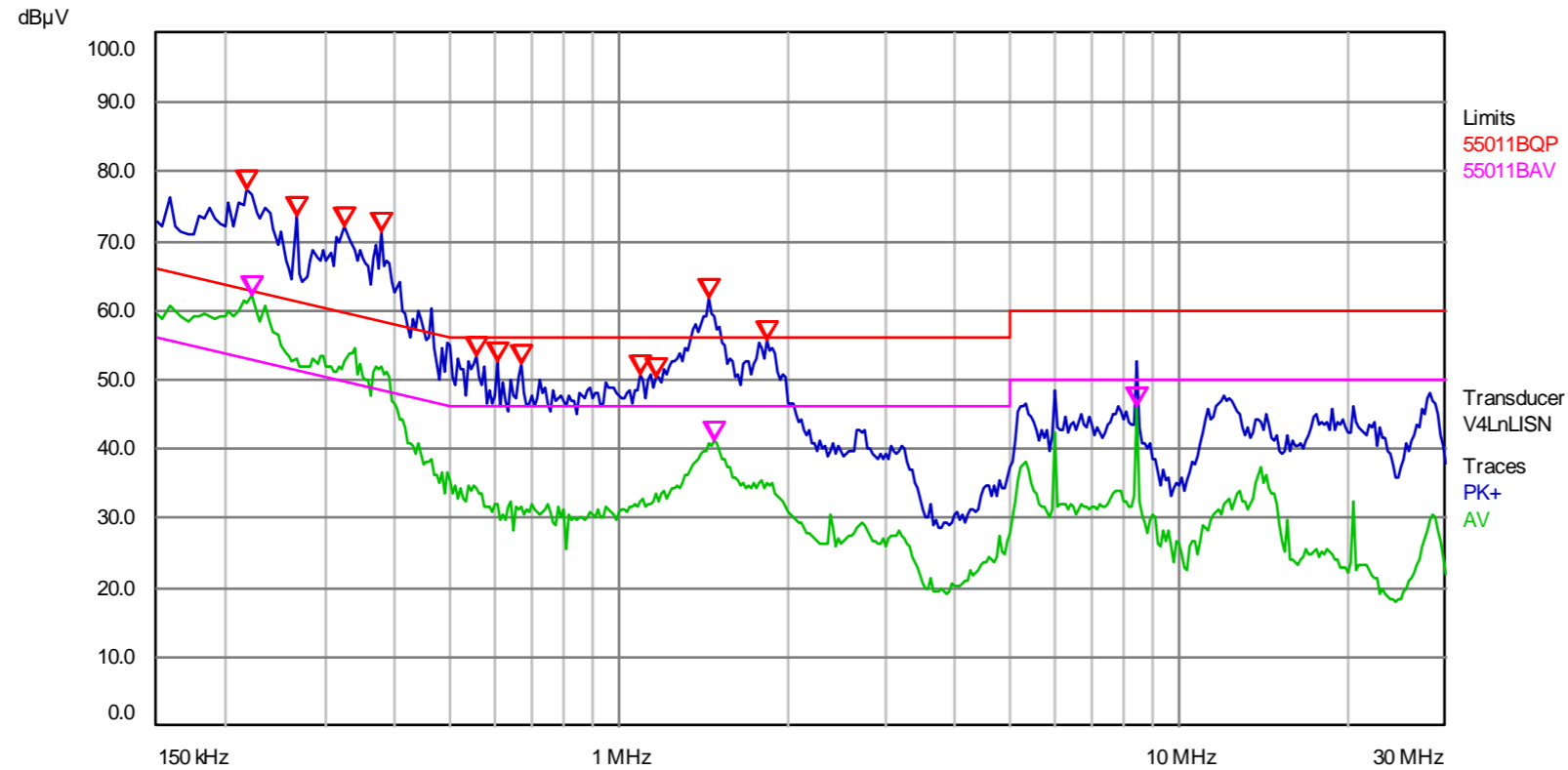
Universal Configurable Test Filter



- > Filter with plugged in capacitors modules
- > 2 x L1, L2, L3 – N (X)
- > 1x L1, L2, L3 – PE (Y)



Measurement 1

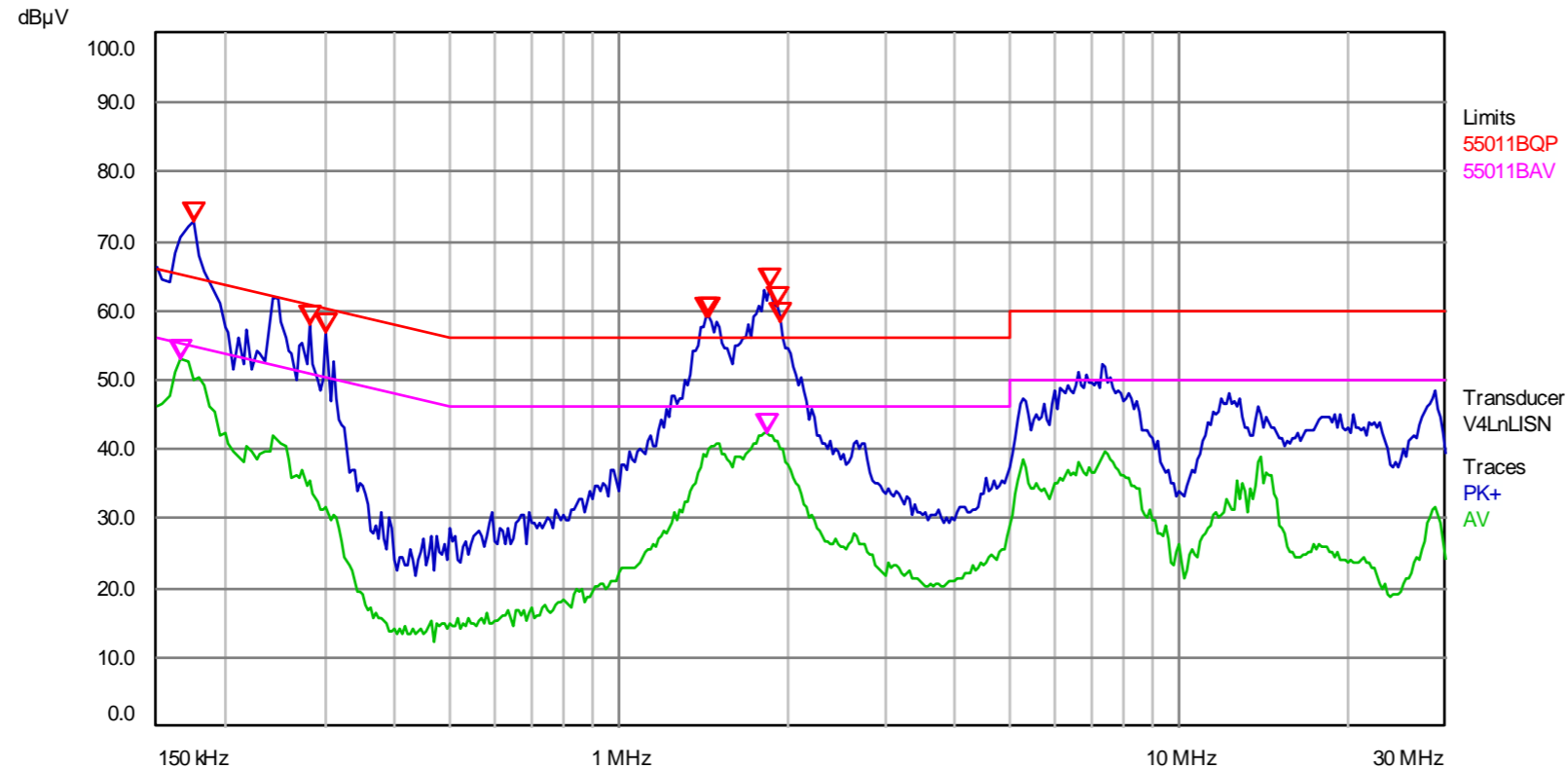


Universal Test Filter

C_x 3x 1µF, C_x 3x 330nF C_y 3x 10nF



Measurement 2

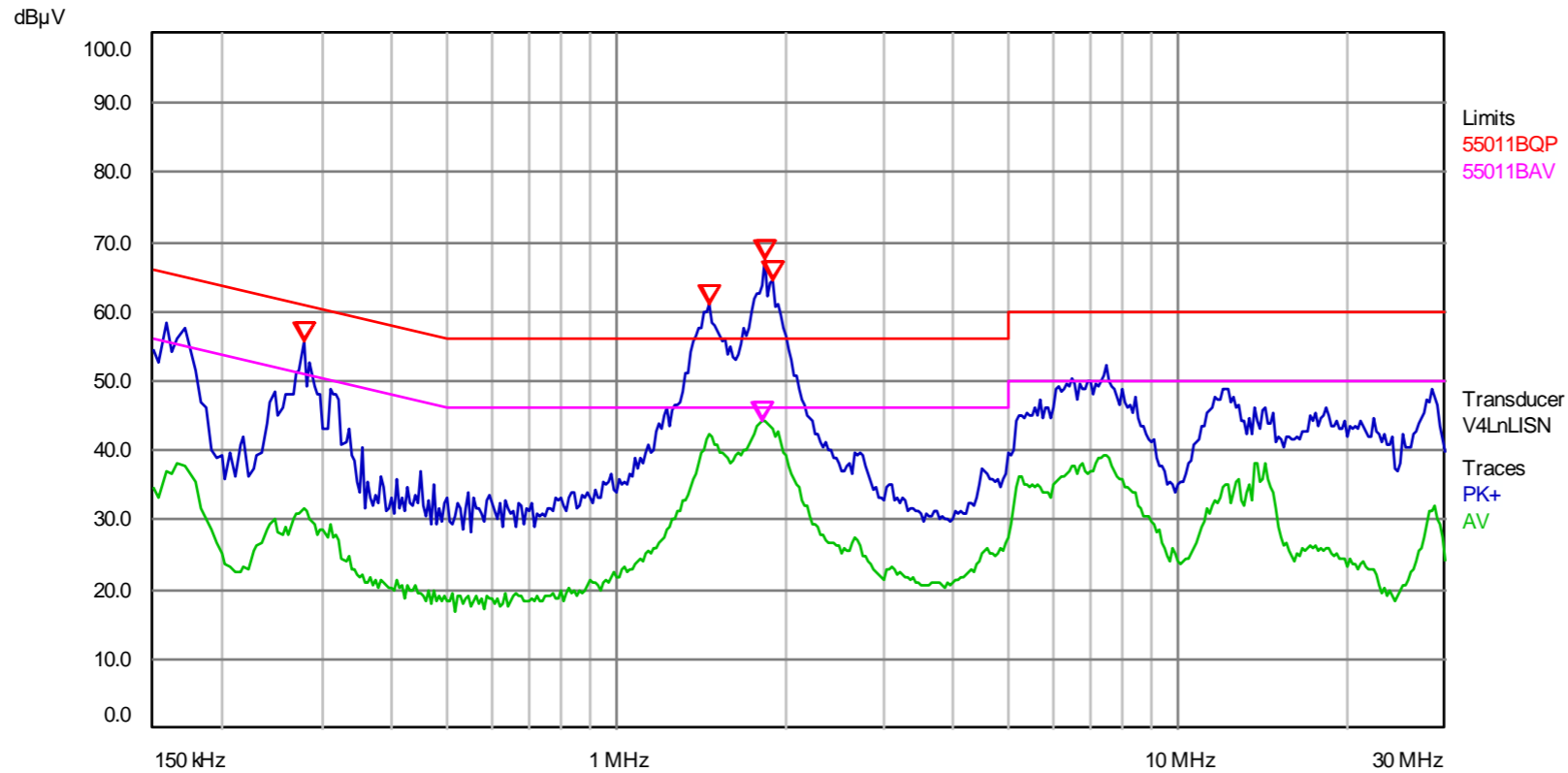


Universal Test Filter

Cx 3x 1µF, 2x 2.6mH, Cy 3x 10nF



Measurement 3

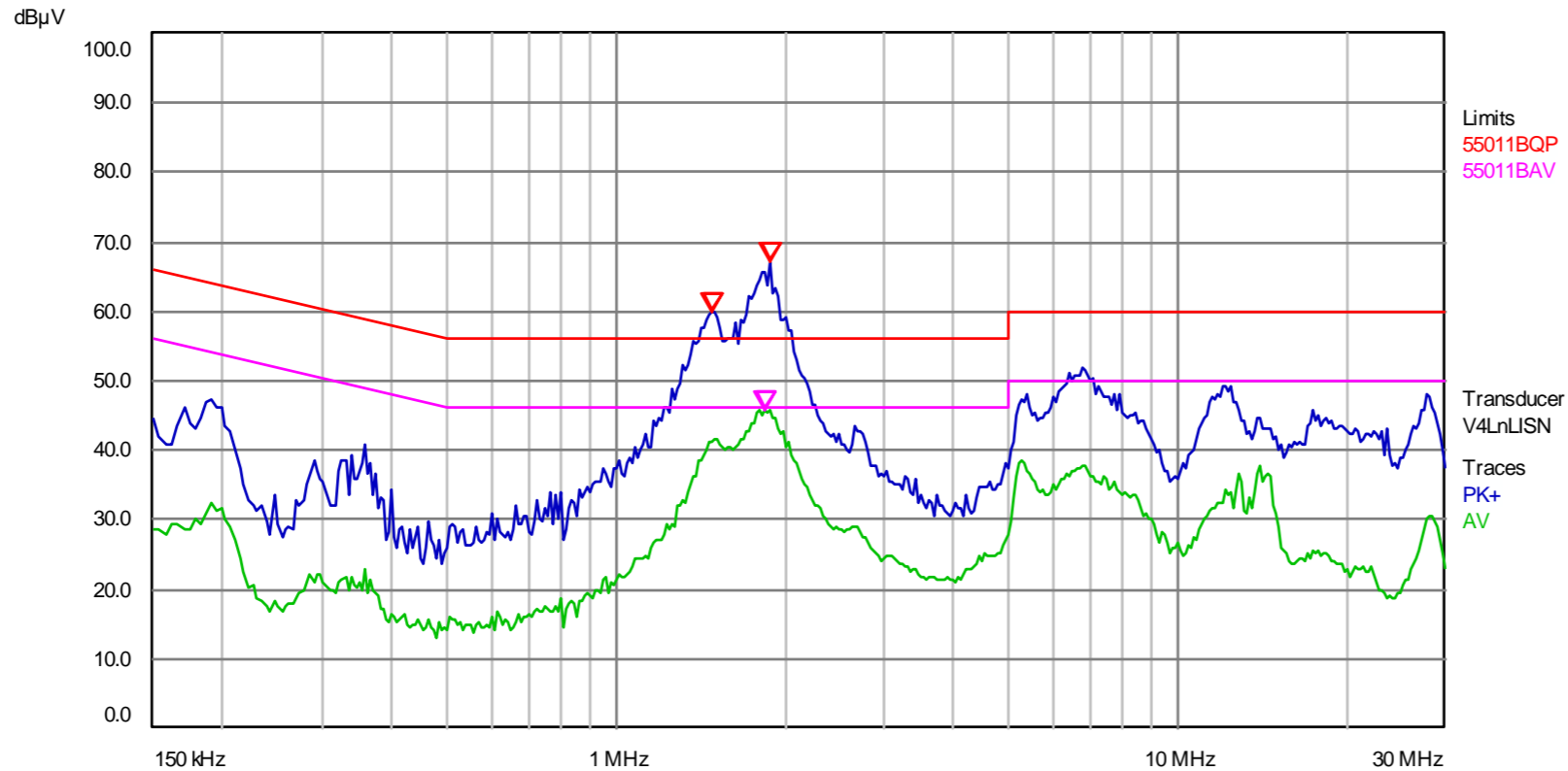


Universal Test Filter

C_x 3x 3.3µF, 2x 2.6mH, C_y 3x 10nF



Measurement 4

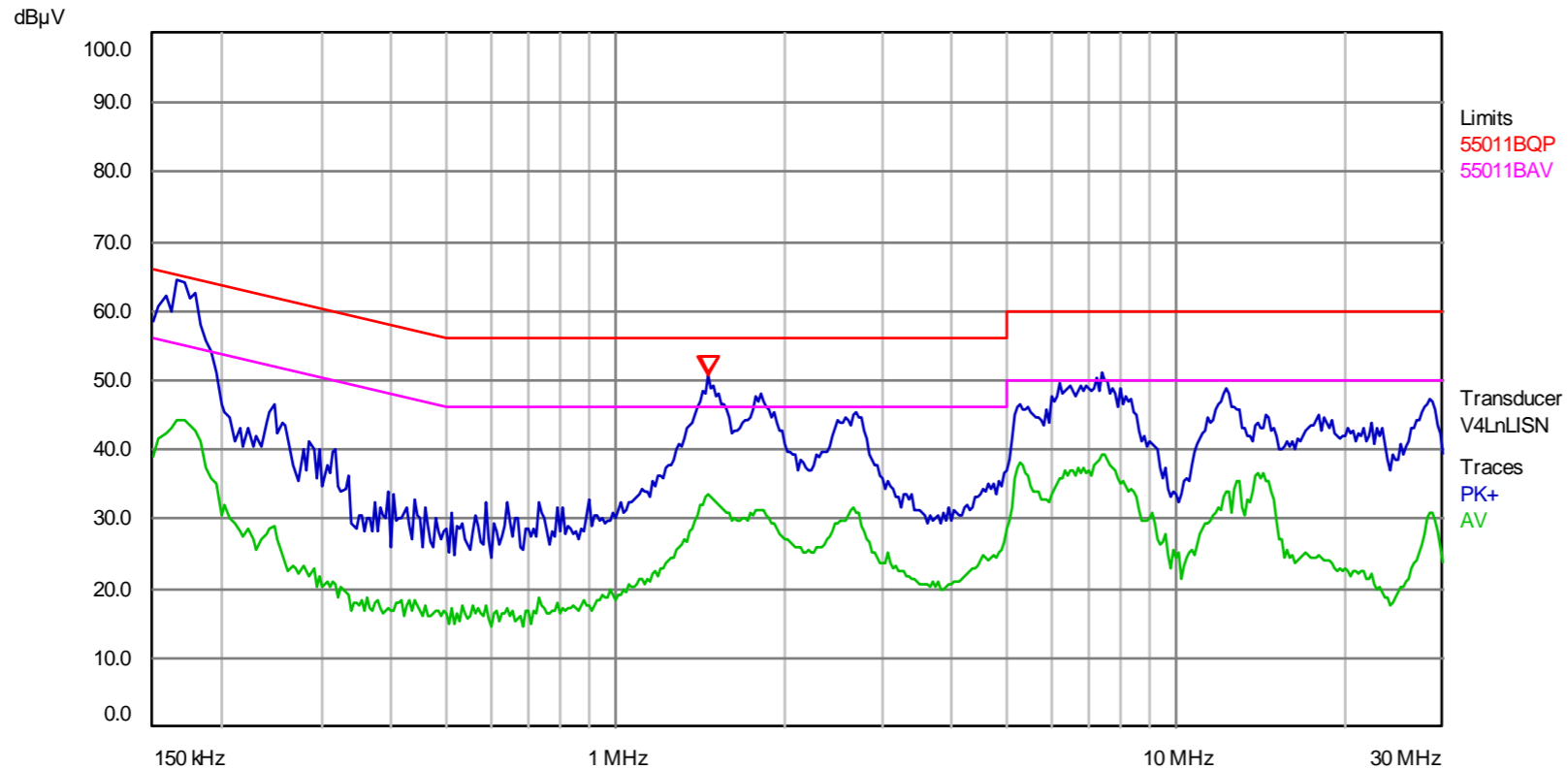


Universal Test Filter

C_x 3x 3.3µF, 2x 2.6mH, C_x 3x 2.2µF C_y 3x 10nF



Measurement 5

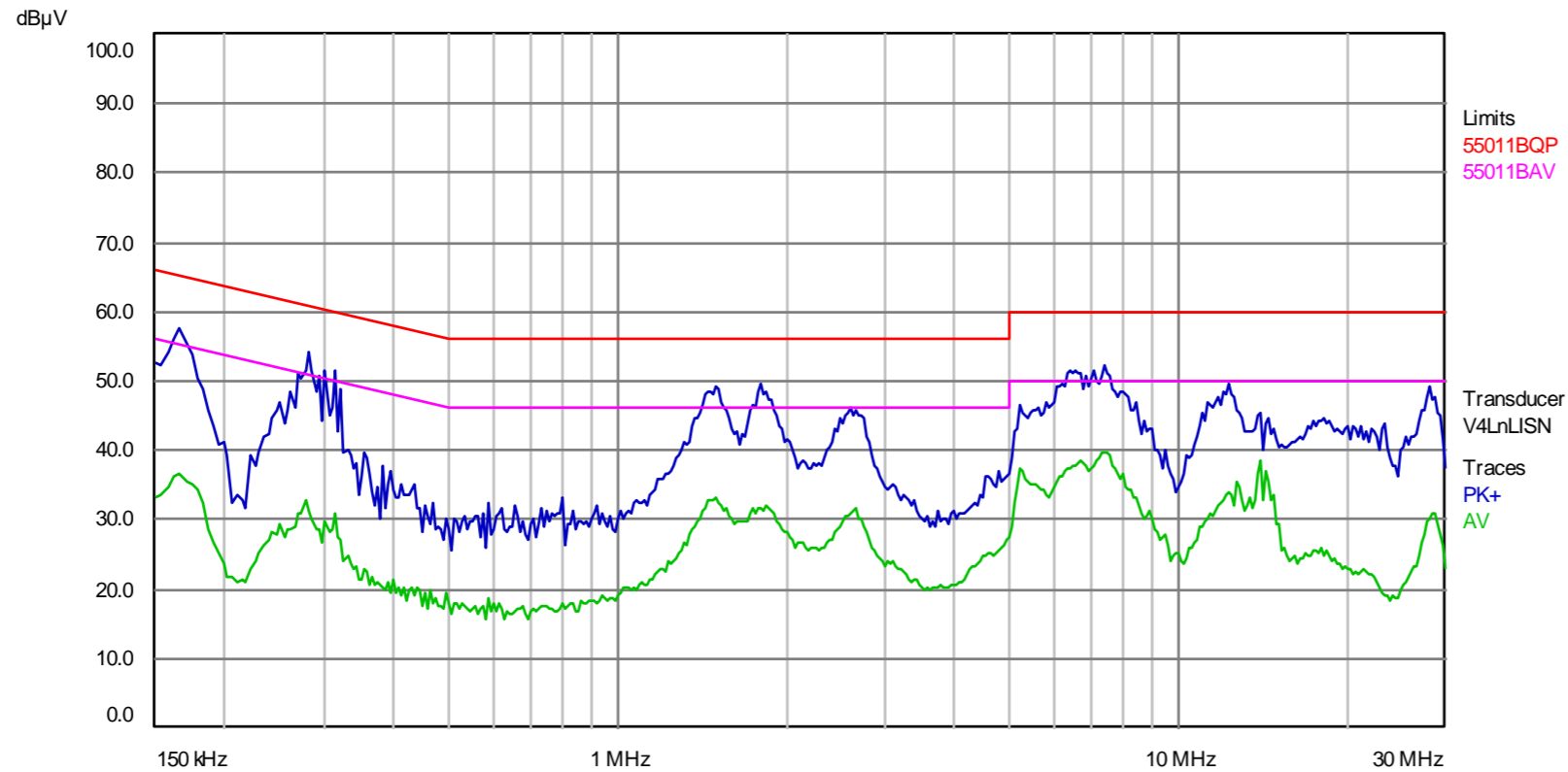


Universal Test Filter

C_x 3x 2.2µF, 2x 2.6mH, 2x 2.6mH, C_y 3x 10nF



Measurement 6

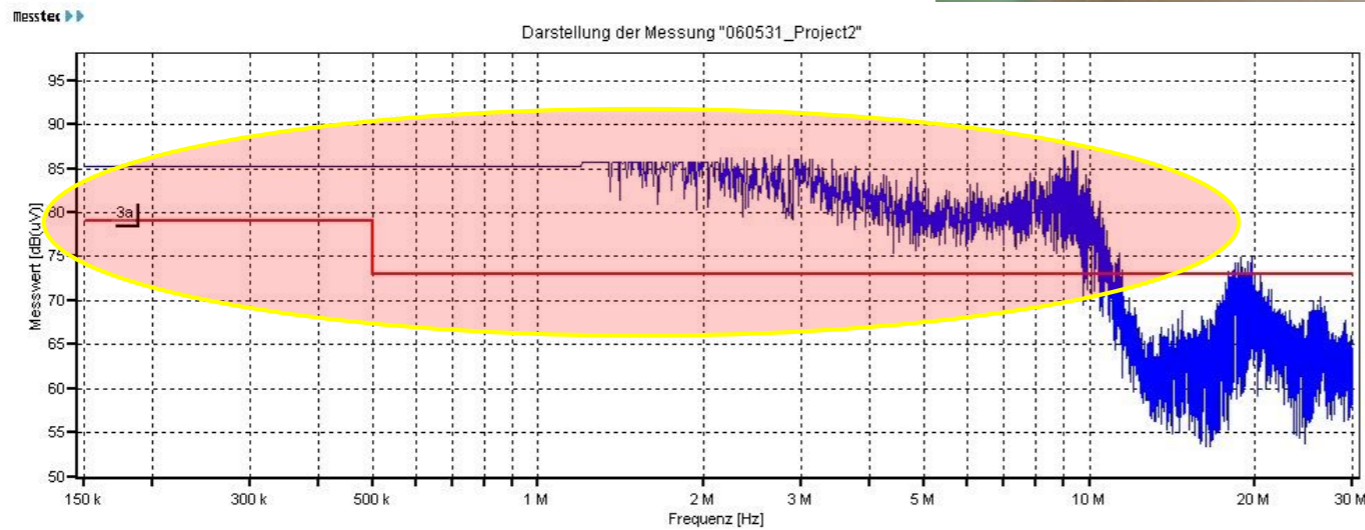


Universal Test Filter

C_x 3x 3.3µF, 2x 2.6mH, 2x 2.6mH, C_y 3x 10nF



- > Filter + Inverter + Motor
 - > Filter not connected

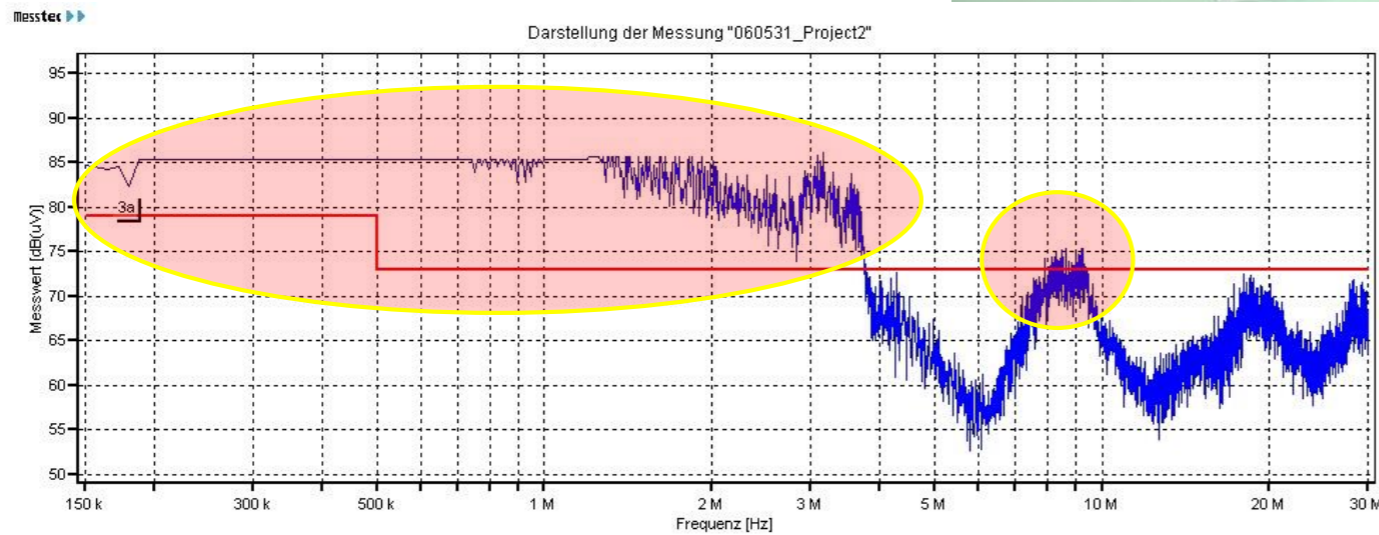
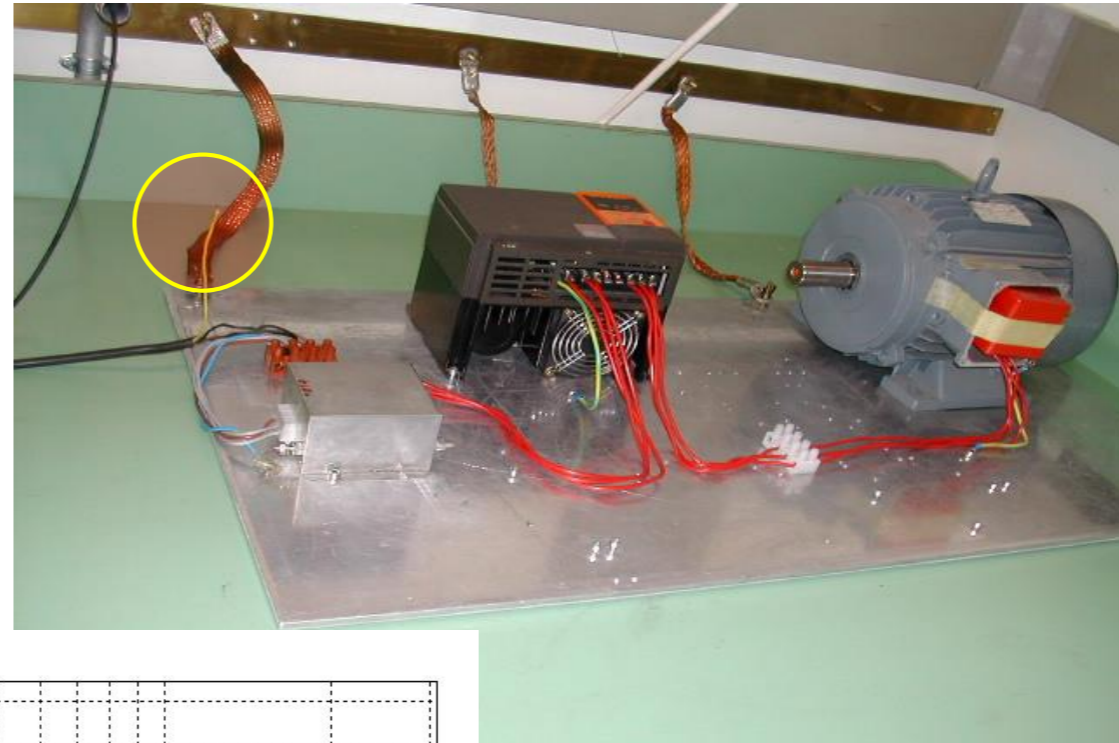


Limit 003a EN 55022, ITE-devices voltage class A, Detector GP.
060531_Project2 (150 k - 30 M): DT:Peak, ATT:20dB, STEP:7.5 kHz, BW:9 kHz, MT:10ms.

gemessen am: 05.31.2006 15:10:17

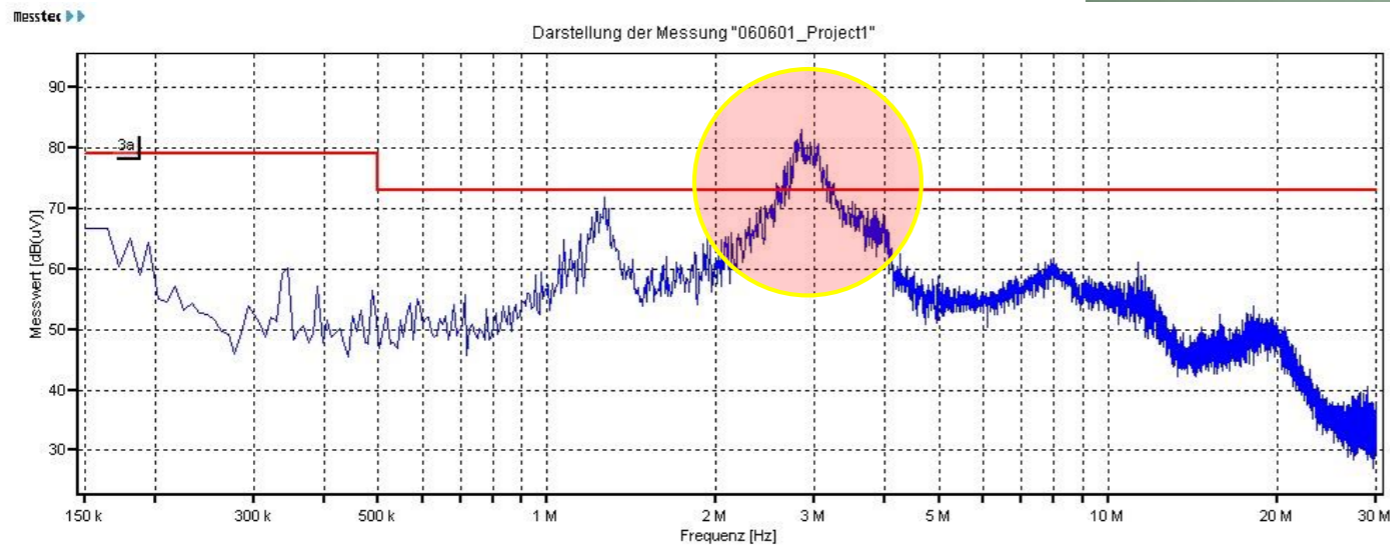
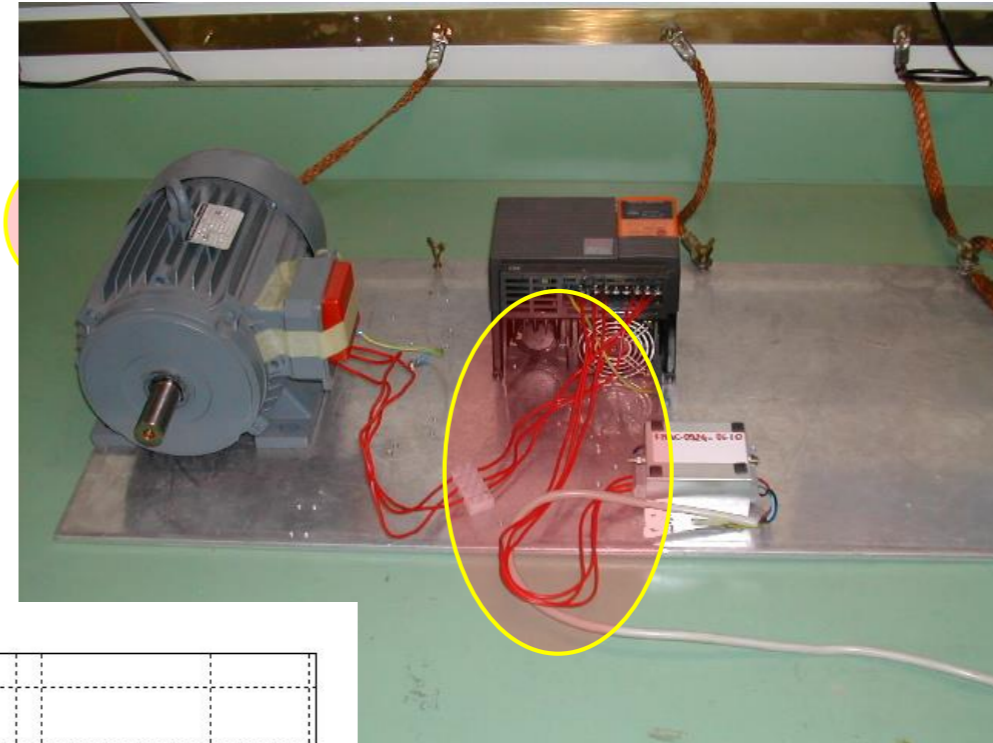


- > Filter + Inverter + Motor
 - > Filter connected
 - > Earth not connected
 - > No cable crossover



gemessen am: 05.31.2006 15:26:49

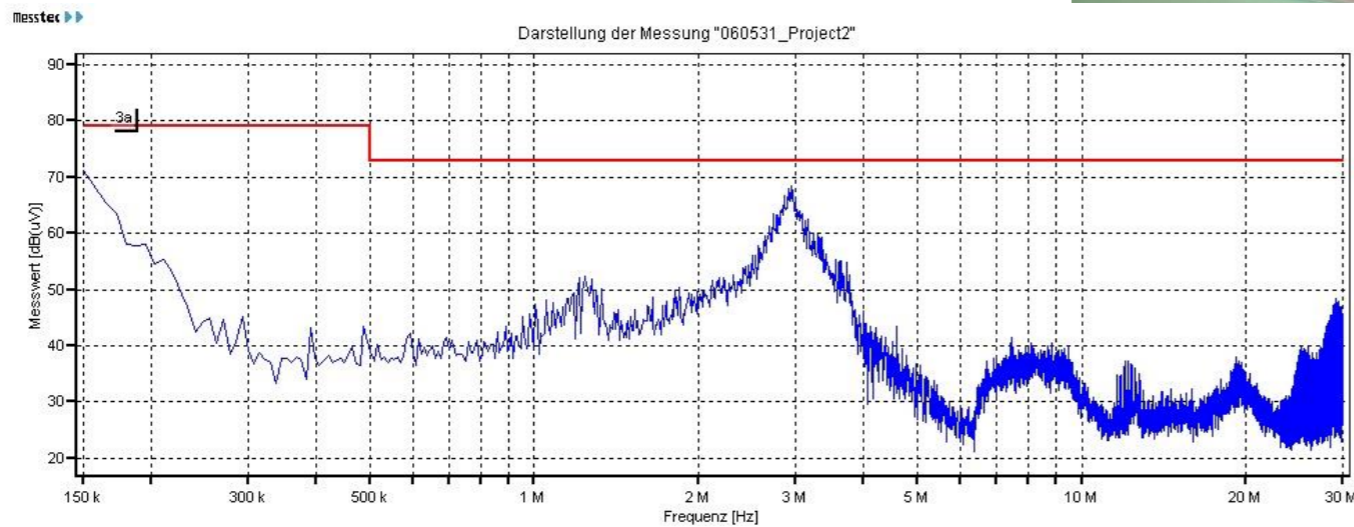
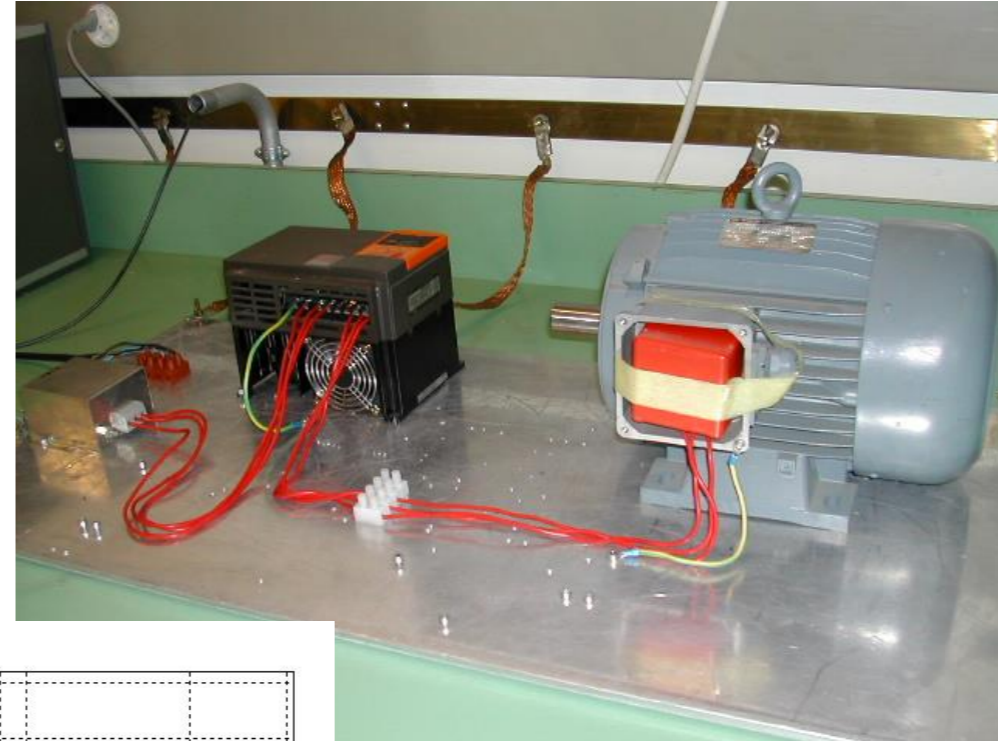
- > Filter + Inverter + Motor
 - > Filter connected
 - > Earth connected
 - > Cable crossover



Limit: 003a EN 55022, ITE-devices voltage class A, Detector GP.
060601_Project1 (150 k - 30 M): DT:Peak, ATT:20dB, STEP:7.5 kHz, BW:9 kHz, MT:10ms.

gemessen am: 06.01.2006 08:26:53

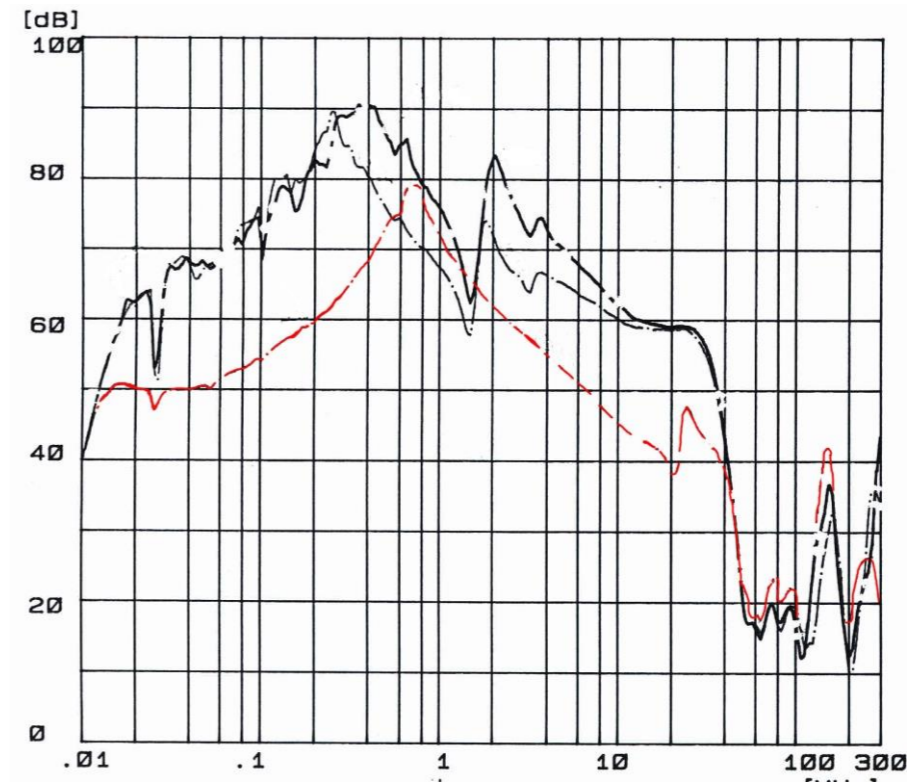
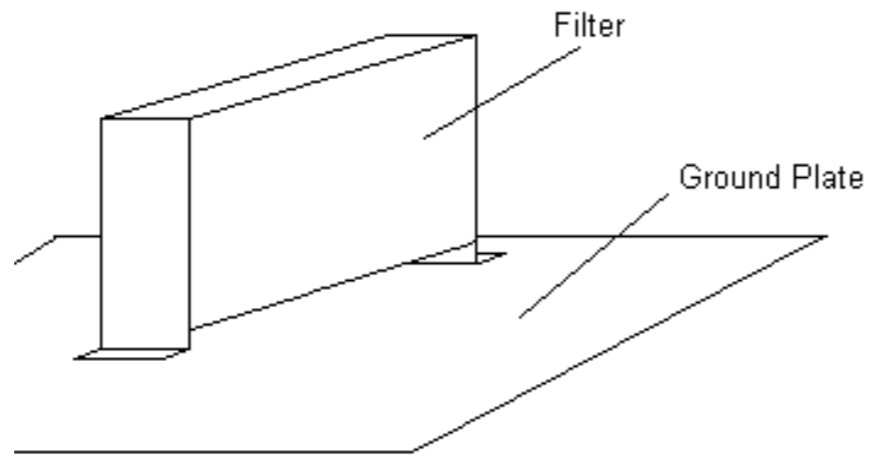
- > Filter + Inverter + Motor
 - > Filter connected
 - > Earth connected
 - > No cable crossover



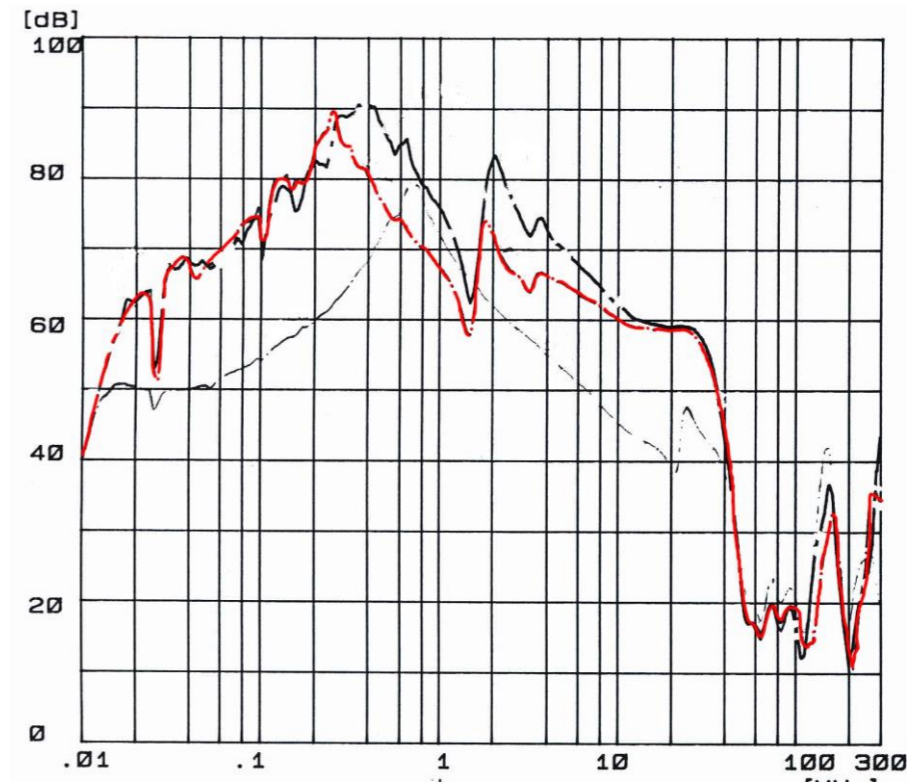
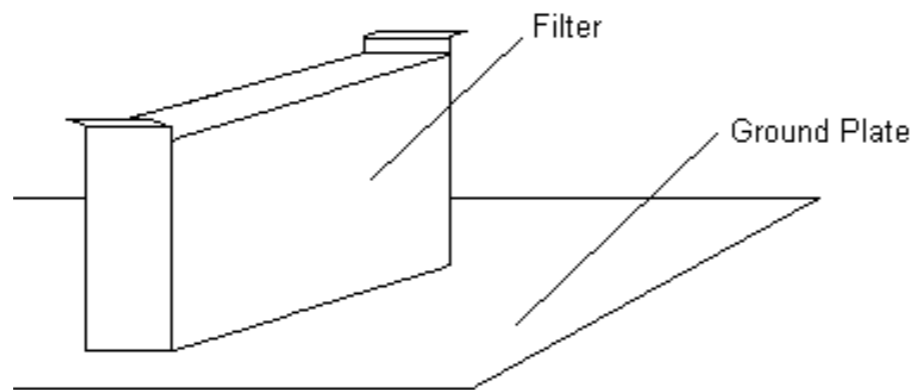
Limit 003a EN 55022, ITE-devices voltage class A, Detector QP.
060531_Project2 (150 k - 30 M): DT:Peak, ATT:20dB, STEP:7.5 kHz, BW:9 kHz, MT:10ms.

gemessen am: 05.31.2006 15:21:48

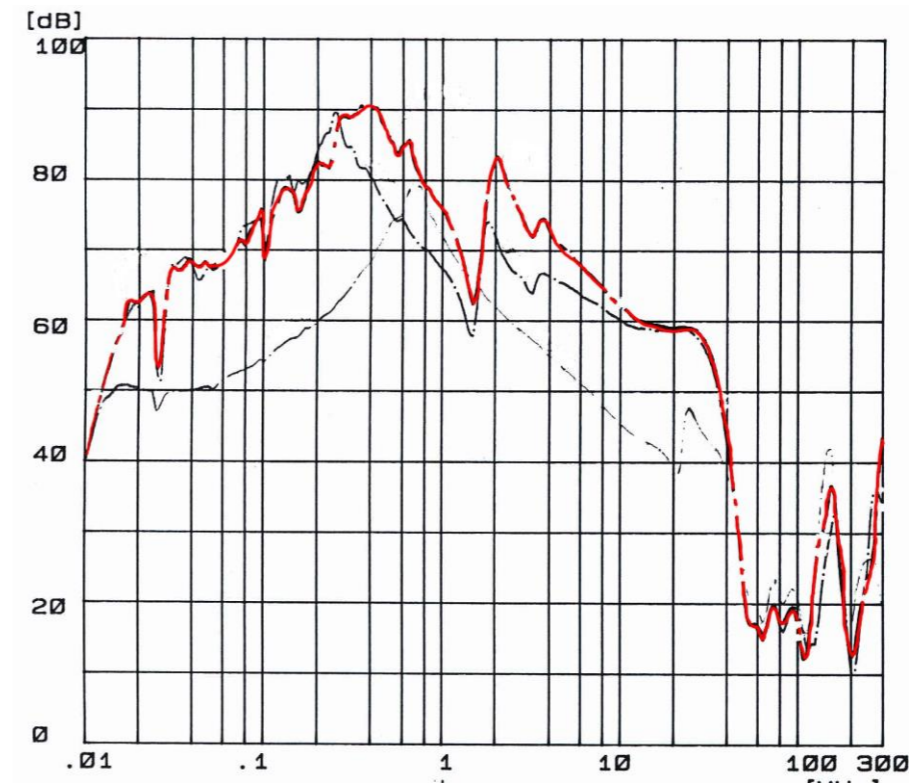
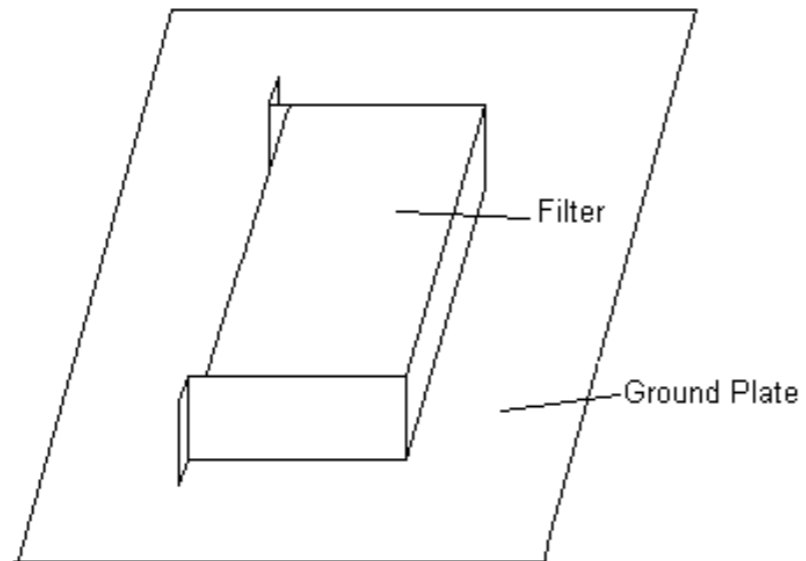
- > Filter mounted in a standard case
 - > Reduced connection area for earth



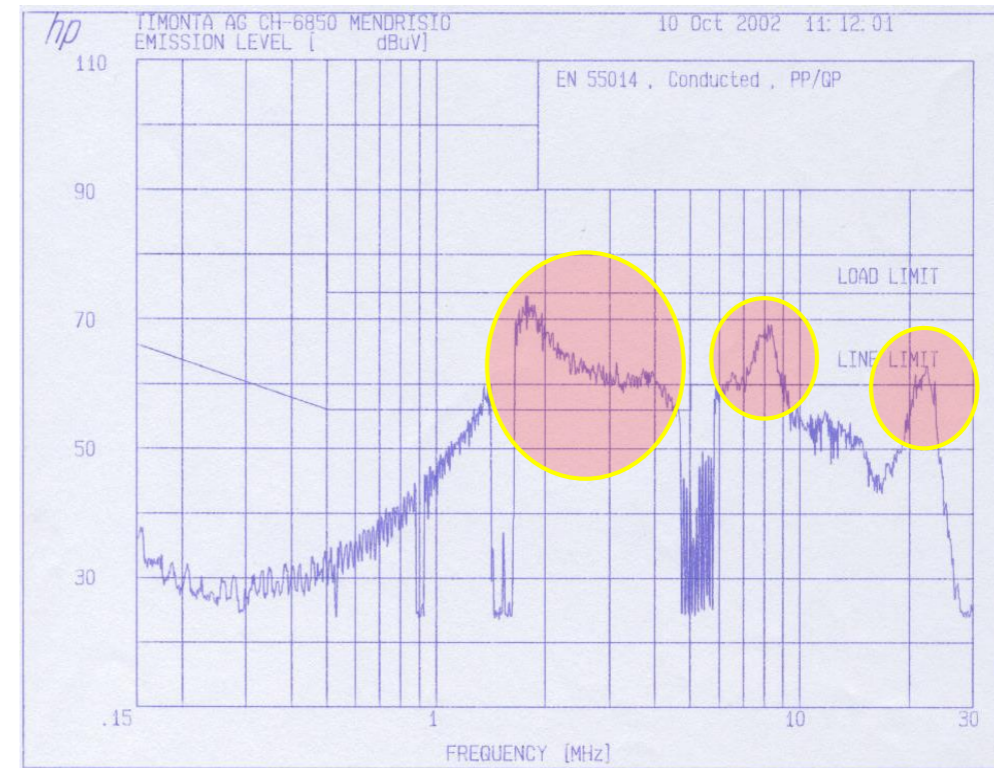
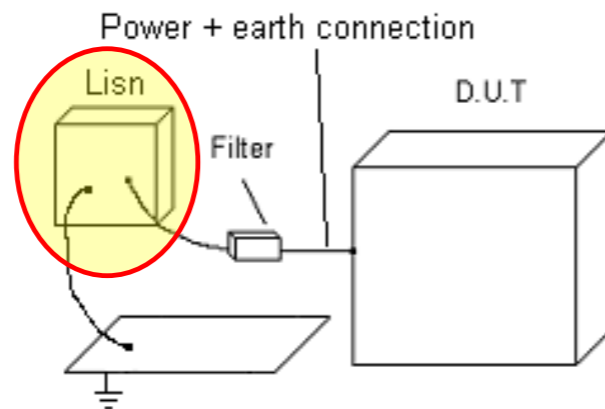
- > Filter mounted top down in a standard case
 - > medium connection area for earth



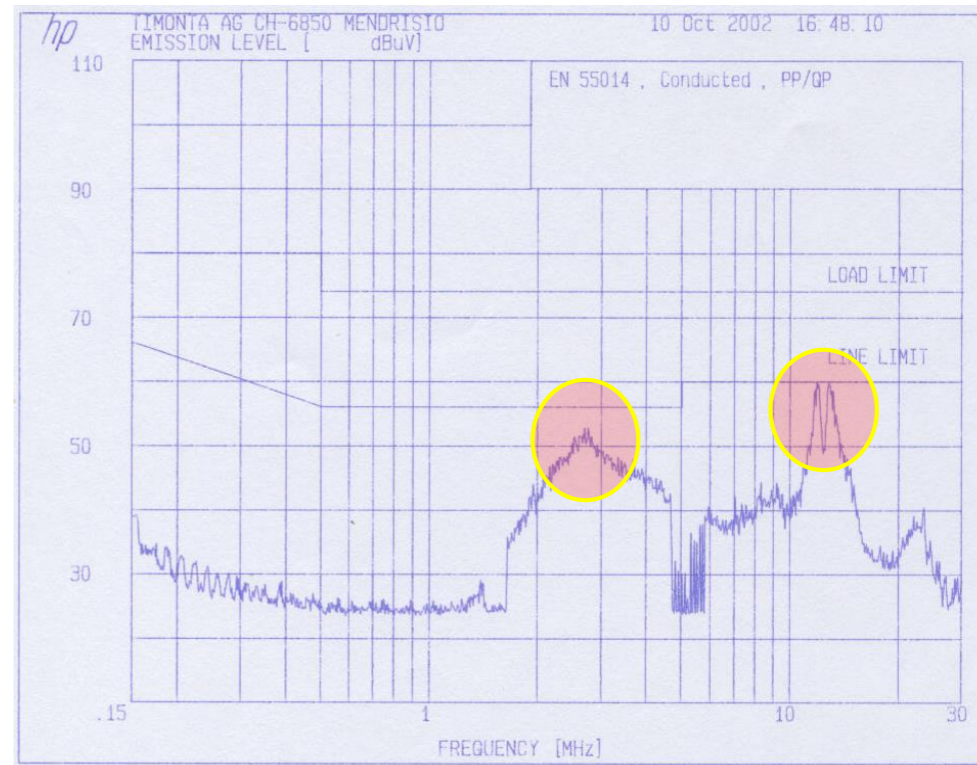
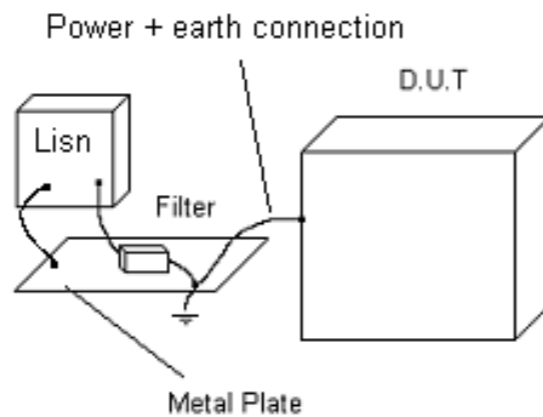
- > Filter mounted flat in a standard case
 - > large connection area for earth



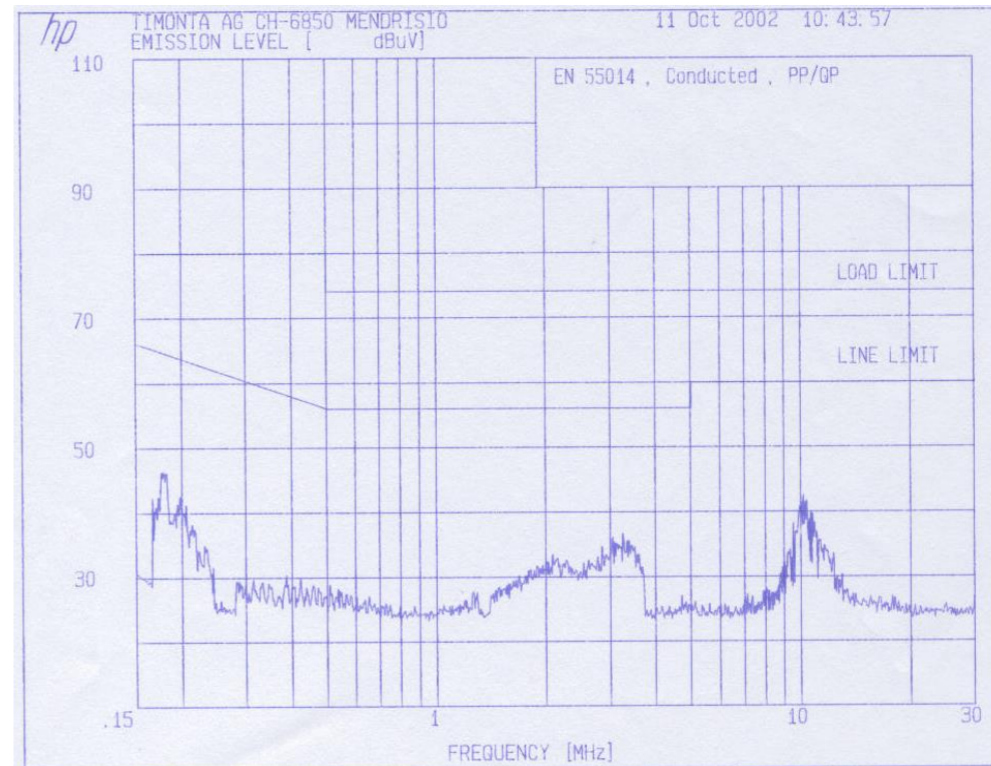
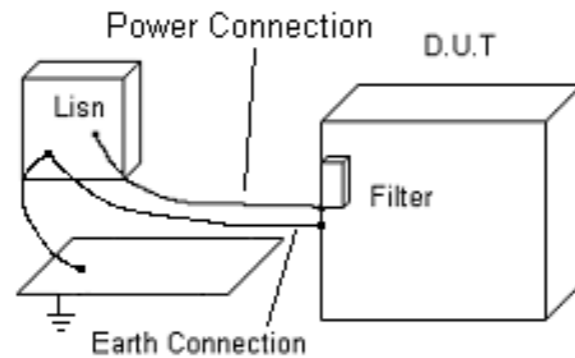
- > Filter connected outside the Device Under Test [DUT]

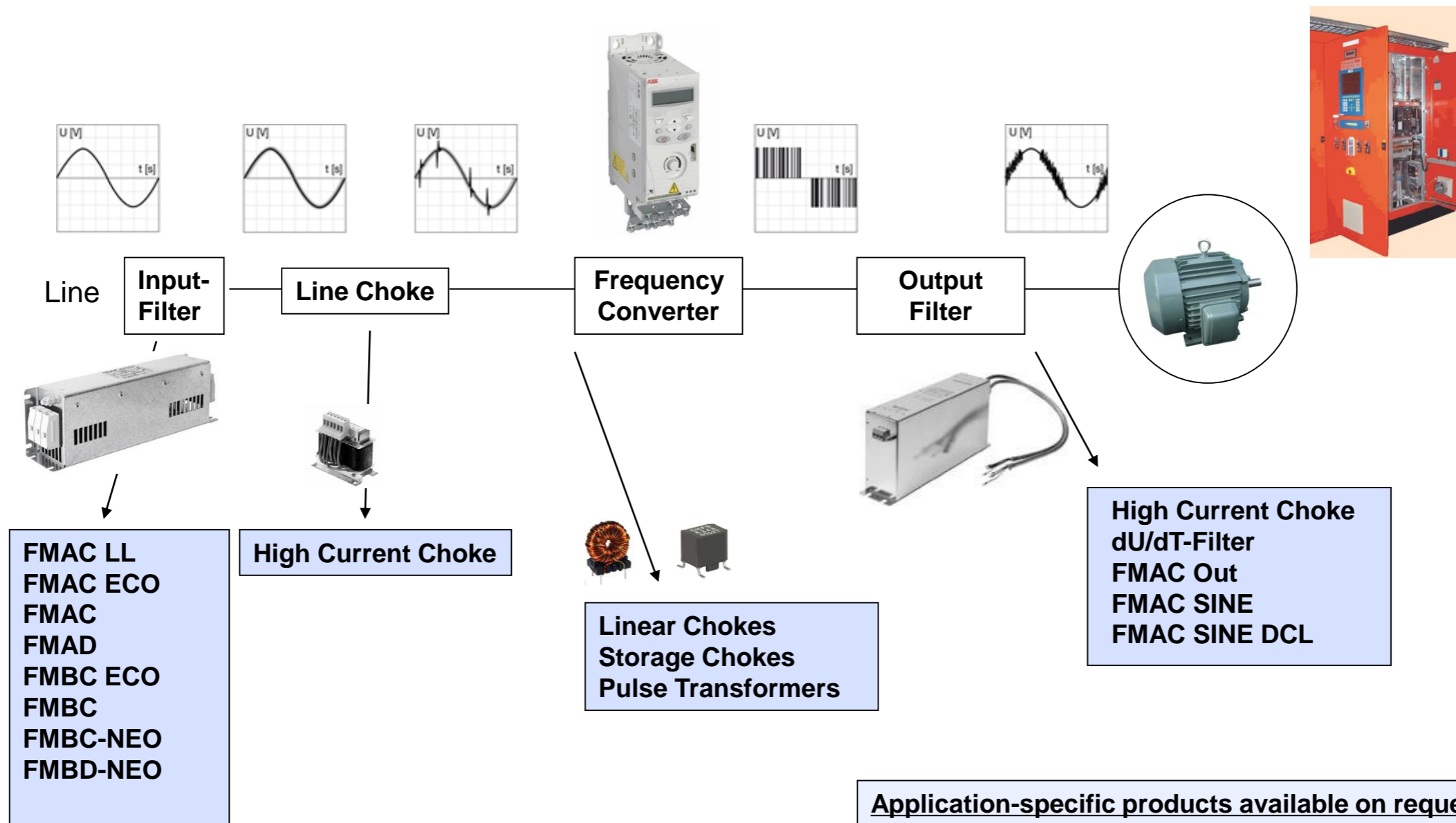


- > Filter connected outside the DUT but connected on a good earth plate



- > Filter connected inside the DUT
 - > **Note** that the DUT is not placed over the earth plate





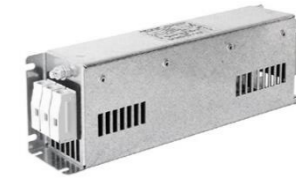
Application-specific products available on request with over 40 years of custom design experience.



General Rules

> Input filter

- > close to the motor drive
- > one central input filter for several inverters
- > use of 4 line filter (3L + N) instead of 3 line to reduce leakage currents



> Power-line choke

- > reduces the current's ripple factor along with harmonics



> Filter elements inside the inverter

- > Common mode / linear chokes on the inner DC circuit help to reduce on direct on the source

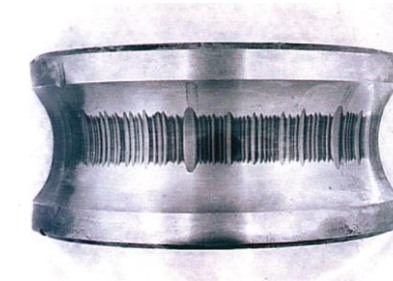


General Rules

> Output filters

> Sinewave filter

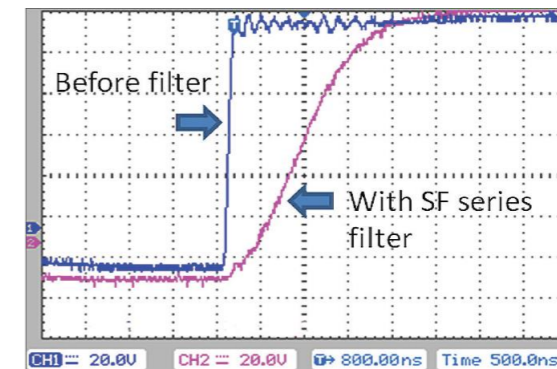
- > converts the PWM signal into corresponding sine waves
- > reduces noise and leakage currents to ground
- > The noise current can damage the motor bear rings

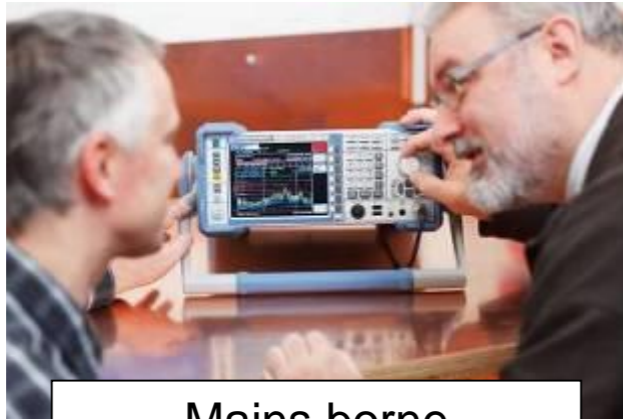


Bearing "fluting"
(NEMA Application Guide)

> dV/dt filter

- > on the drive output
- > reducing the slew rate of the motor voltage





Mains borne
emission



Immunity
Surge/burst



Central testing laboratory
in Lucerne



Radiated
emission*



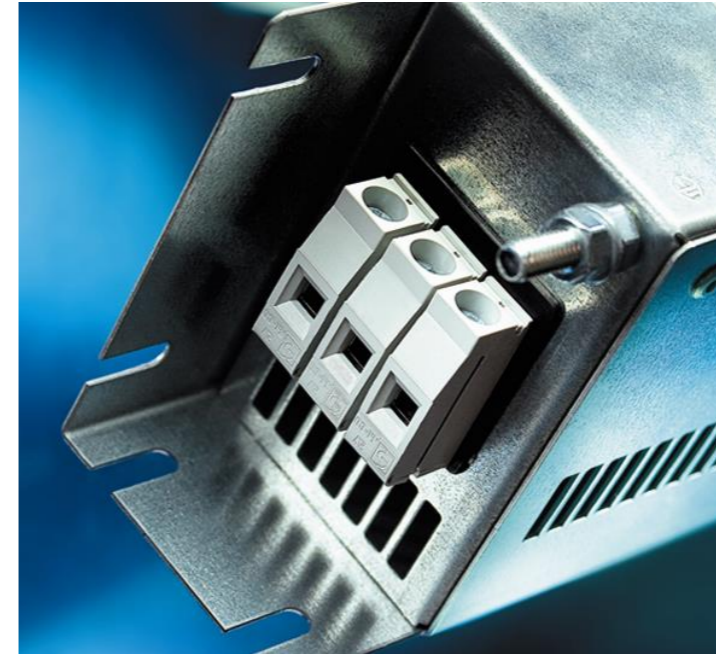
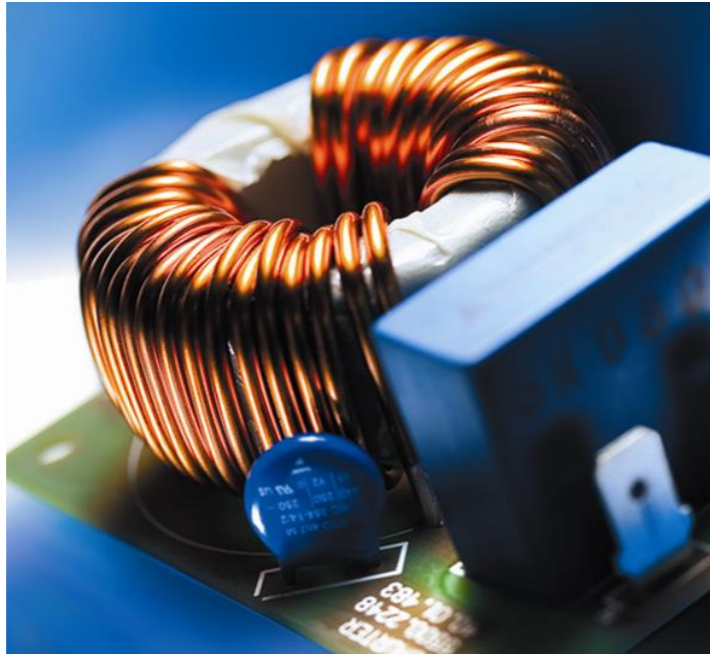
Immunity
ESD



Mobile for testing on
site

* = The measurements for radiated emission are carried out in an unscreened hall. The results lend themselves as reference value fixings during the development phase.





SCHURTER AG
Herbert Blum
Product Manager EMC
herbert.blum@schurter.ch

Thank you!





KONFERENCJA
EMC FOR BUSINESS



Kompatybilność Elektromagnetyczna w przemyśle,
na przykładzie systemów sterowania silnikami

Prelegent:
Herbert Blum
Product Manager EMC

herbert.blum@schurter.ch



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