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EMC-Testlab

Date: 2014-01-29
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Report No. 2013-113

Shielding effectiveness of the cabinet: InterscaleM 44H310B221T 4tlg Art.-Nr.: 14820175 made by Pentair Schroff GmbH

Customer: Pentair Schroff GmbH
Langenalber Str. 96-100
75334 Straubenhardt

Engineers: Dipl.-Ing. D. Geißler
Dipl.-Ing. C. Freitag

This report consists of 10 numbered pages and is valid only with authentic signature. The examination results are related to equipment under test only.

1 Subject of this report

This report describes the shielding effectiveness measured at 3 cabinets of the type InterscaleM 44H310B221T 4tlg Art.-Nr.: 14820175 made by Pentair Schroff GmbH.

2 General

Equipment under test:	InterscaleM 44H310B221T 4tlg Art.-Nr.: 14820175 made by Pentair Schroff GmbH
EUT received:	2013-11-21
Place of test facility:	EMV-Laboratory Institute of Electrical Energy Systems and High Voltage Engineering (IEH) KIT – Campus Süd Engesserstraße 11 76131 Karlsruhe
Test date:	2013-11-21 / -22
Environmental conditions:	temperature: 22,0 °C humidity: 33,3 % barometric pressure: 991 hPa
Representative customer:	Mr. Benko
Test engineer:	D. Geißler / C. Freitag
Applied standards:	Shielding effectiveness in the frequency range of 30 MHz to 1000 MHz according to VG 95373, Part 15 and in the extended frequency range of 1 GHz to 2 GHz in dependence on the mentioned standard

3 Test setup

3.1 Test equipment

Table 1: Test equipment for the frequency range of 30 MHz - 1 GHz

Name	Type	Manufacturer	Inventory number
Signal generator	SMIQ 06 ATE	R & S	07-100976
Power amplifier (9 kHz - 220 MHz)	BTA 0122-1000	BONN GmbH	950003
Power amplifier (220 - 1000 MHz)	BLWA 2010-200	BONN GmbH	950004
Sending antenna	UHALP9108-G	Schwarzbeck	050084
Receiving antenna	E-field probe, Mod.-Nr. 904, 3,6cm ball	Eaton	870035HO
Test receiver	ESVP	R & S	872991/0011

Table 2: Test equipment for the frequency range of 1 GHz – 2 GHz

Name	Type	Manufacturer	Inventory number
Network analyzer	ZVRE	R & S	272/0074/96
Power amplifier	25S1G4A	Amplifier Research	990043
Sending antenna	STLP 9149	Schwarzbeck	TL2008_28
Receiving antenna	E-field probe, Mod.-Nr. 904, 3,6cm ball	Eaton	870035HO

3.2 Setup

The EUT was fixed on upon a brass tubing in a semi anechoic chamber. The tube was used to shield and guide the measuring cable from the receiving antenna via tunnel under the ground plane to the test receiver. Possible eigenfrequencies of the test setup were suppressed with ferrites around the tubing.

Table 3: Position data of the test setup

	30 MHz – 1 GHz	1 GHz – 2 GHz
Height of the receiving antenna	1,16 m	1,16 m
Distance between sending and receiving antenna	3,4 m	1,7 m
Height of sending antenna	1,8 m	1,16 m
Polarization of sending antenna	vertical	vertical
Polarization of receiving antenna	vertical	vertical
Irradiated sides	left, right, top, bottom	left, right, top, bottom

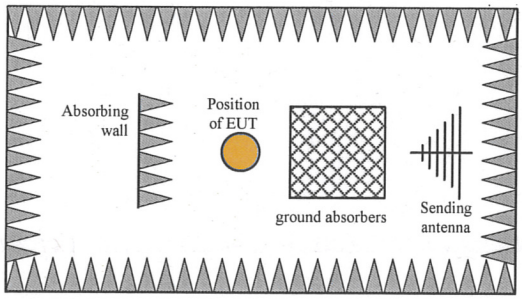

Fig. 1: Setup for 30 MHz – 1 GHz

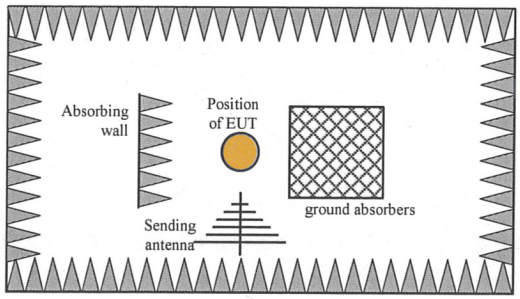

Fig. 2: Setup for 1 GHz – 2 GHz

3.3 Equipment under Test

Three identical and factory new cabinets of the type InterscaleM 44H310B221T 4tlg Art.-Nr.: 14820175 were tested one after another. The cabinets were identified with the labels G1, G2 and G3. Measurement results are drawn as average shielding effectiveness out of the 3 cabinets in blue color.

3.4 Measurement procedures

The measurement of the shielding effectiveness was performed according to the "middle point method" which describes an insertion-loss method.

Coupling is first measured with no enclosure present and afterwards with one inserted. During those measurements the distance between sending- and receiving antenna as well as the orientation and sending power P_0 are kept constant.

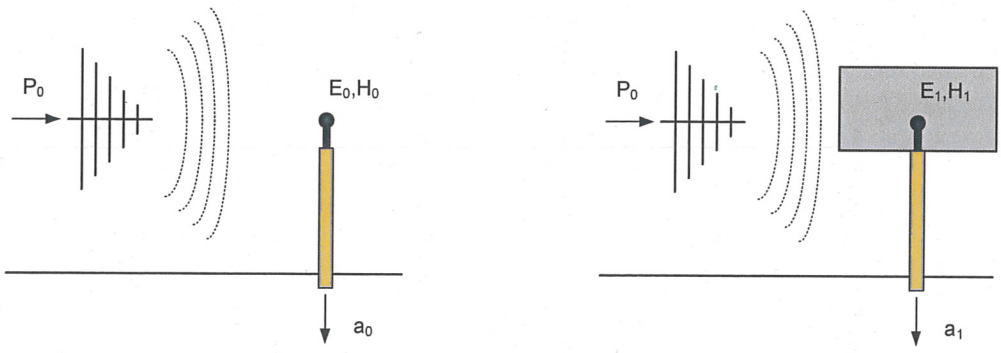

Fig. 3: Illustration of insertion-loss measurement method

The enclosure shielding effectiveness a_s is the difference between the reference level a_0 without and the level a_1 with applied shielding (Fig. 3).

$$a_s = a_0 - a_1 \text{ in dB}$$

In order to reduce the influence of resonances inside the cabinet the measurement results for shielding effectiveness are smoothed by a moving average filter with a width of 10 frequency points.

3.5 Dynamic range

The dynamic range a_D is determined as the difference between reference level a_0 and the level a_2 without receiving antenna and a reflection free enclosed cable (Fig. 4).

$$a_D = a_0 - a_2 \text{ in dB}$$

The dynamic range is quantification for the maximum shielding effectiveness achievable with the used test setup. It depends on the noise level of the equipment (e.g., the shielding effectiveness of the cables) and the intrinsic noise of the receiver. In the measurement results the dynamic range is colored in red.

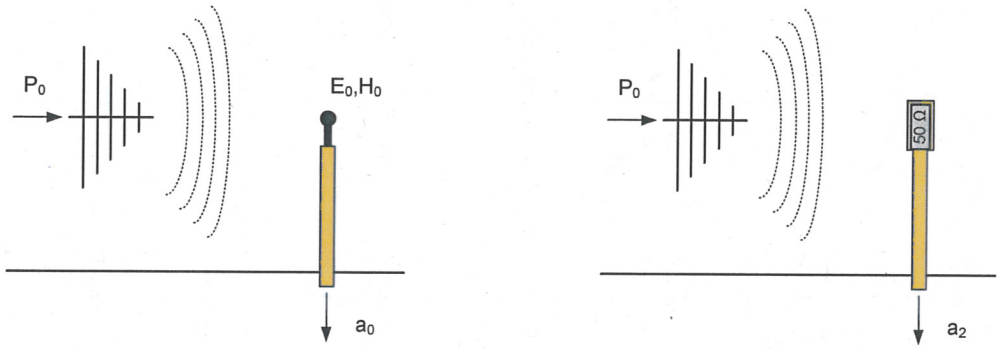

Fig. 4: Determination of the dynamic range

3.6 Pictures of the EUT as part of the test setup

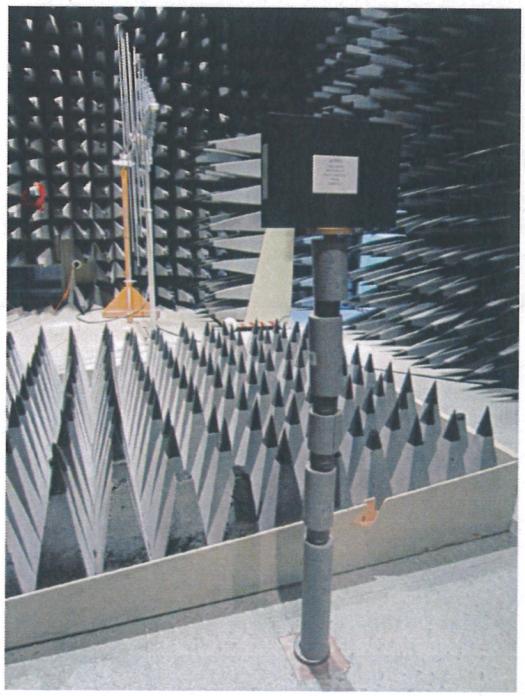

Fig. 5: Setup for the frequency range of 30 MHz – 1 GHz

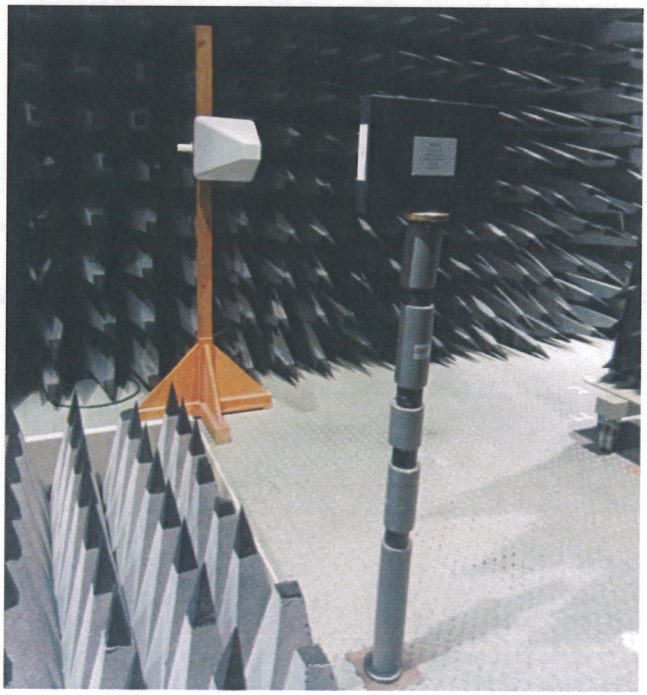

Fig. 6: Setup for the frequency range of 1 – 2 GHz

4 Results

4.1 Measured shielding effectiveness from 30 MHz - 1 GHz

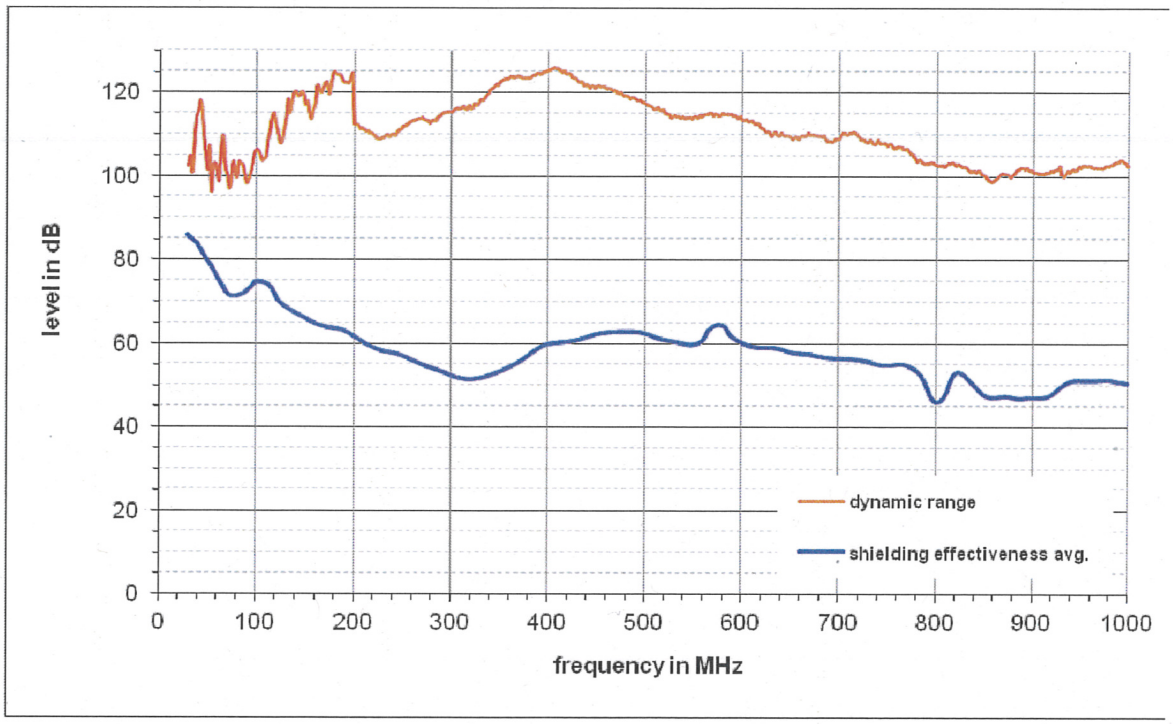

Fig. 7: Average of shielding effectiveness for G1, G2 and G3 with direct radiation on LEFT-side

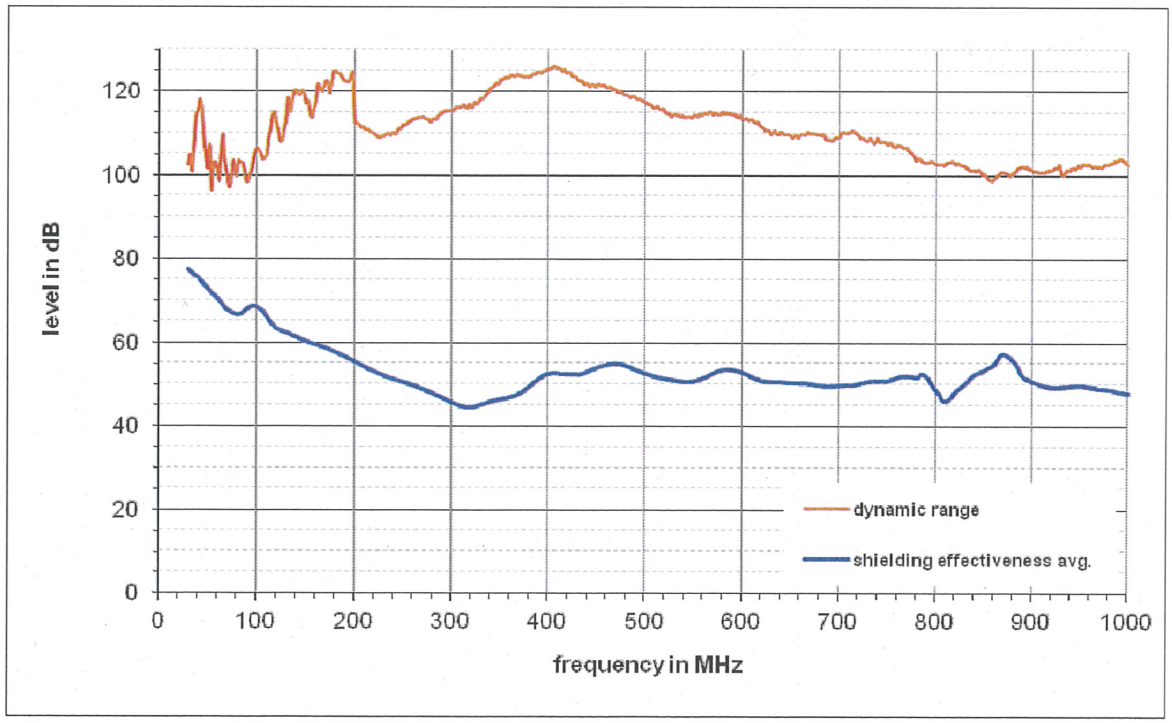

Fig. 8: Average of shielding effectiveness for G1, G2 and G3 with direct radiation on RIGHT-side

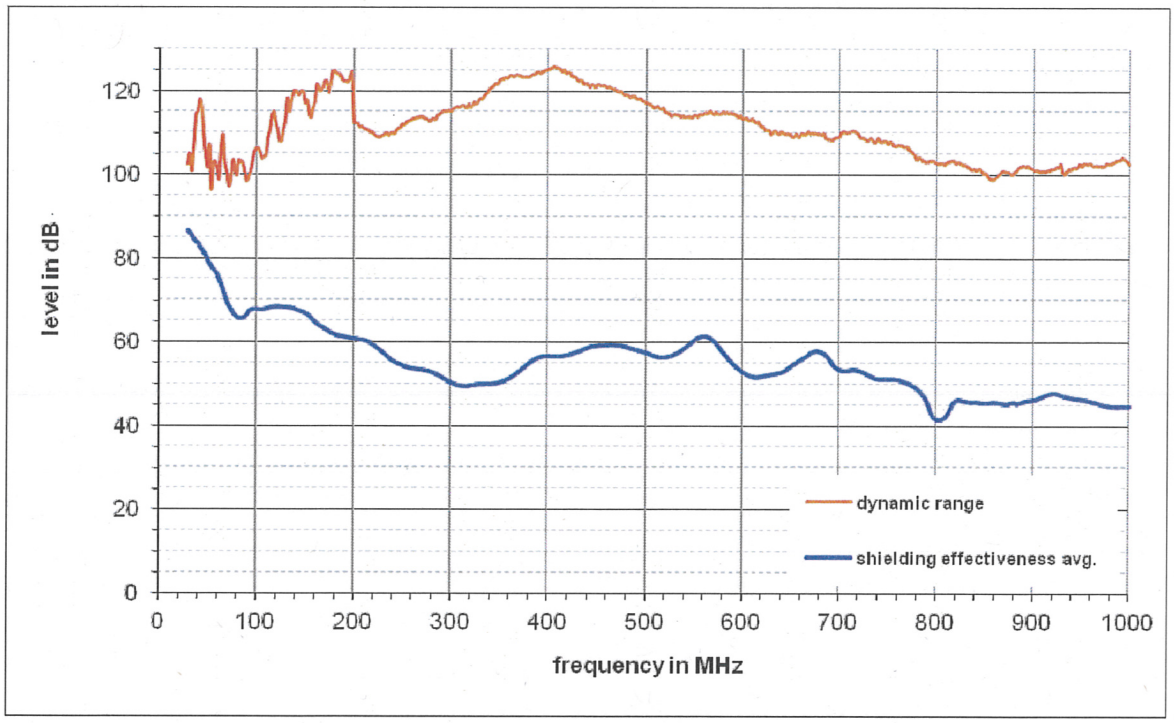

Fig. 9: Average of shielding effectiveness for G1, G2 and G3 with direct radiation on TOP-side

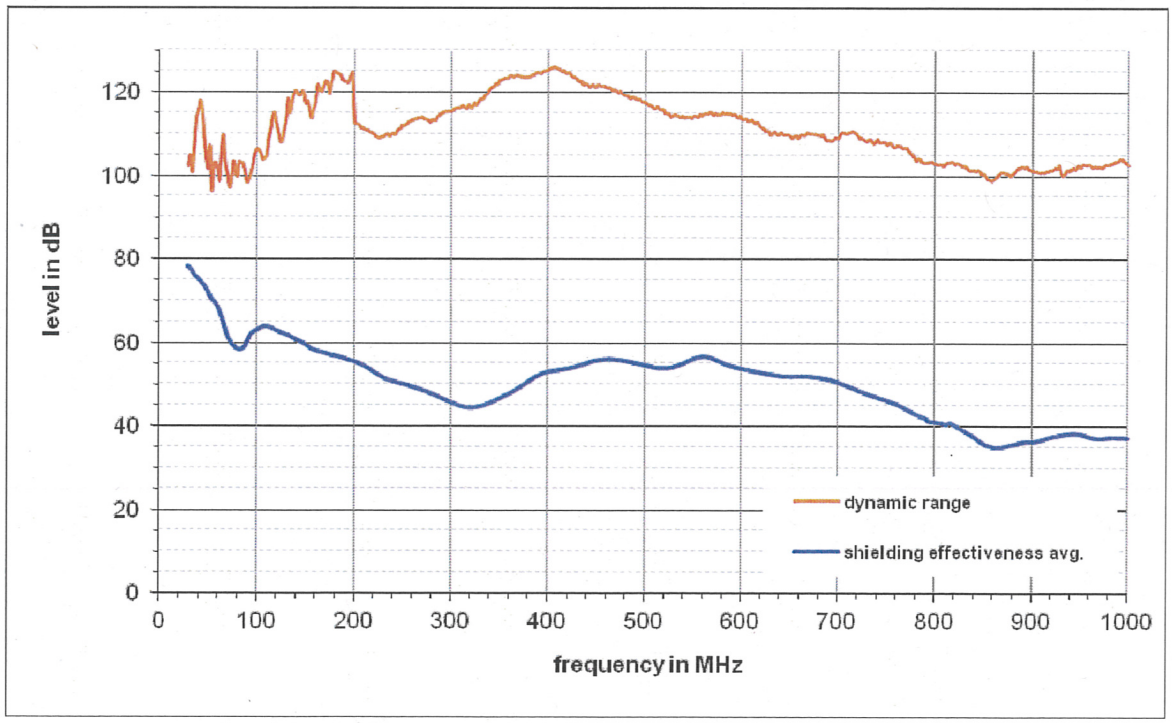

Fig. 10: Average of shielding effectiveness for G1, G2 and G3 with direct radiation on BOTTOM-side

4.2 Measured shielding effectiveness from 1 - 2 GHz

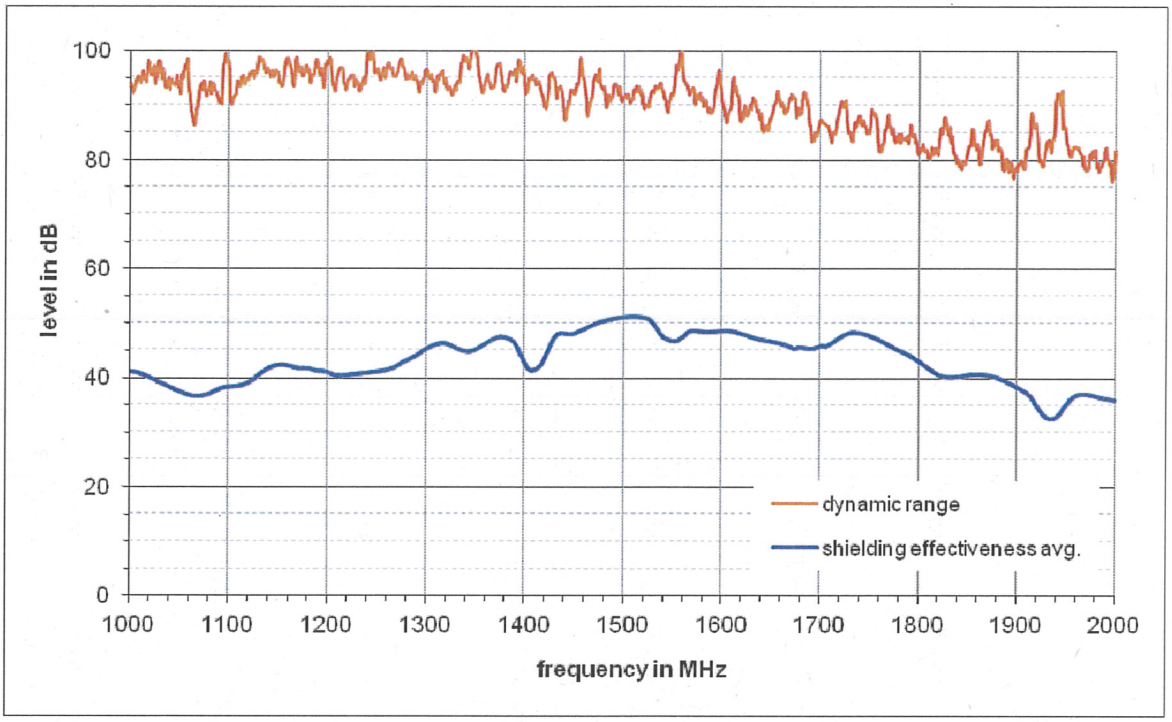

Fig. 11: Average of shielding effectiveness for G1, G2 and G3 with direct radiation on LEFT-side

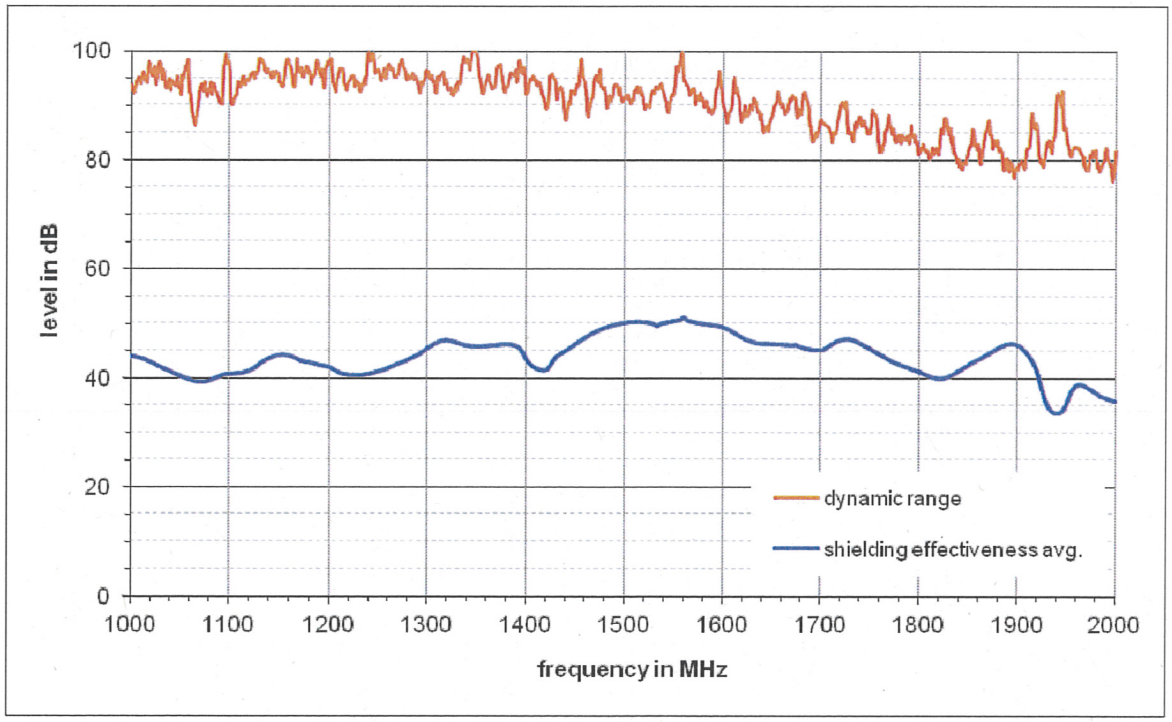

Fig. 12: Average of shielding effectiveness for G1, G2 and G3 with direct radiation on RIGHT-side

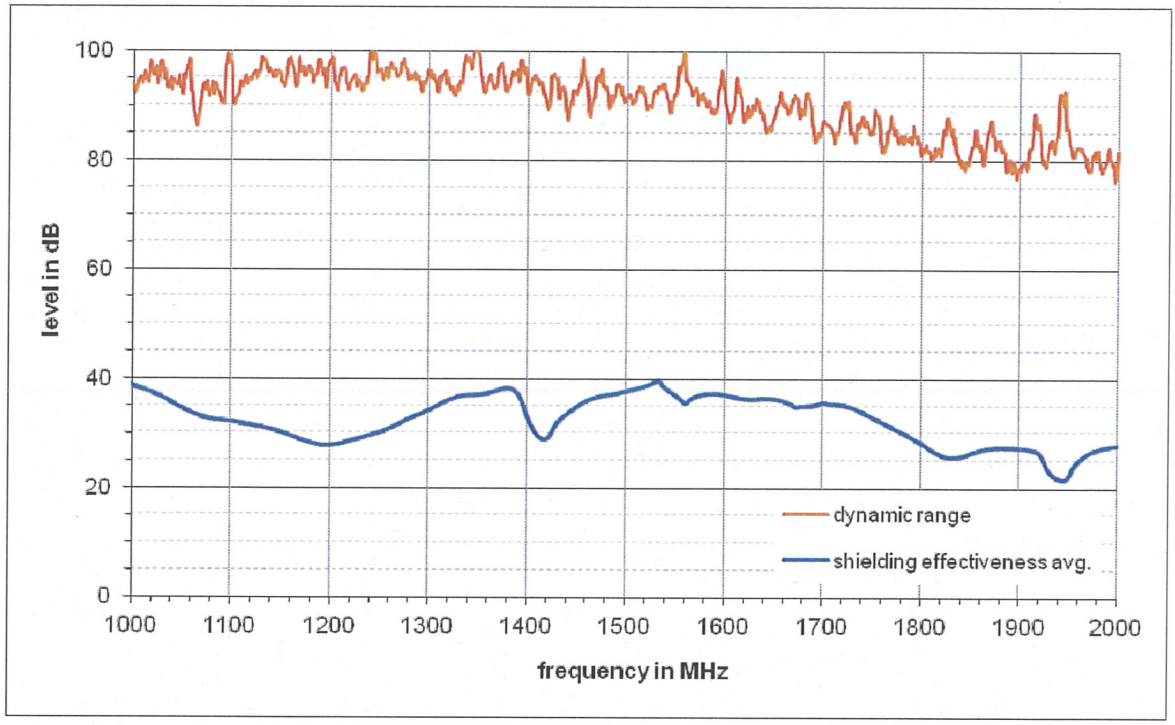

Fig. 13: Average of shielding effectiveness for G1, G2 and G3 with direct radiation on TOP-side

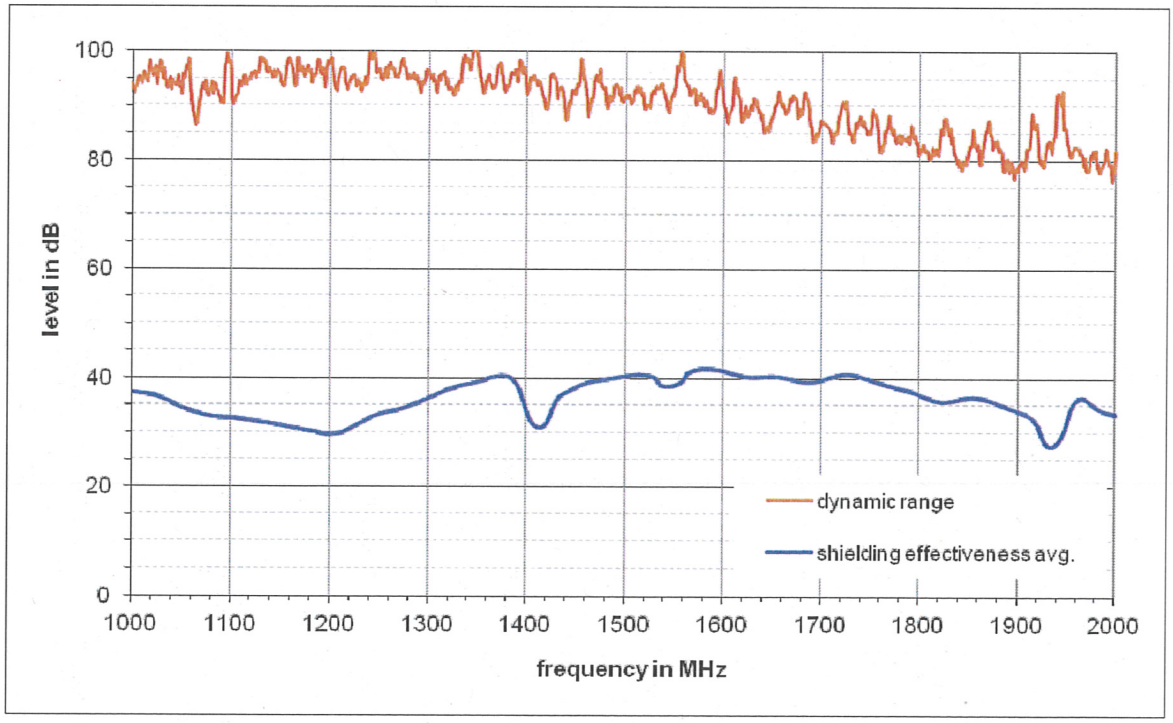

Fig. 14: Average of shielding effectiveness for G1, G2 and G3 with direct radiation on BOTTOM-side

4.3 Typical shielding effectiveness and worst-case scenario

Additionally to the measurements above, with direct radiation on one side of the EUT, an overall worst-case scenario for each cabinet G1, G2 and G3 as well as for the average was calculated. Therefore the total minimum shielding effectiveness of the 4 sides was calculated for every frequency.

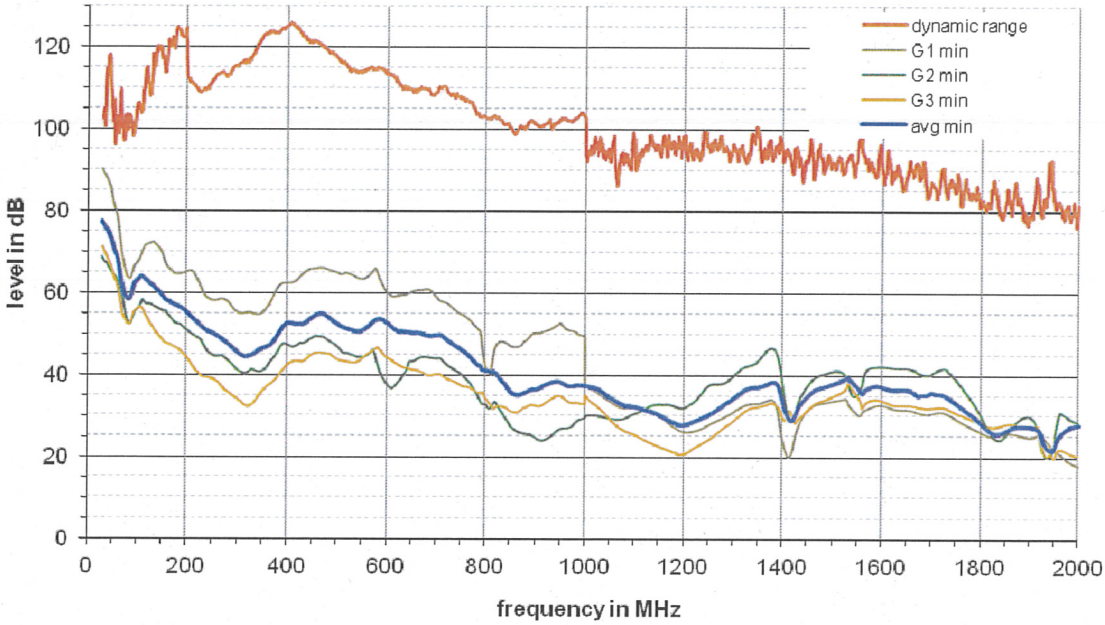

Fig. 15: Typical shielding effectiveness and worst case scenarios of G1, G2 and G3 and the average

5 Conclusion

Shielding effectiveness measurements of the cabinet InterscaleM 44H310B221T 4tlg Art.-Nr.: 14820175 made by Pentair Schroff GmbH were performed in the frequency range of 30 MHz to 2 GHz on the basis of three identical and factory new cabinets.

The results of those measurements are displayed as average graphs in Fig. 7 to Fig. 14. The additionally calculated worst-case scenarios for each cabinet and the average are shown in Fig. 15.

Responsible for the proper execution of the measurements in accordance with acknowledged rules of technology

Karlsruhe, 2014-01-29

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(Head of EMC-testing)	(Deputy Head of EMC-testing)	(Director)