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Date: 2016-04-26

Report No. 2016-37

Shielding effectiveness of the subrack: InterscaleC 94H 184B 189T part no. 14830-005 made by Pentair Technical Solutions GmbH

Customer: Pentair Technical Solutions GmbH
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75334 Straubenhardt

Engineers: M. Zimmerlin M.Sc.
M. Görtz M.Sc.

1 Subject of this report

This report describes the shielding effectiveness measured at 1 cabinet of the type InterscaleC 94H 184B 189T part no. 14830-005 made by Pentair Technical Solutions GmbH.

2 General

Equipment under test (EUT):	InterscaleC 94H 184B 189T part no. 14830-005 with I/O-Shield and masked connector slots		
EUT received:	2016-03-08		
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:	2016-03-10		
Environmental conditions:	temperature: humidity: barometric pressure:	20 23 1003	°C % hPa
Representative customer:	Mr. Benko, Mr. Curatolo		
Test engineer:	D. Geißler, C. Freitag, M. Görtz, M. Zimmerlin		
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 1: 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	2,30 m	1,16 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, top, bottom	left, top, bottom

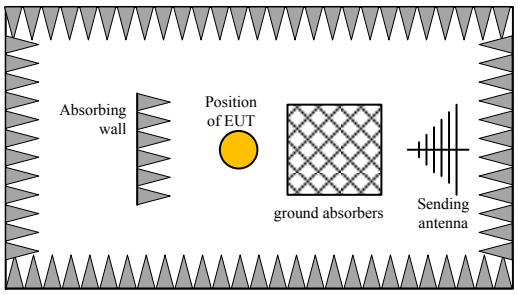

Fig. 1: Setup for 30 MHz – 1 GHz

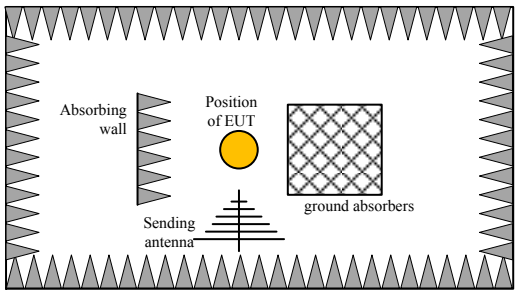

Fig. 2: Setup for 1 GHz – 2 GHz

3.3 Equipment under Test

One factory new cabinets of the type InterscaleC 94H 184B 189T part no. 14830-005 with I/O-Shield and masked connector slots was tested. The cabinet has been identified with the label G6. Thereby only the critical sides left, top and bottom have been irridiated.

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.

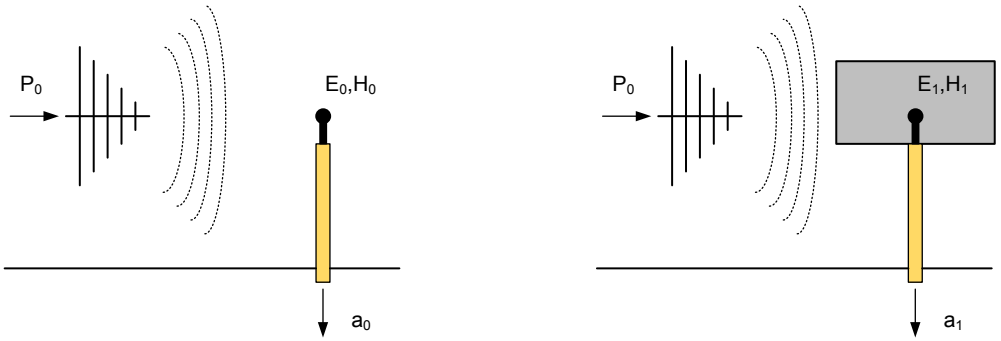

Fig. 3: Illustration of insertion-loss measurement method

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 an 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).

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

Dynamic range is a 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.

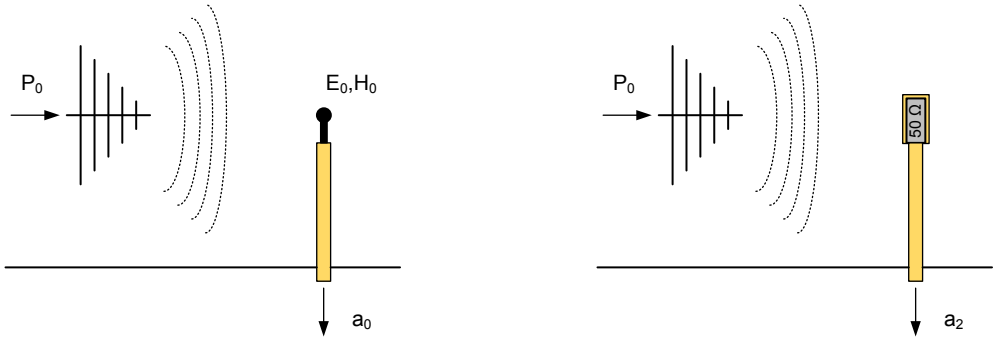

Fig. 4: Determination of the dynamic range

3.6 Pictures of the EUT as part of the test setup

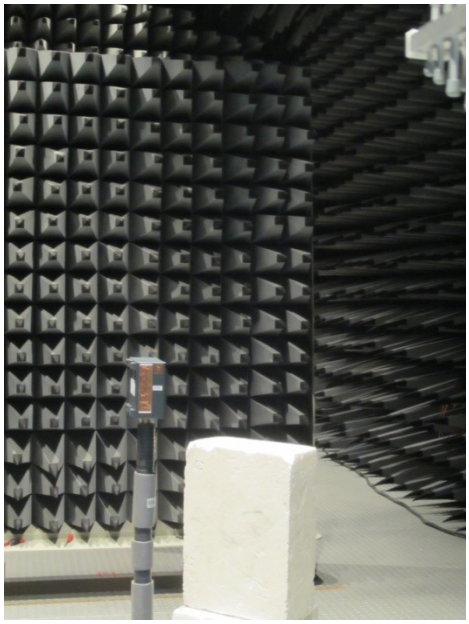

Fig. 5: Setup for the frequency range of 30 MHz - 1 GHz

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

4 Results

4.1 Measured shielding effectiveness from 30 MHz - 1 GHz

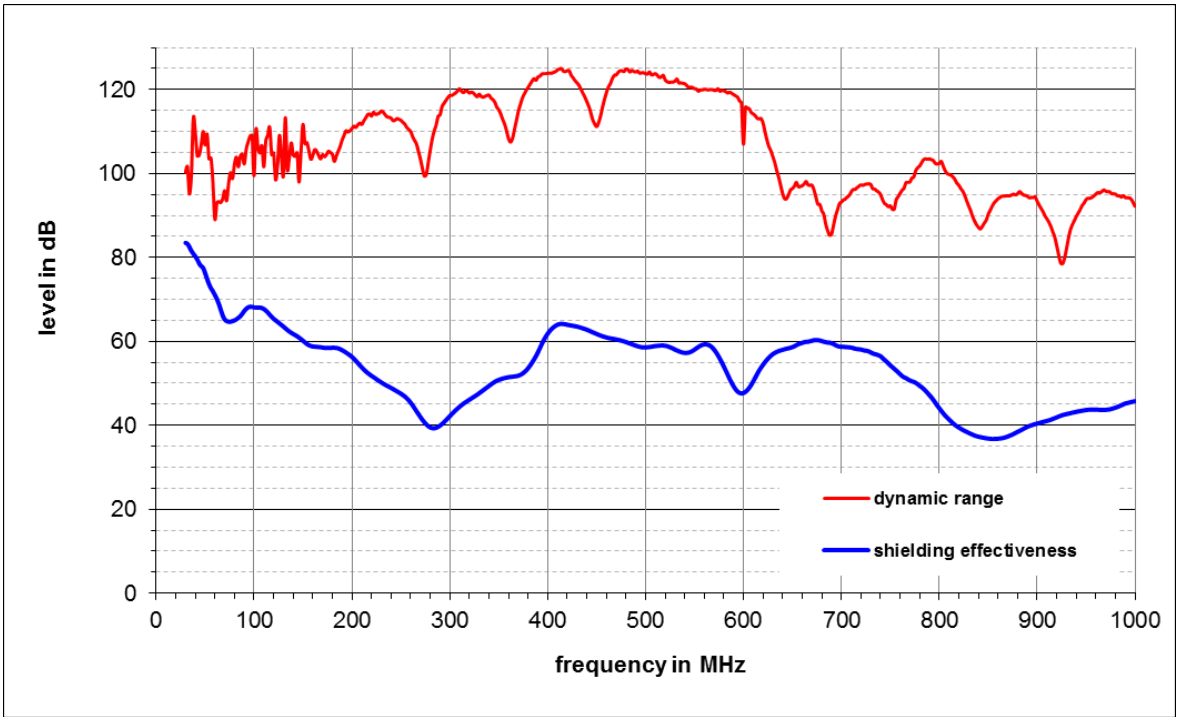

Fig. 7: Measurement results for direct radiation on LEFT-side of the EUT

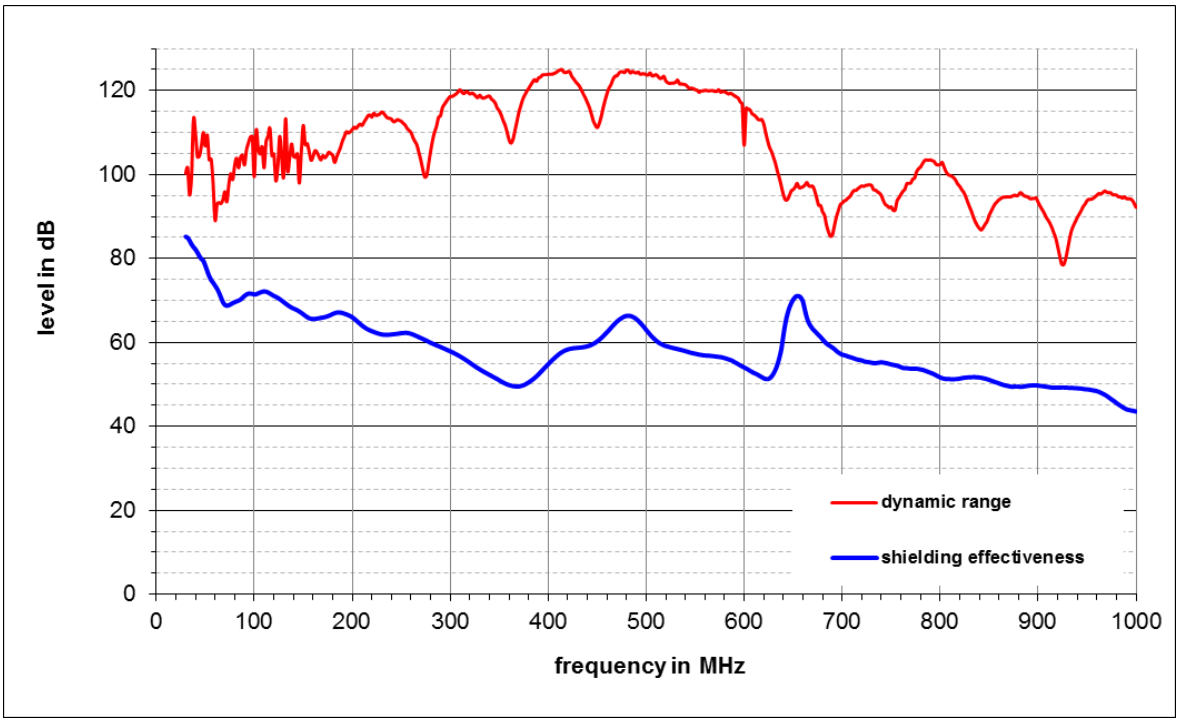

Fig. 8: Measurement results for direct radiation on TOP-side of the EUT

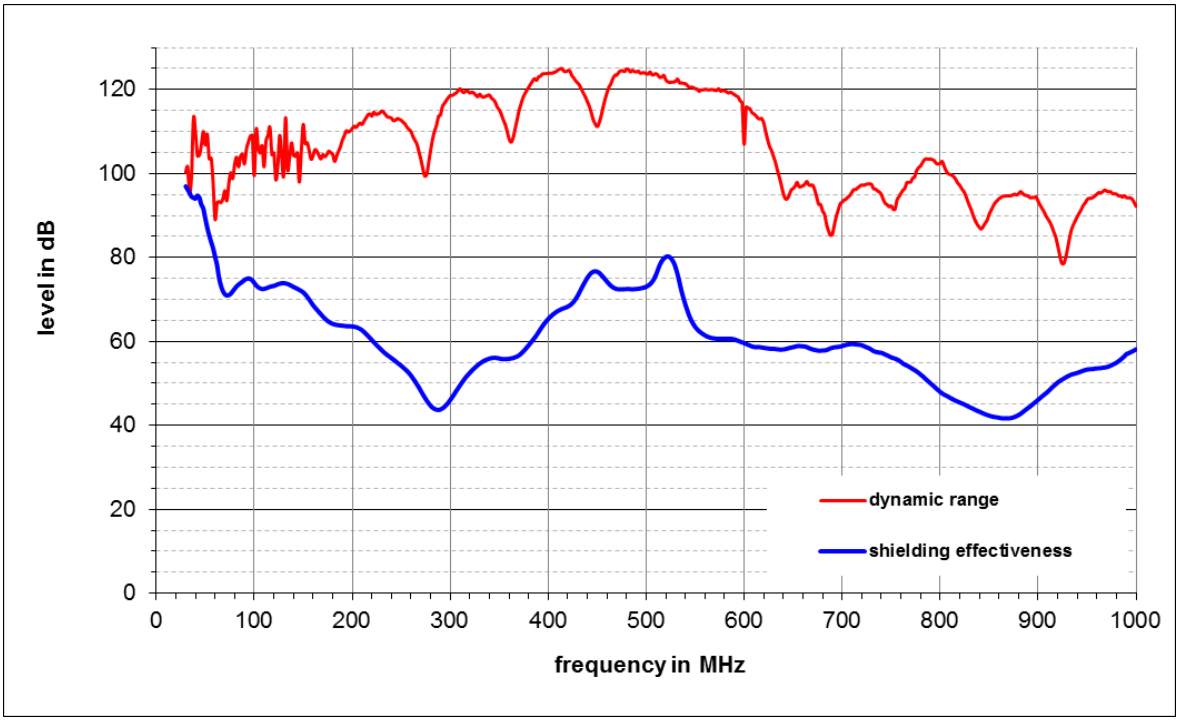

Fig. 9: Measurement results for direct radiation on BOTTOM-side of the EUT

4.2 Measured shielding effectiveness from 1 GHz - 2 GHz

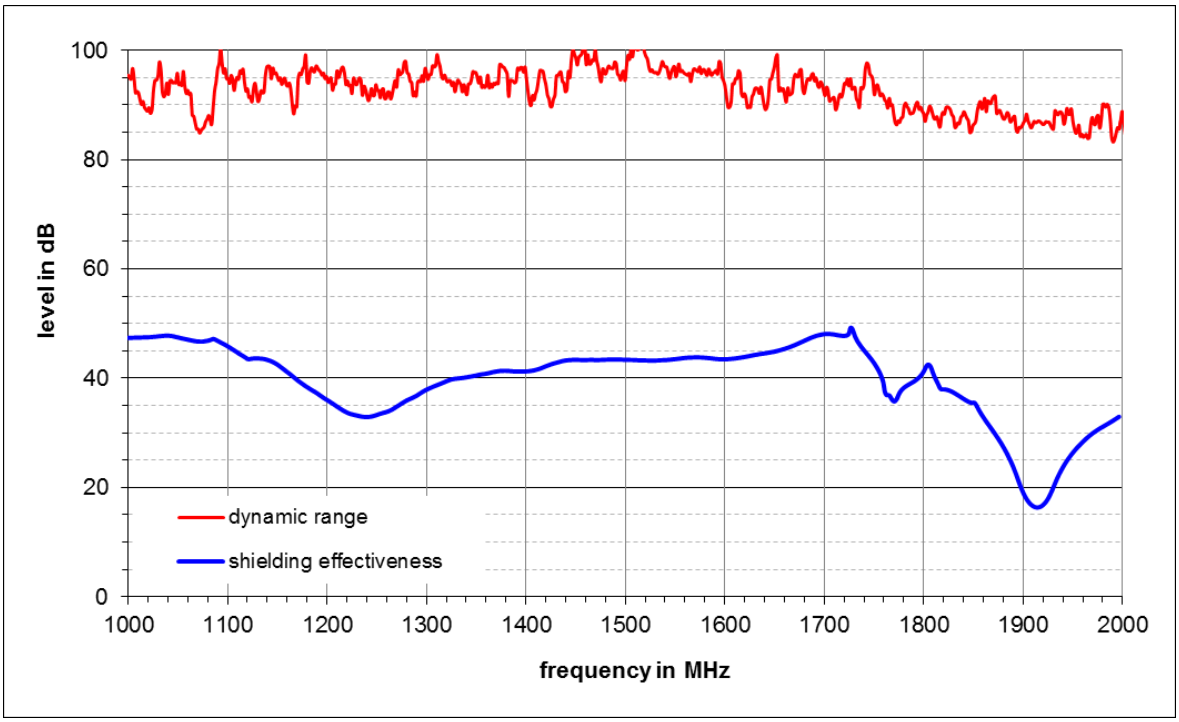

Fig. 10: Measurement results for direct radiation on LEFT-side of the EUT

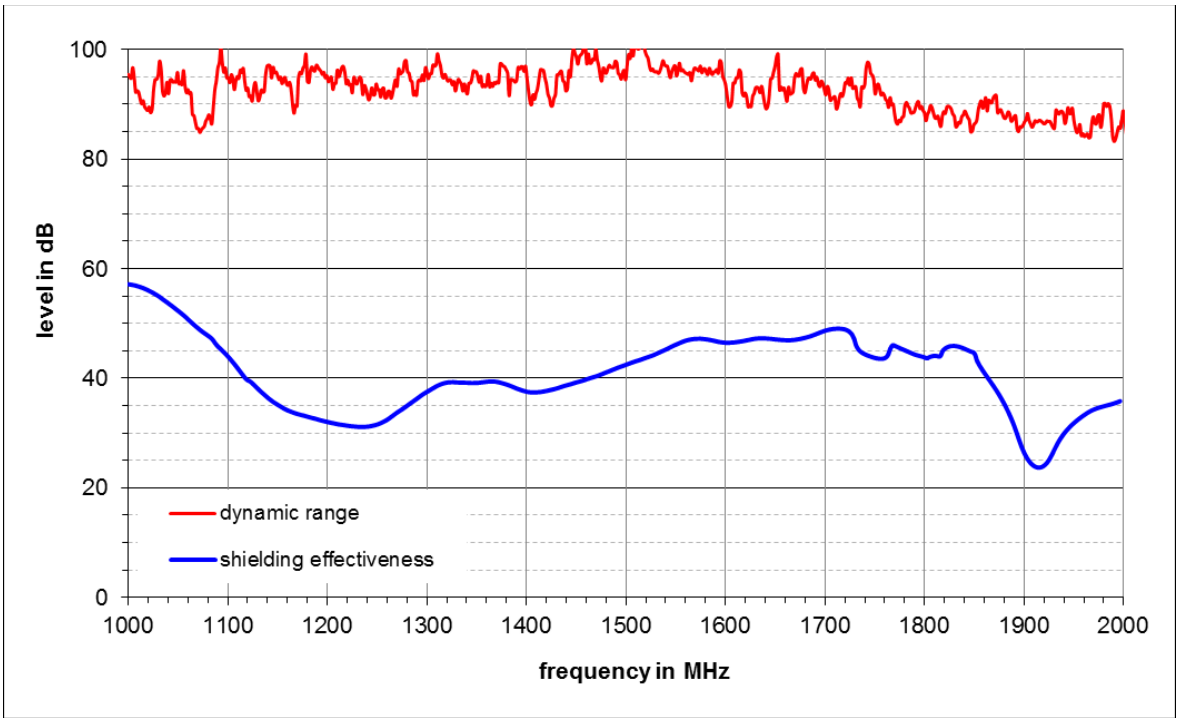

Fig. 11: Measurement results for direct radiation on TOP-side of the EUT

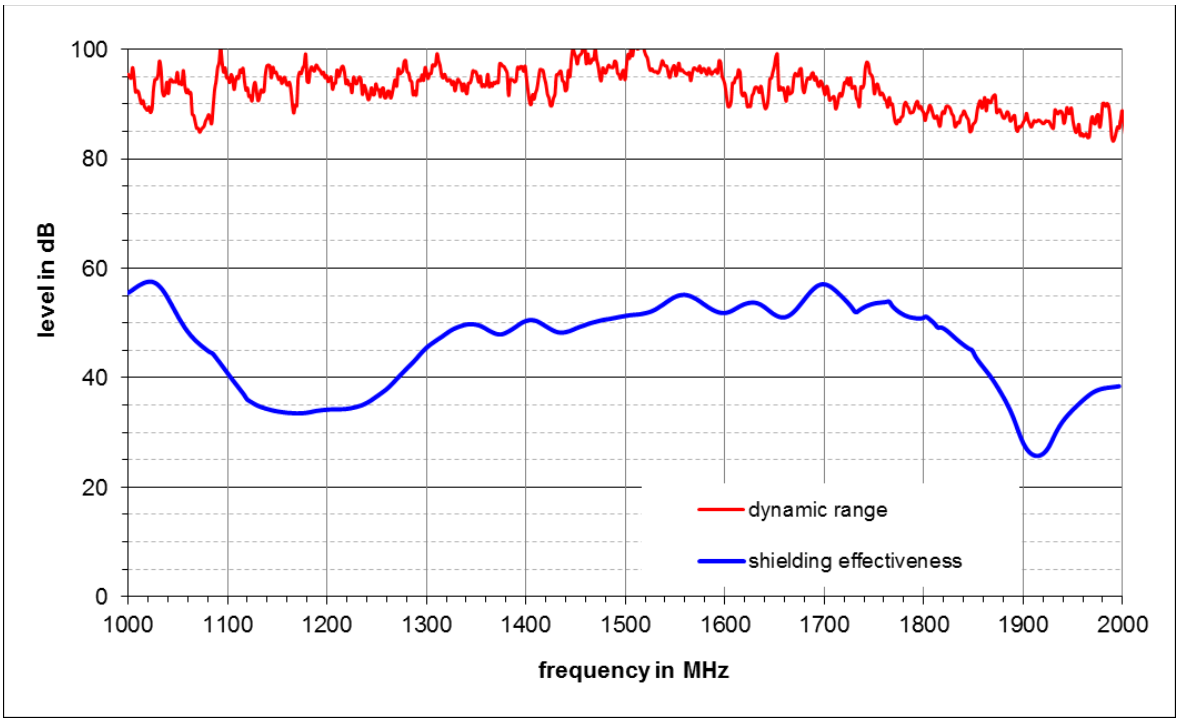

Fig. 12: Measurement results for direct radiation on BOTTOM-side of the EUT

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 was calculated, using the total minimum shielding effectiveness of the previously recorded values. Fig. 13 shows a typical shielding effectiveness of the EUT after an inserted smoothing of resonance frequencies.

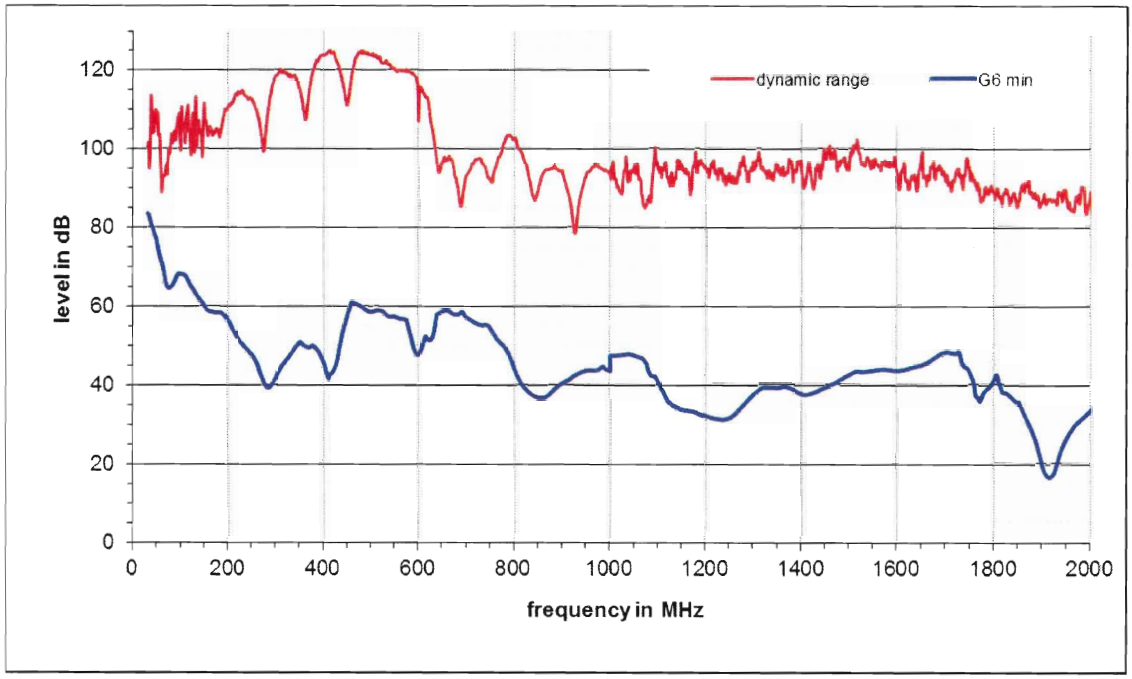

Fig. 13: Typical shielding effectiveness and worst case scenarion of the EUT

5 Conclusion

Shielding effectiveness measurements of the cabinet InterscaleC 94H 184B 189T part no. 14830-005 made by Pentair Technical Solutions GmbH were performed in the frequency range of 30 MHz to 2 GHz.

The results of those measurements are displayed as average graphs in Fig. 7 to Fig. 12. The additionally calculated worst-case scenario for the cabinet is shown in Fig. 13.

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

Karlsruhe, 2014-04-26

Martin Zimmerlin M.Sc.	Max Görtz M.Sc.	Prof. Dr.-Ing. T. Leibfried (Director)