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Date: 2020-11-04

Report Nr. 2020 – 02

Shielding effectiveness of an enclosure type IP-Pro ALU EMC manufactured by nVent in a frequency range of 30 MHz – 4 GHz

Customer: nVent
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Engineers: Max Görtz, M.Sc.

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1 General

Equipment under test (EUT):	Enclosure IP-Pro ALU EMC 26880-008 manufactured by nVent
EUT received:	2020-01-27
Place of test facility:	EMC-Laboratory Institute of Electrical Energy Systems and High Voltage Engineering (IEH) KIT – Campus Süd Engesserstraße 11 76131 Karlsruhe Testing laboratory accredited by DAkkS according to DIN EN ISO/IEC 17025:2005. The accreditation is valid only for the standards listed in the annex of the accreditation certificate No. D-PL-11068-09-00.
Test date:	2020-01-31
Environmental conditions:	temperature: 20,8 °C humidity: 33,2 % barometric pressure: 1002 hPa
Representative customer:	Mr. Daniel Dörflinger
Test engineer:	M. Görtz
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 4 GHz in dependence on the mentioned standard as well as IEEE 299-2006.

2 Conclusion

Shielding effectiveness measurements of an enclosure type IP-Pro ALU EMC 26880-008 manufactured by nVent were performed in a frequency range of 30 MHz – 4 GHz.

The results of those measurements are depicted in Figure 12 to Figure 19. The additionally calculated worst-case scenario is shown in Figure 20.

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

Karlsruhe, 2020-11-04

Dr.-Ing. Michael Suriyah (Head of EMC-testing)	Prof. Dr.-Ing. T. Leibfried (Director)

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
Network analyzer	ZVRE	R & S	272/0074/96
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

Table 2: Test equipment for the frequency range of 1 GHz – 4 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	990042
Receiving antenna	E-field probe, Mod.-Nr. 904, 3,6cm ball	Eaton	870035HO

3.2 Setup

The EUT was situated in a semi anechoic chamber during all measurements. The receiving antenna in the middle of the EUT was connected to the test receiver through the right interface panel. The measuring cable was guided via tunnel under the ground plane. Positions of sending antenna and EUT changed due to different measurement setup above a frequency of 1 GHz (see Table 1, Figure 1 and Figure 2).

Table 3: Position data of the test setup

	30 MHz – 1 GHz	**1 GHz – 4 GHz**
Height of the receiving antenna	1,40 m	1,40 m
Distance between sending and receiving antenna	3,1 m	1,15 m
Height of sending antenna	1,8 m	1,42 m
Polarization of sending antenna	vertical	Vertikal
Polarization of receiving antenna	vertical	Vertikal
Irradiated sides	left, right, front, back	left, right, front, back

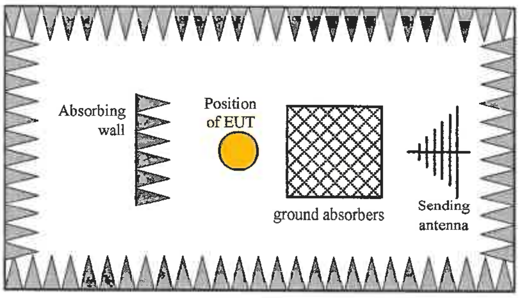


Figure 1: Setup for 30 MHz – 1 GHz

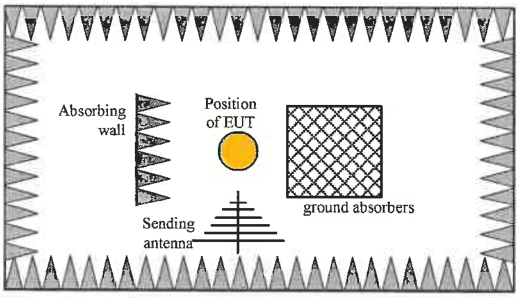


Figure 2: Setup for 1 GHz – 4 GHz

3.3 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.

Hence, the receiving antenna was connected through the bottom side of the EUT (see figures 8, 9, 10 and 11), a reference level for each of the four side of the EUT was recorded.

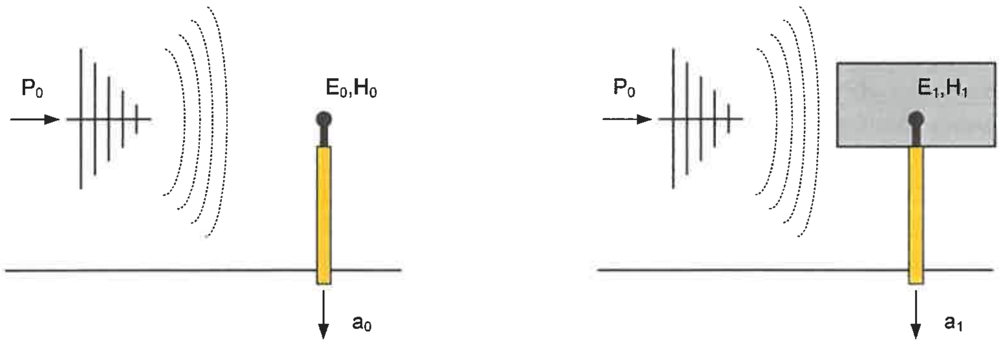


Figure 3: Illustration of insertion-loss measurement method

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

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

3.4 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 (Figure 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. The reference level depends on investigated side of the EUT and therefore a dynamic range for each side was measured. Figure 5 gives an overview of the achieved dynamic in the entire frequency range.

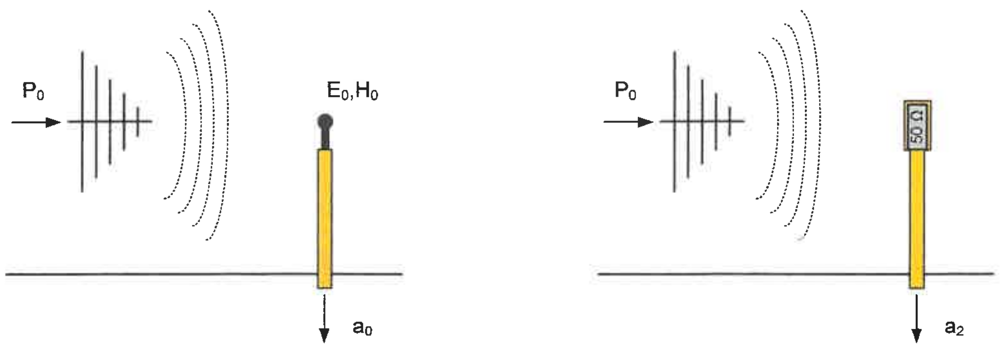


Figure 4: Determination of the dynamic range

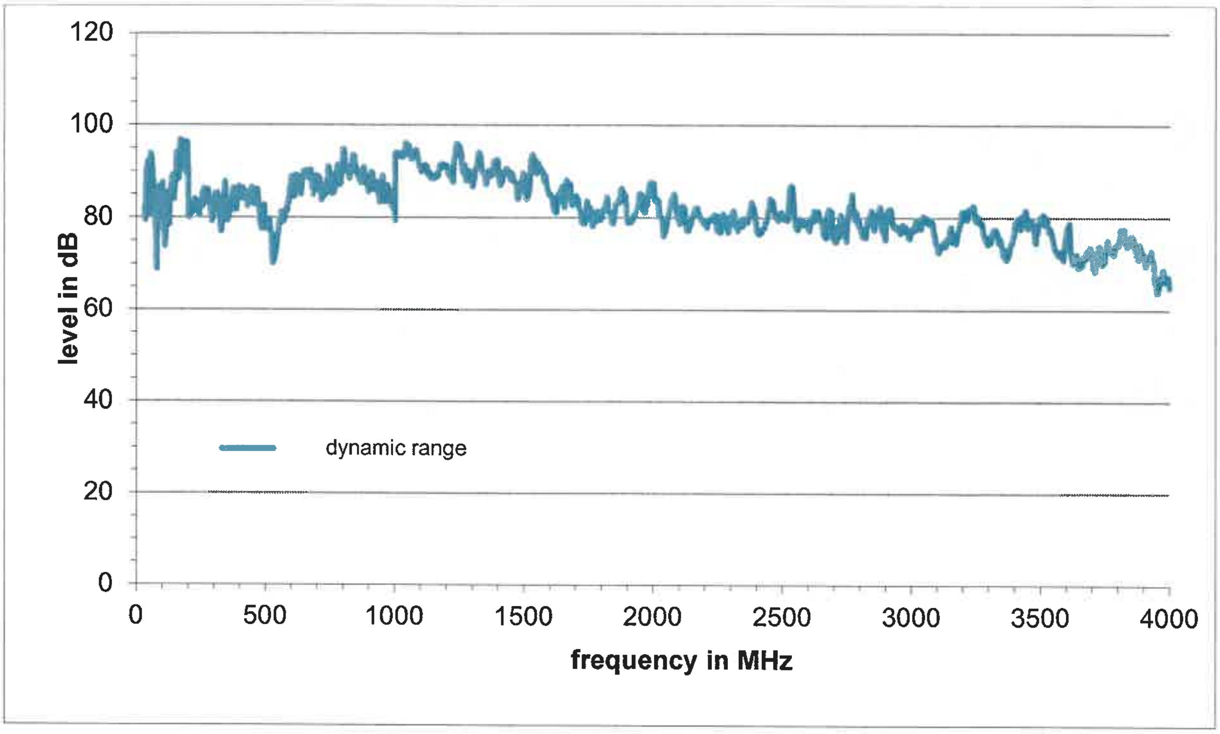


Figure 5: Achieved dynamic range from 30 MHz to 4 GHz

3.5 Measurement processing and illustration

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

The originally measured data is shown in figures with a dashed line whereas the smoothed shielding effectiveness curves are illustrated in red.

3.6 Pictures of the EUT as part of the test setup

Figure 6 : Receiving antenna

Figure 7: Dynamic range measurement

Figure 8: Left side of the EUT

Figure 9: Front side of the EUT

Figure 10: Shielding effectiveness measurement of the front side in the frequency range 30 MHz – 1 GHz

Figure 11: Shielding effectiveness measurement of the back side in the frequency range 1 GHz – 4 GHz

3.7 Construction and assembly of the EUT

The EUT was delivered fully assembled. The technical specifications are shown in the following illustrations:

IP-Pro Alu EMC

IP65 Gehäuse für den Schutz von empfindlicher Elektronik

Das Aluminium-Druckguss-Gehäuse **IP-Pro Alu EMC von nVent SCHROFF** überzeugt mit einem IP-Schutz von IP65, ist EMV-geschirmt, schock-, vibrations- und korrosionsbeständig. Es ist für Elektronik mit standardisiertem oder kundenspezifischem Formfaktor einsetzbar. Ergänzt wird die Gehäuselösung durch die Expertise von **nVent SCHROFF**, welche innovative Lösungen zur Leiterkartenfixierung, Kabelmanagement, sowie ein optimales Entwärmungskonzept beinhaltet.

RoHS Compliant ✓ IP65

Bestell-Nummer	Höhe (mm)	Breite (mm)	Tiefe (mm)
26880-001	90	122	122
26880-002	90	220	122
26880-003	90	160	160
26880-004	90	260	160
26880-005	90	360	160
26880-006	110	200	230
26880-007	180	200	230
26880-008	110	330	230
26880-009	180	330	230
26880-010	110	401	230
26880-011	110	600	230
26880-012	110	402	310
26880-013	180	402	310
26880-014	110	600	310
26880-015	180	600	310

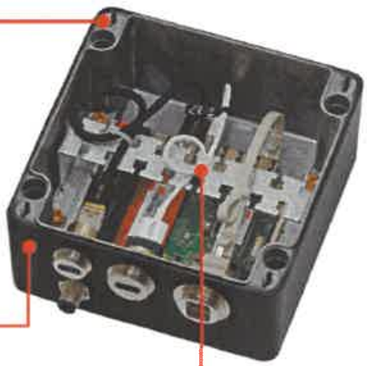
KUNDENSPEZIFISCHES KONZEPT FÜR JEDE ANWENDUNG

Konfiguration einer flexiblen Gehäuselösung

Die Verfügbarkeit von 15 verschiedenen Dimensionen und individuelle mechanische Modifikationen, sowie Lösungen zur Leiterkartenfixierung und Kabelmanagement, ermöglichen einen Einsatz für unterschiedliche Applikationen.

Optimales Entwärmungskonzept

Konvektions- oder Konduktionskühlung ermöglicht eine Wärmeableitung über das Gehäuse selbst und ist an die jeweilige Anwendung anpassbar.



Schutz der Elektronik im Innen- und Außenbereich

- Bahn- und Verkehrstechnik
- Kommunikationstechnik
- Sicherheits- und Verteidigungstechnik
- (Industrial) IoT

Simulationen & Tests

Durch thermische Simulationen, IP- oder EMV-Tests wird die Funktion des gesamten Gehäusekonzepts gewährleistet.

Ästhetisches Gehäuse-Design

Attraktive Gestaltung des Gehäuses durch Pulverbeschichtung, Siebdruck oder Digitaldruck mit einer hohen Resistenz der Farben gegen Umwelteinwirkungen oder Chemikalien.

Entwicklung und Integration elektronischer Komponenten

Kundenspezifische Lösungen von der Verkabelung, über Boards wie COM Carrier bis hin zu Integrationsdienstleistungen.

Das oben gezeigte Produkt ist ein EMV-geschützes Gehäuse mit den Abmaßen H90 x B160 x T160 mm (26880-003) und hat ein integriertes embedded NUC™ Board.

4 Results

4.1 Measured shielding effectiveness from 30 MHz – 1 GHz

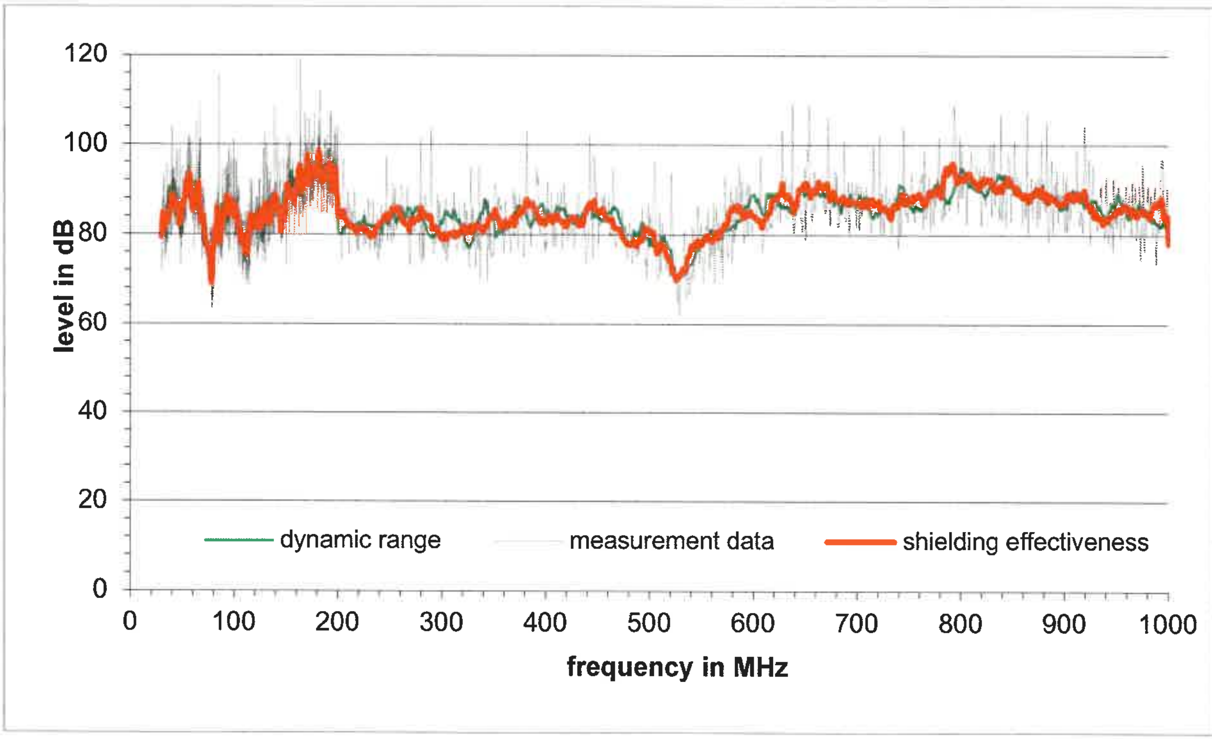


Figure 12: Measurement results for direct radiation on LEFT-side of the EUT

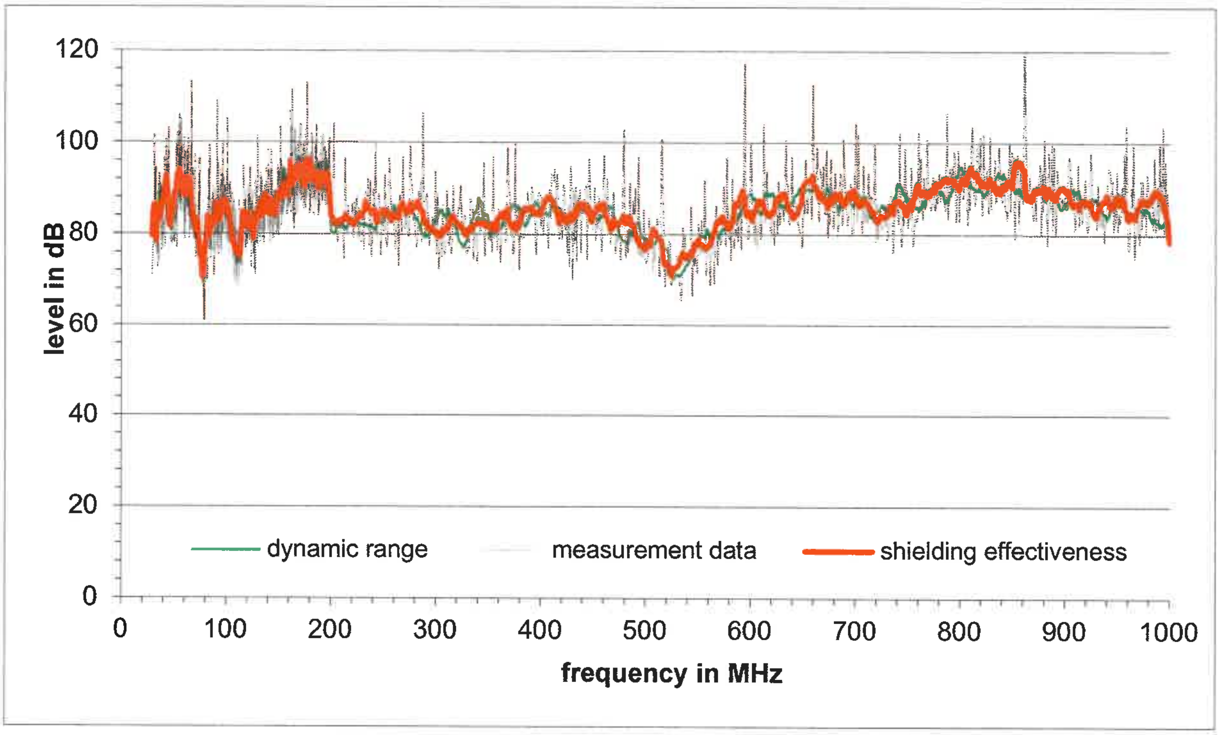


Figure 13: Measurement results for direct radiation on RIGHT-side of the EUT

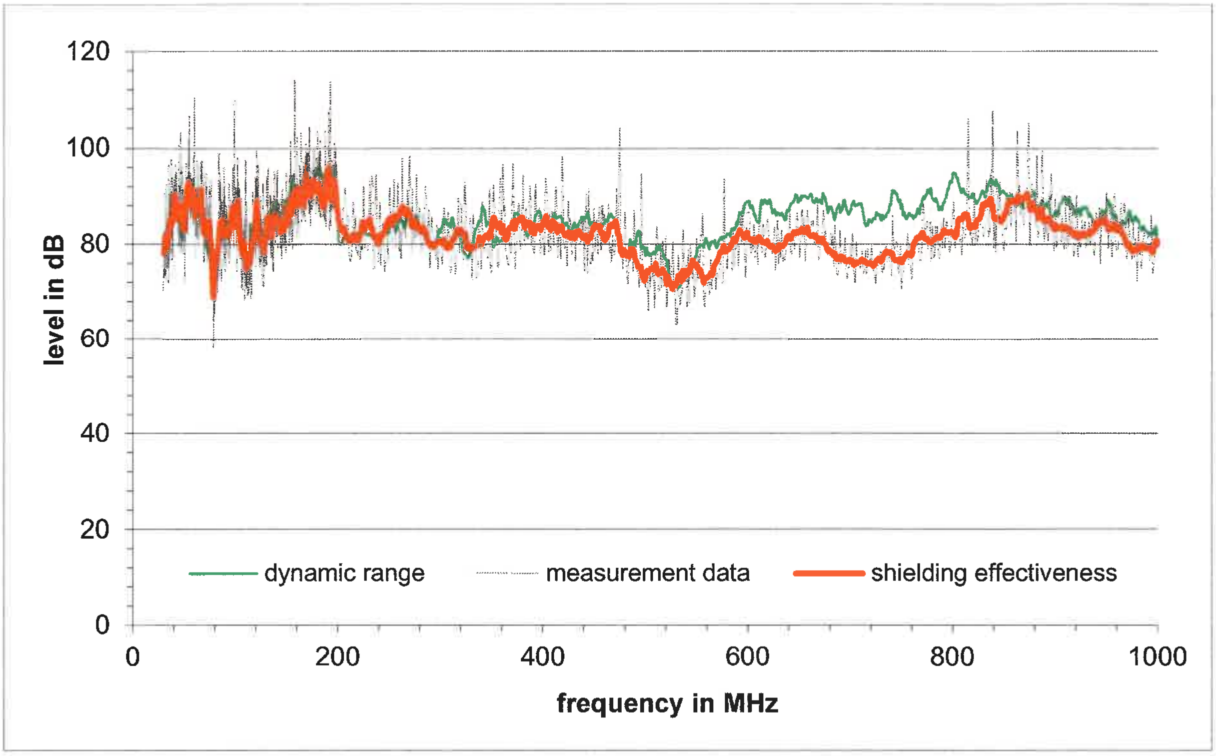


Figure 14: Measurement results for direct radiation on FRONT-side of the EUT

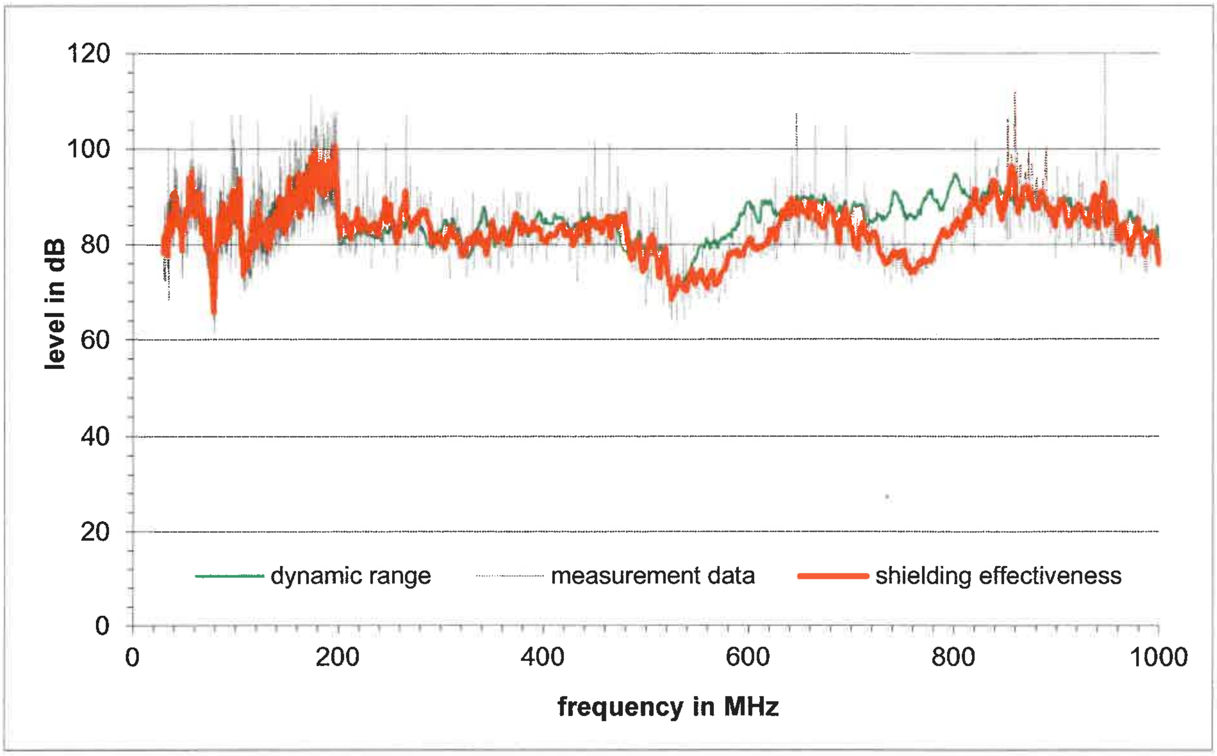


Figure 15: Measurement results for direct radiation on BACK-side of the EUT

4.2 Measured shielding effectiveness from 1 GHz – 4 GHz

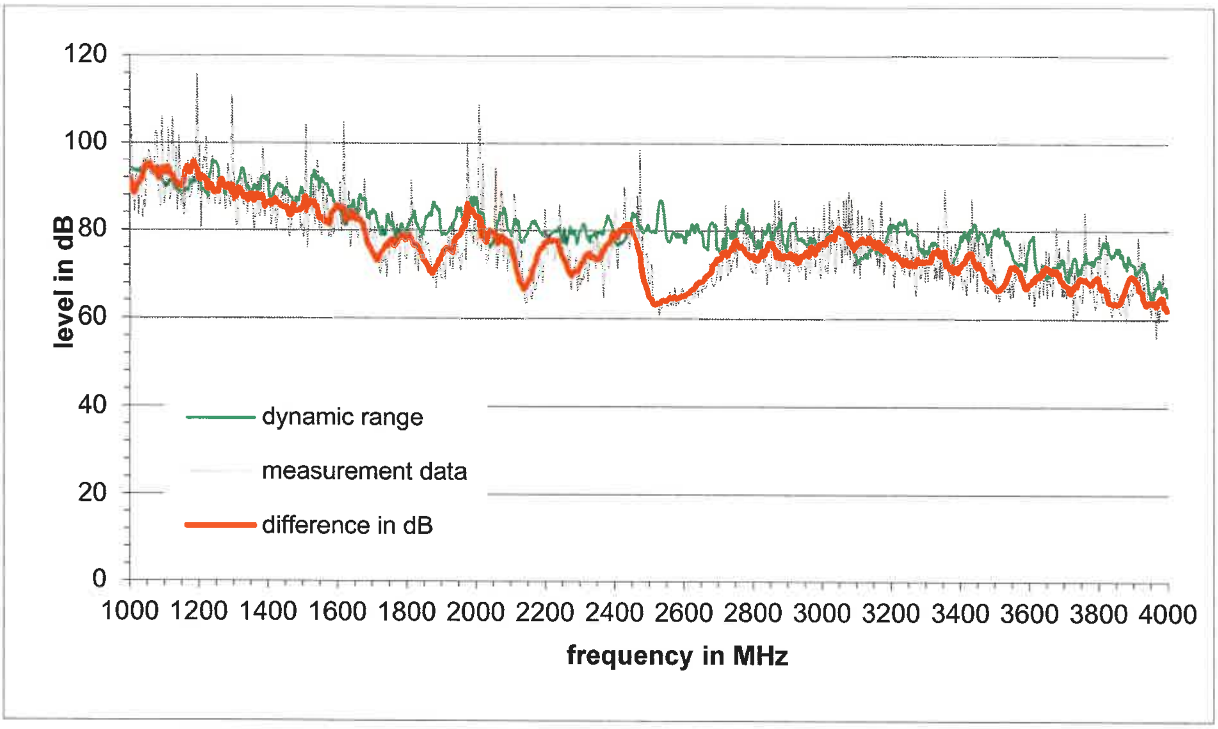


Figure 16: Measurement results direct radiation on LEFT-side of the EUT

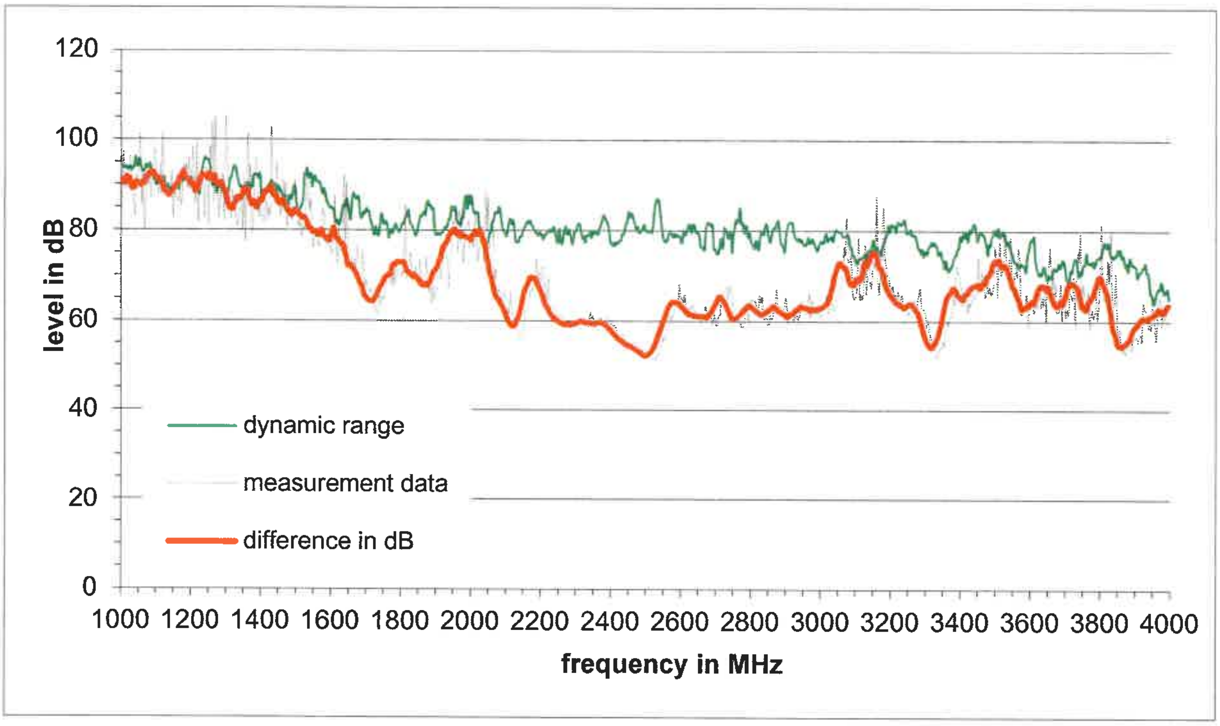


Figure 17: Measurement results for direct radiation on RIGHT-side of the EUT

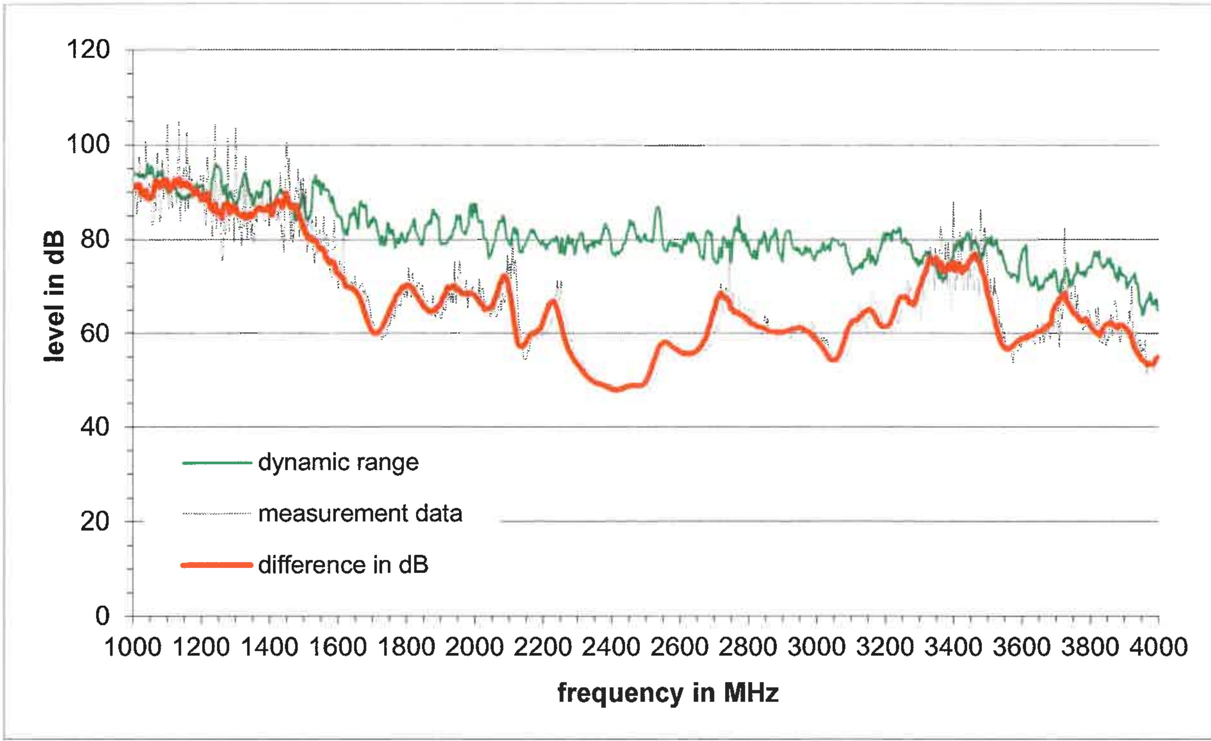


Figure 18: Measurement results for direct radiation on FRONT-side of the EUT

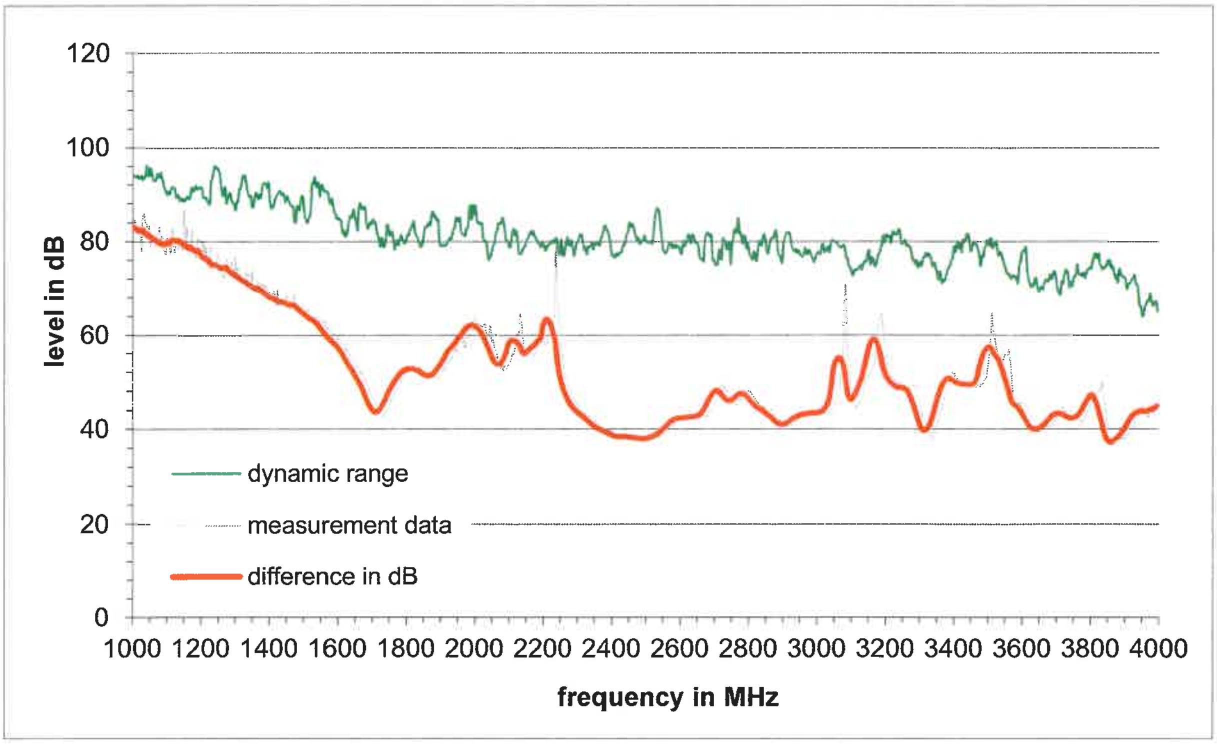


Figure 19: Measurement results for direct radiation on BACK-side of the EUT

4.3 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. Figure 20 shows the worst-case shielding effectiveness of the EUT after smoothing of resonance frequencies. The dynamic ranges are all the same due to the symmetrical setup. The minimal shielding effectiveness reaches from 37 dB as a minimum value at around 3861 MHz to 92 dB as a maximum value at around 197 MHz.

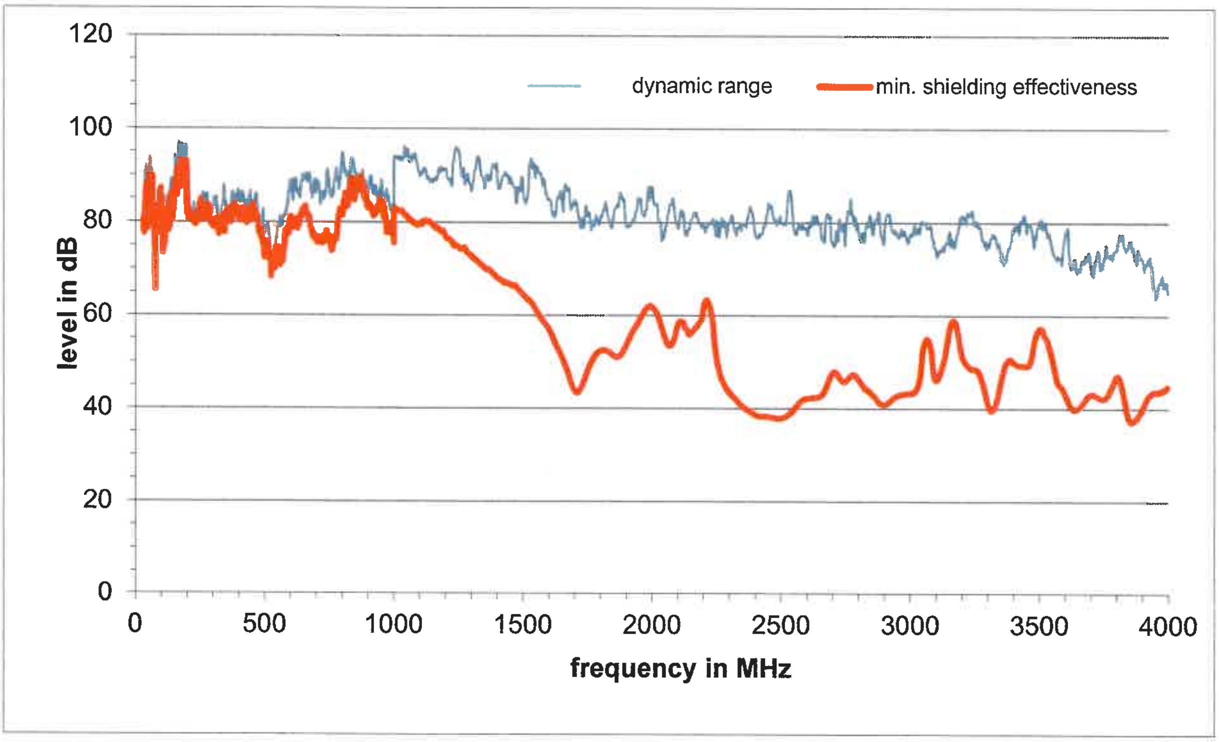


Figure 20: Worst case scenario