An Accurate Validation Procedure for Component Testing Chambers

Alexander Kriz, Wolfgang Müllner
ARC Seibersdorf research GmbH
A-2444 Seibersdorf, Austria
http://itr.arcs.ac.at

Abstract

The current validation technique for absorber lined shielded enclosure (ALSE) described in CISPR 25 induces some problems. We suggest a modified ALSE validation procedure with small conical dipole antennas instead of the test harness as described in the standard. This improves the repeatability and avoids impedance problems of the artificial network and the noise source.

Introduction

The results of a radiated emission measurement depend on the wave propagation characteristic of the test site. It is required to define this characteristic to ensure a good reproducibility and to obtain similar results from different test facilities.
An absorber lined shielded enclosure (ALSE) can be used for automotive component testing if some requirements are fulfilled. All standards prescribe a comparison between the open area test site and the ALSE. Unfortunately there is neither a procedure nor a tolerance of the correlation defined in ISO 13766 [1], ISO14892 [2], Council Directive 95/54/EC [3] and Council Directive 97/24/EC [4]. A detailed procedure and a limit are defined in CISPR 25 [5] and J1113/41 [6].

Current validation technique described in CISPR 25

The calibration of the ALSE is described in the Annex B of CISPR 25. A noise source is used instead of the equipment under test in order to generate an electric field. For our measurements we used the comb generator RefRad (Seibersdorf) which is connected via a simple wire to the artificial network. The electric field of this "test harness" is measured with a monopole antenna in the frequency from 150 kHz to 30 MHz, with a biconical antenna from 30 MHz to 200 MHz and with a log. periodic antenna from 200 MHz to 1 GHz.
Two field strength measurements are performed: The first one is measured on an open area test site as reference. The second one is the measurement in the ALSE. The difference of the two measured field strengths is the subject of investigation.

$$\text{Difference} = E_{OATS} - E_{ALSE} \quad (1)$$

A chamber is assumed to be compliant if the deviation does not exceed ± 6 dB in the frequency range from 70 MHz to 1 GHz. No limits are given for other frequency ranges.

Problems of the current validation technique

The standardised procedure induces several problems above 100 MHz:

- Bad repeatability
- Not defined impedance of the artificial network
- Not defined impedance of the noise source
- Not defined grounding of artificial network and noise source

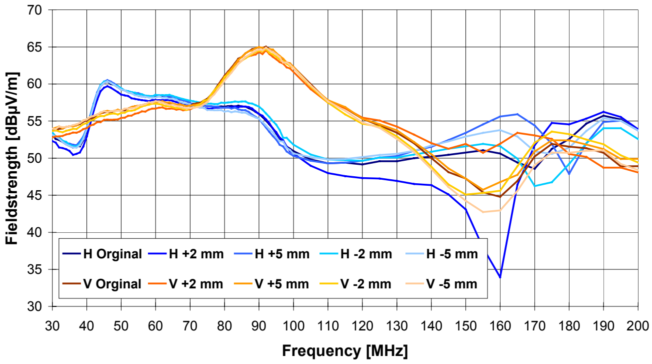
Some of the problems are described by Swanson [7] and Miller [8].

The reason for the bad repeatability is the radiation characteristic of the wire. The wire has a length of the 1.5 m, which corresponds to a wavelength of 1λ for a frequency of 200 MHz. So for higher frequencies the wire acts as beverage antenna. At a frequency of 1 GHz the wire is 5λ long and the directional pattern shows many lobes. These lobes are very sensitive in direction and amplitude to the position of the wire. If the position of the wire is changed by 5 millimetres the field strength changes by several dB, see Figure 1. Below a frequency of 100 MHz the traces are within 2 dB. Above this frequency the situation becomes worse. Table 1 summarises the maximum deviation of the positioning experiment.

Antenna type	Horizontal Polarisation	Vertical Polarisation
Biconical Antenna	21.7 dB	9.0 dB
Log. Per. Antenna	11.7 dB	18.0 dB

Table 1: Maximum deviation due to wire position sensitivity

a)



b)

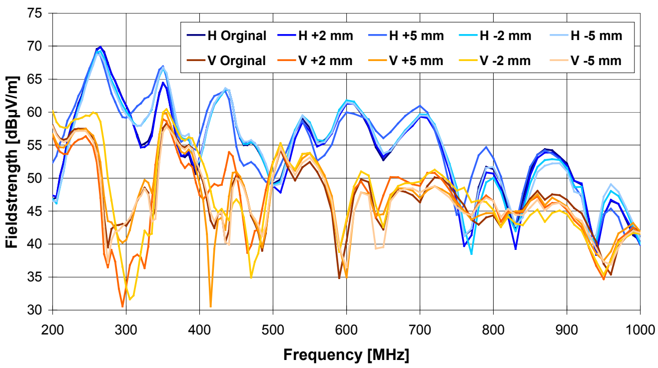


Figure 1: Sensitivity to wire position,

a) Biconical antenna
b) Log. per. antenna

The impedance of the artificial network is defined up to 108 MHz in the standard. Annex F of CISPR 25 shows the schematic for the network. For frequencies above 100 MHz the 0.1 µF capacitor can be neglected, but the inductivity of the cable to the test harness connector and the cable to ground becomes important. So the impedance increases above a frequency of about 70 MHz, see Figure 2. A strong resonance can be observed at about 400 MHz where the impedance reaches nearly 400 Ohm.

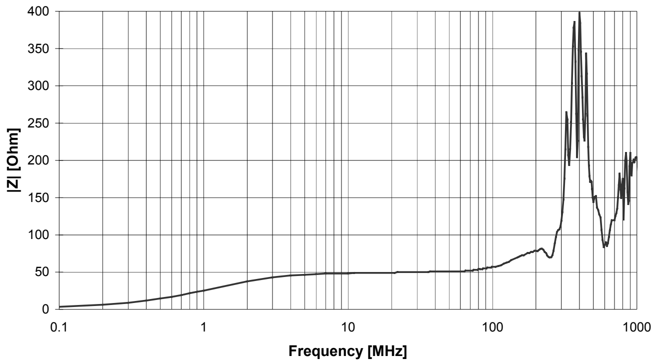


Figure 2: Impedance characteristics of an artificial network

The radiation characteristic of the wire antenna will change due to standing wave on the wire, which are depending on the impedance of the source. Therefore it is essential to use a well matched 50 Ω source like the RefRad. Alternatively matching can be improved by using a 10 dB attenuator at the output of the source.

The general problem of measurements over a metallic table is the low impedance connection to ground. There are several possibilities to connect the artificial network and the noise source to ground. The best way is to use wires as short as possible to decrease the inductivity.

Suggested new validation technique

We suggest modifying the method for a frequency range from 30 MHz to 1 GHz. Instead of the noise source, the wire and the artificial network a small antenna should be used to generate a well defined field. This antenna is placed on five positions on the table, on a location approximate to the former wire position, see Figure 5a.
The transmit antenna can be fed by a signal or a tracking generator. Also a network analyser (NWA) can be used. The advantage of this is that the drift of the test receiver can be reduced by measuring the level of the signal source. It is not required to use the same test receiver for the measurements on the OATS and in the ALSE. An advantage of the NWA is the very good accuracy. Attenuators on the feed points of both antennas should be used in order to reduce the influence of standing waves and improve the accuracy. The height of the antenna above the groundplane is 15 cm to allow measurements in vertical polarisation, see Figure 3a. The precision conical dipole antenna PCD 3100 from ARC Seibersdorf research can be used for this purpose, see Figure 3b.

a) b)

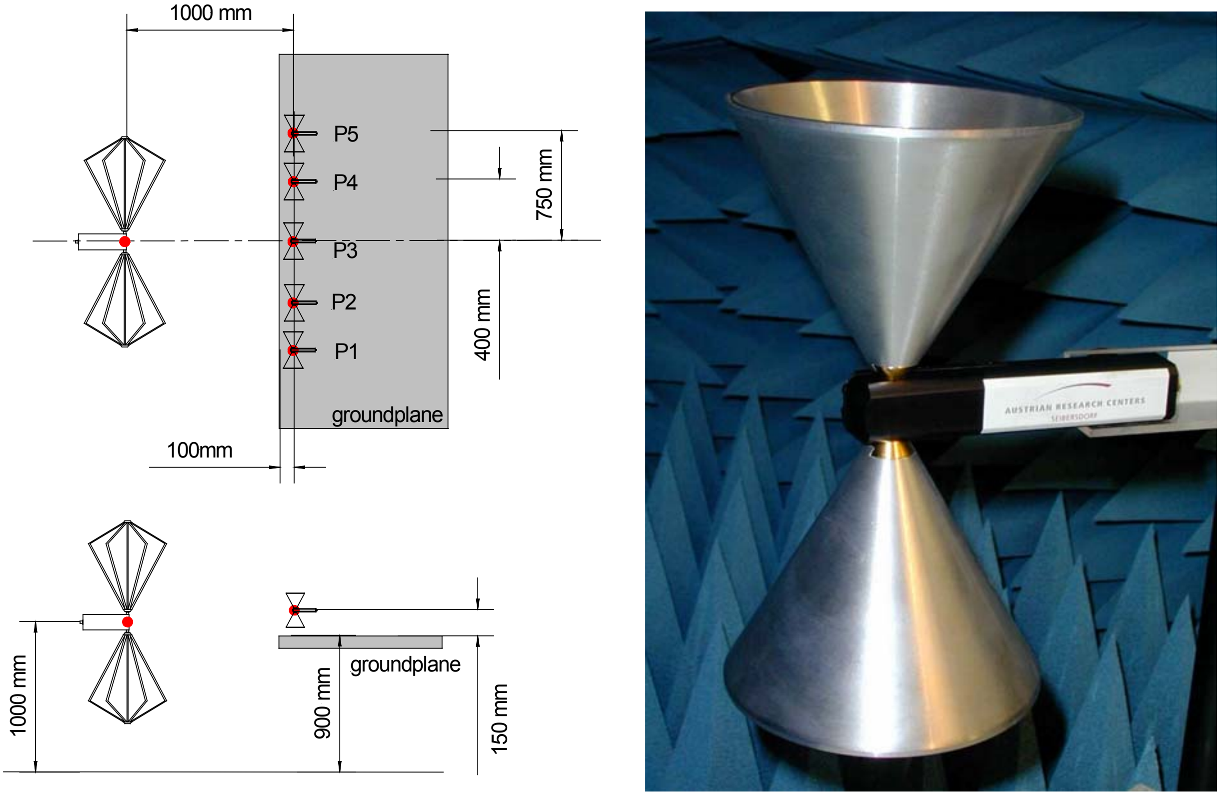


Figure 3: Setup of new validation method

a) Top view and front view of test setup
b) PCD3100 from ARC Seibersdorf research

The site attenuation (SA) measurement procedure requires two different measurements of the voltage received. The first reading V_{DIRECT} is with the two coaxial cables disconnected from the two antennas and connected to each other. The second reading V_{SITE} is taken with the coaxial cables reconnected to the antennas.

$$SA = V_{DIRECT} - V_{SITE} \quad (2)$$

The principle of the comparison between Open Area Test Site and ALSE is the same as in CISPR 25. Therefore two SA measurements should be performed: the SA_{OATS} on the Open Area Test Site and the SA_{ALSE} in the ALSE.

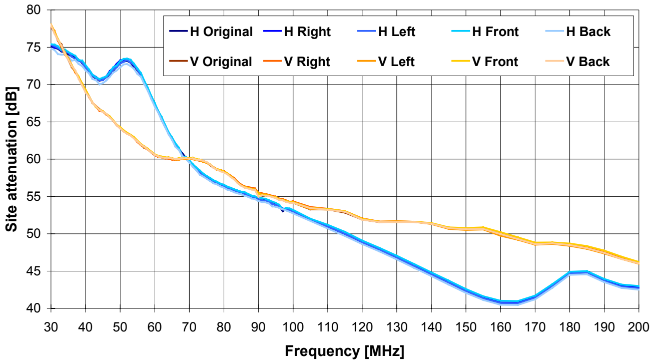
$$\text{Difference} = SA_{ALSE} - SA_{OATS} \quad (3)$$

In this formula the position of OATS and ALSE changes compared with Formula 1. The reason for this is the different sign of the SA. The SA measurements and comparison between different sites are extensively described by Müllner [9].
Measurements have shown that the problem of the bad repeatability is solved by using the new validation technique. Figure 4 shows the SA measurements with a slight change of the position of the small conical dipole antenna. The antenna is moved 10 mm on the right, left, front and back side from its original position.

Antenna type	Horizontal Polarisation	Vertical Polarisation
Biconical Antenna	1.04 dB	0.54 dB
Log. Per. Antenna	0.58 dB	1.12 dB

Table 2: Maximum deviation due to antenna position sensitivity measured on P3 according Figure 3a

a)



b)

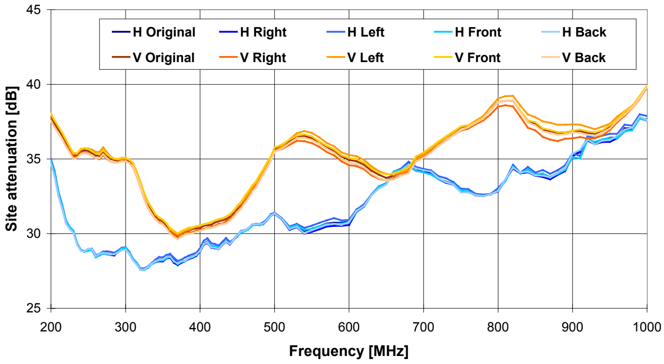


Figure 4: Sensitivity to antenna position new technique,

a) biconical antenna
b) log. per. antenna

Conclusion

Our suggestion for a modified validation method using a small conical dipole avoids the problems of the CISPR 25 procedure like: bad repeatability, undefined impedance of the artificial network, unmatched noise source. For optimum accuracy a network analyser can be used for the ALSE validation measurement. This new technique has been used successfully for an ALSE validation for an accreditation procedure. This procedure was carried out to get an Automotive EMC Laboratory Recognition Program (AEMCLRP) accreditation.

Literature

[1] ISO/DIS 13766: “Earth-moving Machinery- Electromagnetic Compatibility”, Draft International Standard, July 1996

[2] ISO/CD 14892: “Agricultural and Forestry Machines - Electromagnetic Compatibility - test methods and Acceptance Criteria”, Final Committee Draft ISO/TC23/SC2, March 1996

[3] Commission Directive 95/54/EC, Official Journal of the European Communities, 21 October 1995

[4] Council Directive 97/24/EC

[5] CISPR 25: “Limits and methods of measurement of radio disturbance characteristics for protection of receivers used on board vehicles”, First edition 1995-11, IEC

[6] SAE J1113/41: “Limits and Methods of Measurement of Radio Disturbance Characteristics of Components and Modules for the Protection of Receivers used on Board Vehicles”, July 1995

[7] D. Swanson: “Investigation of the Calibration Procedure from CISPR 25, Annex B, for use with Vehicle Component Testing”, IEEE EMC Symposia Record 1998

[8] P. Miller: “A Comparison of Radiated Emissions Testing to European Directive 95/54/EC Using an Open Field Test Site and a Semi-anechoic Chamber”, IEEE EMC Symposia Record 1999

[9] W. Müllner, H. Garn: “From NSA to site-reference method for EMC test site validation”, Int. Symp. on EMC, Montreal 2001, page 948-953 vol. 2