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DAT-P-002/91-02

Center for Quality Engineering

Test Report No.: T19D0003

Order No.: T19D **Pages:** 9 **Munich,** Nov 11, 2005

Client:	marburg TECHNIC
Equipment Under Test:	EMC Mesh, item No. 97446
Manufacturer:	unknown
Task:	Shielding Effectiveness Measurement
Test Specification(s): [covered by accreditation]	ASTM D 4935-99 [Frequency Range from 30 MHz to 1.5 GHz]
Test Specification(s): [not covered by accreditation]	ASTM D 4935-99 [Frequency Range from 1.5 MHz to 4 GHz]
Result:	In the frequency range from 30 MHz to 1.5 GHz, the shielding effectiveness of the material under test (MUT) is within 52 dB to 60 dB, approximately. In the frequency range from 1.5 GHz to 4 GHz, the shielding effectiveness of the material under test (MUT) exceeds 44 dB, approximately.

The results relate only to the items tested as described in this test report.

approved by:	**Date**	**Signature**
Dr. Helmers Test Engineer	Nov 09, 2005	
Dr. Jung Director 'EMC'	Nov 09, 2005	

This document was signed electronically.

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1 Summary

The shielding effectiveness of an EMC mesh, marburg TECHNIC item No. 97446, was measured according to ASTM D 4935-99 in the frequency range from 30 MHz to 1.5 GHz. The shielding effectiveness of the material under test (MUT) is within 52 dB to 60 dB, approximately.

The test standard covers only the frequency range from 30 MHz to 1.5 GHz.

Nevertheless, the shielding effectiveness of the MUT was measured with respect to ASTM D 4935-99 in the frequency range from 1.5 GHz to 4 GHz, the shielding effectiveness of the material under test (MUT) still exceeds 44 dB, approximately.

2 References

2.1 Specification

ASTM D 4935-99 “Standard Test Method for Measuring the Electromagnetic Shielding Effectiveness of Planar Materials”, American Society for Testing and Materials, 100 Barr Harbor Dr., West Conshohocken, PA 194428, USA, 1999.

2.2 Glossary of Terms

ASTM	American Society for Testing and Materials
EMC	Electromagnetic Compatibility
EUT	Equipment Under Test
MUT	Material Under Test

3 General Information

3.1 Identification of Client

marburg TECHNIC
Bertram-Schaefer-Straße 11
35274 Kirchhain

Mr. Klaus Wunderlich

3.2 Test Laboratory

Center for Quality Engineering
Siemens AG
Hofmannstraße 51
81359 München

3.3 Time Schedule

Delivery of EUT:	Sep 19, 2005	Sep 19, 2005
Start of test:	Oct 13, 2005	Oct 13, 2005
End of test:	Oct 13, 2005	Oct 13, 2005

3.4 Participants

Name	Function	Phone	E-Mail
Dr. Sven Helmers	Accredited Testing	+49 89 722 46304	sven.helmers@siemens.com

4 Equipment Under Test

4.1 Description of EUT

The EUT is an EMC mesh, marburg TECHNIC item No. 97446. In the following, it will be denoted as “material under test” (MUT). The structure of the mesh is shown in Figure 1.

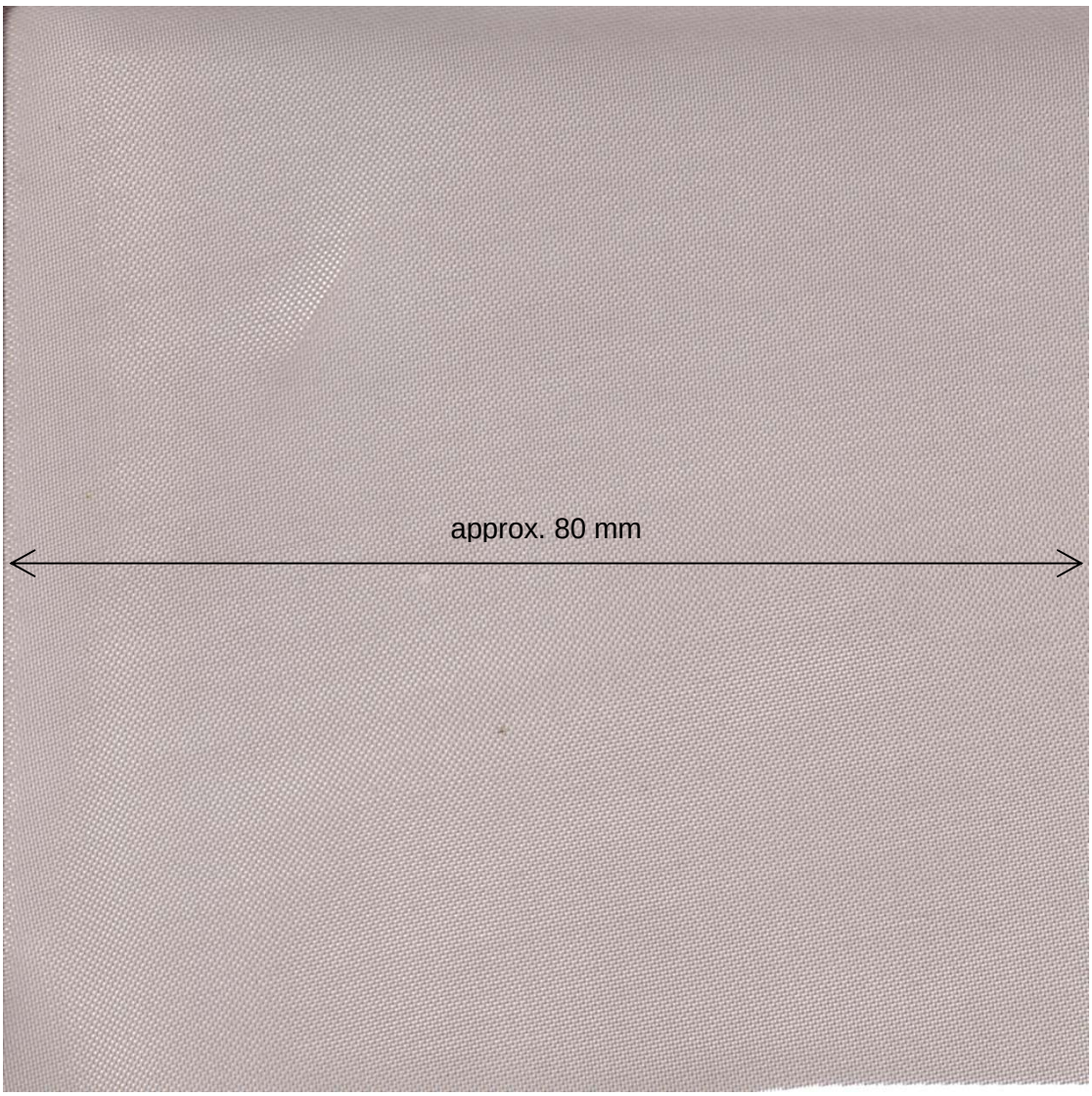


Figure 1: Structure of the MUT

From this MUT, reference and load specimens were cut according to the underlying standard ASTM D 4935-99.

4.2 Configuration of EUT

Not applicable.

4.3 Operating Conditions

Not applicable.

4.4 Compliance Criteria

Not applicable.

5 Test Equipment

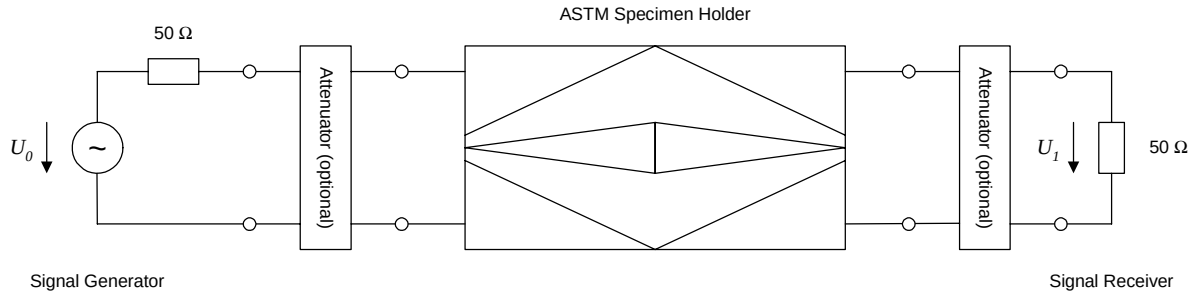
5.1 Test Facility

The measurements were made in the shielding efficiency test laboratory of Siemens AG, Com CTO CQE CoC 1.

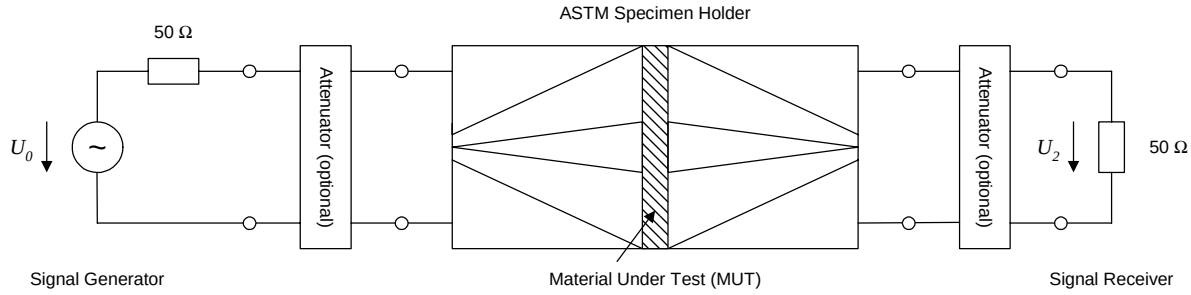
The measuring circuit is sketched in Figure 2. The shielding effectiveness of the material under test (MUT) is calculated from two measurements: the reference measurement without MUT as shown in Figure 2 a and the load measurement with MUT as shown in Figure 2 b. From the voltages U_1 and U_2 at the signal receiver, the shielding effectiveness a_S of the MUT is calculated by:

$$a_S = 20 \cdot \log_{10} (U_1 / U_2)$$

At the entry points of the ASTM specimen holder, the insertion of attenuators is recommended to improve impedance matching within the measuring circuit. At the cost of increased standing waves, these optional attenuators are omitted to get the benefit of a maximum dynamic range of the measurement.



a) Reference Measurement



b) Load Measurement

Figure 2: Measuring Circuit

The overall test set-up is shown in Figure 3 on the following page.

The underlying test standard ASTM D 4935-99 covers only the frequency range from 30 MHz to 1.5 GHz. Due to the construction of the test specimen holder, field modes which are not transverse-electromagnetic might occur at frequencies above 1.5 GHz, thus, having an hardly predictable impact on the test result at certain resonance frequencies.

The dynamic range of the measurement is derived from a special load measurement using a brass plate of 4 mm thickness as MUT. From electromagnetic field theory, the shielding effectiveness of this brass plate exceeds by far 300 dB in the whole measuring frequency range from 30 MHz to 1.5 GHz.

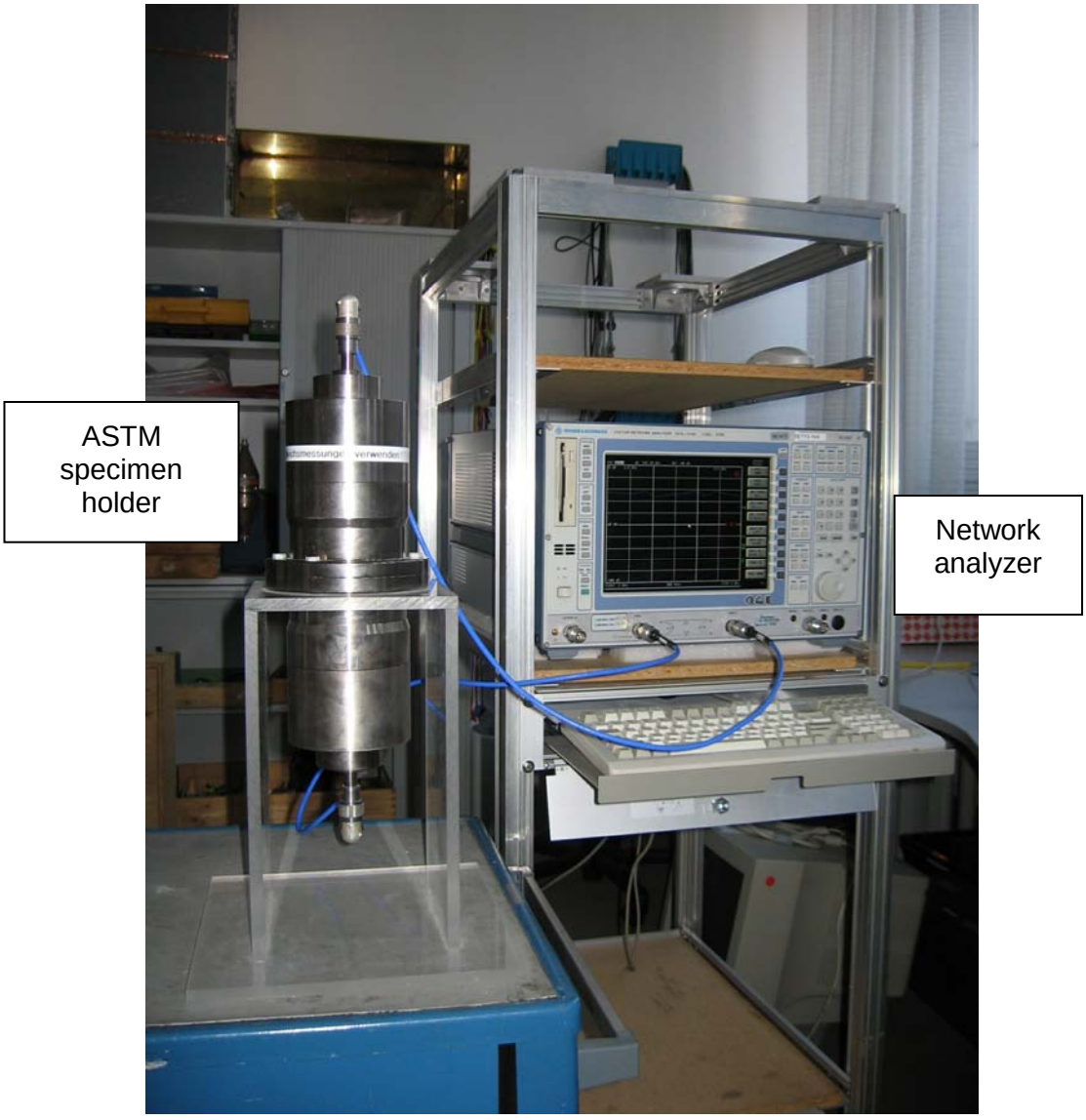


Figure 3: Test Set-Up

5.2 Measuring Equipment

ID No.	Equipment	Manufacturer	Status	Last Cal.	Next Cal.
N0467	EMI Test Specimen Holder	W.E. Meas.	cnn		
N0810	Coaxial Cable	Spectrum	cnn		
N0811	Coaxial Cable	Spectrum	cnn		
N0772	Network Analyzer	R&S	cal	Mar 15, 2004	Nov 2005

cal = Calibration, car = Calibration restricted use, chk = Check, chr = Check restricted use, cpu = Check prior to use, cnn = Calibration not necessary, ind = for indication only

5.3 Measurement Uncertainty

As described in section 5.1, the shielding effectiveness of the material under test (MUT) is calculated from two measurements, the reference measurement and the load measurement. Thus, systematic errors in the measurement circuit cancel out each other because they influence both of the two measurements. Nevertheless, a measurement uncertainty remains

which is mainly due to the instability of the signal source and the receiving circuit of the network analyzer and the instability of the amplification factor of the signal amplifier. An additional contribution to measurement uncertainty arises from impedance mismatching at the entry points of the ASTM specimen holder.

So, the overall measurement uncertainty can be estimated by

Stability of signaling and receiving circuit	± 1 dB
Stability of the signal amplifier	± 0.5 dB
Impedance mismatch	± 1 dB
Total	± 2.5 dB

6 Test Specifications and Results

The test results in the report refer exclusively to the test object described in section 4 and the test period in section 3.3.

6.1 Shielding effectiveness in the frequency range from 30 MHz to 1.5 GHz

The shielding effectiveness of the MUT measured in the frequency range from 30 MHz to 1.5 GHz is shown in Figure 4.

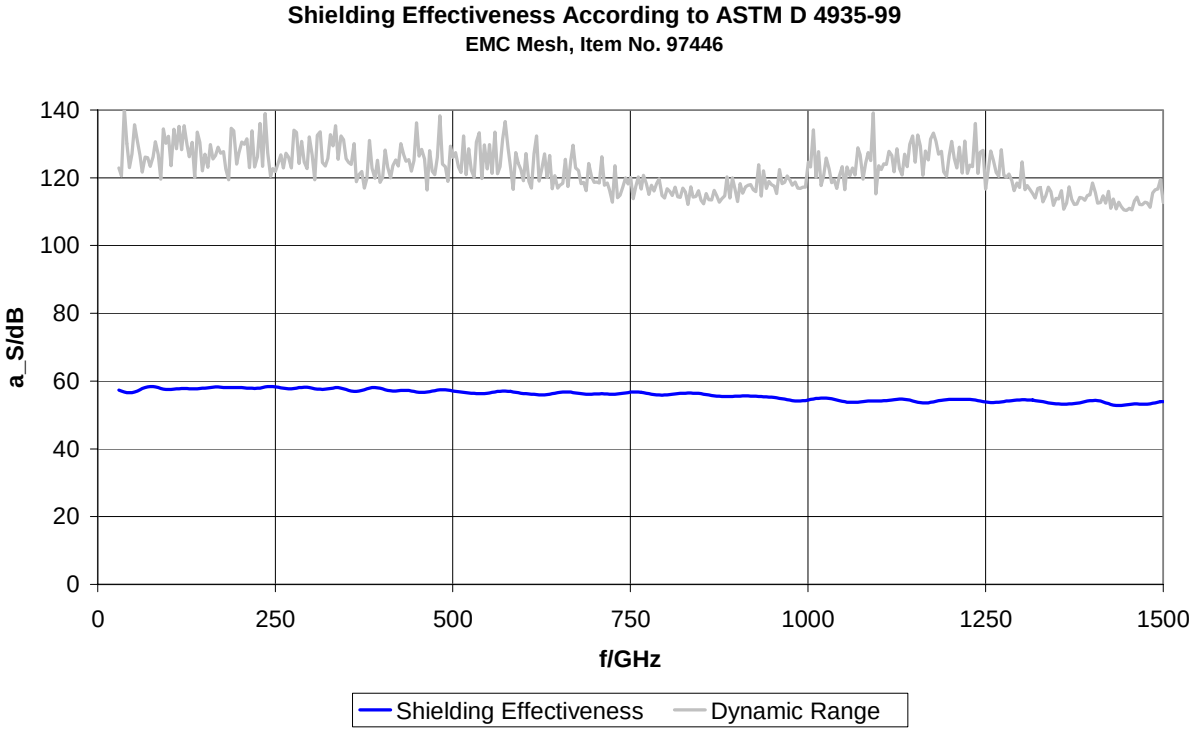


Figure 4: Shielding effectiveness of the MUT

Result

In the frequency range from 30 MHz to 1.5 GHz the shielding effectiveness of the material under test (MUT) is within 52 dB to 60 dB, approximately. The grey curve shows the dynamic range of the measuring system: this range is well above the measured shielding effectiveness.

6.2 Shielding effectiveness in the frequency range from 1.5 GHz to 4 GHz

The underlying test standard ASTM D 4935-99 covers the frequency range from 30 MHz to 1.5 GHz. As explained in section 5.1, the test result at frequencies above 1.5 GHz is influenced by higher field modes within the test specimen holder. For indication only, the shielding effectiveness of the material under test (MUT) was investigated at three fixed frequencies between 1.5 GHz and 4 GHz. The test result is shown in Table 1.

Table 1: Shielding effectiveness of the MUT at Frequencies above 1.5 GHz

*** FOR INDICATION ONLY! ***	
Frequency/GHz	**Shielding effectiveness/dB**
2	> 50
3	> 46
4	> 44