Prof. Dipl.-Ing. Peter Pauli
Lect. RF-, Microwave- and Radars at the
German Armed Forces University Munich

Firm of EMC-Consulting
D-83646 Bad Tölz
Alter Bahnhofplatz 26
<prof.peter.pauli@t-online.de>

Test Report

29th of June 2022

Ordered by : **STATEX Produktions- und Vertriebs GmbH**
Kleiner Ort 9 – 11
28357 Bremen
Germany

Tested devices: **Shieldex® Faraday Bags for Laptops up to 15,6 Zoll**

① Delinova® 200, Shieldex® **Pisa RS** + Shieldex® **Pisa RS** with Velcro™ fastening
② Delinova® 200, Shieldex® **Nora Dell CR** + Shieldex® **Zell RS** with Velcro™ fastening
③ Delinova®200, Shieldex® **Nora Dell CR** + Shieldex® **Zell RS** with quick side release buckle

Subject: Measuring the shielding efficiency (S.E.) against electromagnetic waves from 700 MHz to 4.5 GHz

Regulations: According to IEEE-Standard 299-2006, MIL-Standard 285 and NSA-94-106

Date of measurements: 29th of June 2022

Volume: 5 text pages and 3 appendices

Comments: All three Shieldex® Faraday Bags were tested twice:
In the first measurement the shielding material of the straight side wall was tested according to ASTM-D4935-2018, to find out its individual shielding efficiency.The results are listed in table 2 and in the measured upper traces in the appendix.

After this, a broadband receiving antenna was installed inside of the bag. This antenna inidicated the amount of penetrating power, when the shielding bag was closed properly.
The results are listed in table 3 and can be confirmed by the traces at the bottom oft he three appendices.

1. Introduction

To explain the measured diagrams, it is helpful to use this table. You can easily find the relation between shielding in „dB“ and the transmitted power in „%“.
To calculate the dB-value from the incident power P_1 respectively field strength E_1 and the transmitted power P_2 or field strength E_2, one has to use the following equation:

$$a_{Shield} = 10 \cdot \log \frac{P_2}{P_1} = 20 \cdot \log \frac{E_2}{E_1} \quad in\ decibel(dB)$$

The network analyzer presents the results of the shielding measurements in „Decibel“ (dB). The mode of measurement is a typical transmission measurement (S_{21}-measurement).
This dB value describes, how much the level of an incident power or power flux density has decreased, passing the device under test.

It describes values of field-strengths as well. But the calculation of the percent-values in the table at the right refers to the **power-**relationships.

Conversion of Decibel to Percent of transmitted Power			
dB	**Power Transmission in %**	**dB**	**Power Transmission in %**
0	100,00		
1	81.00	21	0.78
2	62.80	22	0.63
3	50.00	23	0.50
4	40.00	24	0.39
5	31.60	25	0.31
6	25.00	26	0.25
7	20.00	27	0.20
8	16.00	28	0.18
9	12.50	29	0.12
10	10.00	30	0.10
11	7.90	31	0,08
12	6.25	32	0.06
13	5.00	33	0.05
14	4.00	34	0.04
15	3.13	35	0.03
16	2.50	36	0.02
17	2.00	37	0.02
18	1.56	38	0.02
19	1.20	39	0.02
20	1.00	40	0.01
		50	0.001
		60	0.0001
		70	0.00001
		80	0.000001
		90	0.0000001

Table 1: Conversion of SE-values, given in dB, to percent values of transmitted power

2. Methods and Standards of shielding measurements

2.1 Shielding measurements according to ASTM D4935-2018, 700MHz – 4.5GHz

For this measurement two coaxial TEM-adapters were connected to a vector network analyzer (VNWA), used as transmitting and receiving antennas. During a calibration for measuring the S_{21}-parameter (= transmission), the distance between the two adapters was substituted by a neutral distance holder. Now the calibration was set to “0 dB”. Then the shielding material was positioned between the adapters. The reduction of transmitted power was measured and documented in table 3 and in the upper diagrams in the appendix.

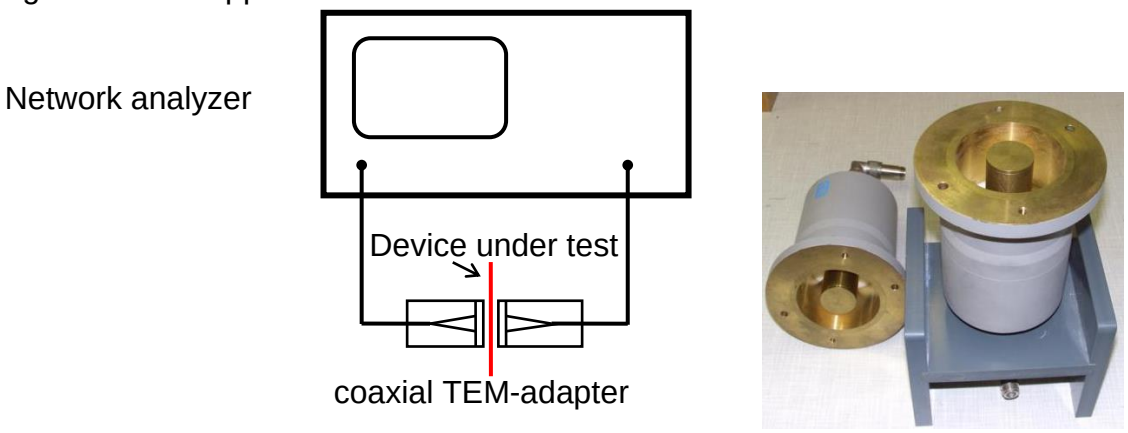


Fig. 1 Test setup to measure the shielding effectiveness of a DUT

Measurement equipment:
Vector Network Analyzer, type ZVRE (30 kHz – 8 GHz), Rohde & Schwarz
Coaxial TEM-Adapter, (1 MHz – 4 GHz), Wandel & Goltermann

During this test, the test signal presents a 360°-polarisation, which means, the electrical field lines of the test signal hit the DUT in all radial directions. If the shielding material presents an excellent shielding performance during this test, the shielding for linear vertically and horizontally polarized signals will be as excellent.
So the results of these measurements are very close to the reality.

Note: The vertical scale of the traces in the appendix was **20 dB**/Division!

2.2 Measurement Set-up according to NSA-94-106

To measure the real shielding efficiency of the Shieldex® Faraday bags against electromagnetic waves, the following set-up was used.
At first the bag was opened widely, whilst it was exposed to electromagnetic radiation between 1.8 GHz to 4.5 GHz. Under this condition, a 0dB-value was determined.
After this, the bag was closed properly and the strongly reduced intensity of the intruding radiation was measured.

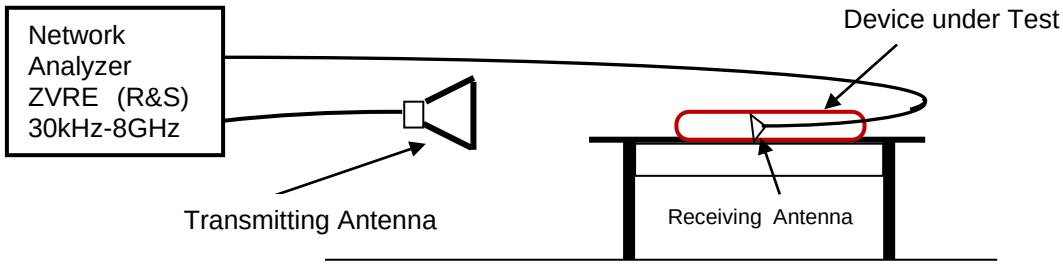


Fig 2: Setup to measure the shielding of the Shieldex® Faraday bag

The results of these measurements are recorded in the lower traces of the appendices and documented in table 3.

In addition to these results a second type of measurements between 800 MHz and 3.8 GHz were performed:
For this purpose, a signal generator type SMB 100A (9kHz – 20GHz) from Rohde & Schwarz was used for the emitted signal and a highly sensitive spectrum analyzer type FSP30 (10kHz – 30GHz) from R&S was used as a receiver.

Details to the measuring procedure:
To calibrate the set-up from 700MHz to 4GHz, the transmission-value of the test-range was set to 0 dB with the receiving antenna installed in the center in the widely opened bag, to state the 0dB-value.
Then the bag was closed properly and the reduced level of the intruding signal was measured and documented, as described above.

Note: In the lower diagrams, the vertical scale of the traces was **10 dB**/Division.

3. Results and their valuation

In the appendices the shielding efficiency of the Shieldex® Faraday Bags is presented in the lower traces between 1.8 GHz to 4.5GHz. In each diagram you can find some individual shielding-values printed in the upper right corner, corresponding tot he markers in the traces.
In table 2 you can find the results of the material measurement. In table 3 , the shielding efficiencies of the properly closed bags are listed at some important frequencies, used by the cellphone services.

Frequencies: **Shieldex® Faraday Bag** Results of the **basic material**	900 MHz GSM900	1800 MHz GSM1800	2450 MHz W-LAN	3.2 -3.8GHz **5G**
Bag ① PisaRS /PisaRS	**103 dB**	**108 dB**	**105 dB**	**105 dB**
Bag ② Nora Dell CR/Zell	**110 dB**	**108 dB**	**105 dB**	**103 dB**
Bag ③ Nora Dell CR/Zell RS	**109 dB**	**105 dB**	**102 dB**	**101 dB**

Tabelle 2: Shielding values of the „**basic material**“, used to produce the bags

One can see, that actually all kinds of the used shielding fabrics and their combinations with their outstanding shieldung efficiencies can be used, to produce an excellent shielding item.

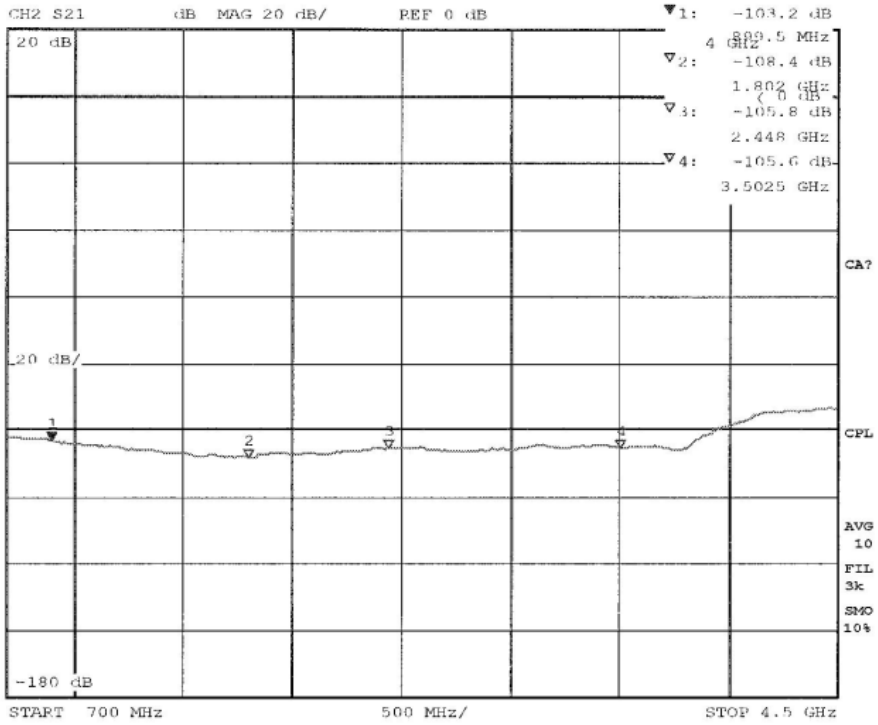
Frequencies: **Shieldex® Faraday Bag** Results oft he **closed bags**	900 MHz GSM900	1800 MHz GSM1800	2450 MHz W-LAN	3.2 -3.8GHz **5G**
Bag① Pisa RS/Pisa RS Velcro	**76 dB**	**80 dB**	**79 dB**	**76 dB**
Bag ② Nora Dell CR/Zell RS Velcro	**75 dB**	**81 dB**	**77 dB**	**77 dB**
Bag ③ Nora Dell CR/Zell RS Buckle	**75 dB**	**79 dB**	**79dB**	**70 dB**

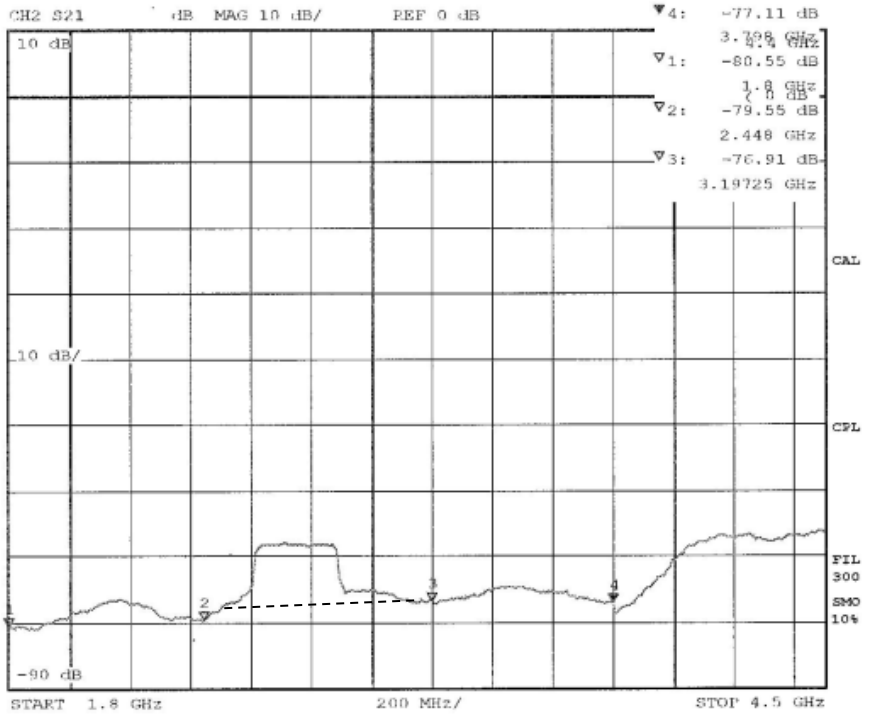
Tabelle 3: Shielding values of the **closed shielding bags**
The frequencies of the 4G-Net (LTE) are, depending on the region and the provider, at 700MHz (Band 28), 800MHz (Band20), 900 MHz (Band 8), 1500 MHz (Band 32) and at 2600MHz (Band 7).

At a shielding of **70 dB,** only **0.00001%** of the incident power can be meausured inside of the bag.. At **80dB** it is only **0.000001%** of the incident power, which can penetrate the shield. Consequently, 99.999999% of the applied power is removed by the Shieldex® Faraday bag.
For this reason, any unintentional communication can be blocked, data theft will be avoided and malicious apps cannot be remotely triggered.

Test device ①: Shieldex® Faraday Bag

Delinova® 200**, Shieldex® Pisa RS** and **Shieldex® Pisa RS**
Upper trace: Basic Material
Trace at the bottom: Measurement of the closed bag with Velcro

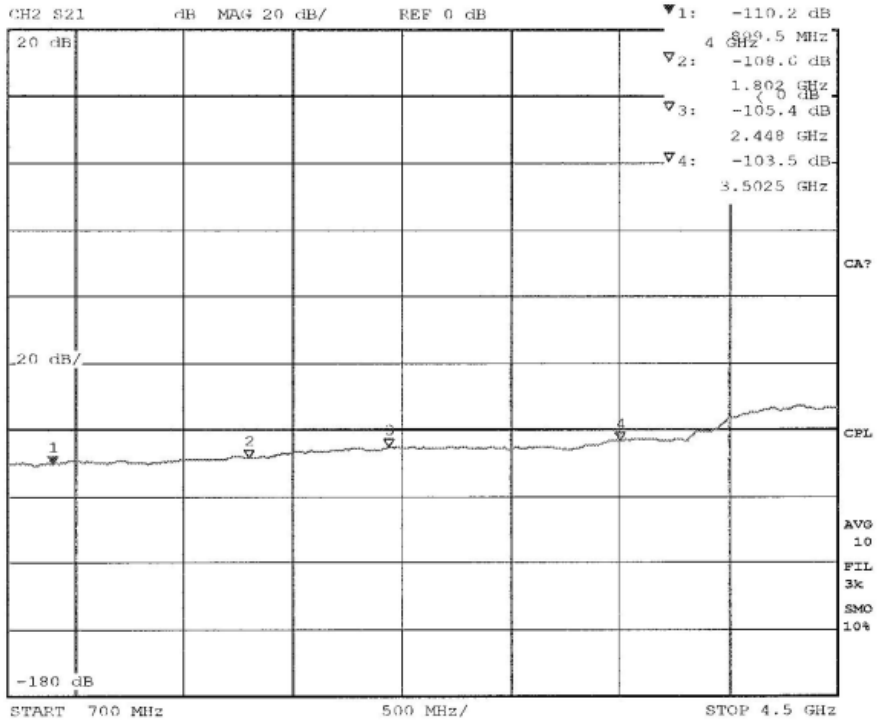


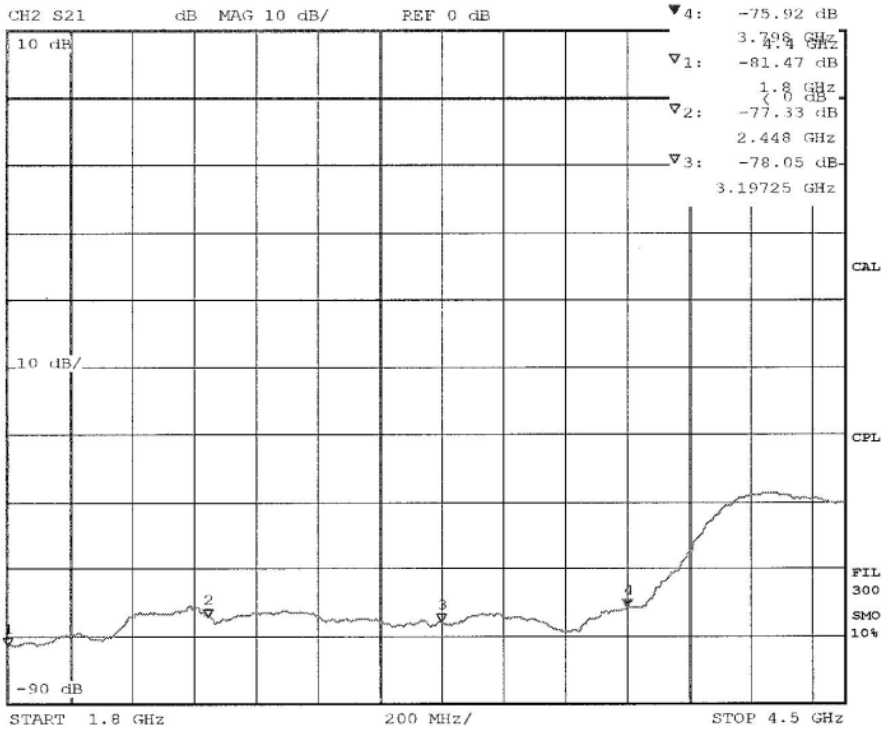


The peculiar “hilltop” of the trace is created by an unwanted resonance in the tested bag. The actual values will follow the dotted line

Test device ②: Shieldex® Faraday Bag

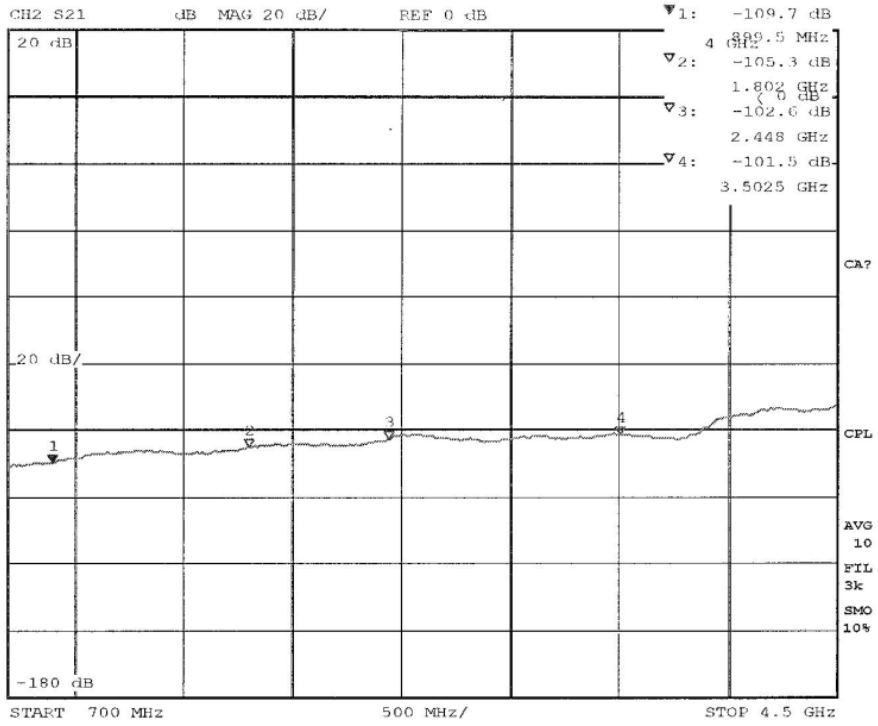
Delinova® 200**, Shieldex® Nora Dell CR** and **Shieldex® Zell RS**
Upper trace: Basic Material
Trace at the bottom: Measurement of the closed bag with Velcro

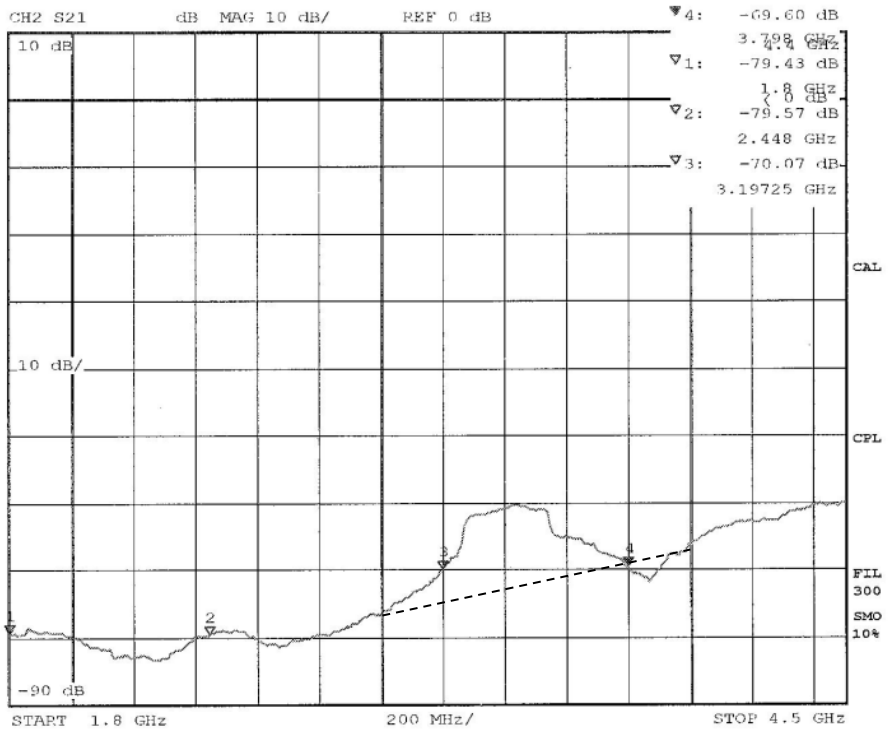




Test device ③: Shieldex® Faraday Bag

Delinova® 200**, Shieldex® Nora Dell CR** and **Shieldex® Zell RS**
Upper trace: Basic Material
Trace at the bottom: Measurement of the closed bag with quick side release buckle





The peculiar "hilltop" of the trace is created by an unwanted resonance in the tested bag. The actual values will follow the dotted line