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85577 Neubiberg, 5th of September 2017
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EXPERT REPORT

Ordered by:	**Spoerry 1866 AG** **Bergstrasse 25** **CH-8890 Flums** **Switzerland**
Device under Test:	Shielding fabric ***Swiss Shield Wear***
Subject:	Measurement of the shielding efficiency (SE) against electromagnetic waves from 800 MHz to 12 GHz
Regulations:	IEEE 299-2006 (similar to MILSTD 285)
Date of Measurements:	5th of September 2017
Content:	4 pages of text, 2 diagrams in the appendix
Results:	The measurements proved that the shielding of the fabric ***Swiss Shield Wear*** is almost independent of the polarisation of the incident waves. The shielding against frequencies in the mobile communication is between 21dB and 26dB. This means, that 99,22% to 99,75% of the incident power flux density is removed by the fabric.

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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 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.
So it tells - for example - that 20 dB shielding reduces the penetrating power power to 1%.

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
		43	0,005

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

2 Shielding measurements according to IEEE 299-2006 from 800MHz to 12GHz

The measurements were performed according to IEEE 299 on 5th of September 2017 at the EMC-test site of the Radar Laboratories at the German Armed Forces University Munich in Neubiberg at frequencies from 800 MHz to 12 GHz. Linear polarisation was radiated and received by double ridged exponential horn antennas. The device under test was attached to a specific aperture (height 40 cm, width 40 cm as shown in the picture below) in a metallic shelter wall with the front dimensions of 210cm x 200cm.
During the measurements neither interferences from external signals nor any creeping waves between DUT and cabin wall could be detected.

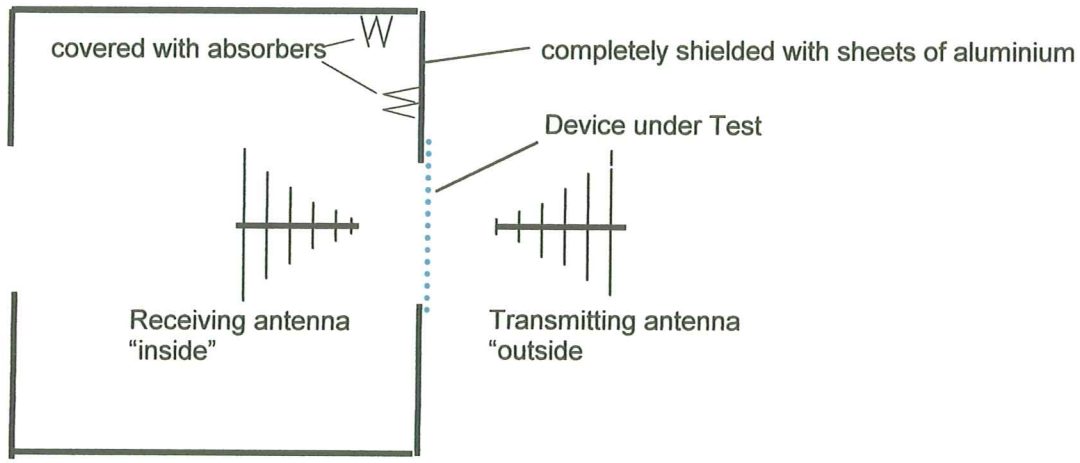

Fig. 1 Setup for Shielding Measurements according to IEEE299 (schematically)

The test range was calibrated without any object between the two antennas, to adjust the zero-dB-transmission-value. The horn antennas were positioned at a distance of 84cm in front of the DUT and 30cm behind it.

Test equipment:

Vector Network Analyzer type 360, (40 MHz – 18.6 GHz), Wiltron
2 Double-ridged exponential horn antennas type HF 906, (1 – 18 GHz), R & S
Printer: Kyocera Ecosys, FS – 1020D

3 Results of the Measurements

The diagrams in the appendices present the transmission values i.e. the shielding efficiency (SE) of the shielding fabric in decibels as a function of frequency.
At the right of the diagrams, some dB-values are printed for some typical marked frequencies.
For a quick overview the following table presents the **shielding efficiency** in Decibel (dB) at some interesting frequencies:

Measurement acc. to **IEEE 299**		
	Name of the DUT:	**Wear**
D-Netz, GSM 900,	900 MHz	**26dB / 26dB**
E-Netz, GSM 1800,	1800 MHz	**24dB / 24dB**
Blue-Tooth, WLAN	2450 MHz	**21dB / 22dB**
W-LAN new generation	5.8 GHz	**17dB / 16dB**
X-Band Radar	9.5 GHz	**12dB / 10dB**

Table 2: Shielding at different frequencies
Values befor the slash: E-Field perpendicular to the weft thread
Values behind the slash: E-Feld parallel to the weft thread

4. Final conclusions

The measurements proved that the shielding of the fabric ***Swiss Shield Wear*** is almost independent of the polarisation of the incident waves.

The shielding against frequencies, used at the mobile communications (i.e. GSM 900, GSM 1800, UMTS and LTE) is between 21dB and 26dB. This means, that 99,22% to 99,75% of the incident power flux density is removed by the fabric.

The reduction of the shielding values is physically determined by the material and the width of the mesh. This is quite normal for all types of fabric or mesh-structures.

Neubiberg, 5th of September 2017

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Appendix to the Test Report of the 5th of Sept. 2017
Measurements according to IEEE 299
with linear polarisation

Device under test: *Swiss Shield Wear*

Upper graph: E-field perpendicular to the weft; lower graph: E-field parallel to the weft