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Section: RF- and Microwaves, Radars

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EXPERT REPORT

Analysis of Consumer Shielding Paint Application

21th of November 2019

Requested by: **GEOVITAL**
Akademie für Geobiologie und Strahlenschutz
Unterwolfbühl 430
A-6934 Sulzberg

Device Tested: Shielding paint T 98 applied by consumers to DIN A4 cardboard (21 cm x 29,7 cm)

Single coat
Double-coated
Triple-coated

Subject: Measuring consumer application of shielding paint and the shielding efficiency against electromagnetic waves from 100 MHz to 8 GHz through

Regulations: ASTM D-4935-10 (ASTM = American Society of Testing and Materials)

Date of Measurements: 18th of November 2019

Content: 5 pages of text, 44 test graphs and 10 appendices

Results: The shielding paint ***T98,*** single coated, double coated and triple coated applied by clients on a DIN A4 cardboard, have been tested by ASTM with electromagnetic waves showing polarizations in all directions. The results of the shielding efficiency are valid as well for vertically as also for horizontally polarized waves.

The following table presents the values of shielding efficiency (SE) in decibels that are relevant for home users when painting their own walls and ceilings.

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1. Introduction

To analyse the measured diagram, 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 indicates, how much the level of an incident power or power flux density has decreased, passing the material 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**.
This means - for example - that 20 dB shielding reduces the penetrating power down 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	31.00	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

Table 1: Conversion of shielding-efficiency-values, given in dB, to %-values of transmitted power

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2. Measurement Setup according to ASTM D 4935-2010 from 100 MHz to 8 GHz

This standard was published by the American Society of Testing and Materials (ASTM).

The DUT (**D**evice **U**nder **T**est) was installed between two coaxial TEM-adapters. The test signal was emitted from port 1 of the network analyzer. The transmitted signal was received by port 2 of the NWA. During a S_{21}-calibration without DUT but with a neutral distance holder of the same thickness as the DUT, the transmission value was set to “0” dB.

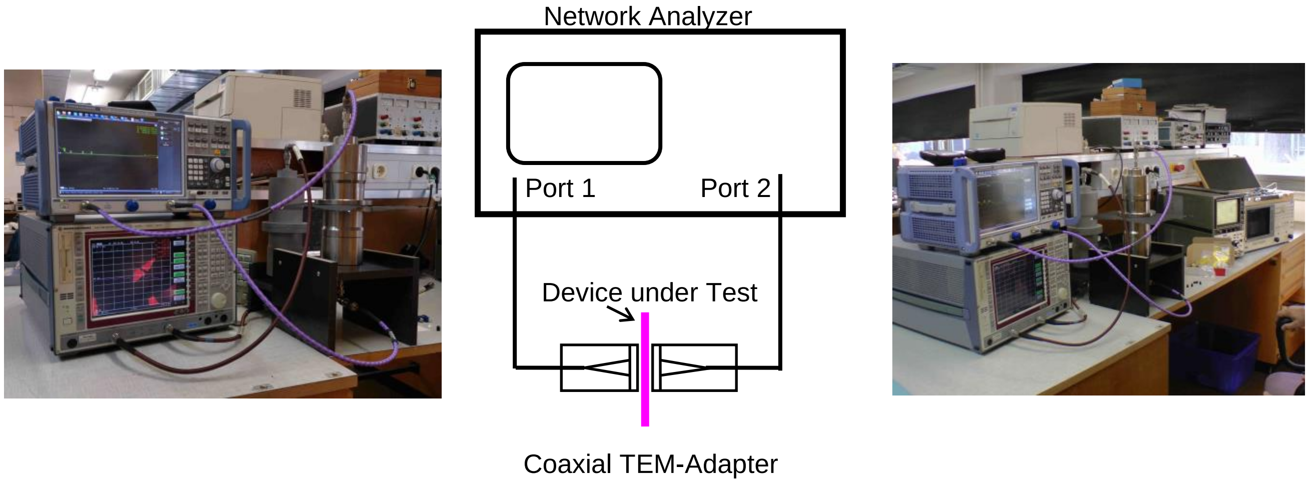

Fig. 1: Set-up to measure the shielding efficiency by means of TEM-adapters

Test equipment:

Vector Network Analyzer, type ZNB 20 (30 kHz – 20 GHz) Rohde & Schwarz
Latest device from 2019 with the latest software
Assistance by Rohde & Schwarz device expert Hr. Schenk

Latest coaxial TEM-Adapters, (1 MHz - 8 GHz),

Due to the coaxial structure of the adapters they transmit a TEM-wave. Thus the DUT was hit by **E-field vectors in all transverse directions**.
The consequence is: If the measured shielding efficiency is very good, you can assume, that the DUT will shield as well against vertically as against horizontally polarized waves in the same qualitative manner.
The results correspond closely to the reality, where the polarization of the incident waves normally cannot be predicted.

3. Results of the Measurements

The diagram in the appendix presents the measured transmission values i.e. shielding efficiency of the shielding paint ***T98*** in decibels values for the layer thicknesses as applied by consumers.
For the table, the frequency 2.44 GHz was selected, which comes closest to a good average of all mobile radio frequencies, from GSM to the 5G frequencies in Europe.

For a quick overview, these values are listed in the table below.

Client/Consumer	**Single coated** paint quantity / Shielding efficiency	**Double coated** paint quantity / Shielding efficiency	**Triple coated** paint quantity / Shielding efficiency
Fam. Amhofer	16 g / 47 dB	+18 g = 34 g / 61 dB	+14 g = 48 g / 75 dB
Fam. Andrae	19 g / 53 dB	+14 g = 33 g / 62 dB	+18 g = 51 g / 79 dB
Fam. Aumer	15 g / 51 dB	+23 g = 38 g / 68 dB	+ 4 g = 42 g / 67 dB
Fam. Bauer	13 g / 55 dB	+21 g = 34 g / 64 dB	+14 g = 48 g / 74 dB
Fam. Berger	16 g / 50 dB	+19 g = 35 g / 65 dB	+12 g = 47 g / 79 dB
Fam. Heeb	13 g / 45 dB	+20 g = 33 g / 62 dB	+18 g = 51 g / 76 dB
Fam. Hoffmann	17 g / 51 dB	+18 g = 35 g / 68 dB	+ 9 g = 44 g / 74 dB
Fam. Klebert	13 g / 47 dB	+22 g = 35 g / 68 dB	+14 g = 49 g / 77 dB
Fam. Martin	16 g / 50 dB	+21 g = 37 g / 70 dB	+12 g = 49 g / 80 dB
Fam. Pacher	15 g / 48 dB	+20 g = 35 g / 59 dB	+15 g = 50 g / 76 dB
Fam. Schuler	18 g / 49 dB	+16 g = 34 g / 60 dB	+11 g = 45 g / 72 dB
Fam. Spindler	16 g / 50 dB	+20 g = 36 g / 66 dB	+ 9 g = 45 g / 71 dB
Fam. Teubner	18 g / 53 dB	+17 g = 35 g / 62 dB	+15 g = 50 g / 75 dB
Fam. Thiel	19 g / 53 dB	+15 g = 34 g / 63 dB	
Fam. Werner	19 g / 50 dB	+16 g = 35 g / 62 dB	+11 g = 46 g / 74 dB

Table 2: Screen attenuation values at 2.44 GHz

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4. Final conclusions

Consumers have painted a normal bedroom with about 15 square meters floor area three times with shielding paint T98 and included, with each paint application, one DIN A4 cardboard. These were provided for this assessment.
The unpainted cardboard was weighed (15 g), as well as the provided painted cardboards. Both values were subtracted from each other, so that the weight of the pure paint application indicated in the table could be determined.
Since the samples were made by consumers, the uniformity of the paint application is relative, but as homogeneous as possible.

The T 98 shielding paint (applied in one layer by users) shows **a shielding effect of 50 dB** on average over the whole range of interesting mobile telephony radio frequencies. This means that less than **0.001%** of the incident power will pass through the paint work. 99.999% of the power was shielded.
In the case of **two-coat application** of paint, the screening effect increases to **over 60 dB and three-layers even to more than 70 dB**. Now only **0.00001%** is allowed through. 99.99999% of the incoming power on such painted wall and ceiling surfaces are screened.

In the currently introduced **5G mobile services at 3.4 GHz - 3.8 GHz** the T 98 paint shielded so applied single-layer over **50dB**, two-layers over **60dB** and a three-layer application of **shielding paint T 98** even guarantees an attenuation of over **70dB**. Less than a millionth of the incoming RF power still passes through the layer of paint. **99.99999%** of the incoming power will be eliminated.

The results show that careful three-layer application the T 98 shielding paint gives excellent RF shielding properties.

Neubiberg, 21st of Nov. 2019

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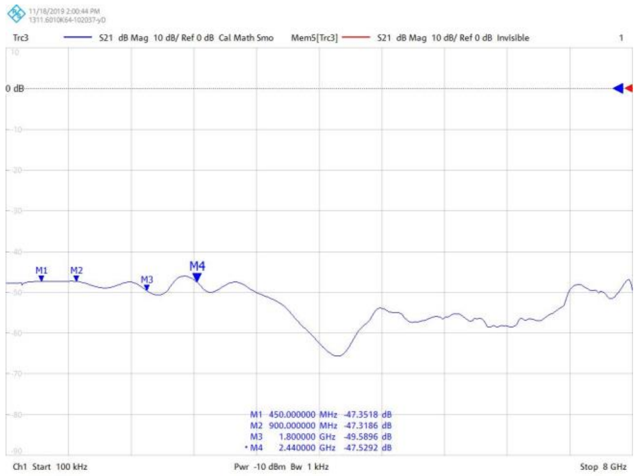
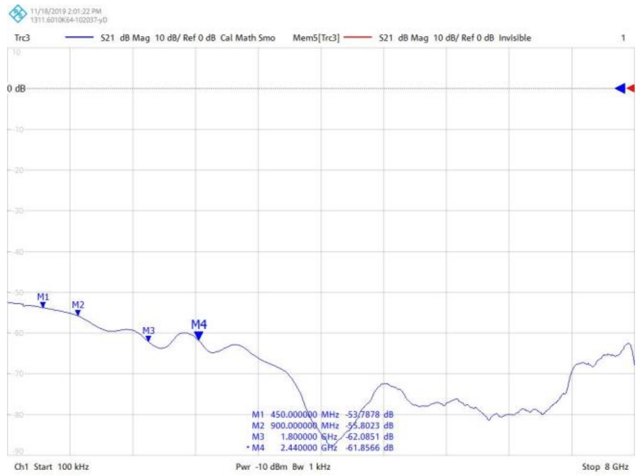
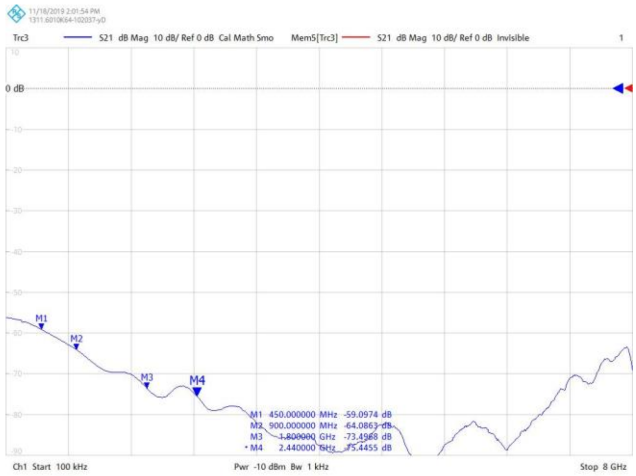
Appendix 1
of the Test Report from 18st of Nov 2019
measured according to ASTM D-4935
with <u>omnidirectional polarization</u>



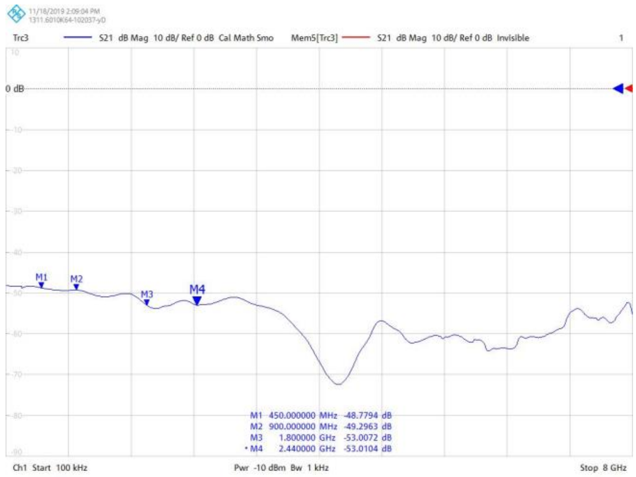
Fam Amhofer 1-layer



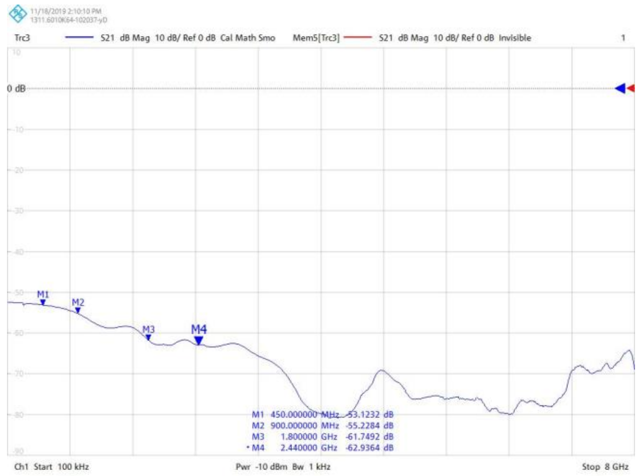
Fam Amhofer 2-layer



Fam Amhofer 3-layer



Fam Andrae 1-layer



Fam Andrae 2-layer

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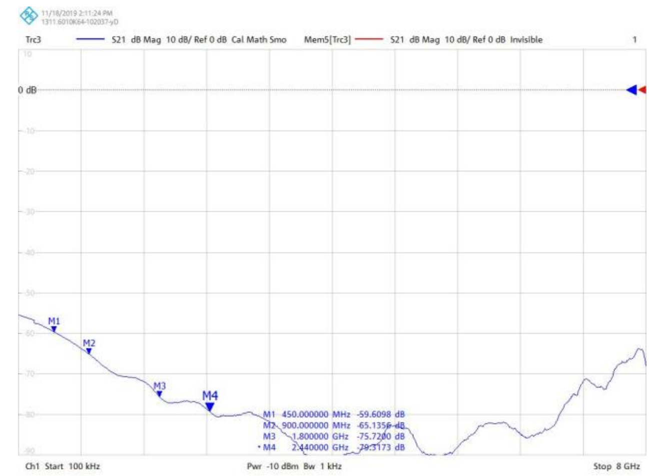
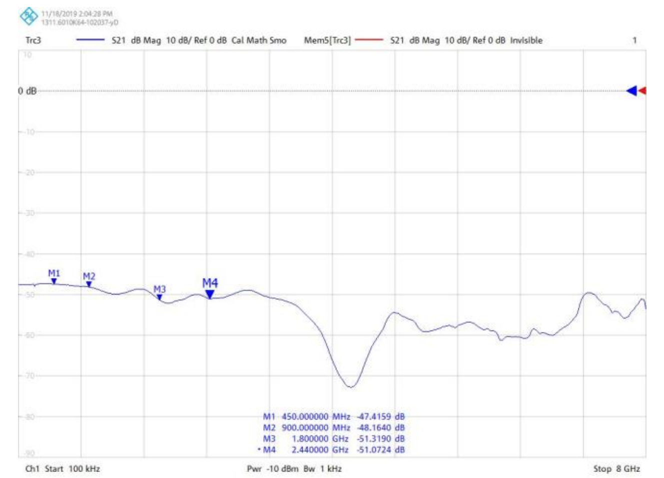
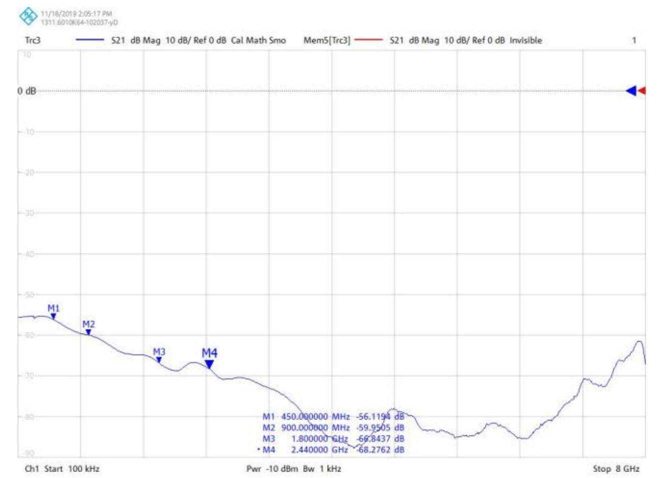
Appendix 2
of the Test Report from 18st of Nov 2019
measured according to ASTM D-4935
with <u>omnidirectional polarization</u>



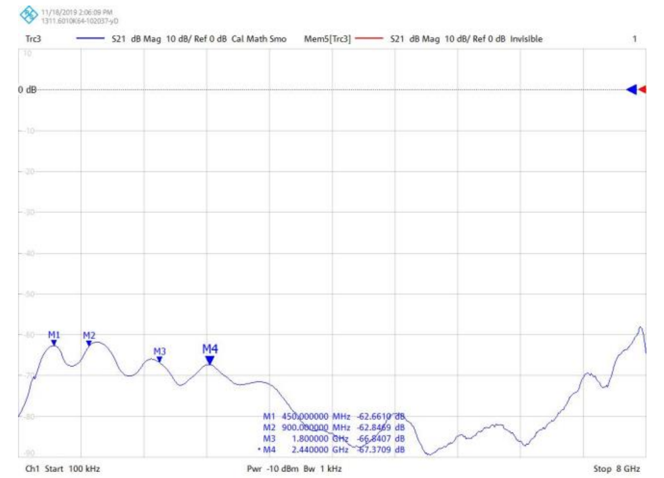
Fam Andrae 3-layer



Fam Aumer 1-layer



Fam Aumer 2-layer



Fam Aumer 3-layer

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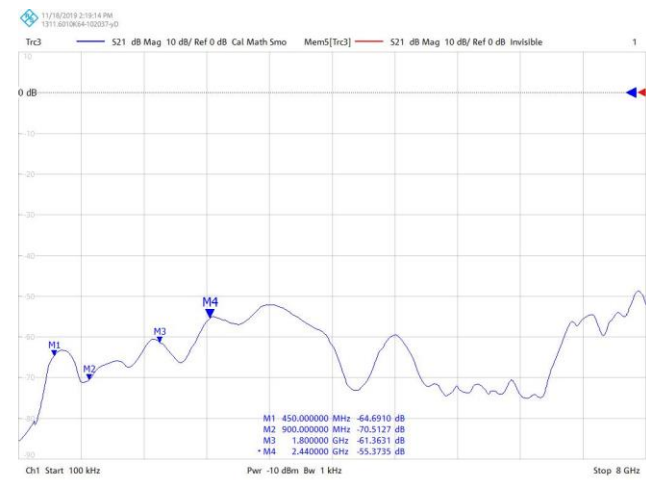
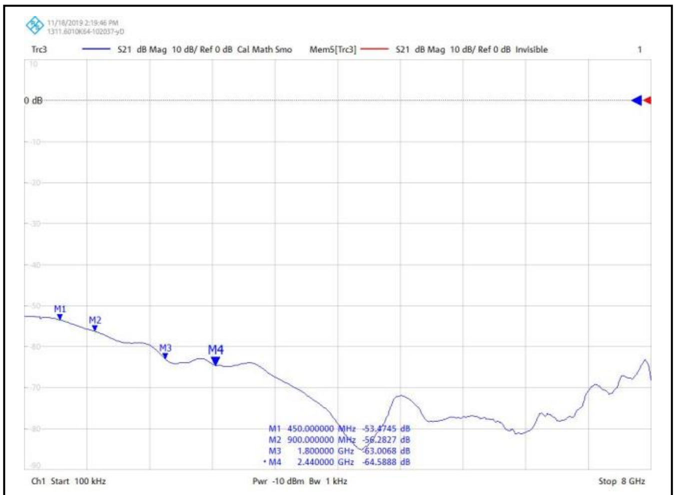
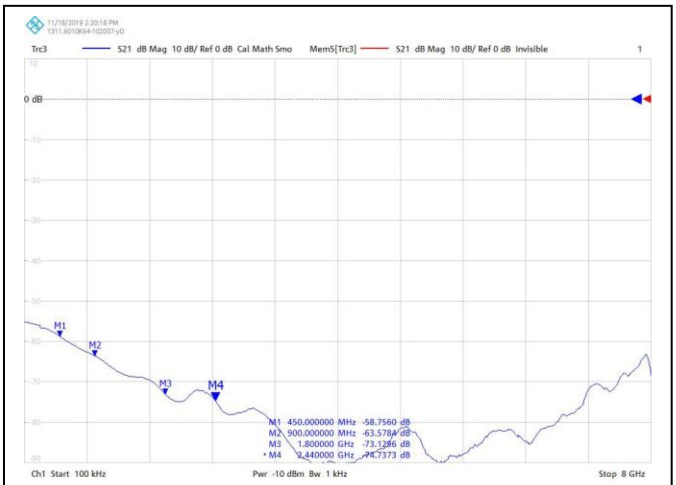
Appendix 3
of the Test Report from 18st of Nov 2019
measured according to ASTM D-4935
with omnidirectional polarization



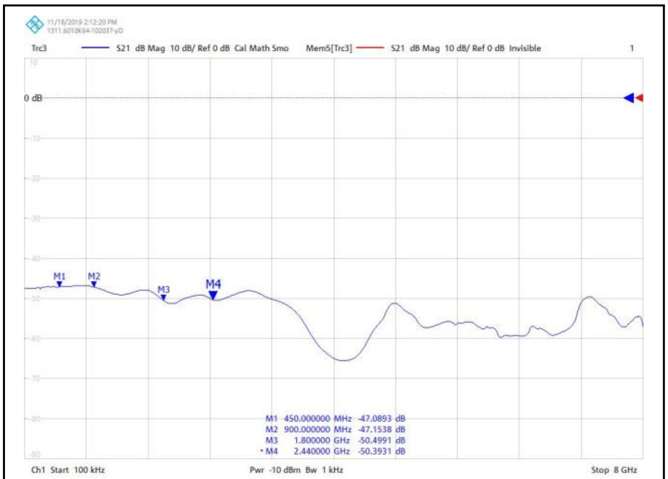
Fam Bauer 1-layer



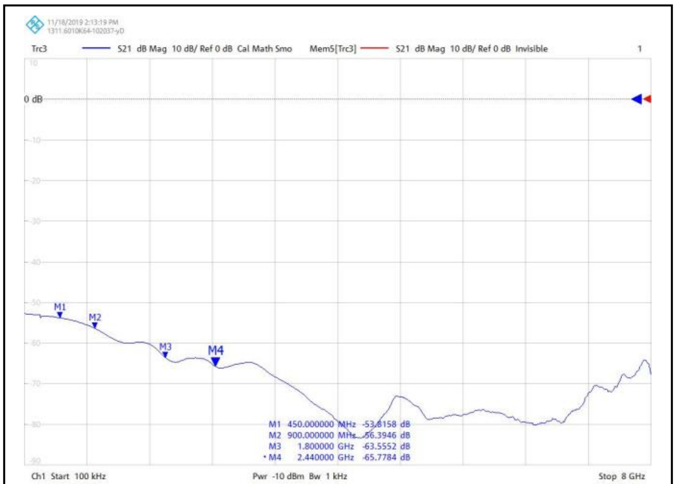
Fam Bauer 2-layer



Fam Bauer 3-layer

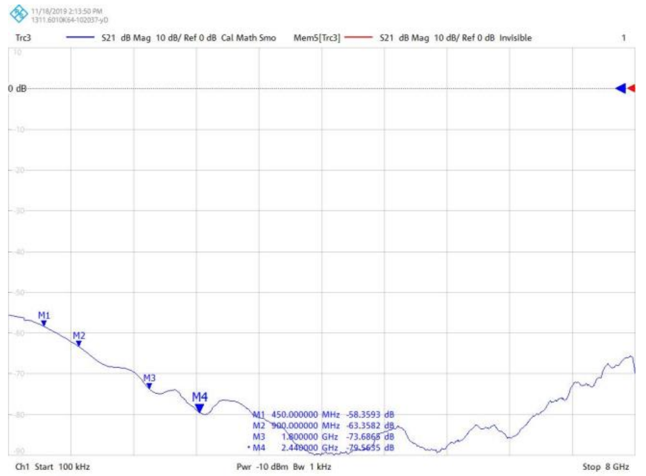


Fam Berger 1-layer

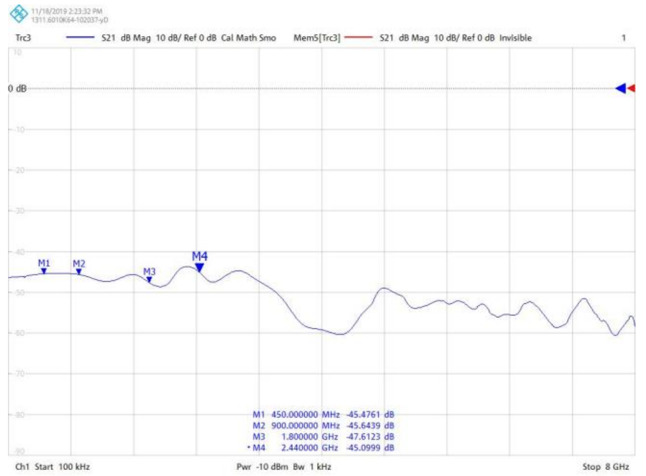


Fam Berger 2-layer

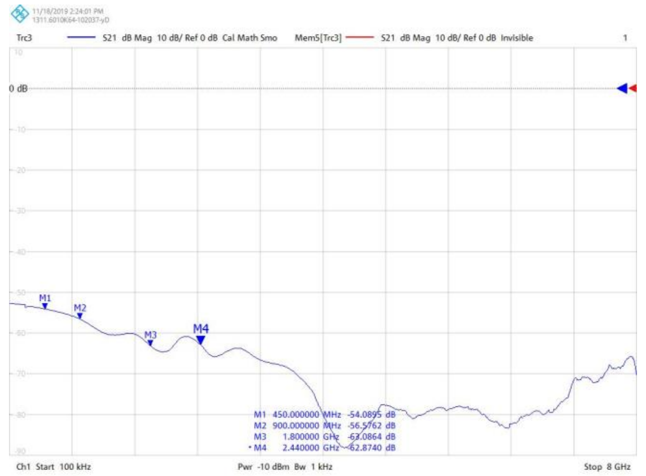
Appendix 4
of the Test Report from 18st of Nov 2019
measured according to ASTM D-4935
with <u>omnidirectional polarization</u>



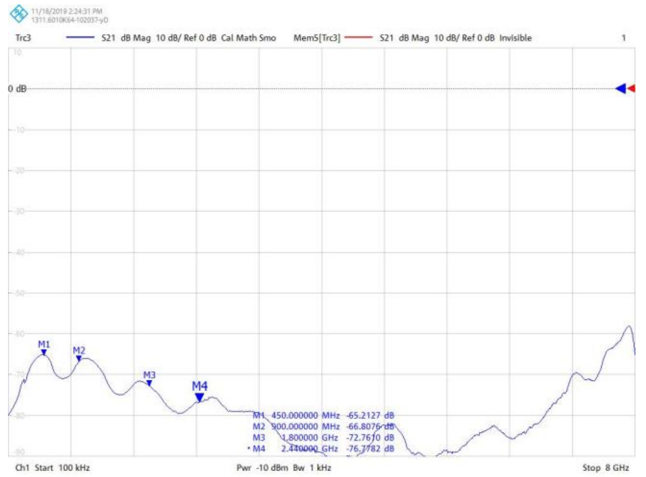
Fam Berger 3-layer



Fam Heeb 1-layer



Fam Heeb 2-layer



Fam Heeb 3-layer

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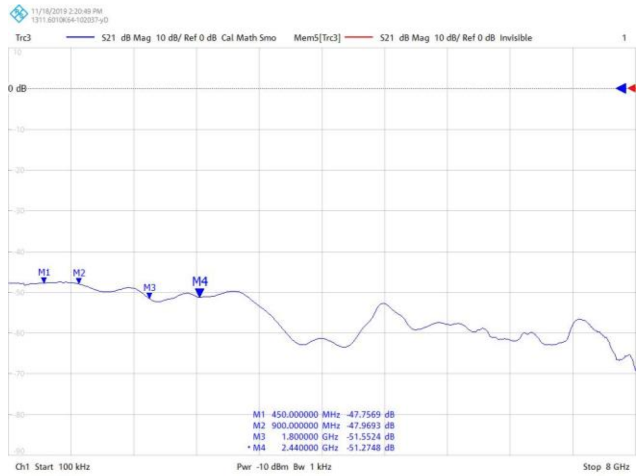
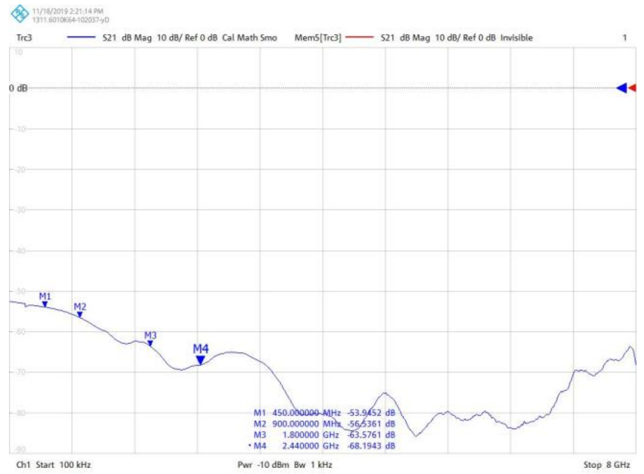
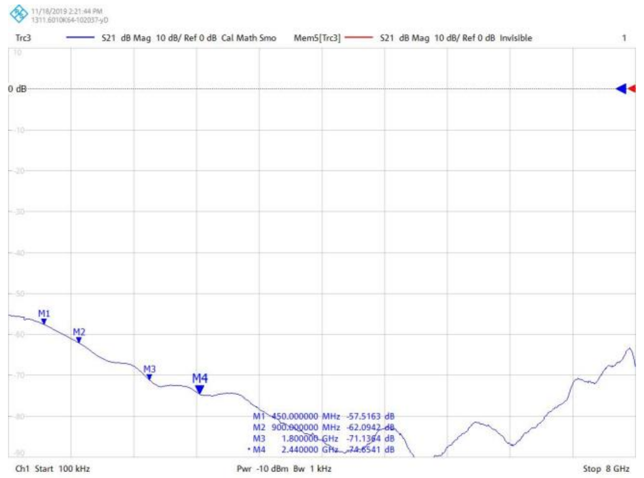
Appendix 5
of the Test Report from 18st of Nov 2019
measured according to ASTM D-4935
with omnidirectional polarization



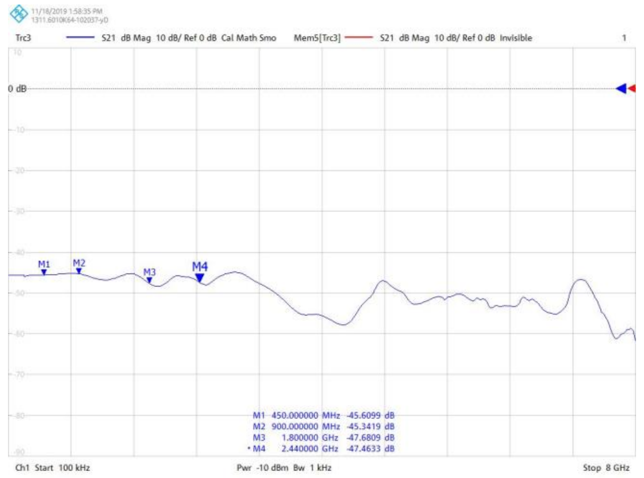
Fam Hoffmann 1-layer



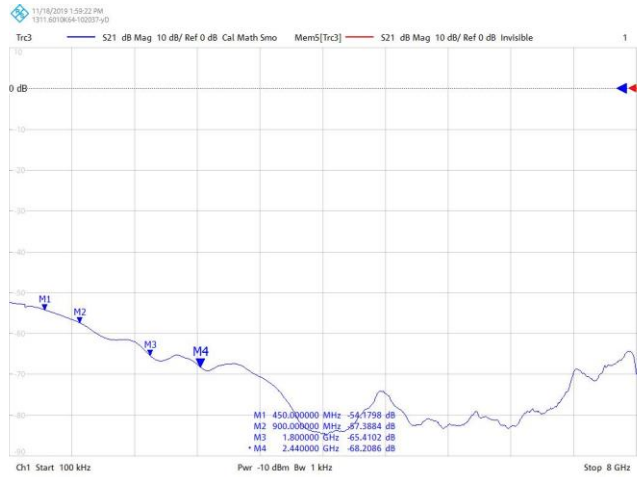
Fam Hoffmann 2-layer



Fam Hoffmann 3-layer



Fam Klebert 1-layer



Fam Klebert 2-layer

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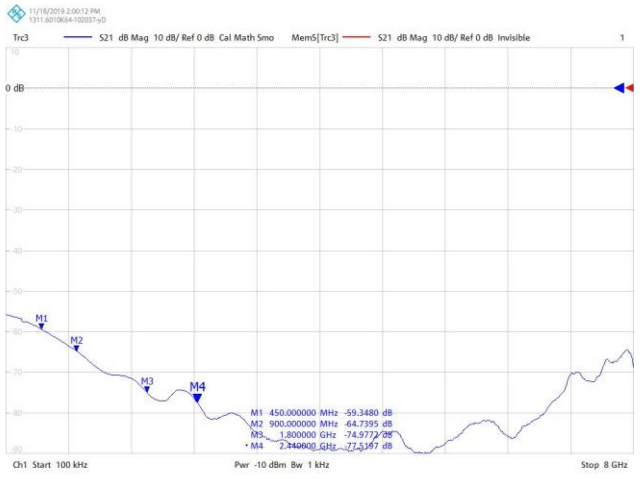
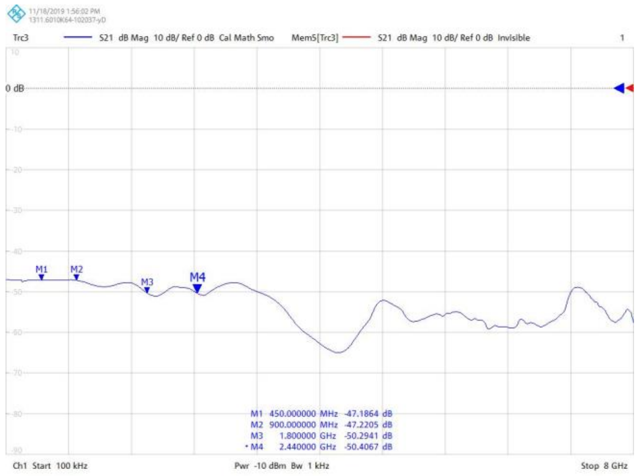
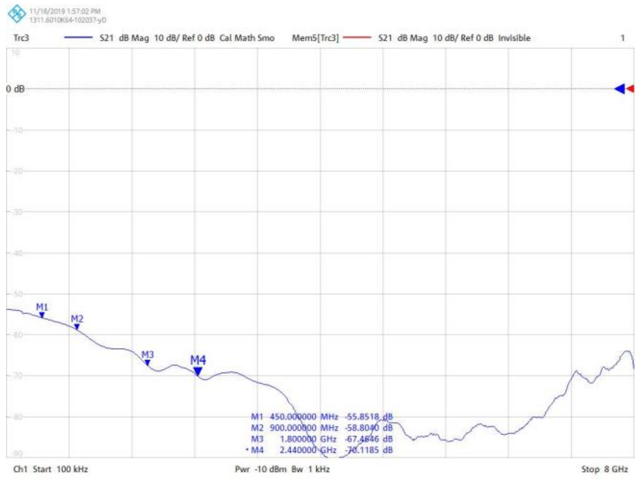
Appendix 6
of the Test Report from 18st of Nov 2019
measured according to ASTM D-4935
with omnidirectional polarization



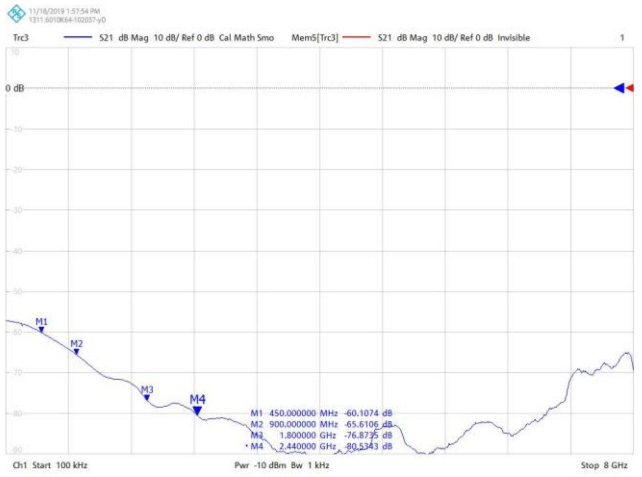
Fam Klebert 3-layer



Fam Martin 1-layer



Fam Martin 2-layer



Fam Martin 3-layer

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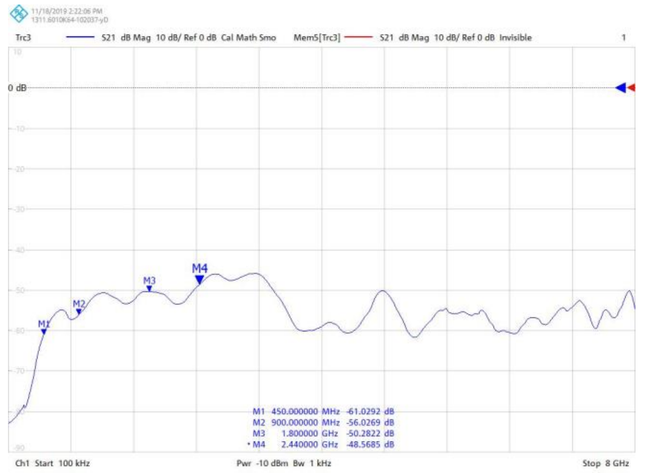
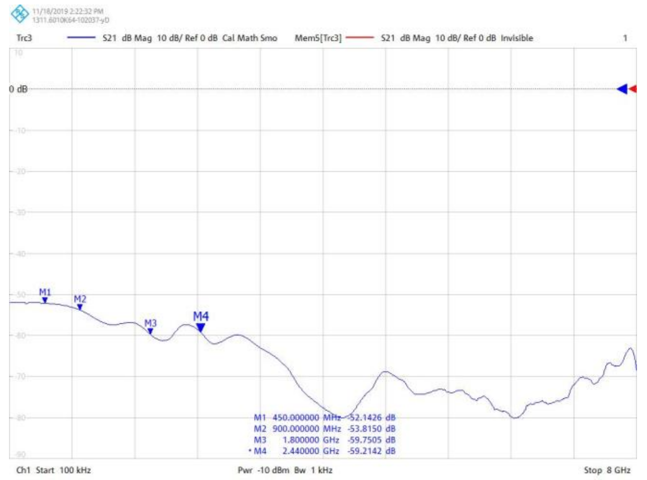
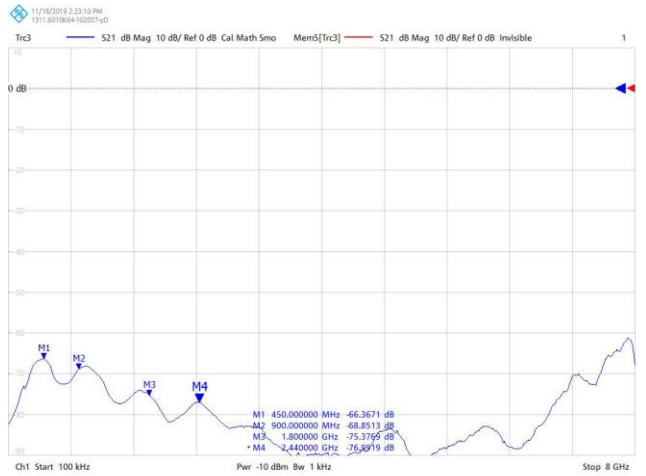
Appendix 7
of the Test Report from 18st of Nov 2019
measured according to ASTM D-4935
with <u>omnidirectional polarization</u>



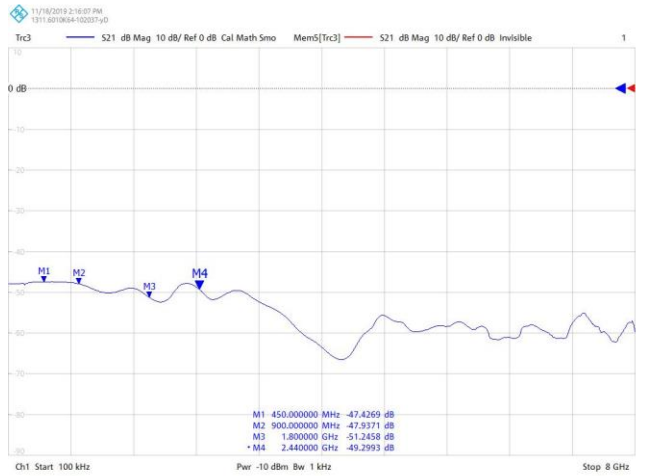
Fam Pacher 1-layer



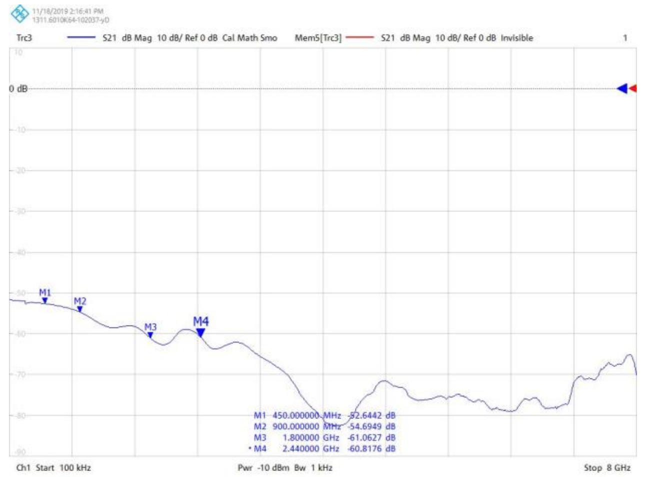
Fam Pacher 2-layer



Fam Pacher 3-layer



Fam Schuler 1-layer



Fam Schuler 2-layer

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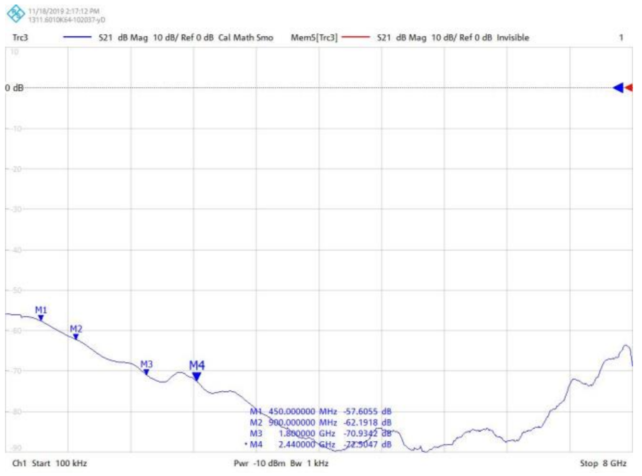
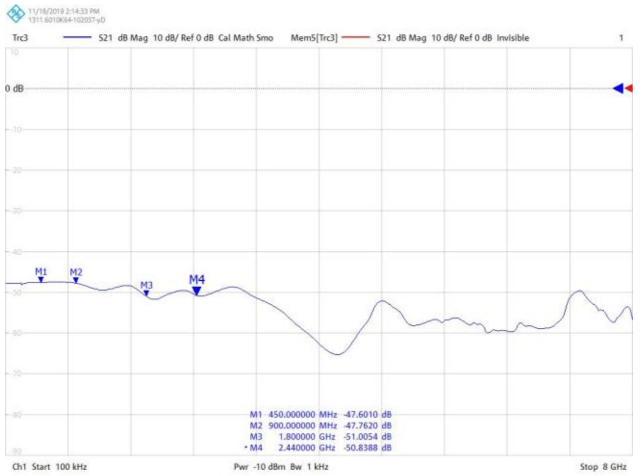
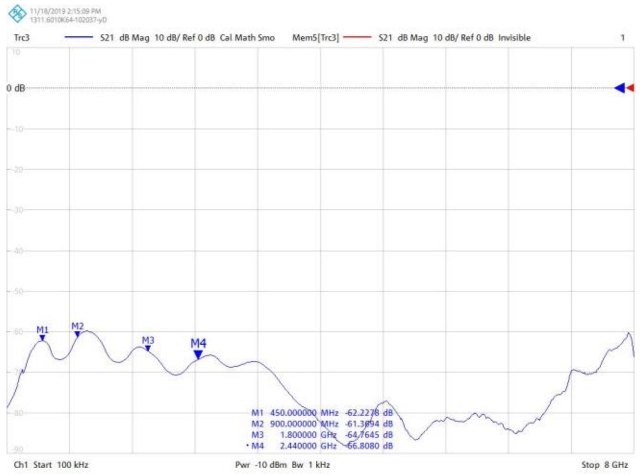
Appendix 8
of the Test Report from 18st of Nov 2019
measured according to ASTM D-4935
with <u>omnidirectional polarization</u>



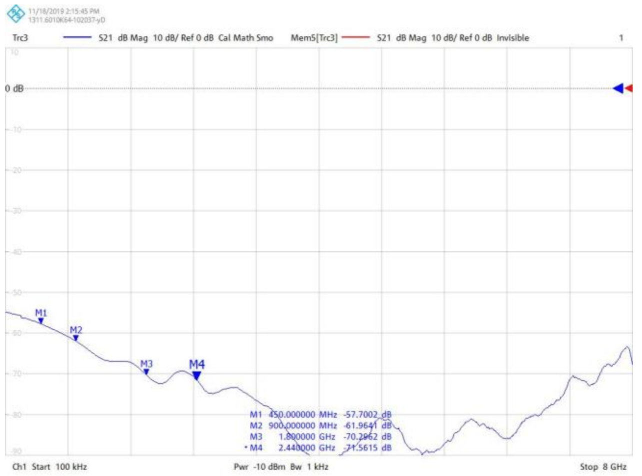
Fam Schuler 3-layer



Fam Spindler 1-layer

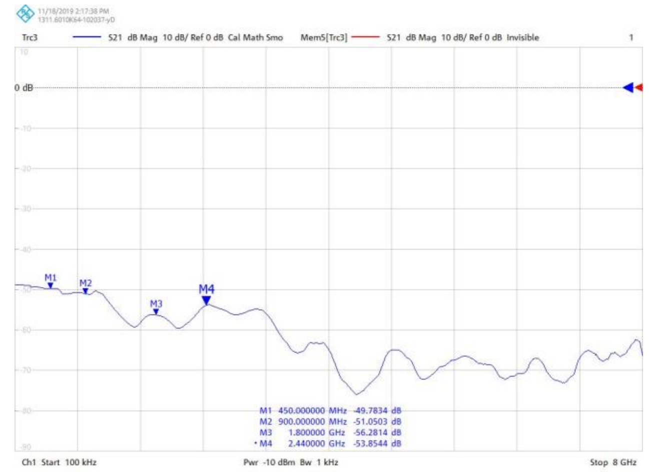


Fam Spindler 2-layer

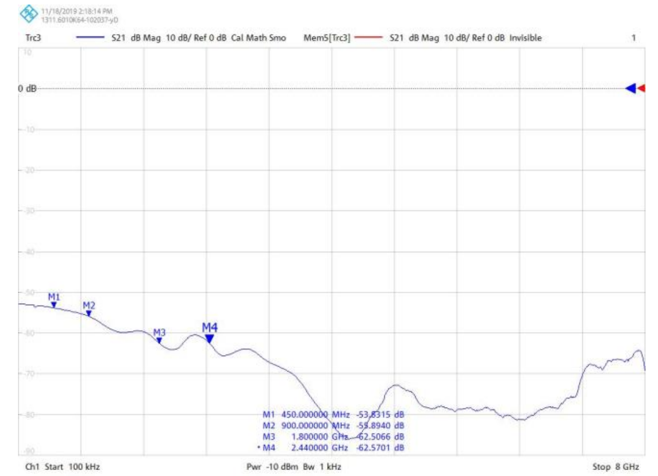


Fam Spindler 3-layer

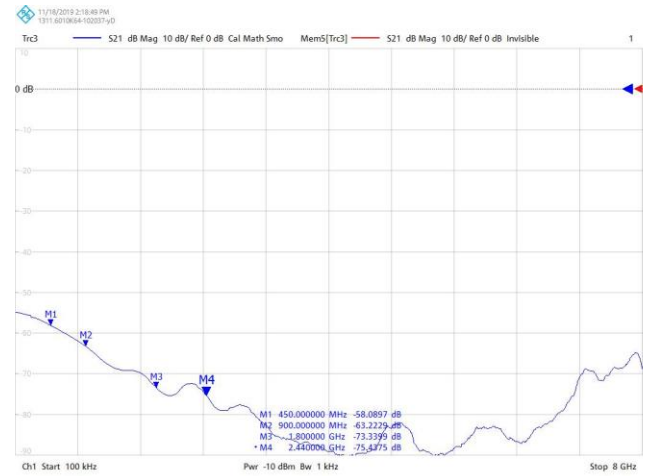
Appendix 9
of the Test Report from 18st of Nov 2019
measured according to ASTM D-4935
with omnidirectional polarization



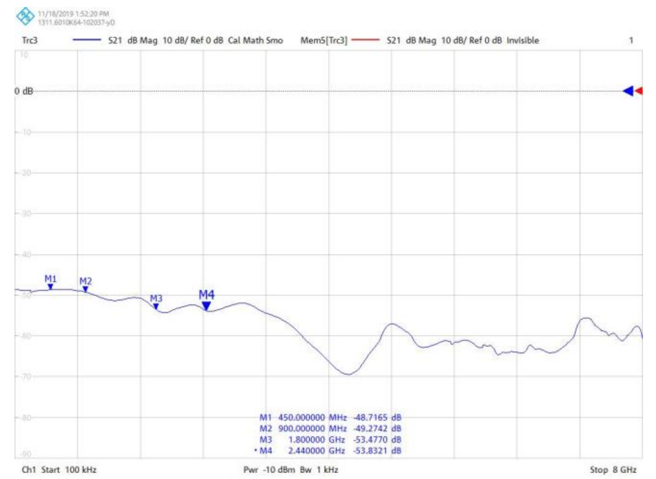
Fam Teubner 1-layer



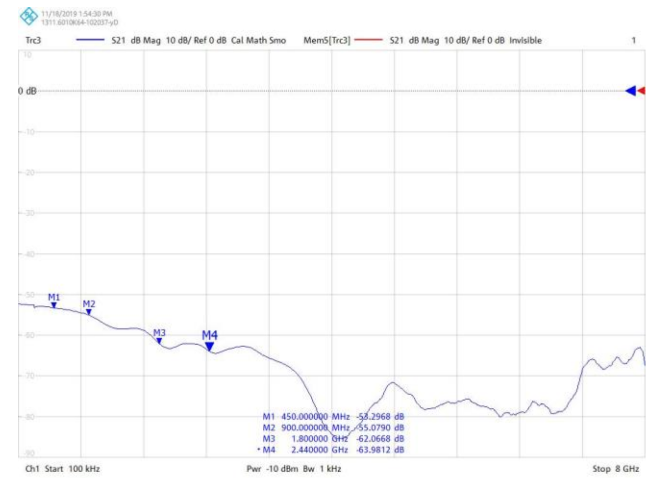
Fam Teubner 2-layer



Fam Teubner 3-layer



Fam Thiel 1-layer



Fam Thiel 2-layer

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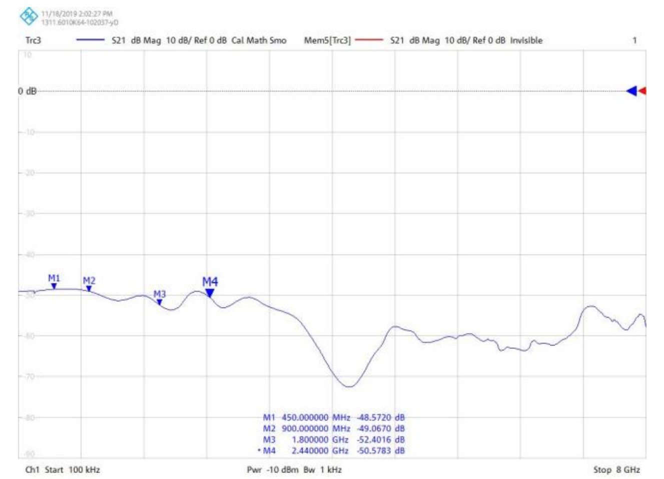
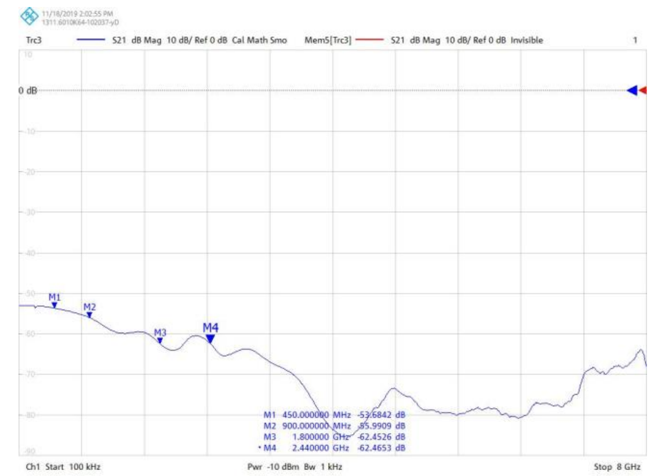
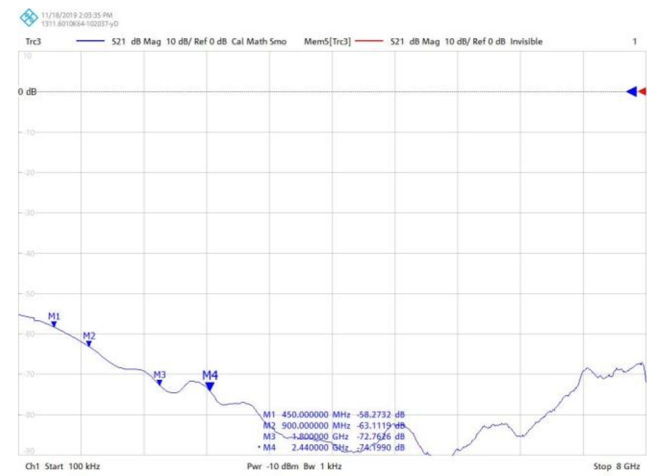
Appendix 10
of the Test Report from 18st of Nov 2019
measured according to ASTM D-4935
with <u>omnidirectional polarization</u>



Fam Werner 1-layer



Fam Werner 2-layer



Fam Werner 3-layer