DefenderShield®

ULTRA ARMOR™ EMF SHIELDING MATERIAL

Shielding Effectiveness Testing Report

Test Date: June 2020

Focused Beam Textile Measurements

Data Report on Focused Beam Textile Measurements

The insertion loss of textile samples of *Ultra Armor*™ were measured in Focused Beam and Millimeter Wave Focused Beam systems.

Table 1: Measurement Equipment	
Measurement System(s)	Lab Group Focused Beam System Lab Group Millimeter Wave Focused Beam System
Network Analyzer	Copper Mountain C4220 with Farran FEV-12 frequency extenders, Copper Mountain C1220, and Anritsu ShockLine MS46122B
Configuration Specifics	”normal” lens configuration

Any device used to block the RF signal between its source and a receiver is an electromagnetic interference (EMI) shield. Such a shield will react differently depending on its design variations (i.e. material, dimensions, etc.). The measure of this ability to attenuate RF is shielding effectiveness (SE), which is expressed in decibels (dB), the ratio of field strength on one side of the shield to the other side. The figure below shows the relationship between shielding effectiveness (in dB) and attenuation percentage.

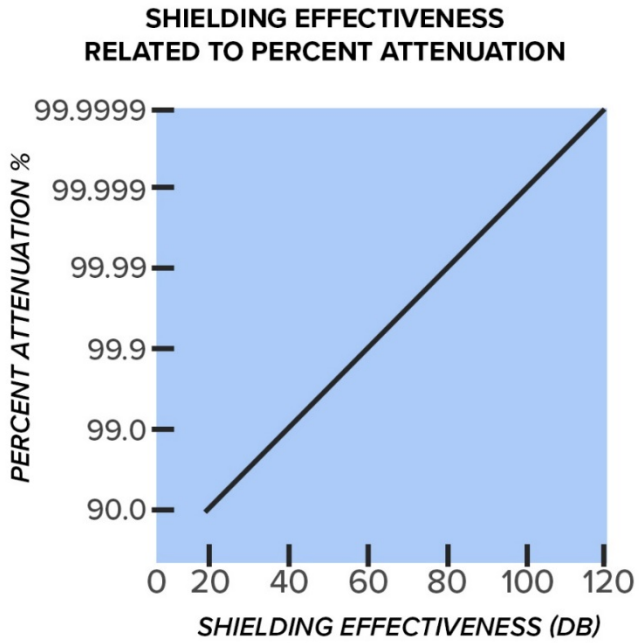
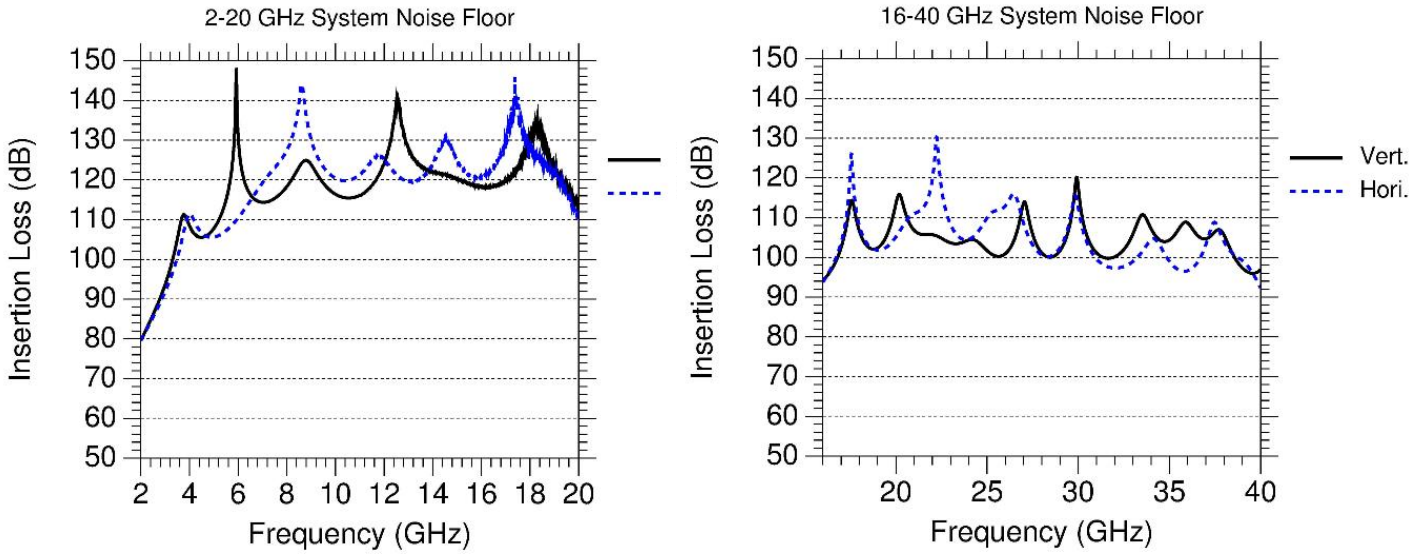


Table 2: Measurement Procedure	
Method/Calibration	Measured S_{21} Transmission S-parameter & calibrated with a clearsite (no specimen) and metal plate.
Data Processing	Used time-domain gating with a 0.5 ns wide gate
Inversion(s)	The shielding effectiveness / insertion loss is computed as the negative of the transmission coefficient in dB
Procedure	Standard Test Method: TM-0101-2020

Focused Beam Test for 2-40 GHz range

System Noise Floor Measurements for 2-20 GHz (WiFi, 4G, 5G low- and mid-band) and 16-40 GHz range (5G high-band)



Observations:

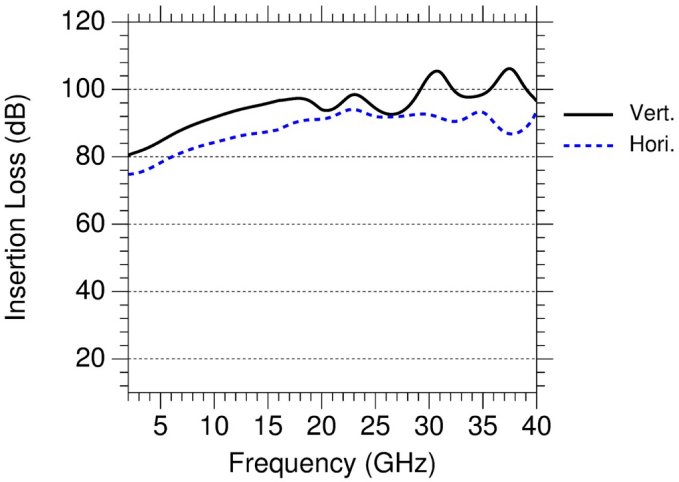
- Plots show the noise floor measurement conducted twice for both the Copper Mountain C1220 VNA (2-20 GHz) and Anritsu MS46122B VNA (16-40 GHz)
- Measurement is made after removing and then replacing the metal calibration specimen

- Focused beam system noise floor is 105-115 dB or higher between 4 and 20 GHz and 95-100 dB or higher between 20 and 40 GHz
- Note: if greater dynamic range is needed in the 20-40 band, a higher quality VNA will need to be leased for that range

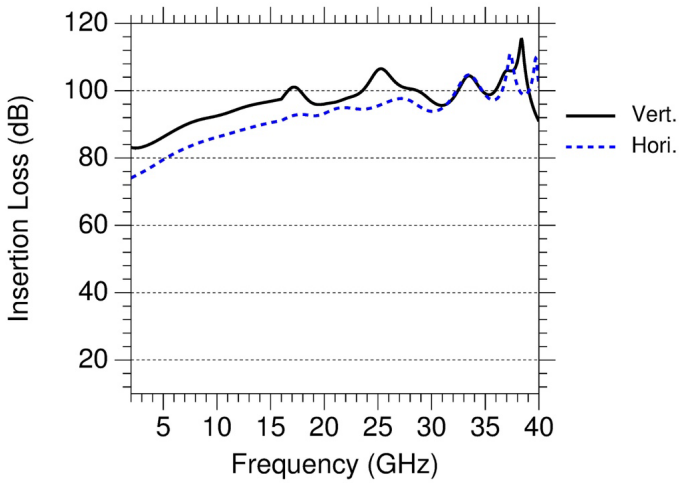
Results for Focused Beam 2-40 GHZ Shielding Sample 1 and Shielding Sample 2

- Plots show S_{21} magnitude vs frequency for 1 sample each.
- Solid black lines show data for vert orientation and blue dashed lines show data for horizontal orientation.
- For 2-20 GHz, Insertion Loss along the vertical orientation (dB) ranged from 80 dB to 148 dB, with an average 99.9999% attenuation loss.
- For 2-20 GHz, Insertion Loss along the horizontal orientation (dB) ranged from 80 dB to 146 dB, with an average 99.999% attenuation loss.
- For 16-40 GHz, Insertion Loss along the vertical orientation (dB) ranged from 94 dB to 120 dB, with an average 99.999% attenuation loss.
- For 16-40 GHz, Insertion Loss along the horizontal orientation (dB) ranged from 94 dB to 130.5 dB, with an average 99.999% attenuation loss.

Shielding Sample 1



Shielding Sample 2

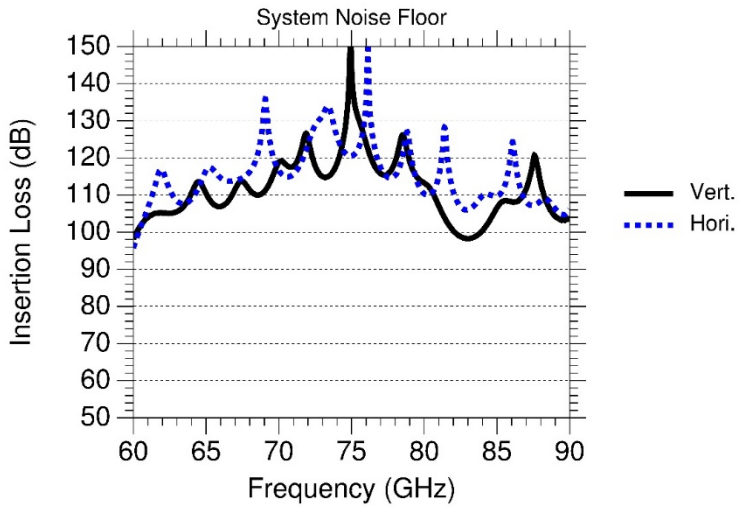


Observations:

- Many samples are anisotropic
  - Insertion loss varies with E-field polarization relative to weave
- Some specimens with high shielding effectiveness in 20-40 GHz band are near the noise floor due to lower dynamic range of Anritsu MS46122B VNA.
  - Dynamic range limitation manifests as ripples in data
- 2-20 GHz and 16-40 GHz data merged onto same plot using linear transition between data sets on the 16-20 GHz sub-band.
  - In a few cases there are differences between upper and lower bands, probably due to material inhomogeneity (the illumination spot size is different between the lower and upper band, and therefore illuminates different areas of the specimen)

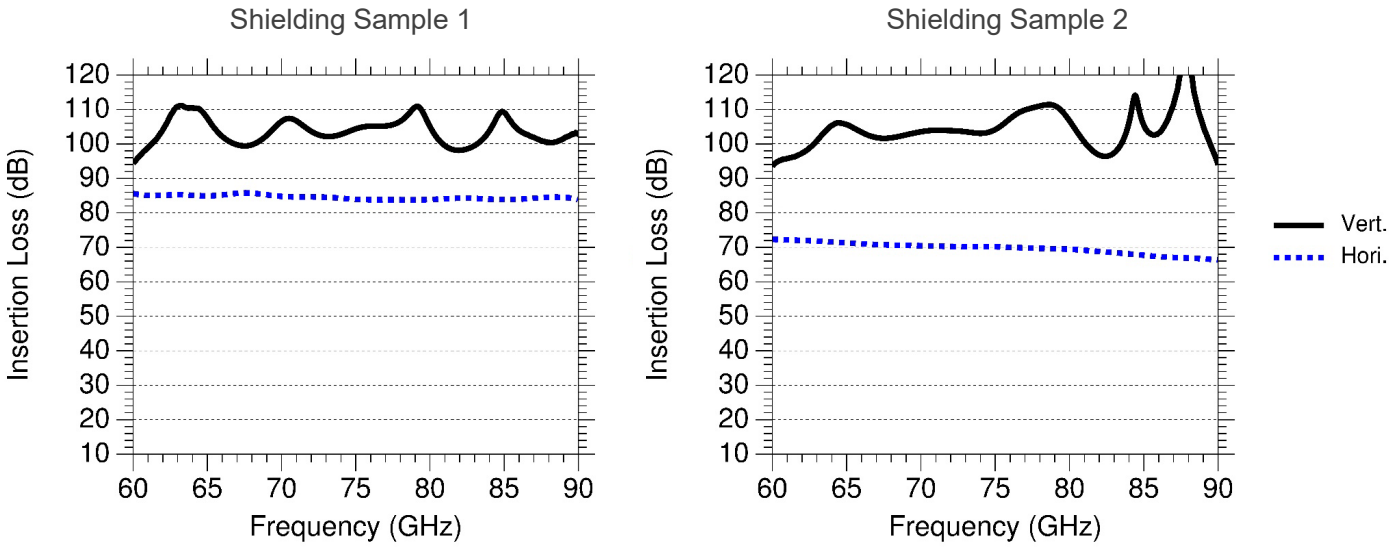
Focused Beam Test for the 5G High Band Millimeter Range: 60-90 GHz

System Noise Floor Measurements for 60-90 GHz range



- Millimeter wave focused beam system noise floor is 110 dB or higher between 67 and 80 GHz, and 100 dB or higher for other frequencies.
- Plot shows the noise floor measurement conducted twice.

Results for Focused Beam 60-90 GHz Shielding Sample 1 and Shielding Sample 2



Observations:

- Plots show S_{21} magnitude vs frequency for 1 sample each.
- Solid black lines show data for vertical orientation and blue dashed lines show data for horizontal orientation.
- For Shielding Sample 1, the Insertion Loss for vert orientation ranged from 95 dB to 111 dB, which yields an average of 99.999% attenuation loss.
- For Shielding Sample 2, the Insertion Loss for horizontal orientation ranged from 84 dB to 88 dB, which yields an average of 99.9927% attenuation loss.

Summary of Results

Testing of *Ultra Armor*™ in both vertical and horizontal orientations (above) showed that an average of 99.97% radiation attenuation was recorded for all frequencies tested, reaching up to 90 GHz.