# A Method for the Measurement of RF Absorber using Spectral Domain Transformations

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***Abstract*— Indoor antenna ranges must have the walls, floor and ceiling treated with RF absorber. Pyramidal absorber is shaped to create an impedance transform from free space to that of the absorbing material. The pyramidal shape provides this very effectively for normal incidence, but performance typically gets worse as the angle of incidence deviates from normal. Unfortunately, it is difficult to measure reflectivity at large oblique angles because of difficulty differentiating the reflected signal from that of the direct path. In this paper, a novel approach for performing such measurements is introduced. Preliminary measurements are compared to RF simulations. The comparison appears to indicate that this approach is a valid way to perform RF absorber measurements at wide angles.**

***Keywords—measurements, RF Absorber, Antenna Ranges***

## I. INTRODUCTION

RF absorber is used in indoor ranges to reduce reflection from certain areas of the range to create a free-space condition for testing. The pyramidal shape of the absorber helps the electromagnetic (EM) wave penetrate into the absorber where it is transformed into thermal energy and dissipated. In most applications of absorber in indoor ranges, it is important to know its bi-static reflectivity for oblique angles of incidence.

Reference [1] is the IEEE recommended practice for RF absorber measurements; however, its recommended approach for oblique incidence, while acceptable for angles smaller than 50 degrees, is difficult to apply to very wide angles of incidence. The reason becomes obvious by looking at Fig. 1 The direct path between the two horns (red arrow) is very close to the reflected path form the absorber field (yellow arrow).

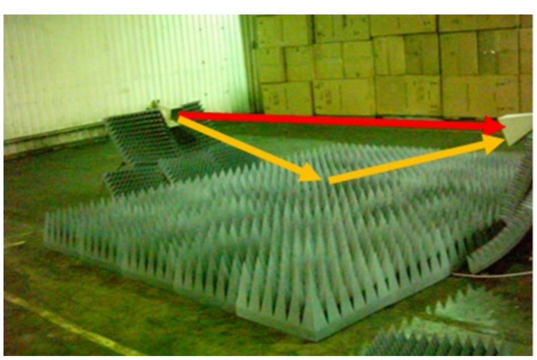

Fig. 1. Absorber reflectivity measurement at large angles of incidence

The similar length of the two paths makes it extremely difficult to time-gate out the direct coupling between the horns. For a direct path with distance D between the horns, at 85° of incidence the difference in path between reflected and direct is 0.08D.

The use of baffles or absorber barriers to block the direct path is an appealing approach, but their presence affects the measurements and adds uncertainty to the method. A novel approach is introduced here that uses the spectral domain to post-process the data and remove the direct path between horns.

## II. THE SPECTRAL DOMAIN TECHNIQUE

### *A. Description of the approach*

The proposed approach consists of performing a planar scan to obtain a spectral domain representation of the direct-path incident field from the illuminating antenna in free-space conditions, at least as far as possible. This direct-path-only measurement is used as a reference or calibration. The absorber

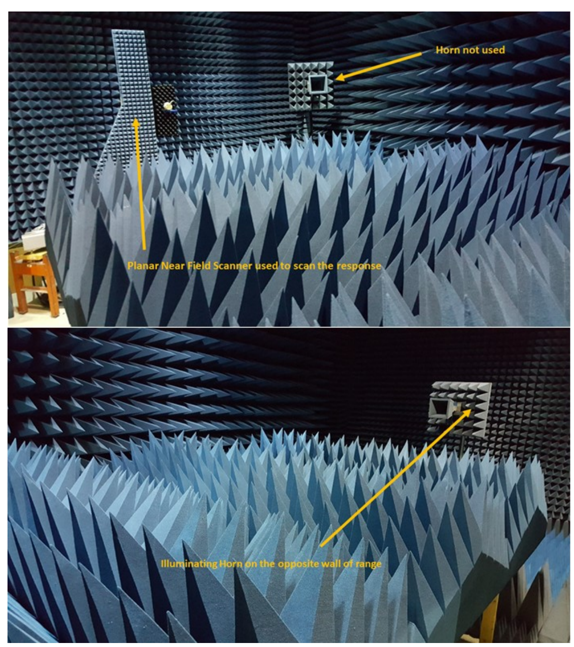


Fig. 2. Measurement set up, receive side (top) and transmit side (bottom)

sample is then positioned such that the main specular reflection is close to the angles of incidence being measured and the planar scan is repeated. This scan contains the direct path and the reflected signal.

Within the spectral domain, the direct illumination is subtracted from the spectral domain with the sample in place. After this subtraction is performed, the spectral domain can be transformed to far field spherical coordinates to show the level of field arriving at the angles that correspond to the specular bi-static reflected energy.

Figure 2 shows a picture of the set-up with a sample of absorber in place at an elevation that achieves an oblique angle. The planar scanner is depicted in the top picture and the transmit horn in the bottom. The calibration measurement, which is not shown, is performed with the absorber on the floor such that the reflectivity is very high (close to normal incidence). In [2], it was shown that for incident angles smaller than 45 degrees and for absorbers that exceed 3λ in overall height, the reflectivity is close to that of normal incidence.

## *B. Preliminary results*

Reflectivity values are obtained from the measurements. The highest value from the reflected signal is extracted. These values are normalized relative to the highest value of the reference measurement. Because the illuminating antenna is not bore-sighted to the sample but to the scan plane, it is necessary to adjust the reflected level by the change in the radiation patterns of the transmit and receive antennas. The results for SFC-24 pyramidal absorber are shown in the following table.

TABLE I. Measured Results for SFC-24 at 82°

| **Frequency** | **Measured H-pol reflectivity** | **Measured V-pol reflectivity** |
|---|---|---|
| **5 GHz** | -23.5 dB | -22.6 dB |
| **6 GHz** | -27.6 dB | -26.0 dB |
| **7 GHz** | -32.4 dB | -30.0 dB |
| **8 GHz** | -33.0 dB | -31.7 dB |

## III. Comparison with Computed Results

The same SFC-24 absorber was modeled in CST using the typical material properties for the carbon-loaded foam. The approach used in [2] to model absorber was used in this paper. That approach and the results it provides were validated in [2] against the manufacturer's data. In [3], the equations for absorber performance obtained from the CST results were validated against measurement of antenna ranges.

Figure 3 shows the data from the simulations at 80 and 82 degrees compared to the measured data. The insert on Fig. 3 shows the transformed data after the reference is subtracted. The plot shows the reflected energy from the absorber sample at around 7.5 degrees below horizontal, which corresponds to about the 82 degree simulation.

Given the potential variations between the actual material properties and the typical average permittivity used in the simulations, the results appear promising. Some of the variation can be explained by the material properties. The numerical model used an average typical complex permittivity. That epsilon is based on measurements of several samples of loaded

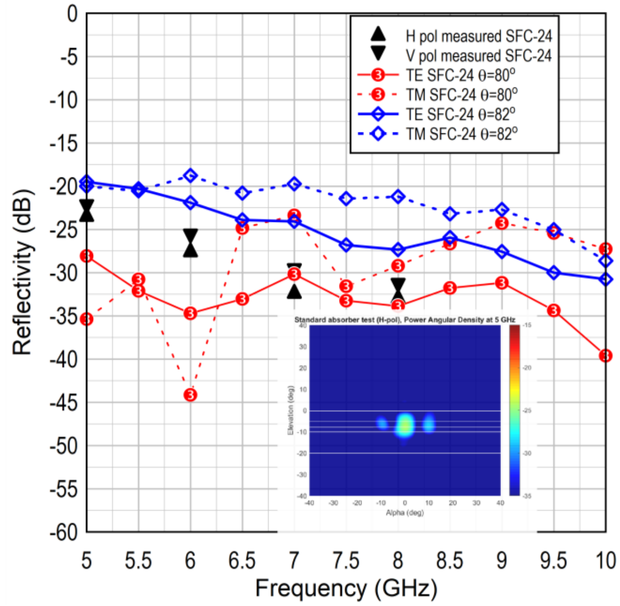


Fig 3. Measured and computed results for SFC-24 showing good agreement between them. The inset shows the measurement results at 5 GHz.

foam. However, due to the manufacturing process, there will be variations from batch to batch that may account for some of the differences between measurements and computation.

## IV. Conclusion

While more work is required to fully validate the methodology, the preliminary results for 82° off-normal incidence seem to agree fairly well with the model results. Given some of the unknowns, like the actual versus typical material properties, overall the method seems to provide good results. Future work will include measuring and modeling other absorber geometries at multiple oblique angles to further validate the method.

## References

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