THE EFFECT OF THE ABSORBER COLLAR ON OPEN ENDED WAVEGUIDE PROBES

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ABSTRACT

This paper describes measurements performed at the National Physical Laboratory (NPL) and Near Field Systems Inc (NSI) on Open Ended Waveguide (OEWG) probes that are typically used for near-field measurements. The effect of the size and location of the absorber collar placed behind the probe was studied. It was found that for some configurations, the absorber collar could cause noticeable ripples in the far-field patterns of the probe and this in turn could affect the probe correction process when the probe was used in near-field measurements. General guidelines were developed to select an absorber configuration that would have minimal effect on the patterns, polarization and gain of the probes.

Keywords: Antennas, Measurements, Near-field, Probes, Absorber, Errors.

1.0 Introduction

Rectangular Open Ended Waveguide (OEWG) probes are widely used on planar, cylindrical and spherical near-field measurement systems. They are inexpensive to fabricate, easy to mount on the measurement system and their patterns can be calculated fairly accurately to provide the data for probe correction. Since the probes have a very broad pattern, an absorber collar must be placed behind the probe to prevent reflections from the metal flange, the coax adapter, and mounting structures behind the probe being received by the probe. Very little data exists to determine if scattering from the absorber collar causes changes in the probe's pattern, gain, cross polarization and directivity. If a theoretical calculation is used to model the probe's pattern and the absorber collar affects its actual pattern, errors in the probe correction will occur during the processing of near-field data to derive the far-field result. If the probe is calibrated with a specific absorber configuration the pattern may change if the collar is damaged, replaced with a different size or moved relative to the end of the probe. Changes to the probe pattern at wide angles would have the largest effect on planar measurements where there is a one-to-one mapping between the probe pattern and the correction to the far-field. It is desirable to have guidelines based on measurements that can be used to guide users in the choice of an absorber for an OEWG probe and the care and replacement of the collars.

A WR90 OEWG with different absorber treatments was selected as the primary test antenna for this study. Measurements were also made on a WR340 probe/absorber combination to generalize the results to other frequency bands.

2.0 Test probe and measurement configurations

Figure 1 shows the WR90 OEWG probe used for these measurements on the NSI Spherical Near-field Range. The probe is 6” long and has a collar that is 12” square constructed from 3” pyramidal absorber. This is the standard configuration for the NSI probes used on most planar, cylindrical and spherical ranges. On some ranges or for some mounting configurations a larger absorber collar may be used and Figure 2 shows the same probe with a 24” X 24” in collar also using the 3”pyramidal absorber

A WR90 probe with the larger absorber collar was calibrated at the National Physical Laboratory for an NSI customer using a spherical near-field/far-field range. The results of these measurements showed significant ripples on the E-plane pattern and further measurements indicated that the absorber collar was the cause of the ripples.

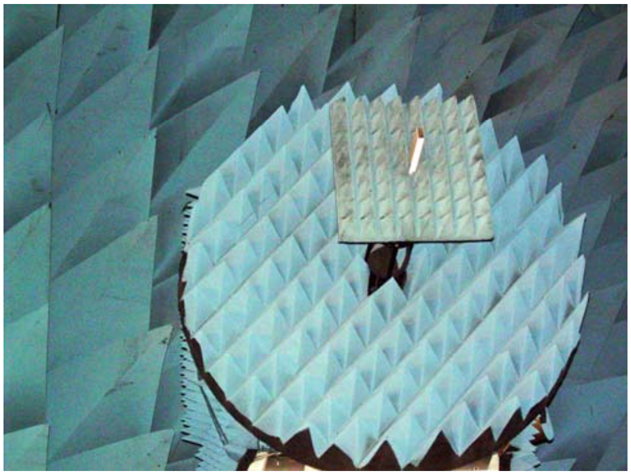

Figure 1 - WR90 Open Ended Waveguide probe on the NSI spherical range.

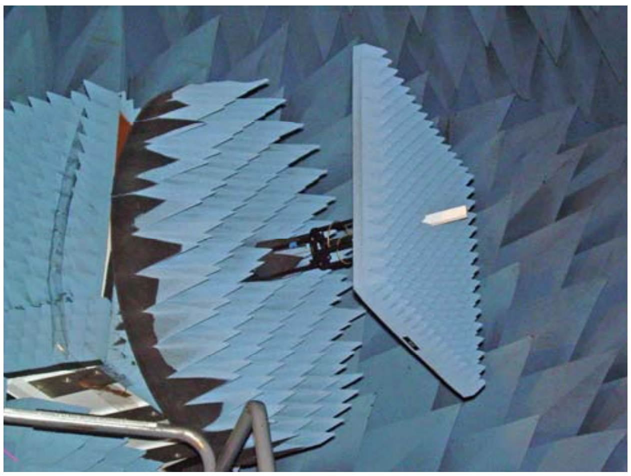

Figure 2 - WR90 OEWG probe with 24 X24 in absorber collar.

Figure 3 shows the E-plane patterns for different absorber sizes and orientations from the NPL measurements.

The results from the NPL testing clearly show that the pattern is affected by the configuration of the absorber collar and in some cases there were ripples of more than 1 dB peak-to-peak for off-axis angle of 60 degrees or greater.

To investigate this in more detail, the 6" long WR90 OEWG probe shown in Figures 1 and 2 was installed on the NSI spherical near-field range as the Antenna Under Test (AUT). A WR90 Standard Gain Horn was used as the "probe" for these measurements to reduce the effect of chamber scattering. The measurement radius of 118" and the small aperture of the OEWG mean that this is

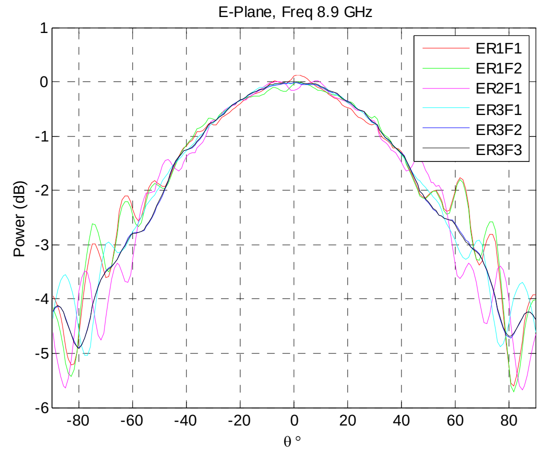

Figure 3 - WR90 OEWG E-plane pattern results from NPL measurements.

Key to Far-Field Plots	
ER1F1	24" square x 3" with small standoff
ER1F2	24" square x 3" with small standoff, extra absorber around probe/absorber interface
ER2F1	24" square x 3" " with no standoff
ER3F1	24"square x 4"
ER3F2	24" square x 4" rotated 45 degrees about probe axis
ER3F3	24" square x 4" extra absorber around probe/absorber interface no rotation

Table 1 - Absorber configurations tested at NPL showing absorber width, thickness, orientation position and modifications.

essentially a far-field measurement and so the SGH probe does not produce any probe correction effect. The data was collected using the near-field measurement option and the far-field patterns were computed using the spherical near-to-far-field transformation. This option made it possible to evaluate the chamber scattering effects and other range related limitations and correct for these with the MARS[1] processing if necessary.

Initial tests showed that the scattered signals in the chamber were approximately 30 dB below the peak on-axis signal and produced a high frequency variation on the order of 0.2 dB on the E-plane pattern. These could be distinguished from the lower frequency variations on the order of 1 dB that were produced by the absorber collar.

3. Measurement Results on WR90 OEWG with Different Absorber Collars

The WR90 OEWG probe was measured with absorber collars constructed from 3”pyramidal absorber of 12 in square and 24” square. Five inch absorber was used for a 24” square collar and 1”flat absorber was used for a 24” square collar. Very little ripple was observed on the patterns with the smaller 12” square collar using the 3”absorber and so we used this as the reference and the other results are shown compared to this configuration in the following figures.

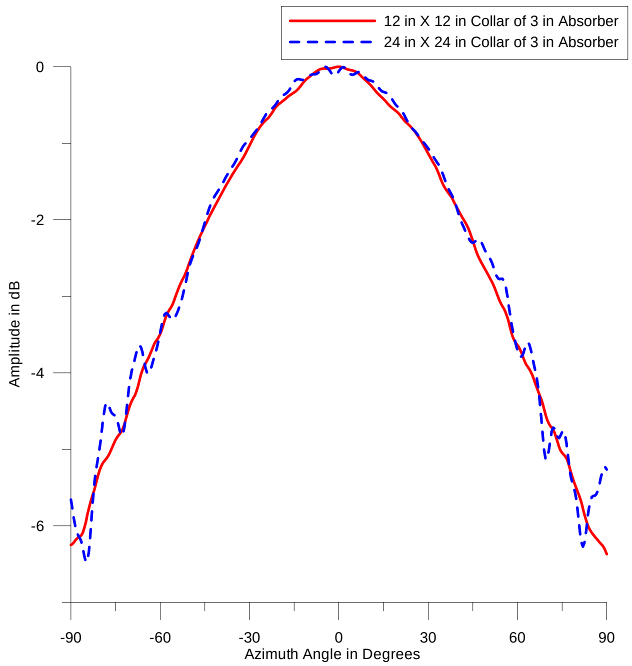

Figure 4 - E-Plane patterns for WR90 OEWG with different absorber collars.

These results are consistent with the NPL measurements and verify that the absorber collar can produce significant ripples on the E-plane pattern. From these combined measurements it has been determined that the absorber collar will have minimal effect on the probe pattern if the “absorber shadow angle” shown in Figure 7 is at least 120 degrees.

In addition to the measurements on the WR90 probe, similar measurements were performed on a WR340 OEWG probe with different absorber collars. These measurements also confirmed the conclusions from the initial measurements.

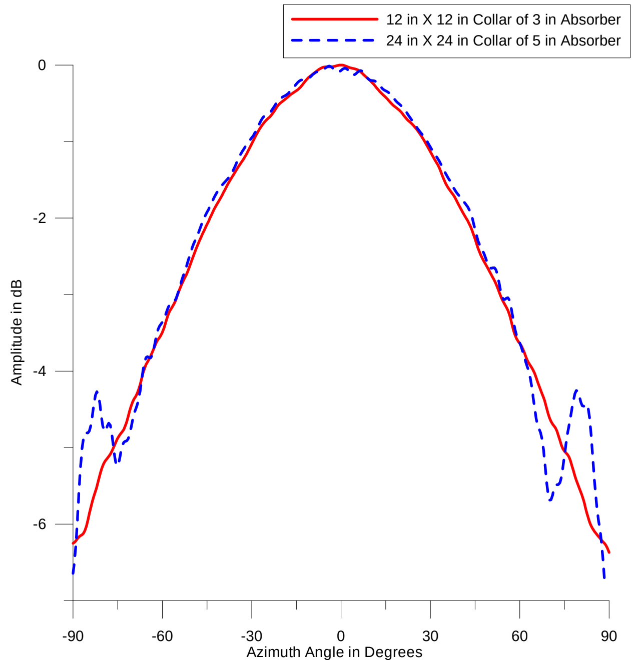

Figure 5 - E-Plane patterns for WR90 OEWG with 3”and 5”absorber collars.

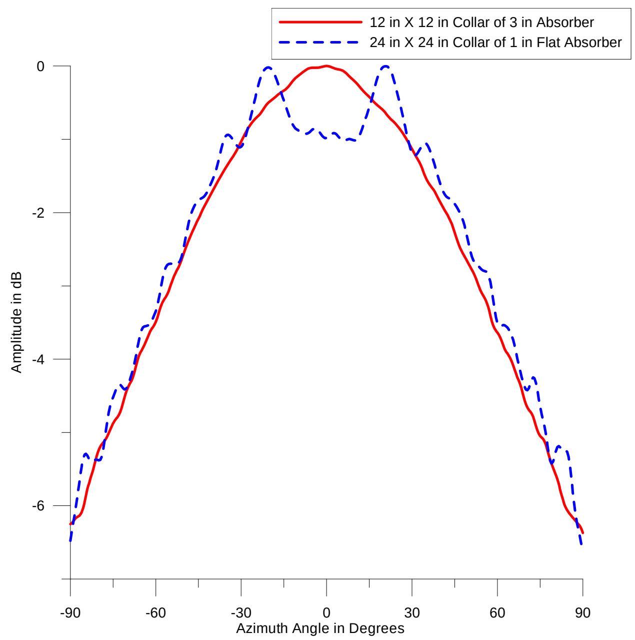

Figure 6 - E-Plane patterns for WR90 OEWG with 3 in pyramidal and 1” flat absorber collars.

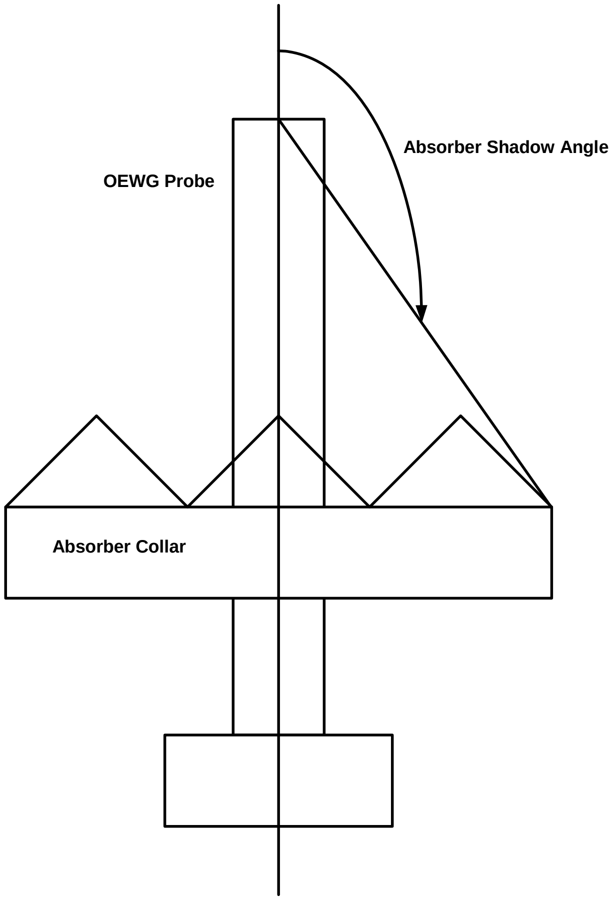

Figure 7 - Schematic showing the angular region shadowed by the absorber collar.

4. Absorber Affect on Gain

The absorber collar could possibly affect the on-axis gain as well as the pattern of the probe. This would not produce errors for comparison gain measurements where the same probe/absorber configuration was used for both the gain standard and the AUT. But this would cause problems if the probe is used as the gain standard in a direct gain measurement and the collar had been moved or changed after it was calibrated. The potential effect on gain can be inferred from the pattern measurements by examining the pattern in the on-axis region and looking for small ripples in this region. Figure 8 shows the comparison between the 12" and 24" collars at 10 GHz for the WR90 probe. Similar effects were observed at other frequencies. From these we conclude that if the shadow angle shown in Figure 7 is less than 120 degrees, the absorber collar can cause gain variations on the order of 0.1 dB, which are undesirable, so this reinforces our conclusion that the "absorber shadow angle" should be greater than 120 degrees.

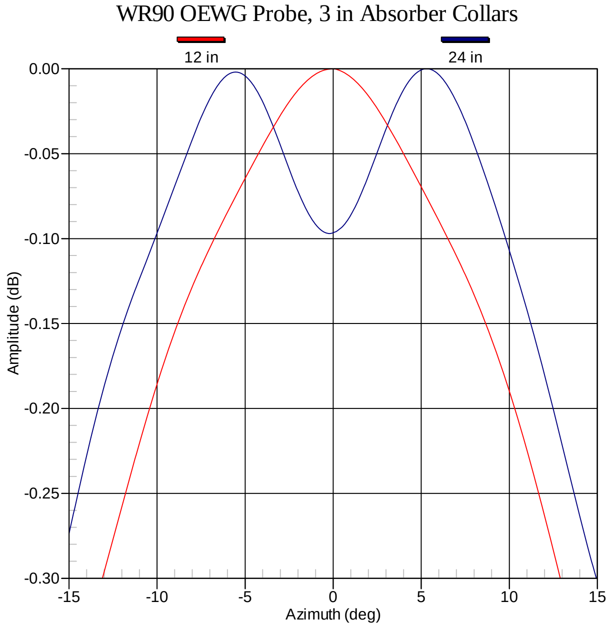

Figure 8- Pattern ripples in the on-axis region caused by the absorber collar.

5. Summary

Measurements have shown that the absorber collar used with Open Ended Waveguide probes can have a significant effect on both the pattern and on-axis gain. To minimize the effect of the collar, the angle between the end of the probe and the edge of the absorber should be equal to or greater than 120 degrees. These results also demonstrate that the absorber collar configuration should not be changed after calibration and extra care should be taken when handling probes and their absorber collars.

6. References

[1] Hindman, G, Newell, A.C., "Reflection Suppression in a large spherical near-field range", AMTA 27th Annual Meeting & Symposium, Newport, RI, Oct. 2005.