3:1 Bandwidth Dual Polarized Feeds for Compact Range and Near-Field Probes

German Cortes-Medellin, Brett T. Walkenhorst
NSI-MI Technologies, Suwanee, GA, USA
gcortes-medellin@nsi-mi.com  bwalkenhorst@nsi-mi.com

Abstract—The authors have developed a new family of dual-polarized compact range feeds with a bandwidth ratio of 3:1. These feeds are also suitable for use as near-field probes.

I. INTRODUCTION

Compact Antenna Test Ranges (CATR) make use of low gain feeds located at the focal point of a reflector, typically a paraboloid section, to produce a uniform plane wave illumination at the quiet zone (QZ) of the antenna test range, as shown in Figure 1. For a given QZ size, the proper illumination of the QZ is determined by the subtended angle $\theta_M$ of the QZ, projected onto the surface of the reflector at the focal point. Typically this angle is of the order of $\theta_M \approx 30^\circ$. To achieve a maximum amplitude taper of 1 dB, we constrain our feed pattern to have less than 1 dB rolloff over this angular region. Therefore, compact range feeds (CRF) are mainly wide-beam prime focus feeds. Typically, circular waveguide (CWG) feeds with a choke ring are used. These feeds have an excellent input match and 1.5:1 instantaneous bandwidth, which is compatible with rectangular waveguide frequency bands. The chokes improve cross polarization, beam-symmetry, phase center location, and stabilize the gain over the 1.5:1 bandwidth of operation, as shown in Figure 2.

Other types of CRFs include cavity-backed sinuous feeds, which are capable of providing a dual-polarized, wide-beam response, and have very wide-band performance (more than 5:1). They are often used at low frequencies. However, they suffer from two issues: (1) they use a cavity backed absorber to eliminate the back-lobe radiated by the sinuous structure, resulting in negative gains in some instances; and (2) the polarization direction oscillates as a function of frequency approximately $\pm 7^\circ$, multiple times across the band.

We present here the results of a new wide-band dual-polarized feed design for both compact range and near-field probe applications. This feed has an edge taper illumination $>-1$ dB for $-15^\circ \leq \theta \leq +15^\circ$, positive gain varying from $+4$ dBi to $+9$ dBi, stable phase center location, and no polarization tilt variation vs. frequency, all over a 3:1 instantaneous bandwidth.

II. 3 TO 1 BANDWIDTH COMPACT RANGE FEEDS

Figure 3 shows the family of these new NSI-MI 3:1 bandwidth feeds with operating bands ranging from 0.5 GHz to 18 GHz.

Figure 4 shows the gain of a typical CWG feed with choke over a 1.5:1 bandwidth used as a compact range feed. The inset shows the cross section of calculated fields inside the CWG feed and Choke structure at midband.
A. **Calculated Feed Performance**

Figure 4 shows the calculated performance of a 2 to 6 GHz version of this feed. In the left panel we show the calculated input VSWR for each port. Notice that although the compact range performance is rated only from 2 to 6 GHz, its input match extends from 2 to 13 GHz. The right panel shows the antenna realized gain form 2 to 7 GHz.

Figure 5 shows the calculated E and H-plane normalized pattern cuts from 2 to 6 GHz. A horizontal red line marks the -1 dB level edge taper extending from ±15°.

Figure 6 shows the calculated cross-polarization levels (Left panel) and the phase center variation vs. frequency (Right panel) indicating a maximum variation of ±0.09 λ over a 3 to 1 frequency band.

**Figure 7** shows the calculated performance of a 2 to 6 GHz CRF at the focal point of a NSI-MI 508C compact range reflector with a QZ size of 2.4 m.

The top figure corresponds to the field amplitude ripple at different depths in the QZ, with maximum values of 0.4 dB and 0.25 dB, well within the 0.5 dB maximum specification. The bottom left plot, corresponds to the field taper across the QZ, with a peak value of 0.4dB (specification is 1 dB). In the bottom right, we show the phase ripple at different depths in the QZ, with a maximum value of 2.5 deg. The phase ripple specification is 5 deg max at this frequency band. All of this indicate that these new 3:1 bandwidth feeds have an excellent performance as compact range feeds.

Finally, the fact that these feeds continue to be operational beyond 6 GHz, from 2 to 13 GHz, with fairly wide-beams, makes them excellent planar near field probes with instantaneous bandwidths in excess of 6:1.

**III. Expected Compact Range Performance**

**Figure 7** shows the calculated performance of a 2 to 6 GHz CRF at the focal point of a NSI-MI 508C compact range reflector with a QZ size of 2.4 m.

The top figure corresponds to the field amplitude ripple at different depths in the QZ, with maximum values of 0.4 dB and 0.25 dB, well within the 0.5 dB maximum specification. The bottom left plot, corresponds to the field taper across the QZ, with a peak value of 0.4dB (specification is 1 dB). In the bottom right, we show the phase ripple at different depths in the QZ, with a maximum value of 2.5 deg. The phase ripple specification is 5 deg max at this frequency band. All of this indicate that these new 3:1 bandwidth feeds have an excellent performance as compact range feeds.

Finally, the fact that these feeds continue to be operational beyond 6 GHz, from 2 to 13 GHz, with fairly wide-beams, makes them excellent planar near field probes with instantaneous bandwidths in excess of 6:1.

IV. **Conclusions**

A new family of wideband feeds have been presented for use in compact antenna test ranges. Feed patterns and quiet zone performance in a typical range indicate excellent performance over a 3:1 bandwidth.

**REFERENCES**