

# Development of Broadband Coaxial Components for a 0.04 to 110 GHz Measurement System

Bill Oldfield  
Wiltron Company, Morgan Hill, California

## ABSTRACT

Coaxial components including a new connector system (the W connector), couplers, switches, terminations and Waveguide to coax adapters, were used to configure a VNA with continuous coverage from 0.04 to 110 GHz. Wafer probes covering the same range are also described.

## DEVELOPMENT OF COMPONENTS

The development of broad band, high frequency coaxial connectors and measurement systems has allowed the expansion of the mm microwave spectrum. Twelve years ago coverage to 40 GHz was considered impractical. Now 40 GHz coax systems and components are run of the mill. Today, many high volume consumer applications have been identified in the range from 60 to 110 GHz. Wireless links, collision avoidance, road surface monitoring and device characterization are all in development.

While waveguide is the preferred transmission medium at these frequencies, coax is the simplest and most flexible method of connecting and testing components and systems.

This paper describes the development of a new 110 GHz connector system and other components, which allow configuration of a VNA system having single test ports and, continuous coverage from 0.04 to 110 GHz. The system test ports are either wafer probes or coax. Calibration standards are available for both mediums.

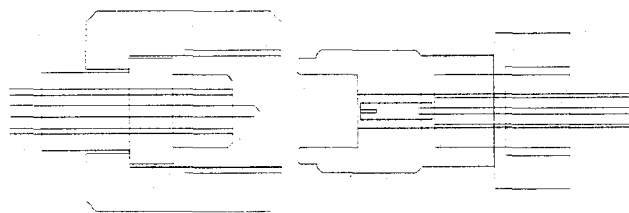


Figure 1. W Connector

The W Connector uses the common UT 47 coax as the transmission line. The connector is "cable based", in that the male pin is the center conductor of the coax cable. The construction is similar to the familiar SMA, providing inexpensive connectors and simple construction. Performance is shown in Fig. 2.

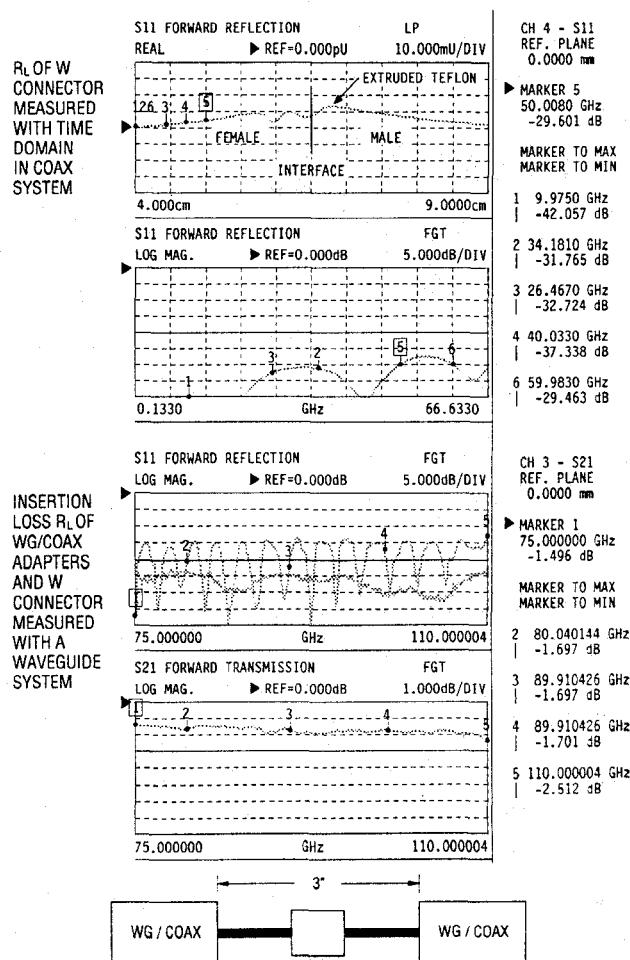


Figure 2. Performance

Like the SMA connector, the W connector is not a precision connector. However, using a VNA with time domain, the connector performance can be measured easily and accurately.

Connector systems have two interfaces, the connector interface is the most described and least important to a designer. The back side interface, where the connector is mated with a housing or other transmission media, is of much greater interest to the designer and is most critical to system or component performance. Various backside interfaces are shown in Fig. 3.

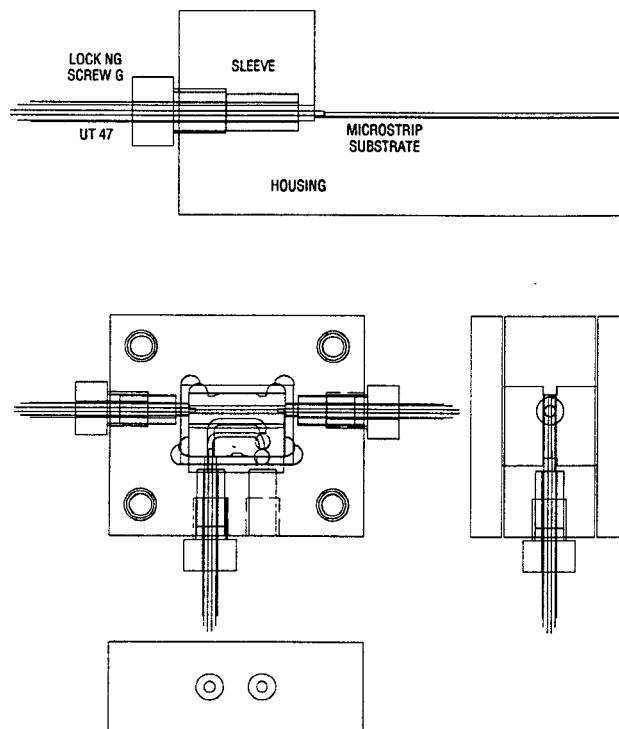


Figure 3. Back side interfaces

The W connector has no support bead, therefore connection to components uses the UT 47 coax and a short length of coax before connection to the W connector. The center conductor of the coax makes contact to the substrate inside of the component housing.

One of the unique components developed was a 3 dB coupler covering DC to 110 GHz. The coupler, shown in Fig. 4 has a 3 dB crossover frequency of 65 GHz. The patented coupler uses suspended substrate stripline, with patterns on both sides.

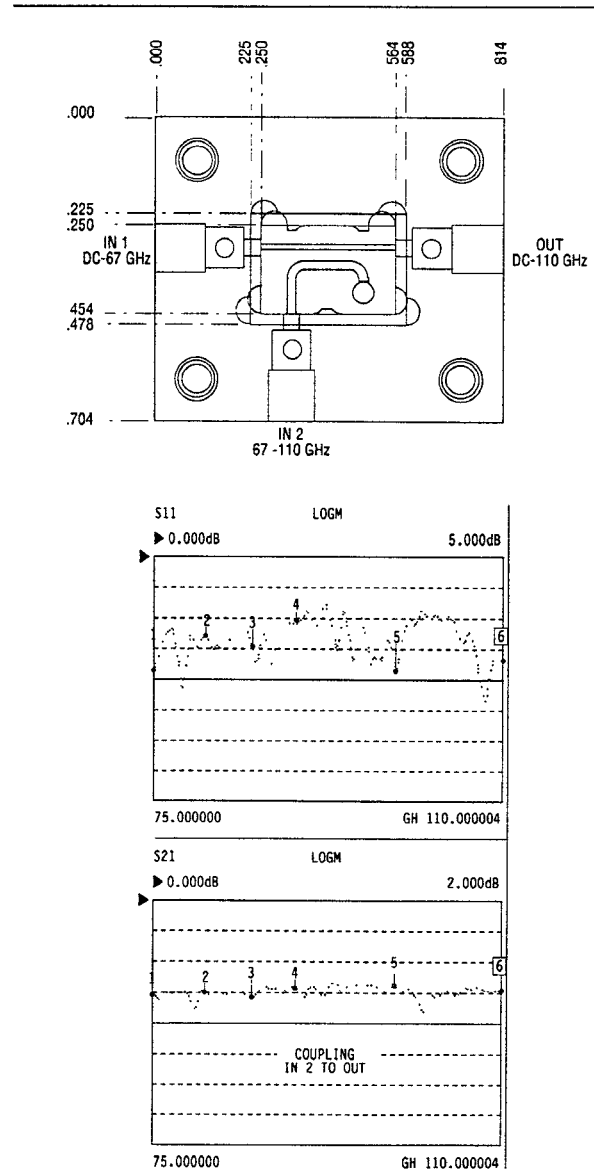
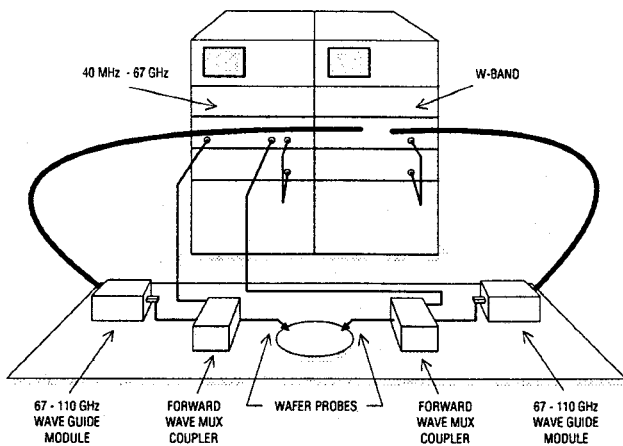


Figure 4. 3 dB Coupler

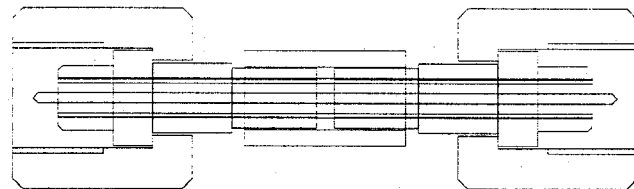
The substrate material is alumina. The termination is a "dot" termination. The coupling is "forward" as in a waveguide coupler, not contradirectional as in a coax coupler. Directivity is typically greater than 15 dB.

The coupler is used to combine the test ports of two VNA's into a single test port (Fig. 5). The VNA's are calibrated independently and their output are combined by an external controller. The result is continuous frequency coverage from 40 MHz to 110 GHz with either coax or wafer probe testports.



**Figure 5. 110 GHz VNA System**

Calibration and calibration standards in coax and CPW (wafer probe) are accomplished by using LRL type of calibration. The coax LRL lines as shown in Fig 6. Sections of UT 47 coax are



**Figure 6. Coax LRL Lines**

used for the LRL lines and are not considered "precision", but are capable of delivering reasonable and usable calibrations. The wafer probe also uses LRL calibrations.

**Summary:** Coaxial systems and components can be built to 110 GHz. A practical inexpensive connector allows connections. Using existing components, a Vector Network Analyzer can be configured covering from 40 MHz to 110 GHz.