

# Rectangular Waveguide to Coax Transition Design

Learn how to find the optimum dimensions for a waveguide to coax transition using an empirical approach that relies on a set of impedance measurements and a few calculations.

Paul Wade, W1GHZ

A question I am frequently asked is, "Why do the antenna dimensions in the *W1GHZ Microwave Antenna Book — Online* not include the probe dimensions (for the transition from waveguide to coaxial transmission line)?"<sup>1</sup> The answer is that the transition is part of the transmission line, not the antenna, and does not directly affect the performance of an antenna. The transition may be right at the antenna, seemingly part of it, or at the other end of a run of waveguide transmission line, many meters away.

The transition is an important part of most microwave systems, however, since solid-state components are usually constructed on microstrip transmission lines and interconnected with coax, while microwave antennas normally use waveguide techniques.

A typical transition consists of a coaxial connector on the broad side of a rectangular waveguide with the center conductor extended as a probe into the waveguide, with one end of the guide ending in a short circuit, like Figure 1. Since the structure is well-known, *designs* may be too ambitious a term, but the correct dimensions are far from obvious and are difficult to calculate. A number of sets of dimensions have been published, but there is little agreement between them, so it is difficult to tell which are right. Also, many of the published transitions are part of an antenna, so the dimensions may have been chosen to compensate for a poorly matched antenna impedance.

Therefore, I chose an empirical approach: making a comprehensive set of measurements from which the optimum dimensions may be reached. I had previously used this technique

<sup>1</sup>Notes appear on page 16.

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to determine probe dimensions for circular waveguide made from copper water pipe.<sup>2</sup> It is easier to determine the dimensions for rectangular waveguide, since commercial guide and components are readily available from surplus sources.

Characteristics of a transition are best viewed by measuring the complex impedance (magnitude and phase) in the waveguide, using a waveguide slotted line. Figure 2 shows a typical X-band slotted line — the precision impedance measurement instrument of a few years ago, and, for waveguide, still more accurate than most network analyzer measurements. Since all professional microwave work today uses automatic network analyzers and computers, and few remember how to use a slotted line, slotted lines are almost given away today. I have paid as little as \$2 for one at a hamfest.

To find the optimum dimensions for a transition, I needed to make measurements over a range of transition dimensions, so an adjust-

able transition was desirable. The probe dimensions are readily varied by unscrewing the coax connector and trimming the probe, but the distance to the shorted end of the waveguide, or backshort, must also be varied. I machined a sliding plug to fit inside the guide, with alternating quarter-wave sections of high and low impedance to form an electrical short circuit, so that the performance of the short does not depend on intimate contact with the waveguide walls. Figure 3 is a photograph of adjustable transitions for two common sizes of X-band waveguide, WR-90 and WR-75, as well as one for circular waveguide.

## Measurement Technique

The first measurement is with a short circuit (flat metal plate) closing the end of the slotted line. The short provides a clear standing-wave pattern with sharp nulls at half-wavelength intervals, so we can measure the guide wavelength, and make any adjustments to the slotted line measuring probe.

The next measurement is of the sliding tran-

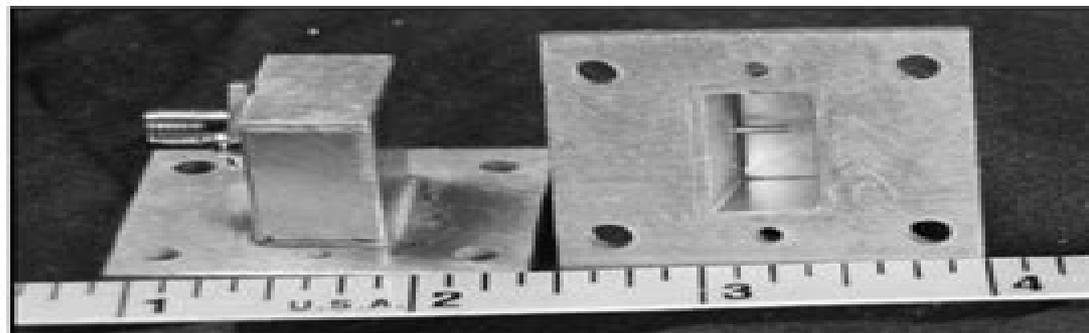


Figure 1 — WR-75 waveguide to coax transition for 10 GHz.

# Rectangular Wave To Coax Transition Design

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## **Rectangular Wave To Coax Transition Design:**

**Development of Passive Components for Millimeter-wave Circuits** George Edward Ponchak,1997 MURA ,19??  
**EPAC96, Fifth European Particle Accelerator Conference** ,1996 **Electrical Design News** ,1957 *On-Wafer Calibration Techniques Enabling Accurate Characterization of High-Performance Silicon Devices at the mm-Wave Range and Beyond* Andrej Rumiantsev,2022-09-01 The increasing demand for more content services and security drives the development of high speed wireless technologies optical communication automotive radar imaging and sensing systems and many other mm wave and THz applications S parameter measurement at mm wave and sub mm wave frequencies plays a crucial role in the modern IC design debug Most importantly however is the step of device characterization for development and optimization of device model parameters for new technologies Accurate characterization of the intrinsic device in its entire operation frequency range becomes extremely important and this task is very challenging This book presents solutions for accurate mm wave characterization of advanced semiconductor devices It guides through the process of development implementation and verification of the in situ calibration methods optimized for high performance silicon technologies Technical topics discussed in the book include Specifics of S parameter measurements of planar structures Complete mathematical solution for lumped standard based calibration methods including the transfer Thru Match Reflect TMR algorithms Design guideline and examples for the on wafer calibration standards realized in both advanced SiGe BiCMOS and RF CMOS processes Methods for verification of electrical characteristics of calibration standards and accuracy of the in situ calibration results Comparison of the new technique vs conventional approaches the probe tip calibration and the pad parasitic de embedding for various device types geometries and model parameters New aspects of the on wafer RF measurements at mmWave frequency range and calibration assurance **Minutes of the 1964 Conference on Proton Linear Accelerators, Held at Midwestern Universities Research Association, July 20-24, 1964** ,1965 **Electronic Industries & Tele-tech** ,1960 *Radio-Frequency Electronics* Jon B. Hagen,1996-11-13 This accessible and comprehensive book provides an introduction to the basic concepts and key circuits of radio frequency systems covering fundamental principles which apply to all radio devices from wireless data transceivers on semiconductor chips to high power broadcast transmitters Topics covered include filters amplifiers oscillators modulators low noise amplifiers phase locked loops and transformers Applications of radio frequency systems are described in such areas as communications radio and television broadcasting radar and radio astronomy The book contains many exercises and assumes only a knowledge of elementary electronics and circuit analysis It will be an ideal textbook for advanced undergraduate and graduate courses in electrical engineering as well as an invaluable reference for researchers and professional engineers in this area or for those moving into the field of wireless communications **QEX.** ,2006 *Handbook of Ion Sources* Bernhard Wolf,1995-08-31 The Handbook of Ion Sources delivers the data needed for daily work with ion sources It also gives information for the selection

of a suitable ion source and ion production method for a specific application The Handbook concentrates on practical aspects and introduces the principle function of ion sources The basic plasma parameters are defined and discussed The working principles of various ion sources are explained and examples of each type of ion source are presented with their operational data Tables of ion current for various elements and charge states summarize the performance of different ion sources The problems related to the production of ions of non gaseous elements are detailed and data on useful materials for evaporation and ion source construction are summarized Additional chapters are dedicated to extraction and beam formation ion beam diagnosis ion source electronics and computer codes for extraction acceleration and beam transport Emittance and brilliance are described and space charge effects and neutralization discussed Various methods for the measurement of current profile emittance and time structure are presented and compared Intensity limits for these methods are provided for different ion energies Typical problems related to the operation of ion source plasmas are discussed and practical examples of circuits are given The influence of high voltage on ion source electronics and possibilities for circuit protection are covered The generation of microwaves and various microwave equipment are described and special problems related to microwave operation are summarized The Handbook of Ion Sources is a valuable reference on the subject of benefit to practitioners and graduate students interested in accelerators ion implantation and ion beam techniques *Electronic Industries* ,1960

IEEE Transactions on Microwave Theory and Techniques ,1953      Proceedings of the ... Midwest Symposium on Circuits and Systems ,1999      **Radio-electronic Engineering** ,1950      **IRE Convention Record** Institute of Radio Engineers,1955      IRE International Convention Record ,1955      **IEEE International Convention Record** Institute of Electrical and Electronics Engineers,Institute of Radio Engineers,1955      *RLE Progress Report* Massachusetts Institute of Technology. Research Laboratory of Electronics,1991      **Conference Record** ,1983      **Microwave Packages Characterization and Simulation** Kaiwai Emily Chiu,1998

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