EXPERIMENTAL CHARACTERISATION OF COAXIAL SLEEVE BALUNS FOR HANDSET MEASUREMENTS

S. A. Saario, J. R. Thorpe and D. Iellici
Antenova Ltd.
Far Field House, Stow-Cum-Quy,
Cambridge, CB5 9AR, UK

Abstract

A broadband method for measurement of devices for counteracting cable effects is proposed. A magnetic dipole source is emulated by an electrically small shielded-loop probe next to a coaxial cable. Measurement results for a typical 890 MHz coaxial sleeve balun are presented.

Introduction

Measurements of electrically small antennas with coaxial cables are performed daily by antenna designers. One area of continuing interest is the reduction of cable loading effects on the device under test. Cables connected to a mobile handset have been shown to perturb the radiation pattern measurement results by up to ~5dB [1].

Baluns and chokes of various forms have been proposed over the years with no direct way of comparing their performance. Generally, the performance of coaxial baluns has been compared by inspection of the perturbation effects of the cable and balun combination. Icheln *et. al.* have investigated the performance of baluns in a waveguide below cutoff [2]. However, the effects of the relatively close proximity of the waveguide walls have not been considered to date. In this paper, coaxial sleeve baluns are measured with an experimental setup which closely represents the real operating conditions of these baluns, including both radiation effects and cable coupling effects.

Numerical Simulations

A Body of Revolution (BOR) FDTD code developed in house was used for modeling the rotationally symmetric coaxial balun structure. The simulation domain was 200 x 400 cells in the r and z axes respectively. A uniform cell spacing of 0.5mm was used. The structure of the balun is presented in Figure 1. It can be seen that the far ends of the cable penetrate into the Perfectly Matched Layer (PML) absorbing boundary, presenting a perfect match for the propagating wave along the cable. The induction of current onto the cable was implemented with a rotationally symmetric ring of current around the cable.

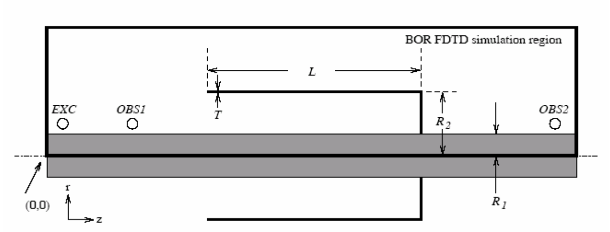

Figure 1 BOR FDTD Structure for the calculation of balun isolation characteristics.

The isolation characteristics of an 890MHz balun were calculated and are presented along with experimentally measured results in Figure 2.

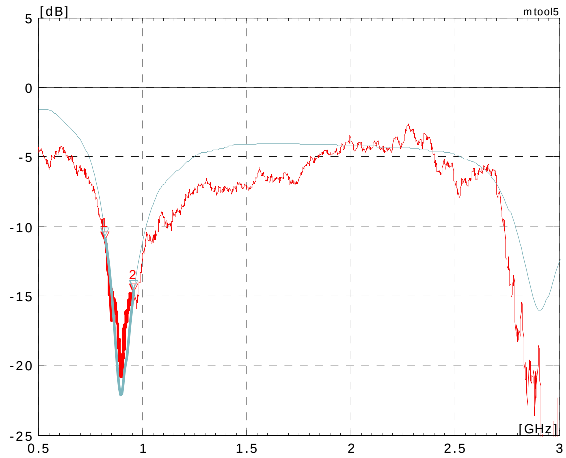

Figure 2 Measured (thick line) and Simulated isolation characteristics for an 890 MHz balun

Experimental Setup

To experimentally measure the isolation performance of the balun, a measurement platform was implemented as shown in Figure 3, which represents the ideas in the thesis of one of the authors [3]. In this setup, two electrically small shielded-loops are placed in close proximity to a semi-rigid coaxial cable. These loops couple energy onto the cable structure and allow the characterization of series chokes placed on the cable. The ends of the cable are terminated in a single pyramid of Emerson & Cuming SFC-18 absorber backed with AN-77 absorber to absorb the propagating energy on the cable structure under test. The probes also have absorber on them to mitigate reflections and radiation from the loop probes. A two port normalization calibration is performed to set a reference propagation loss through a standard cable structure. The standard through cable section is replaced with a balun and the isolation characteristics are recorded. A photograph of the measurement setup is shown in Figure 4. Figure 2 shows a comparison of the measured and experimental results for an 890MHz coaxial sleeve balun with a PTFE plug in the end.

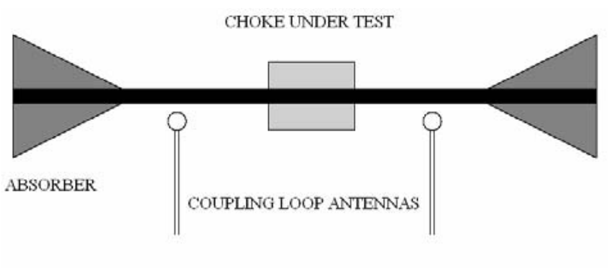

Figure 3 Experimental configuration for isolation measurement of chokes on cables.

During the experimental trials, it was found that to obtain enough dynamic range (30dB), it was required to offset the probes 45 degrees relative to the cable, such that each probe was offset 90 degrees relative to the other probe. This configuration reduced the parasitic probe-to-probe radiation significantly. Also, as expected, the distance between the probes and the cable was important in determining the amount of power induced onto the cable. If the coupling between the loop probe and the coaxial cable was too low, the dynamic range of the VNA limited the measurement.

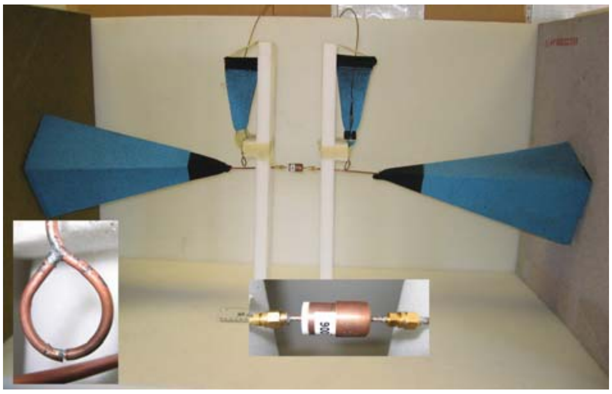

Figure 4 Photograph of balun measurement fixture with probe and balun inset shown.

Conclusions

An experimental platform was implemented which was able to directly measure the effectiveness of baluns on coaxial cables across a wide band. The probe orientation and separation was found to be very important in determining the usable dynamic range of the measurement. The agreement between the simulated and measured baluns was good, confirming the validity of the simulation results, the physical implementation of the balun, and the measurement method. This method of measurement can be used to characterise any kind of choking structure on a cable such as ferrite beads, ferrite coated cable and coaxial chokes as shown in this paper.

References

[1] S. Saario, D. V. Thiel, J. W. Lu, and S. G. O'Keefe, "An assessment of cable radiation effects on mobile communications antenna measurements," *1997 IEEE Int. Antennas Propagat. Symp. Dig.* Vol. 35, pp. 550 - 553, June 1997.

[2] C. Icheln, J. Krogerus and P. Vainikainen, "Use of Balun Chokes in Small-Antenna Radiation Measurements", *IEEE Trans. Instrumentation and Measurement*, Vol. 53, No. 2, pp. 498 – 506, April 2004.

[3] S. A. Saario "FDTD modeling for wireless communications: antennas and materials" Ph.D. dissertation Griffith University, Australia, September 2002.