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DESIGN NOTES

Matching Using Only 50Ω and 75Ω Transmission Lines

In the upper HF through UHF range, broadband ferrite transmission line transformers are not always practical, and microstrip or stripline circuits may occupy too much p.c. board area. Lumped elements are common, but an alternative is transmission line matching using common coaxial cables.

The most common coaxial cable impedances are 50 and 75 ohms, so this note looks at the range of impedances that can be matched using only these two types of coax. For simplicity, non-reactive impedances are used in these examples, but this method can match a wide range of reactive impedances, as well.

Transmission lines are easy to analyze on a Smith® chart, and there are several handy software-based tools that avoid the need for paper charts, compass, and other manual methods. winSmith 2.0 [1] was used for this note; see the References for other options.

The highest impedance that can be matched using these lines is 112.5 ohms, using a 1/4-wavelength 75-ohm line. The low-impedance range goes to near zero, since low impedance lines can be made by connecting multiple lines in parallel. In practice, any impedance between a few ohms and 112.5 ohms can be readily matched with the proper combinations of lines.

Examples: Matching to 30Ω and 90Ω Loads

Figure 1 Shows three possible combinations of coaxial lines that can match a 30-ohm load to a 50-ohm system impedance. The shortest overall length is the combination of 50- and 25-ohm cables, at 52.8º electrical length. The 25-ohm line would typically be made using two sections of 50-ohm line in parallel. Figure 2 shows the center portion of the Smith chart display for this configuration.

Figure 3 Shows two solutions for matching between a 90-ohm load and 50-ohm system impedance. The shorter total length is the one using 75-ohm and 37.5-ohm line sections, with 62.1º electrical length. Figure 4 is the Smith chart display.

Summary

By manipulating the lengths of lines with different standard characteristic impedances, the load and source points on the Smith chart can be "connected" over a wide range, allowing you to easily determine a match for antennas, devices or modules.

Smith Chart Resources

1. winSmith 2.0, available from SciTech Publishing: www.scitechpub.com

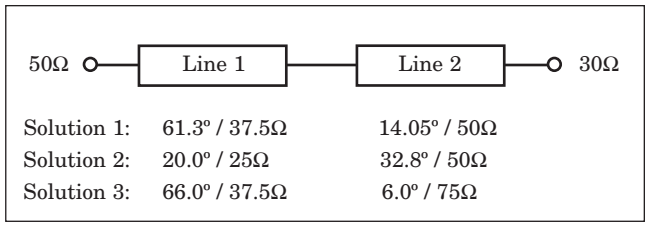

Figure 1 · Three matching solutions for a 30-ohm load and 50-ohm system impedance.

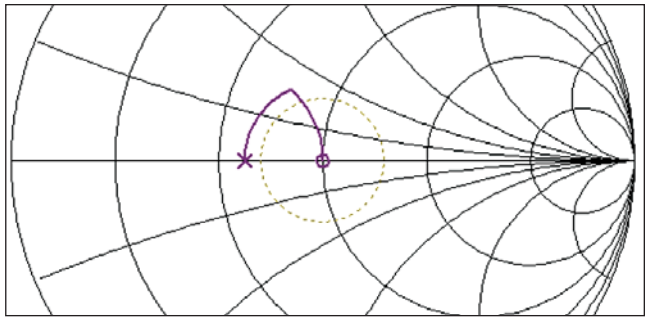

Figure 2 · Smith chart display for Solution 2 in Fig. 1. (The dotted line is the 1.5:1 VSWR circle.)

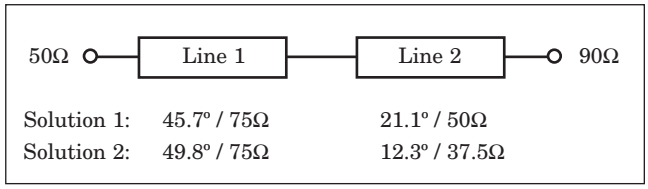

Figure 3 · Two matching solutions for a 90-ohm load and 50-ohm system impedance.

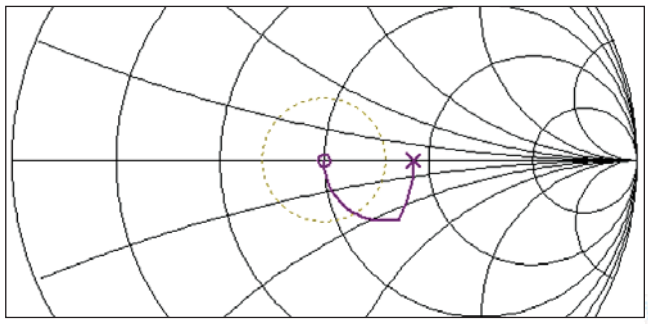

Figure 4 · Smith chart display for Solution 2 in Fig. 3.

2. Besser Associates, applet and tutorial notes: www.bessernet.com

3. Agilent Technologies, Smith chart info and applet: http://education.tm.agilent.com

4. RF Cafe, Smith chart applications for Visio and Excel, plus links to other resources: www.rfcafe.com/references/electrical/smith.htm