More on Narrowband Impedance-Matching Limitations

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In the August, 2004, issue of this *Magazine*, Lopez [1] presented an equation,

$$QB_n = \frac{1}{b_n \sinh\left[\frac{1}{a_n}\ln\left(\frac{1}{R}\right)\right] + \frac{(1-b_n)}{a_n}\ln\left(\frac{1}{R}\right)},$$

which is believed to be in exact agreement with Fano's fundamental impedance-matching formulation [2].

In [3], the objective was the quantification of the bandwidth increase provided by one additional tuning circuit. Approximate relationships, valid for large values of the maximum reflection magnitude (introduced in [3] and refined in [1]), indicated that double tuning provided a very substantial benefit with respect to single tuning, and that the benefit over double tuning provided by triple tuning was questionable. The above-referenced equation provides a relatively simple means for evaluating the bandwidth-increase factor for all values of the maximum-reflection magnitude. Figure 1 presents the improvement factor over the complete range of maximum-reflection magnitude. After evaluation of the figure, the remarks made based on large values of the maximum-reflection magnitude are still valid.

In [1], the grid lines for the figures were omitted. Figure 2 reproduces Figure 5 of [1] with the grid lines.

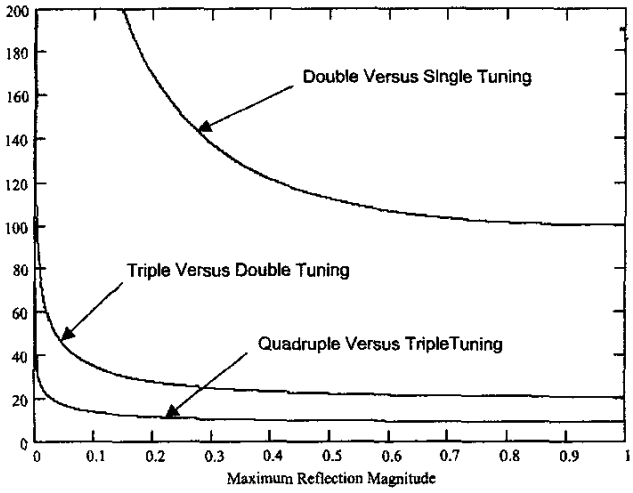

Figure 1. The percentage bandwidth increase with one level of tuning-circuit increase (vertical axis) as a function of the maximum-reflection magnitude.

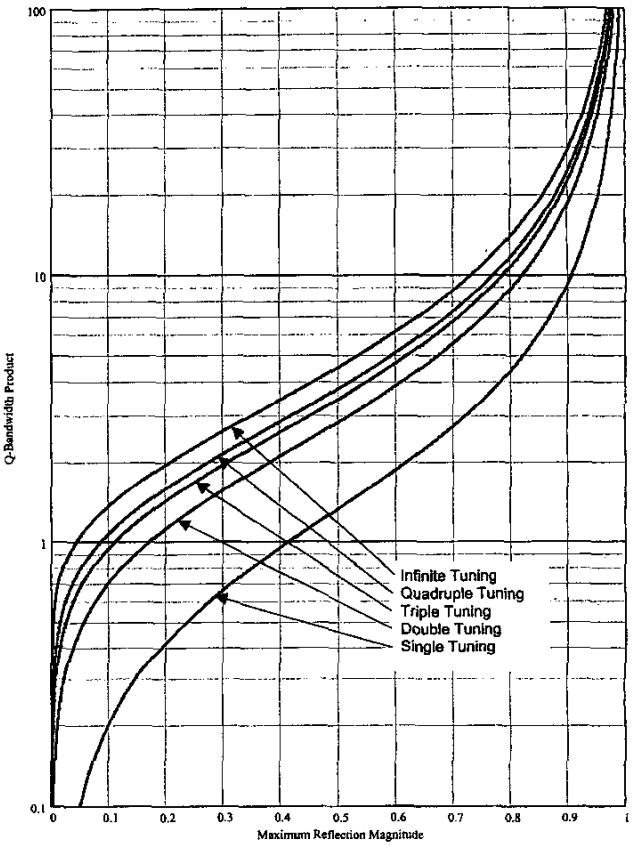

Figure 2. Figure 5 of [1] with grid lines included.

References

1. A. R. Lopez, "Review of Narrowband Impedance-Matching Limitations," *IEEE Antennas and Propagation Magazine*, **46**, August, 2004, pp. 88-90.

2. R. M. Fano, "Theoretical Limitations on the Broadband Matching of Arbitrary Impedances," Research Lab. Electronics, Massachusetts Institute of Technology Technical Report 41, January, 1948; also *Journal of the Franklin Institute*, **249**, 1, January, 1950.

3. A. R. Lopez, "WL Multiple Tuning Techniques," Hazeltine Wheeler Laboratory Memorandum G300-73-RL9012, January 1973 (available in electronic format upon request from the author).

Ideas for Antenna Designer's Notebook

Ideas are needed for future issues of the Antenna Designer's Notebook. Please send your suggestions to Tom Milligan and they will be considered for publication as quickly as possible. Topics can include antenna design tips, equations, nomographs, or shortcuts, as well as ideas to improve or facilitate measurements.