

## Simplified Determination of Impedances of Chebyshev Transformers

If it is desired to match two different impedances by means of cascaded quarter-wavelength transformers, one may possibly refer to the tables of Young [1] or to the design curves of Jasik [2]. Because these works limit their information to less than seven sections, it is not possible to easily obtain the characteristic impedances for transformers which must operate over a large frequency band or which have very low reflection coefficients. The evaluation of the characteristic impedances for transformers having eight or more sections is very tedious. One can, however, evolve a relationship between the characteristic impedances of Chebyshev transformers and the excitation coefficients of Chebyshev arrays.

A design constant "C" has been defined by Jasik and is a measure of the difficulty of transformation. This design constant may be expressed as a function of the impedance transformation ratio and the maximum standing wave ratio, or as a function of the number of transformer sections and the ratio

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of the maximum to minimum operating frequencies. Knowing or assuming three of the above parameters, the fourth can be determined. Generally the unknown parameter is the number of transformer sections, and it can be evaluated from the expression involving the design constant  $C$ .

By comparing the transformer theory with antenna array theory it can be shown that the number of quarter-wavelength sections  $N$  corresponds to one less than the number of elements in an array. The design constant  $C$  corresponds to the voltage sidelobe level of an array.

Once the number of elements and the sidelobe level of the equivalent Chebyshev array are determined, then available tables [3] or graphs [4] may be used to determine the excitation coefficients. These excitation coefficients correspond to the  $a_m$ 's as derived by Cohn [5]. The ratio of impedances at each step is  $Z_{m+1}/Z_m$ .

A relationship between the characteristic impedances of each section of the transformer, the input and terminating impedances, and the  $a_m$ 's are given by the expression

$$\ln \frac{Z_{m+1}}{Z_m} = \frac{a_m \ln \frac{Z_{n+1}}{Z_1}}{\sum_1^n a_m}$$

where

$$n = N + 1.$$

Once the number of transformer sections and the design constant  $C$  have been calculated, the array which most closely satisfies these parameters may be chosen. The maximum VSWR and bandwidth may be recalculated from these data. In this manner the total time required to calculate the impedances of a multisection transformer can be minimized.

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## REFERENCES

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## Contributors



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During the summer of 1962, he was employed as an Electronics Engineer by Texas Instruments, Inc., Dallas. While at the University of Texas, he held a Graduate Teaching Assistantship in Electrical Engineering and a position as Research Engineer in the Electronic Materials Research Laboratory. Since June, 1965, he has been

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He joined the research staff of RCA Laboratories in 1957, and since then has specialized in semiconductor research, especially on effects related to negative mass phenomena and, more recently, on studies of plasma effects in solids including the "Oscillistor," and microwave emission from indium antimonide.

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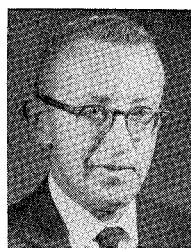


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Prior to and during his attendance at the University of Illinois, he worked as an electromechanical designer for the Magnavox Co., Urbana, Ill., and the Offner Electronics Corp., Chicago, Ill. From 1960 to 1961, he worked as a Technician in the University of Illinois Antenna Research Laboratory. Since 1961 he has been on the staff of the Applied Electronics Division of Airborne Instruments Laboratory, Deer Park, N. Y. He is currently a Project Engineer on programs for developing techniques and components for RFI measurements in waveguide systems. Other areas which his experience spans include low-noise cryogenic parametric amplifier systems, state-of-the-art high power filter design, and studies of properties of superconducting microwave filter structures.

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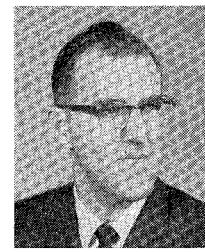


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