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An Explicit Derivation of the Relationships Between the Parameters of an Interdigital Structure and the Equivalent Transmission-Line Cascade

H.J. Riblet. "An Explicit Derivation of the Relationships Between the Parameters of an Interdigital Structure and the Equivalent Transmission-Line Cascade." 1967 Transactions on Microwave Theory and Techniques 15.3 (Mar. 1967 [T-MTT]): 161-166.

The general nth-order admittance matrix for an array of parallel conductors placed between ground planes is exhibited, subject to the assumption that direct coupling exists only between adjacent conductors and that only a TEM wave is present whenever all the conductors but one are grounded. When the alternate terminals of one of these arrays are connected to ground, as in an interdigital bandpass filter, the admittance matrix yields a subsystem of equations which, except for sign, is identical in form with the node equations of suitably selected transmission-line cascade. The identification of the coefficients in these similar systems of equations explicitly determines the coefficients of the admittance matrix in terms of the parameters of the prototype transmission-line cascade. In turn, the capacities to ground and the mutual capacities, each per unit length, for the array of parallel conductors can be determined from the coefficients of its admittance matrix by imposing the pertinent voltage conditions on the admittance equations. Thus, one arrives, explicitly, at the general formulas used in the design of interdigital filters which relate the capacities per unit length of the parallel conductors to the parameters of the prototype transmission-line cascade. It is shown that, if the first element of the interdigital structure is open-circuited, the transmission-line cascade begins with a series, open-circuited quarter-wave stub while, if the first element of the interdigital structure is short-circuited, the first element of the cascade is a shunt, short-circuited quarter-wave stub. Extensions of the method to equivalences with other prototype networks are suggested. In the Appendix, closed expressions for the self and mutual admittances of the parallel conductor array are given in terms of the self impedances and coupling coefficients of the nth-order impedance matrix proposed by Bolljahn and Matthaei for this structure, subject to the assumption of no coupling between nonadjacent conductors. These are shown to be consistent with the requirement that

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the admittance matrix be the reciprocal of the impedance matrix.

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