BROADBAND RF TRANSFORMERS AND COMPONENTS CONSTRUCTED WITH TWISTED MULTIWIRE TRANSMISSION-LINES

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C E R T I F I C A T E

Certified that the dissertation entitled "Broadband RF Transformers And Components Constructed With Twisted Multiwire Transmission-Lines", which is being submitted to the Indian Institute of Technology Delhi, by G. SOUNDRA PANDIAN in fulfilment for the award of the Degree of DOCTOR OF PHILOSOPHY is a record of the student's own work carried out by him under our joint supervision and guidance. The matter embodied in this dessertation has not been submitted for the award of any other Degree or Diploma.

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ABSTRACT

This thesis deals with the development, analysis and design of broadband RF multiwire transmission-line transformers. A theoretical technique of computing, the leakage inductance and winding capacitance of multiwire transformers from principles is reported. Broadband RF signal processing components, namely, 0° hybrids, 180° hybrids, 90° hybrids, directional couplers, and RF amplifiers (all of which incorporate twisted multiwire transformers) are investigated.

To start with, bifilar transmission-lines are considered and the effects of twisting a bifilar line on its electrical parameters are studied experimentally. For the popular 4:1 Ruthroff transformer, a lumped equivalent circuit is proposed. It is shown that matched multiwire transformers exhibit excellent wideband characteristics comparable to (or even superior to) the bifilar 4:1 transformer, with bandwidths of the order of 4-5 decades in the frequency range of 10 kHz-1000 MHz.

Simple equivalent circuits are proposed for the analysis of multiwire transformers. The "characteristic impedance" of a multiwire transformer is defined as $\sqrt{L_T/C_T}$ where L_T is the leakage inductance and C_T is the winding capacitance. It is shown that the transformer performance is optimum, when $\sqrt{L_T/C_T}$ is matched to the load resistance. The upper 3-dB cut-off of a matched transformer occurs at a frequency $f_o = 1/\pi(2\sqrt{L_T C_T})$.

A method of modelling the inductance and capacitance parameters of multiwire transmission-lines is presented.

Also a theoretical procedure for determining L_T and C_T of multiwire transformers is reported. This helps in predetermining the performance of multiwire transformers before actually constructing them.

A detailed analysis of the basic 0° hybrid employing a bifilar line is presented. A simple method of "compensating" this hybrid to obtain improved isolation characteristics is proposed. A novel RF 90° hybrid with one-octave bandwidth is reported. Methods of constructing miniature broadband directional couplers by using twisted wire transformers are given, and a novel 10 dB directional coupler is reported. Applications of the transformers in the design of broadband RF amplifiers are outlined.

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