1.2: SUPERCONDUCTING DELAY LINE

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Advances in cryogenic engineering have made low temperature electronics feasible. A number of devices have operated successfully in cryogenic environments with considerable improvement in their characteristics.

The use of transmission time delay for the storage of microwave signals is normally limited by the attenuation produced by the transmission line. One approach under investigation, toward reduction of the attenuation and thereby the achievement of a nearly ideal lossless transmission line, is the use of very low temperatures. Near absolute zero some conductors become superconductive, losing all resistance, and dielectric losses are reduced.

This paper discusses the design and development of superconductive transmission lines for the delay of microwave signals for periods in excess of one microsecond. The propagation characteristics of lowest order modes in coaxial cable permit the use of miniature cable, giving a realistic package size for long delays. The nature of the losses encountered and the values anticipated for the dielectric loss tangent as the result of theoretical investigations are considered.

It is shown theoretically that in plastic film dielectrics such as polyethylene and "Teflon," which have low loss tangents at room temperatures, the mechanisms contributing to this loss all decrease with decreasing temperature. The mechanism with the least temperature dependency varies as T^2. In order to provide low attenuation for lines in excess of 1 microsecond, loss tangent values in the order of 10^{-6} to 10^{-7} are required. These theoretical values will be compared with the experimental data obtained.

The design problems of small cable fabrication, low temperature operation and the design of broad-band microwave transitions from conventional size connectors to the miniature cable are discussed. The effect of impedance discontinuities on effective line noise level is reviewed.

Characteristics of delay lines providing delays of over 1 microsecond with rise times better than 0.5 nanoseconds and 50 ohm characteristic impedance will be presented and their salient features discussed.

The status of the line development and its effect in extending capabilities of microwave storage are presented. The use of the line in obtaining basic data on the electrical properties of dielectrics at low temperature is also discussed.