Abstracts

An Approximate Nonlinear Analysis of Tunnel-Diode Converters

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Approximate analyses published previously on tunnel-diode converters are basically phenomenological in nature by restricting the currents flowing through the tunnel diode or (and) the voltage across it to the signal, local oscillator, and intermediate frequencies only. Because of the nonlinear nature of the tunnel diode, many higher-order frequency components corresponding to harmonics and products, sums, and differences of the above mentioned frequencies are present. By including the effects of series resistance and series inductance and restricting the operating region within the parabolic portion of the tunnel-diode characteristics, the present analysis attempts to formulate the problem in a "rigorous" manner through the derivation of a second-order nonautonomous nonlinear differential equation with time-varying coefficients. The solution to a "first-order" approximation is obtained by incorporating a variational type treatment with an expansion type perturbation method. In an effort to verify the validity of the theoretical results obtained by the nonlinear analysis, an analog simulation is carried out since the control of required parameters in actual experiments is extremely difficult, especially in the microwave frequency region. The general agreement between the theoretical results and the analog simulation is promising and, therefore, should yield enough information to facilitate the control and adjustment of the various parameters in actual experiments especially in the microwave region. Specifically, we have verified by the analog simulation the theoretical prediction that the optimized conversion gain is obtained when the source resistance is about one third of the load resistance. In addition to minimizing the converter noise, the noise due to the first IF amplifier can also be minimized by selection of the correct converter load resistance by using Figs. 4 through 8.

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