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NASA TECH BRIEF

Marshall Space Flight Center

Determination of Nonlinear Resistance Voltage-Current Relationships by Measuring Harmonics

The problem:

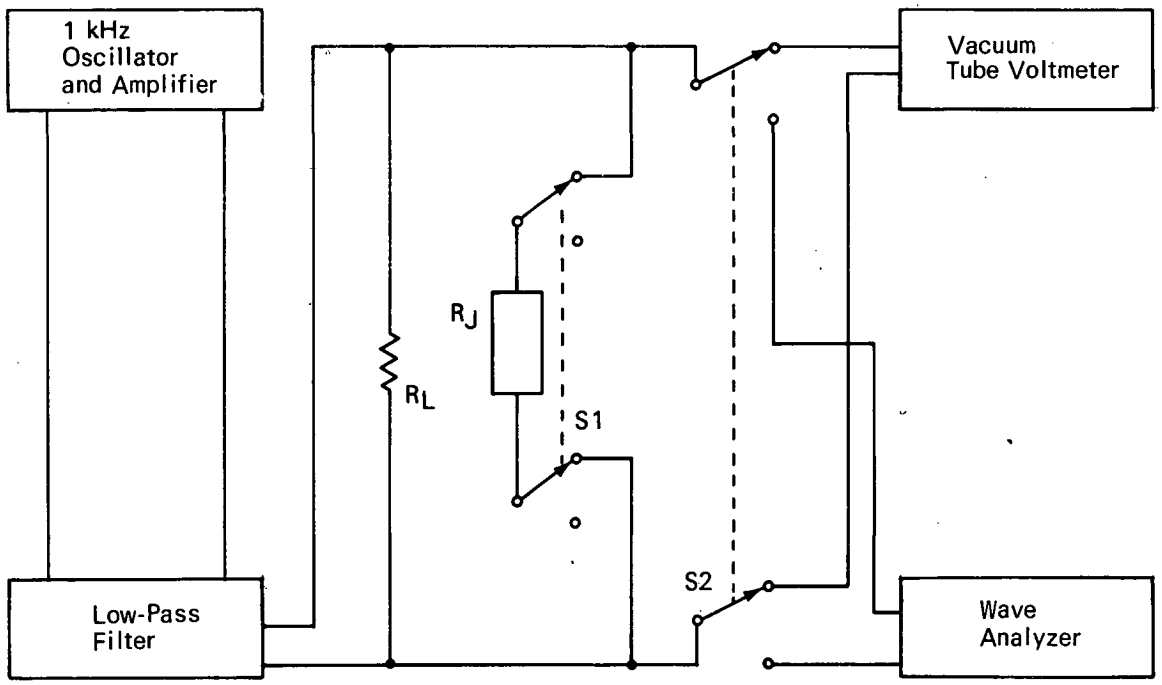
To develop a highly accurate model describing voltage-current relations, for determining the intermodulation-product amplitudes generated by a nonlinear resistance. Conventional techniques, involving voltage-current measurements and curve-fitting procedures, do not enable development of a model with the required accuracy.

The solution:

A model designed to provide the accuracy required, using harmonics.

How it's done:

A test configuration (see fig.) is used to measure the amplitudes of the harmonic signals generated in a nonlinear resistance, R_J, which may be any type of junction. A vacuum-tube voltmeter is used to measure the amplitude (rms) of a low-frequency sinusoidal input signal, and a wave-analyzer measures the amplitude of the harmonic signals generated in the junction. The amplitude of the harmonics contained in the input signal must not exceed the amplitude of the harmonics generated in the nonlinear resistance. Switch S1 is used to remove



(continued overleaf)

the nonlinear resistance from the circuit when the input signal harmonic content is measured.

The amplitudes of the harmonic signals are used for determining the short-circuit peak harmonic current, I_N, in the following equation:

$$I_N = \left[\frac{1.414\,A_N}{R_L}\right]\left[\frac{R_J + R_L}{R_J}\right]$$

where,

A_N = amplitude (rms, volts) of the Nth harmonic,

R_J = effective resistance of the nonlinear resistance

R_L = load resistor, which must be much lower in value than R_J

$\frac{R_J + R_L}{R_J}$ = correction factor which compensates for the effect of R_L on I_N.

The peak harmonic currents are inserted into the equations for determining the constants in a truncated power series. These equations are found by accumulating like terms in expansions of $(A \cos \omega t)^N$ The constants are substituted in the following equation (truncated power series):

$$I = +K_1V + K_2V^2 + K_3V^3 + \ldots + K_NV^N$$

where, $V = A \cos \omega t$

A = peak value of the input voltage.

This equation describes the voltage-current relation for the nonlinear junction resistance, to the required accuracy.

Note:

Requests for further information may be directed to:

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Patent status:

No patent action is contemplated by NASA.

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