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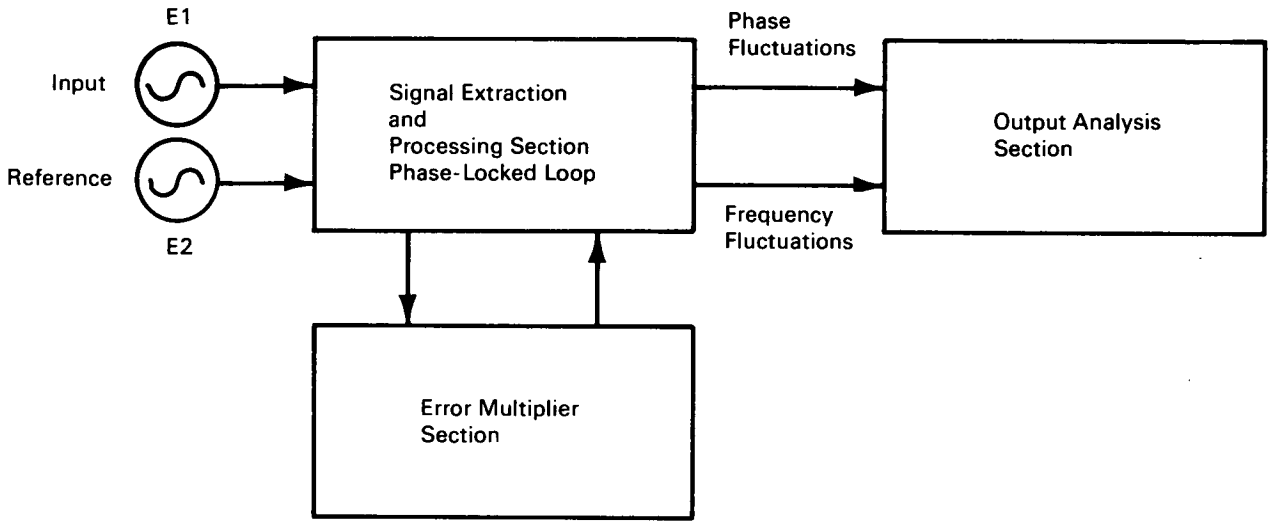
NASA TECH BRIEF

Spectral Analysis of Oscillation Instabilities in Frequency Standards



Basic Configuration of the Measurement System

The phase and frequency fluctuations inherent in oscillators used as frequency standards have been measured over the spectral frequency range of 1 Hz to 5 kHz. Experimental data for nine commercially available oscillators were obtained with the oscillator instability analyzer shown in the figure. The basic measurement system consists of an electromechanical phase-locked loop that extracts the phase and frequency fluctuations and an error multiplier that extends the threshold sensitivity. Operational features include a selection of loop bandwidths, calibrated offset controls, and several output level selections.

The analysis of the data involves the application of the spectral density of the frequency or phase fluctuation as a function of spectral frequency. The format of the data, a spectral representation of the performance throughout the frequency, enables the designer to apply standard circuit and system analysis techniques to determine the effects of various portions of the spectrum on the performance of the overall system.

Analysis of the experimental data has shown that the major stability degrading mechanisms are flicker and thermal noise in both the oscillator feedback loop and the external circuits.

The instrumentation and mathematical analysis developed in this program can be used in the evaluation of such frequency standards as masers, crystal oscillators, and lasers, and in the development of low-noise synthesizers. The measurement techniques

(continued overleaf)

can be used for acceptance testing, design evaluation, and definition of performance specifications in terms of the phase angle and frequency spectral densities.

Note:

Requests for further information may be directed to:

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No patent action is contemplated by NASA.

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