Characterized Generator Extends Phase Meter Calibrations from 50 kHz to 20 MHz

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Summary Abstract

A phase angle generator made by phase locking two function generators is described. The generator produces two sine waves that are programmable in phase (0-360°), amplitude (0-40 V_{rms}), and frequency (<1 Hz - 20 MHz). The uncertainty in the phase linearity is ±0.05° to ±0.25° over the above frequency range without external phase standards.

Summary

Programmable phase angle standards such as the one described in reference 1 are used to calibrate phase angle meters below 100 kHz. However, a new class of wideband counters, known generically as time interval analyzers (TIAs), can be configured as phase meters that operate up to 20 MHz and beyond. These instruments are being used to enhance the measurement precision of heterodyne interferometers [2], but there are no established standards to support them. Existing phase standards at NIST (based on digitally synthesized waveforms) operate from 1 Hz to 50 kHz with uncertainties from ±0.005 to ±0.05° [3].

A simple method has been developed to extend the NIST capability from 50 kHz out to 20 MHz while maintaining uncertainties from ±0.05 to ±0.25°.

The technique, shown in Fig. 1, employs two commercial function generators that are phase locked by connecting the "clock out" of one to the "clock in" of the other. The output signal of each generator can be phase shifted relative to the common clock. Thus a 30° phase angle between the two output signals can be programmed by setting one generator to 0° and the other to 30°, or by setting one to 60° and the other to 90°, etc. In this manner, the differences between n combinations of settings that produce 30° can be measured using a phase meter only as a 30° detector. The phase meter accuracy is not important; however, it must have sufficient

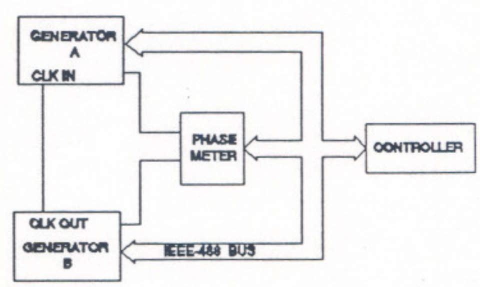

Fig. 1. Block diagram of the phase standard consisting of two phase-locked function generators.

differential linearity to measure the differences to within the required accuracy. As long as the differences are small, this is not a stringent requirement. A series of equations describing the phase errors of each generator and the measured differences can be expressed as:

$$\delta_{ij} = A_i - B_j + C_k$$

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δ_{ij} is the measured difference at the i-j phase settings
A_i is the error of generator A at the i phase setting
B_j is the error of generator B at the j phase setting
C_k is the error of the phase meter at the i-j phase setting.

: n measurements are made at each of n ifferent phase angles (equally spaced etween 0° and 360°), there will be n^2 ıdependent measurements and 3n nknowns. A solution for this set of quations requires that n be greater than r equal to three.

'his calibration technique was used to redict the generator linearity at several est frequencies. Results indicate that the naximum linearity errors were less than :0.5° from 1-20 MHz. The phase errors t each setting have sufficient short-term tability to permit the generator to be haracterized, at fixed phase angles, to ıncertainties ranging from ±0.05° below l MHz to ±0.25° out to 20 MHz.

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References

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