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AN ESTIMATE OF THE JITTER OF TEST GENERATORS USING TIME-MEASURING APPARATUS

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A method of estimating the jitter of test pulse generators using time-measuring apparatus (event timers) is considered. It is shown that the covariance of results of simultaneous measurements of the period by two measuring instruments gives an estimate of the jitter of the period of the test sequence. An experimental estimate of a jitter of 0.66 psec with an error of 8 fsec is obtained. The method enables generators of test pulse trains with small jitter to be checked and enables the results to be used further to test precision time measuring instruments.

Key words: *test pulse sequence period jitter, event timer, testing of precision time measuring instruments.*

In a number of physical experiments, the need arises to measure and analyze the time characteristics of pulse sequences. The apparatus for making such measurements has different names: multistop time-analysis systems [1], time analyzers [2], timer-analyzers (for example, the CNT-91 timer-analyzer manufactured by the Pendulum Instruments Company), and event timers [3]. The most complete information for time analysis is obtained using event timers, which measure (record) the time at the instant of an event. For pulse sequences, the event is associated with the intersection of a given level by one of the leading edges of the pulses of the sequence being investigated. The results of the measurement – time-stamps – can be stored in the memory of the measuring instrument or/and transmitted to a computer for subsequent processing as the events occur. The processing can be completed, for example, by calculating the differences between adjacent time markers, which enables the time intervals between the pulses in the sequence to be determined. One of the greatest problems which designers of precision apparatus for investigating pulse sequences encounter, is the correct estimate of the error in measuring the time intervals between pulses (at the present time this amounts to 5–10 psec). An estimate of this error can be obtained by investigating a test periodic pulse sequence, generated either by a fairly accurate pulse generator (for example, the AFG3251 generator made by Tektronix), or a specialized test source. Each of the results of a measurement A_i of period T_i of a test periodic pulse sequence can be represented as the sum of the period T_i and the error a_i of the measurement:

$$A_i = T_i + a_i.$$

By storing the data matrices of n results of measurements of the test-sequence period, we can calculate the variance $D[A]$ of this data matrix, which, starting from the assumption that the measurement errors and the period of the test sequence are independent, will be equal to the sum of the variance of the test periods $D[T]$ and the variance of the error of the measuring instrument:

$$D[A] = D[T] + D[a]. \quad (1)$$

From the quantity $D[A]$, we can estimate the inherent error of the measuring instrument $D[a]$, but only if we know an estimate of the variance of the test-sequence period:

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