NASA TECH BRIEF

FM Carrier Deviation Measured by Differential Probability Method
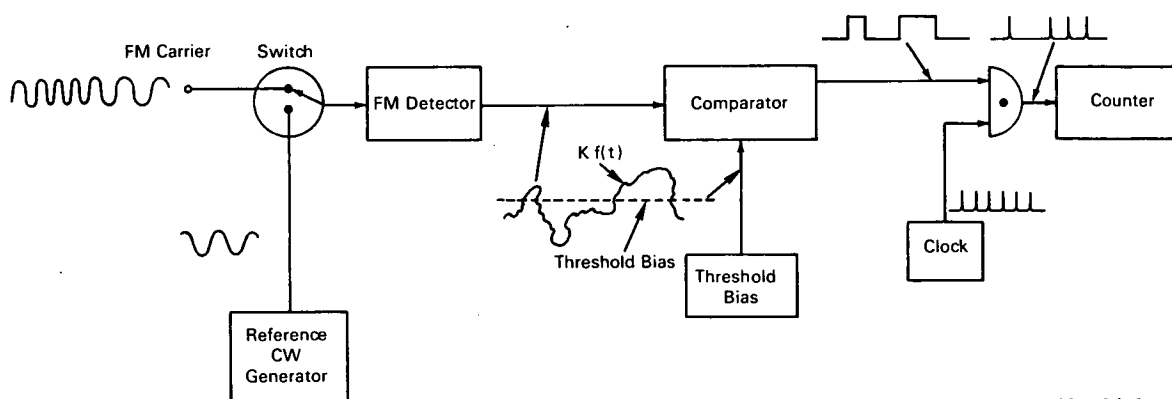
The problem:

To devise a system that will accurately measure deviation, caused by adjacent channel interference, of an FM carrier modulated by a complex signal.

The solution:

A differential probability FM deviation measuring system in which the peak-to-peak amplitude, or a certain portion of the peak-to-peak amplitude, of a complex signal is measured and related to the frequency shift of the carrier signal. With this system, the deviation is described in terms of a probability, as well as a peak value. The system utilizes commercially available equipment consisting of a reference cw generator, an FM detector, a comparator circuit, a 1-MHz crystal controlled clock, an *and* gate, and a counter.

How it's done:

The FM carrier enters the FM detector through a coaxial switch. The intelligence signal, Kf(t) (where K=gain of the FM detector and f(t)=complex modulation data), is extracted in the FM detector and

passed to the comparator, a low drift, high gain, dc differential amplifier, where it is compared with a threshold bias. The output of the comparator is a "one", if Kf(t) is greater than the threshold bias. The comparator output and the high frequency clock signal (250 KHz counted down from the crystal controlled 1-MHz clock) are fed to an *and* gate. A coincidence of a "one" Kf(t) output and a clock signal gates the counter, which sums the enabled clock pulses over a given time interval. The value of the threshold bias, which is equal to the peak value of Kf(t) and prevents the clock from being enabled, corresponds to the peak deviation of the modulated carrier. The frequency of this peak deviation is determined by closing the coaxial switch to the reference cw generator and tuning to the frequency whose demodulated output just exceeds the threshold bias. The system clock is thereby enabled 100 percent of the time; thus the reference frequency corresponds to the peak deviation frequency.

The system can also determine the probability of exceeding a given deviation limit. Consider an FM

(continued overleaf)

communication system limited to a peak deviation frequency with an allowable deviation from the limit for a given fraction of the time. The probability that this deviation will exceed the limit can be determined by tuning the reference generator to that value of the peak deviation frequency for which the threshold bias of the comparator just prevents the system clock from being enabled. When the reference generator signal is removed and the intelligence signal is compared to the threshold bias, the system clock will be enabled for only that fraction of the time the peak deviation is exceeded. The resultant clock count divided by the maximum possible clock count (i.e., for the clock enabled 100 percent of the time) would be the fraction of the time that the deviation limit is exceeded. This fraction is numerically equal to the probability of exceeding the deviation limit.

Notes:

1. Three types of implementation errors are associated with this system: clock resolution error, comparator hysteresis error, and reference frequency error. The clock resolution error and the comparator hysteresis error effectively cancel each other, but the reference frequency error is significant. Tests made on the deviation measuring system to verify its feasibility showed high accuracy on an individual component basis. The comparator circuit was found to have an error of less than 0.1 percent, and the system clock stability was better than 0.005 percent. Thus, for a large clock frequency to maximum modulating frequency ratio f_c/f_m, the measurement accuracy depends primarily on the generator and counter used in the system.

2. Inquiries concerning this innovation may be directed to:

   Technology Utilization Officer
   Marshall Space Flight Center
   Huntsville, Alabama 35812
   Reference: B67-10213

Patent status:

No patent action is contemplated by NASA.

Source: J. Haddican and A. F. d'Aquin, Jr.
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