PERFORMANCE ANALYSIS OF NONCOHERENT AGC FOR SIGNAL PRESENCE DETECTION AND AUTOTRACK SIGNAL EXTRACTION

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Abstract

The acquisition of a communication satellite data signal starts with a spatial search for the incoming direction of arrival. As the antenna scans the received signal level builds up as this direction is approached. This level builds up according to the antenna gain pattern. Once detected, this level can be used to determine when the pull-in range is reached. This allows the automatic tracking, or the autotrack system to take over and maintain the pointing control. An AGC control voltage can provide an indication of signal level, gain, and thus the pointing error. A non-coherent AGC can be used to provide both a signal presence indication and tracking error signal, if a single channel autotrack signal with AM or AM-PM modulation is used. This includes five horn and dual mode feed systems.[*]

A non-coherent AGC loop is modeled and analyzed for transient signal level and autotrack noise effects. The AGC is designed to track the time varying power build-up during a scan, but not the AM modulation on the autotrack signal. The loop equations are obtained by simply extending the Victor-Brockman-Tausworthe AGC error approximation to the non-coherent case with a SQPSK modulated carrier and AM autotrack modulation. A Gaussian antenna pattern shape is assumed over the acquisition range, resulting in a similar shape for the normalized input SNR $\rho(t)$. The ideal control voltage output is shown to be proportional to $K_1 \ell n[1+\rho(t)] + K_2$. These constants are functions of loop parameters and K_2 is a function of the input gain drift and noise power. By calibrating the constants out, $\ell n[1+\rho(t)]$ will follow the input $\rho(t)$ closely for useful ranges of $\rho(t)$. The effect of closed loop AGC filtering is obtained by using the "exponential shift" formula of operator theory to obtain an asymptotic series in inverse powers of AGC bandwidth. The first two terms of

[*] For general systems performance, see:
D. D. Carpenter and W. E. Lindsey, "Performance Analysis of Single Channel Autotracking Systems for Communication Satellites", National Radio Science Meeting, Boulder, Colorado, November, 1978.

the series show a rapid approach to the ideal response once the AGC bandwidths exceed 2.5 to 5 Hz for many beamwidths and scanning rates of interest.

The AGC suppression of the autotrack scale factor is derived and agrees with the well-known result of $K_s = \rho/(1+\rho)$, usually obtained from Rice's square law detector results. The SQPSK data modulation produced negligible SxS contributions to scale factor variation and tracking error noise properties. Expressions for the tracking error noise power were derived in terms of K_s, AGC parameters, and input SNR.