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A Nonlinear-Coherence Receiver

Mathematical analysis and detailed study of a generic model for a coherent receiver has demonstrated that the nonlinear coherence between a given biphase-modulated input signal and a supplied reference signal can be used advantageously in present-day receivers to improve telecommunication systems. There are many special cases of the general structure, but the only two that have been explored thus far (the data-aided and hybrid carrier tracking loops) have provided significant improvement in performance over the present-day phase-coherent tracking, telemetry, and command systems which utilize PCM/PSK/PM modulation.

The usual method for examining the mutual power between two signals at an arbitrary frequency is through the use of a cross-spectrum, that is, the spectral density of power that is mutually shared in a phase-coherent manner. It is important to note that each signal can have power in a common frequency band without there being cross-spectral power in that band; the existence of common frequency-components does not imply mutually coherent power.

In a nonlinear system, it is possible to have coherency between a signal at one frequency and another signal at some multiple of that frequency. For example, when the generic model includes a squaring loop, an input signal with energy centered at a nominal frequency is squared (nonlinear operation) to produce a signal that is centered at twice the nominal frequency and is phase-coherent with the suppressed carrier signal. The signal at the higher frequency is tracked by a conventional phase-lock loop with an oscillator of the same nominal frequency.

The results of detailed mathematical analyses of the generic model also demonstrate that nonlinear coherence receivers operated in a multiple loop configuration can very readily be made to provide improved signal-to-noise figures inasmuch as phase–time relatoinships within desired signals are not common with noise signals. Moreover, with telemetry signals which can have constant phase errors over several symbol intervals, appropriate delay elements can be introduced into the generic model in order to exploit sideband power in much the same manner as is done in differentially coherent detection or time diversity reception; mathematical expressions for the signal and noise components of voltages appearing at various points in the generic model are tabulated in the report which summarizes the results of the study.

Note:

Requests for further information may be directed to:

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