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ASSIGNMENT

Phase Locked Loops (PLL) and Frequency Synthesis

A PLL is a feedback system that includes a VCO, phase detector, and low pass filter within its loop. Its purpose is to force the VCO to replicate and track the frequency and phase at the input when in lock. Applications include Clock generation, Frequency synthesizer, Clock recovery in a serial data link.

Phase detector: compares the phase at each input and generates an error signal, ve(t), proportional to the phase difference between the two inputs. KD is the gain of the phase detector (V/rad).

VCO: The VCO oscillates at an angular frequency, ωout. Its frequency is set to a nominal ω0 when the control voltage is zero. Frequency is assumed to be linearly proportional to the control voltage with a gain coefficient KO or KVCO (rad/s/v).

Lock Range: Range of input signal frequencies over which the loop remains locked once it has captured the input signal. This can be limited either by the phase detector or the VCO frequency range.

Capture range: Range of input frequencies around the VCO center frequency onto which the loop will lock when starting from an unlocked condition. Sometimes a frequency detector is added to the phase detector to assist in initial acquisition of lock.

There are 2 main sources of low phase noise:

1. Reference noise – usually small since we frequently use a crystal oscillator
2. VCO noise – often high. We hope that the PLL will suppress most of the noise, at least close to the carrier.

The effect caused by each of these noise sources can be seen from the closed loop transfer functions.

Analog Multipliers

There are several analog multipliers that depend on the exponential transfer function of bipolar transistors, they include;

- **The Emitter-Coupled Pair**: The emitter-coupled pair, was shown in to produce output currents that were related to the differential input voltage.
- **Two-Quadrant restriction**: a circuit that functions as a multiplier under the assumption that Vid is small, and that Vi2 is greater than $V_{BE(on)}$. The latter restriction means that the multiplier functions in only two quadrants of the Vid - Vi2 plane, and this type of circuit is termed a two-quadrant multiplier.

- **Gilbert multiplier cell**: is a modification of the emitter-coupled cell, which allows four-quadrant multiplication. The Gilbert multiplier cell is the basis for most integrated circuit balanced multiplier systems.

- **Gilbert cell as a Balanced Modulator**: In communications systems, the need frequently arises for the multiplication of a continuously varying signal by a square wave. This is easily accomplished with the multiplier circuit by applying a sufficiently large signal directly to the cross-coupled pair.

- **Gilbert cell as a phase detector**: If unmodulated signals of identical frequency coo are applied to the two inputs, the circuit behaves as a phase detector and produces an output whose dc component is proportional to the phase difference between the two inputs.