NAME: ADENIRAN TOLUWANIMI DEBORAH
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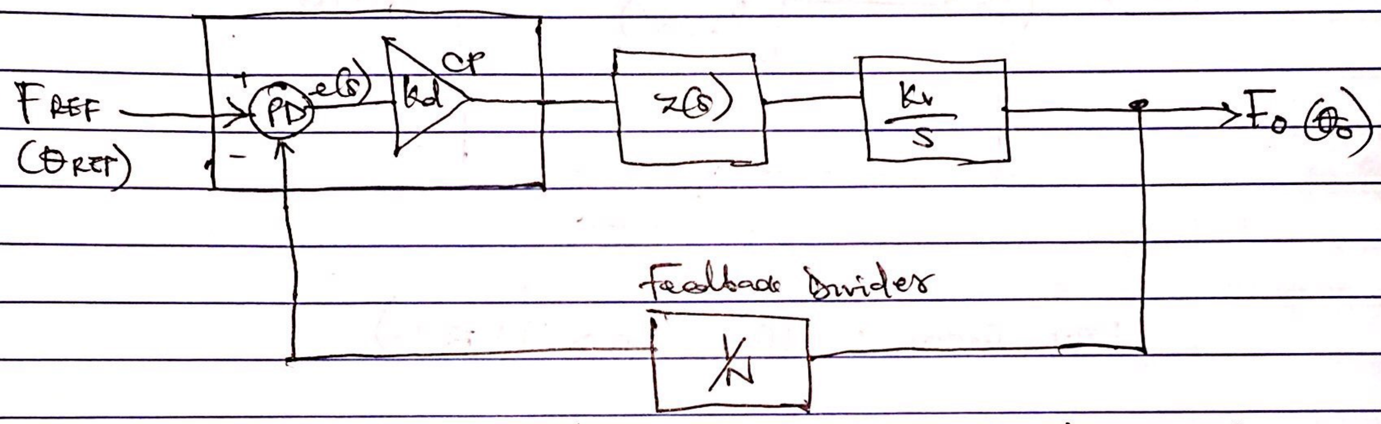
⇒ PHASE LOCKED LOOPS (PLLS) (TOPIC 1)

PLLs are feedback systems which combine a voltage controlled oscillator (VCO) and a phase comparator so connected that the oscillator maintains a constant phase angle relative to a reference signal



A Basic Phase Locked Loop (PLL) Model

The PLL output can be taken from either Vcont the filtered VCO control voltage, or from the output of the VCO depending on the application. The former provides a baseband output that tracks the phase variation at the input.

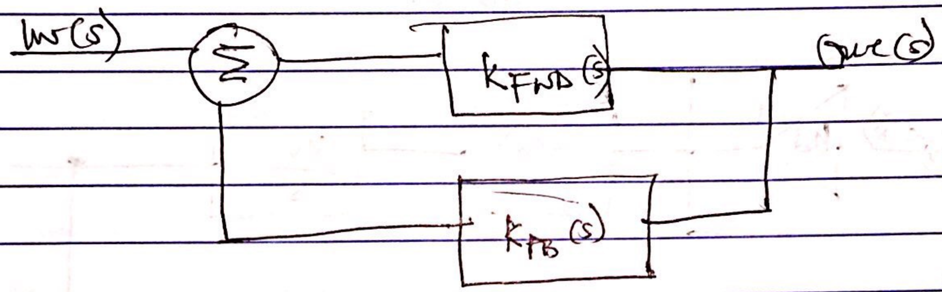
Some applications include.

1. Clock Generation.
2. Frequency Synthesizer.
3. Clock recovery on a serial data link.

VCO is a treated as a linear, time-invariant system. The VCO oscillates at an angular frequency which is assumed to be linearly proportional to the control voltage with a gain coefficient K_o or K_{VCO} (rad/s/V)

$$\omega_{out} = \omega_0 + K_0 V_{cont}.$$

⇒ PLL is a feedback system.

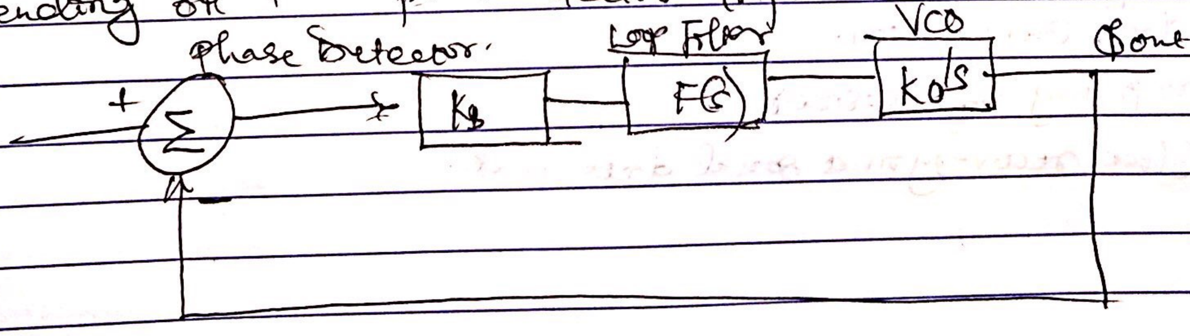


Loop Gain : $T(s) = K_{FWD}(s)\, K_{FB}(s)$

Transfer Function : $\dfrac{Out(s)}{In(s)} = H(s) = \dfrac{K_{FWD}(s)}{1 + T(s)}$

⇒ Frequency and phase Tracking Loop

PLL with feedback = 1 ; therefore, input and output frequencies are identical. The input and output phase should track one another but there may be a fixed offset depending on the phase detector implementation.



Transfer Function : $H(s) = $ forward path gain / $[1 + T(s)]$.
With feedback = 1,

$$H(s) = T(s)/[1 + T(s)]$$

$$H(s) = \frac{\phi_{out}}{\phi_{in}} = \frac{K_D K_O F(s)/s}{1 + K_D K_O F(s)/s}$$

Phase error function

$$\theta_e = \phi_{in} - \phi_{out} = \frac{s\phi_{in}}{s + K_D K_O F(s)}$$

For the frequency synthesis application, we want to have ideally perfect phase tracking for phase and frequency steps. When the synthesizer frequency is changed, it is a discontinuous step in modulus, and we want to have zero steady state phase error in this case

The transfer function is : $G(s) = \frac{K_O}{s} \frac{K_D}{1+s/\omega_1} = \frac{K_V}{s(1+s/\omega_1)}$

2 ANALOG MULTIPLIER (Topic 2)

Analog Multipliers are circuits that take two analog inputs and produces an output proportional to their product