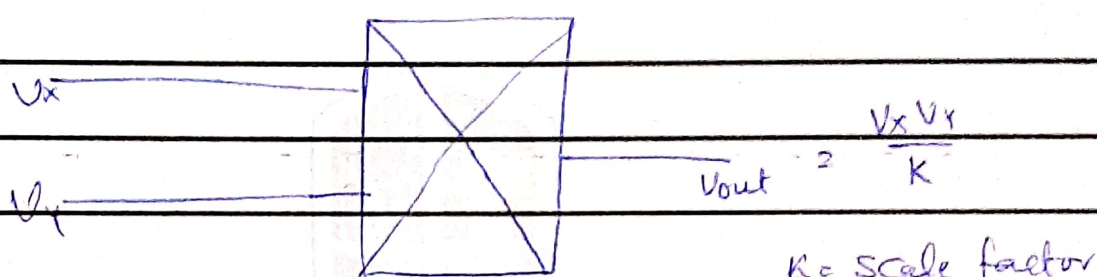


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ANALOG MULTIPLIERS

In analog signal processing the need often arises for a circuit that takes two analog inputs and produces an output proportional to their product. Such are analog multipliers.



GILBERT MULTIPLIER CELL

Gilbert multiplier cell is the basis for most integrated circuit balanced multiplier system. The series connection of an emitter coupled pair with two cross coupled, emitter couple pairs produces a particularly useful transfer characteristic.

$$I_{C3} = \frac{I_{C1}}{1 + \exp(-V_1/V_T)}$$

$$I_{C4} = \frac{I_{C1}}{1 + \exp(V_1/V_T)}$$

$$I_{C5} = \frac{I_{C2}}{1 + \exp(V_1 + V_2)} = I_{C2} \cdot \frac{I_{C2}}{1 + \exp(-V_1/V_T)}$$

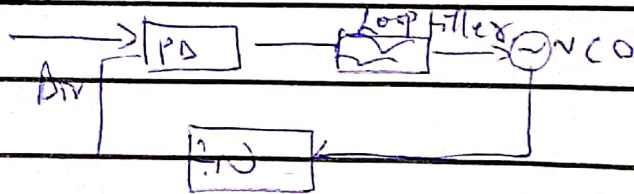
The different output current as then given by:

$$\Delta I = I_{C3-5} - I_{C4-6} = I_{C3} + I_{C5} - (I_{C4} + I_{C6}) = (I_{C5} - I_{C4}) - (I_{C6} - I_{C3})$$

$$= I_{EE} \tanh(V_1 / 2V_T) - I_{EE} \tanh(V_2 / 2V_T)$$

Phase Loop Lock

Phase locked loop are ubiquitous circuits used in Counters, Communication and engineering applications. Components includes VCO, reference divider, phase detector (PD) and loop filter.



PLL are truly mixed signal circuits involving the co-design of RF, digital and analog building blocks. A non-linear negative feedback loop that locks the phase of a VCO to a reference signal. Other applications include Frequency modulation and demodulation. Electronic PLLs are common but optical and mechanical are used.

