BITT POLYTECHNIC, RANCHI

DEPARTMENT OF ELECTRONICS & COMMUNICATION ENGINEERING

Communication Systems

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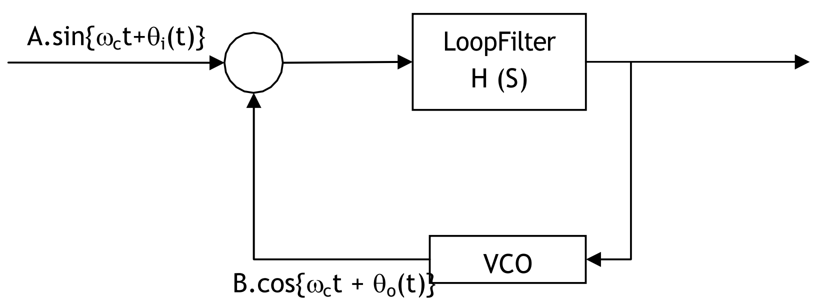
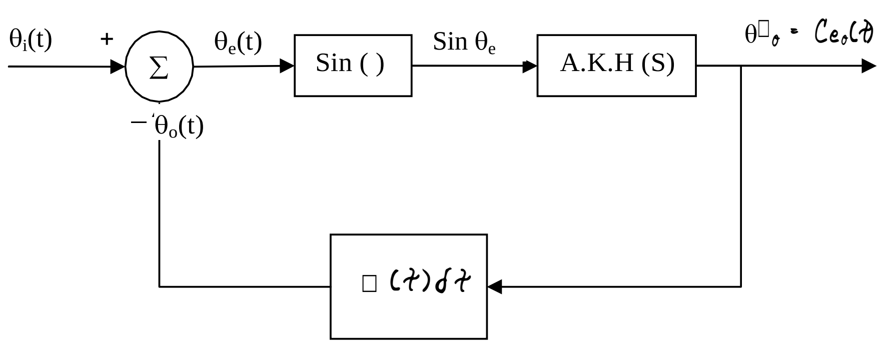
Phase Lock Loop (PLL)

The PLL is an important circuit which helps to detect the original signal from a frequency modulated signal corrupted by noise. The operation of this device has been properly explained here.

In fact PLL is very popular because of their low cost and superior performance, especially when SNR is low. FM demodulation using PLL is the most widely used method today. We know PLL tracks the incoming signal angle and instantaneous frequency.



a)



b)

Figure: a) Phase Lock Loop (PLL) b) Equivalent circuit of PLL

The free running frequency of VCO is set at the carrier frequency.
The instantaneous frequency of the VCO can be given by

$\omega_{VCO} = \omega_c + C.e_o(t)$

If the VCO output is $B.\cos\{\omega_c t + \theta_o(t)\}$,

Then the instantaneous frequency can be represented as

$$\omega_{VCO} = \omega_c + \dot{\theta}_o(t)$$

This means, $\dot{\theta}_o(t) = Ce_o(t)$

In the above equations C and B are constants of PLL.

The multiplier output in figure is

$AB.\sin(\omega_c t + \theta_i)\ \cos(\omega_c t + \theta_o) = (AB/2)[\sin(\theta_i - \theta_o) + \sin(2\omega_c t + \theta_i + \theta_o)]$.

The term $(AB/2).\sin(2\omega_c t + \theta_i + \theta_o)$ is suppressed by the loop filter (LPF). Hence the effective input to the is $(AB/2).\sin\{\theta_i(t) - \theta_o(t)\}$. If $h(t)$ is the unit impulse response of the loop filter, then

$$e_o(t) = h(t) * \frac{1}{2} AB\sin\{\theta_i(t) - \theta_o(t)\} = \frac{1}{2} AB\int_0^T h(t - x)\sin\{\theta_i(x) - \theta_o(x)\}dx$$

But, $\dot{\theta}_o(t) = Ce_o(t)$, therefore $\dot{\theta}_o(t) = AK\int_0^t h(t - x)\sin\theta_e(x)\,dx$

Where, K = (CB/2) and is the phase error and defined by $\theta_e(t) = \theta_i(t) - \theta_o(t)$

i.e. $\theta_o(t) = \theta_i(t) - \theta_e(t)$.

FM carrier is $A.\sin\{\omega_c t + \theta_i(t)\}$

Thus PLL works as a FM demodulator. If the incoming signal is phase modulated wave, then,

$$e_o(t) = K_p \dot{m}(t)/C$$

In this case we need to integrate $e_o(t)$ to obtain the desired signal.