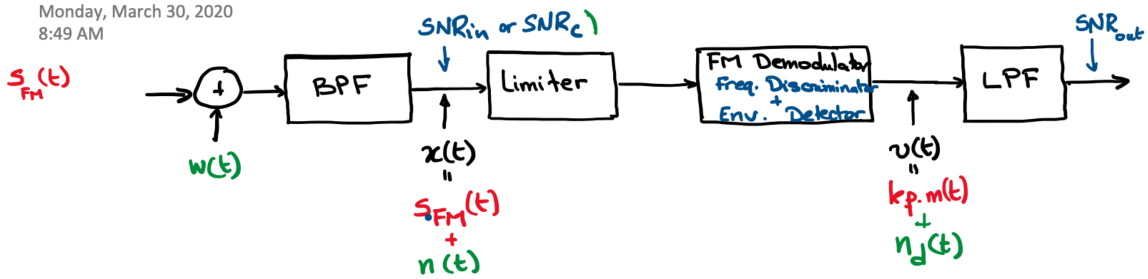
Online Lecture # 05 - FM Demodulation in the Presence of Noise

Monday, March 30, 2020
8:49 AM



$w(t)$: the white noise at the Rx input [it has infinite BW and power]

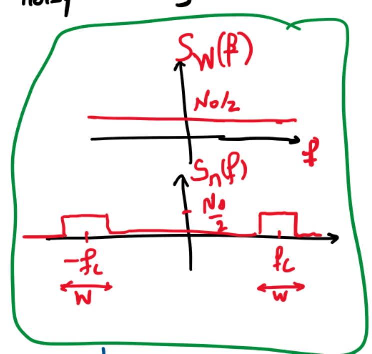
$n(t)$: the filtered noise around the carrier f_c in a the bandwidth of $W = 2f_m$

$n_d(t)$: the demodulated noise.

Limiter: keeps a constant amplitude of the received noisy FM signal.

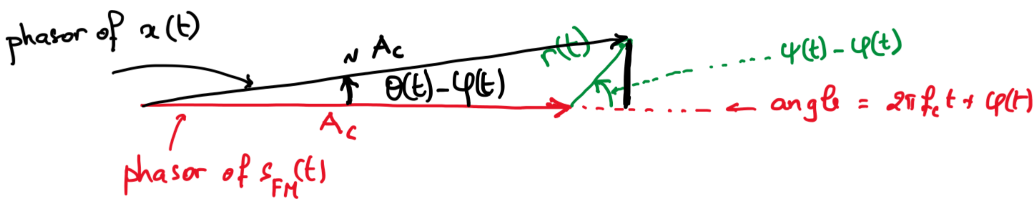
LPF: removes the noise outside the message BW.

$$\boxed{s_{FM}(t) = A_c \cos\Big(2\pi f_c t + \underbrace{2\pi k_f \int_0^t m(\tau)\,d\tau}_{\varphi(t)}\Big)}$$



$$n(t) = \underbrace{r(t)}_{\text{amplitude variation}} \cdot \cos\big(2\pi f_c t + \underbrace{\psi(t)}_{\text{phase variation}}\big)$$

the phasor diagram representation of $x(t)$ is given by:



Assuming that the noise is quite small compared to the FM signal

$$\boxed{x(t) \simeq A_c \cdot \cos\big(2\pi f_c t + \theta(t)\big)}$$

from the phasor diagram, we can get:

$$\sin\left(\theta(t)-\varphi(t)\right) = \frac{r(t)}{A_c}\cdot\sin\left(\psi(t)-\varphi(t)\right) \simeq \theta(t)-\varphi(t)$$

using 1^{st} order Taylor series approximation

$$\boxed{\theta(t) = \varphi(t) + \frac{r(t)}{A_c}\cdot\sin\left(\psi(t)-\varphi(t)\right)}$$

$$v(t) = \frac{1}{2\pi}\frac{d\theta(t)}{dt} = k_f\, m(t) + \underbrace{n_d(t)}_{??}$$

$$\boxed{n_d(t) = \frac{1}{2\pi}\, d\left[\frac{r(t)}{A_c}\sin\left(\psi(t)-\varphi(t)\right)\right]}$$