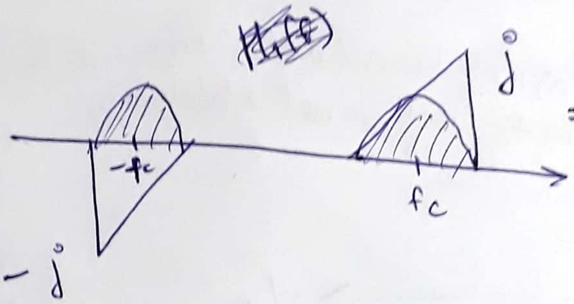
Date

$$\text{Arg}\left(e^{j\phi[n]-j\phi[n-1]}\right) \simeq 0.2 \text{ rad} \checkmark$$

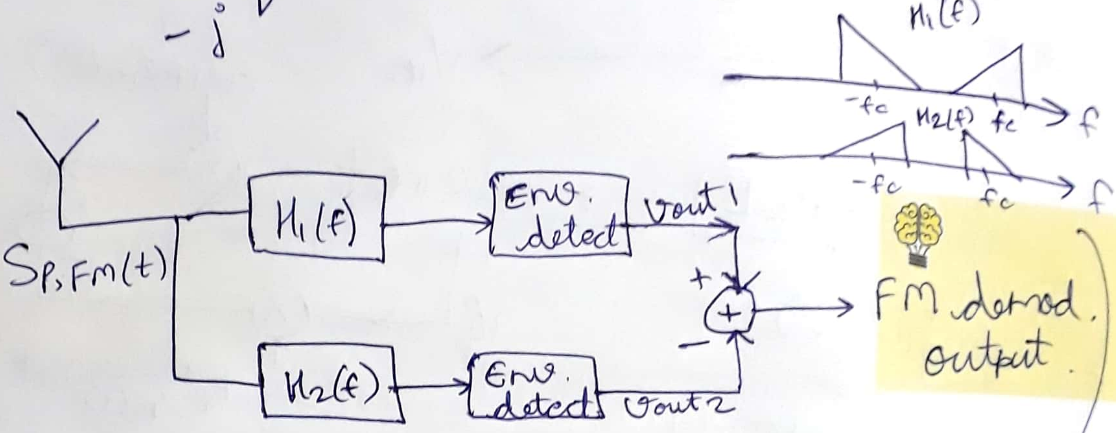
$$\text{Arg}\left(e^{j\phi[n]}\right) - \text{Arg}\left(e^{j\phi[n-1]}\right) = 0.2 - 2\pi$$

(2)

27/08



$\Rightarrow$ Output. Ampl $\propto$ freq.



FM demod. output.

Output Amp. $\propto \underbrace{f_i(t) - f_c}$ $\rightarrow \propto m(t)$

Differential Adv.

(1) Noise is reduced (Common Mode Noise is rejected)

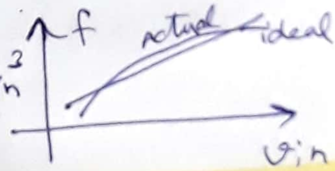
(2) 2^{nd} order distortion

$\hookrightarrow$ $v_{out1} = c_1 m(t) + c_2 m^2(t) + c_3 m^3(t) + \ldots$

$v_{out2} = c_1(-m(t)) + c_2(-m(t))^2 + c_3(-m^3(t)) + \ldots$

$\therefore \dfrac{v_{out1} - v_{out2}}{2} = c_1 m(t) + c_3 m^3(t) + c_5 m^5(t) \ldots$

$$f_i = k_1 v_{in} + k_2 v_{in}^2 + k_3 v_{in}^3$$



Notes: FM Demod

1) Digital demod

2) Freq. Dependant gain + Env. detector } ~~Non~~ Non coherent methods.

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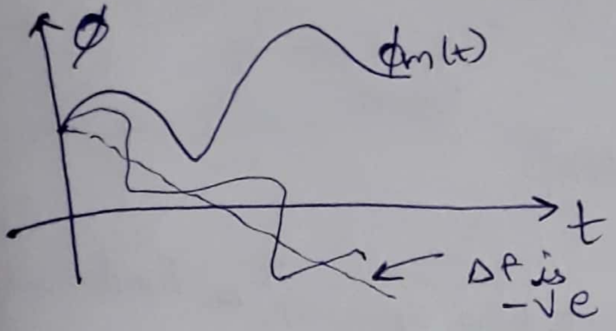
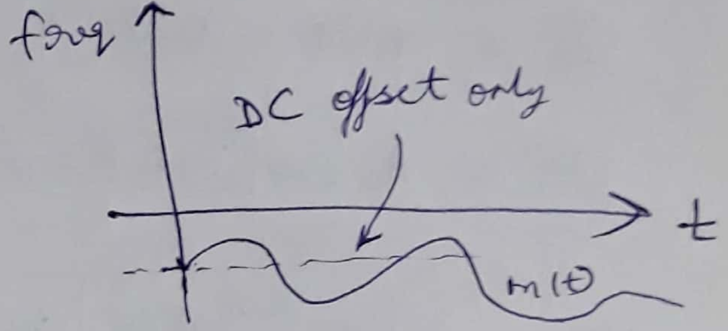
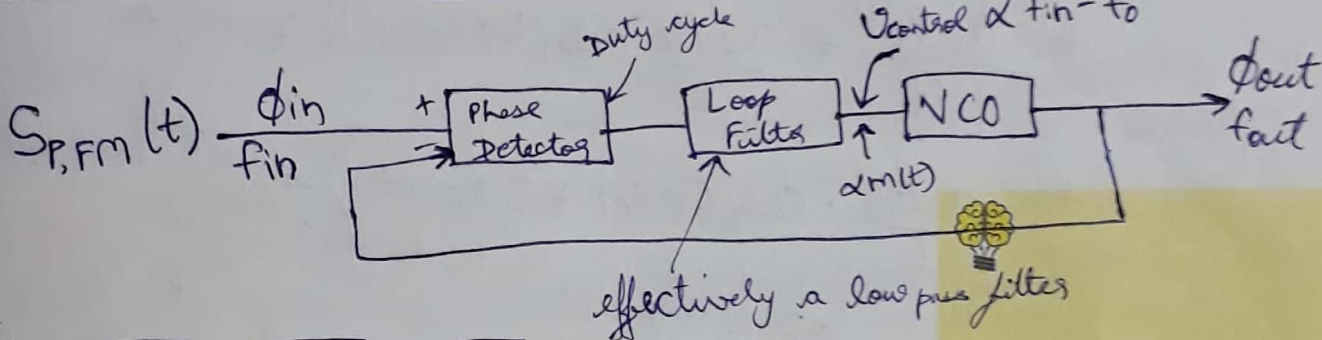
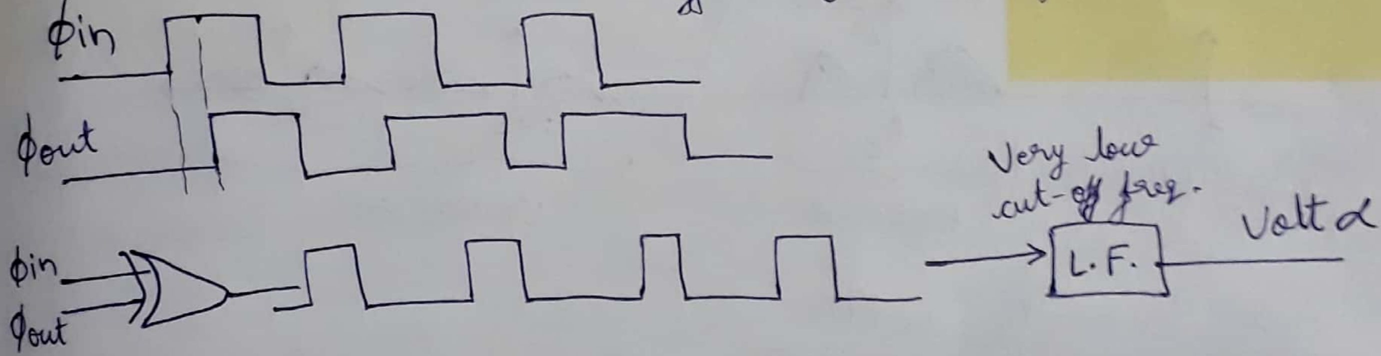
Date Exact f & ϕ of carrier is not req. for FM demod.



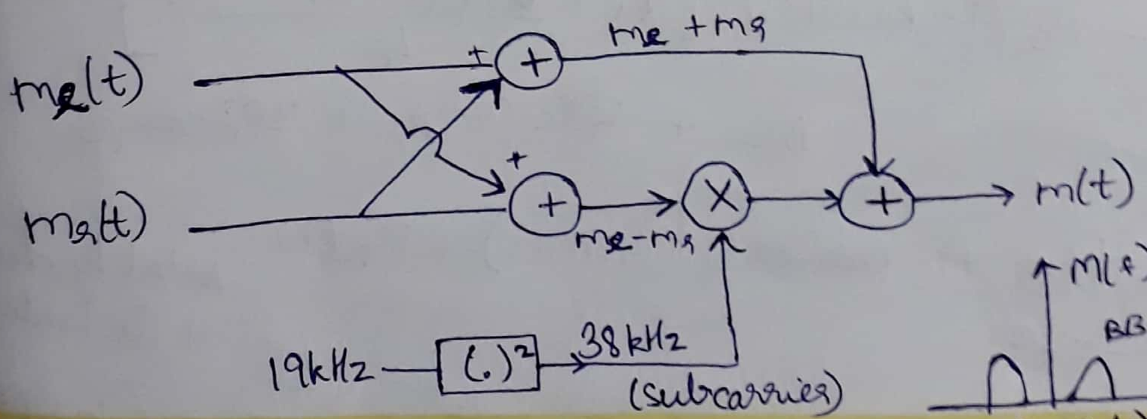


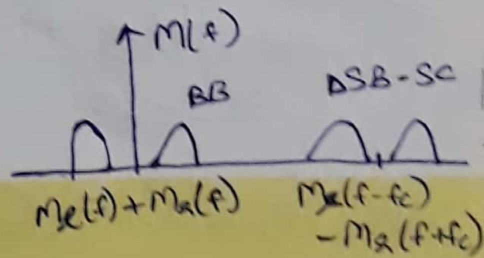
Coherent Approach (Use a PLL)



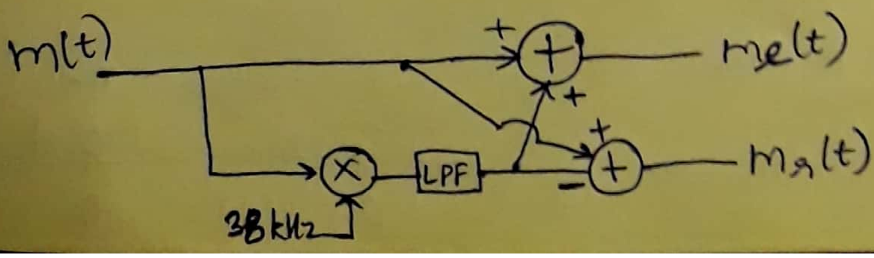


28/08 FM Stereo





Notes:



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Date: <u>Non-linearity</u>

$$v_0 = a_1 v_i + a_2 v_i^2 + a_3 v_i^3 + \underbrace{\cdots\cdots}_{\text{ignore}}$$

$$v_i = A_c \cos[2\pi f_c t + \phi_{FM}(t)]$$

$$v_0 = A_c\left[a_1 + \frac{3}{4}a_3 A_c^2\right]\cos(2\pi f_c t + \phi_{FM}(t)) \leftarrow \text{Fundamental}$$

$$+ \frac{a_2 A_c^2}{2} + \frac{a_2 A_c^2}{2}\cos(4\pi f_c t + 2\phi_{FM}(t)) \leftarrow 2^{nd}\text{ harmonic}$$

DC

$$+ \frac{a_3 A_c^3}{4}\cdot\cos(6\pi f_c t + 3\phi_{FM}(t)) \leftarrow 3^{rd}\text{ harmonic}$$

Bandwidth ↑

Non-linearity in AM

$$v_i = A_c(1 + k_a m(t)).\cos 2\pi f_c t$$

$$v_0 = A_c(1 + k_a m(t)).\left[a_1 + \frac{a_3 A_c^2(1 + k_a m(t))^2}{4}\right]\cos(2\pi f_c t)$$

$$+ DC + 2f_c \text{ comp.} + 3f_c \text{ comp}$$

30/08

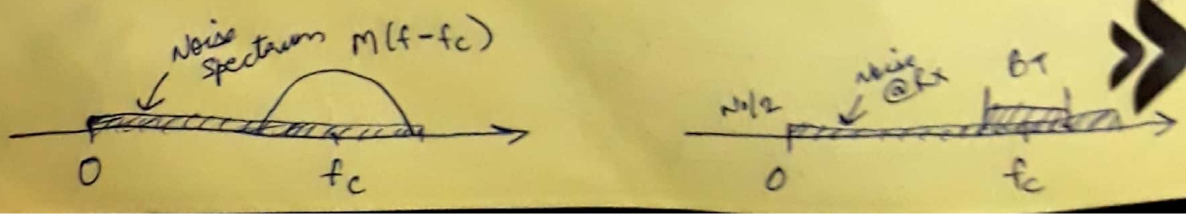
$$S_{P,Tx}(t) = A_c \cos(2\pi f_c t).\, m(t) + n_{Tx}(t)$$

DSB-SC

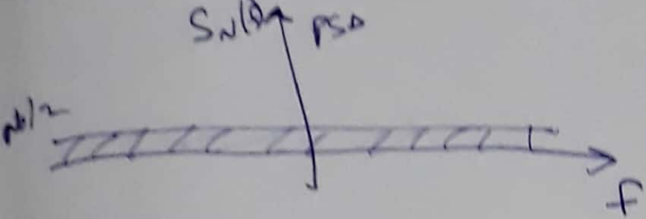
Added by channel + Rx hardware

Notes: $$S_{P,Rx}(t) = C A_c.\cos(2\pi f_c t).m(t) + n_p(t) + C n_{Tx}(t)$$

negligible



Date In band noise power = $\frac{N_0}{2} \times B_{T_x} 2$ (@ Receiver that affects received SNR)



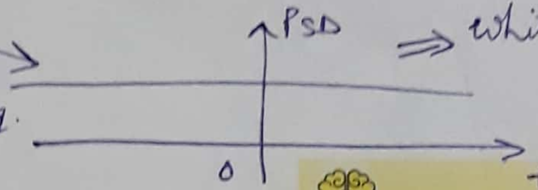
PSD → W/Hz = Joules
↓
(Power / unit BW)

$$SNR_{Rx} = \frac{P_{Tx}.C^2}{B_T.N_0} = \frac{\text{Signal Power}}{\text{Noise Power}}$$

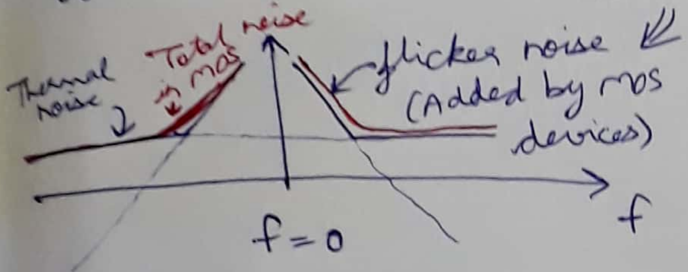
$$C = B.\log_2(1+SNR)$$

Noise

White OR Coloured → PSD not Const. w. freq.



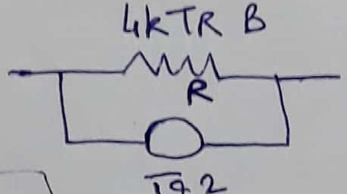
⇒ white, PSD Const. with freqn.



Commonly channel + electronics add white noise

Sources

1) Thermal Noise



k = Boltzmann constn. (1.38×10^{-23} J/K)

kTB : min. amt. of noise power.

2) Short Noise ↓I $i_n^2 = 2q\,IB$ electric charge.

3) Quantization Noise (Analog to digital conv.)