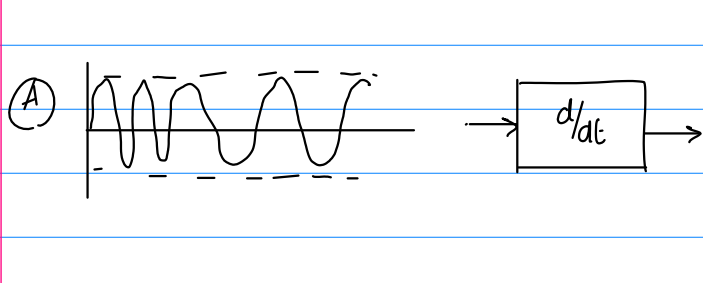
Demodulation of FM signals.

$m(t) \longrightarrow A_c \cos\left(2\pi f_c t + 2\pi k_f \int_0^t m(u)\,du\right) \longrightarrow$ P.B.C (ideal)

Ⓐ $A_c \cos\left(2\pi f_c t + 2\pi k_f \int_0^t m(u)\,du\right)$

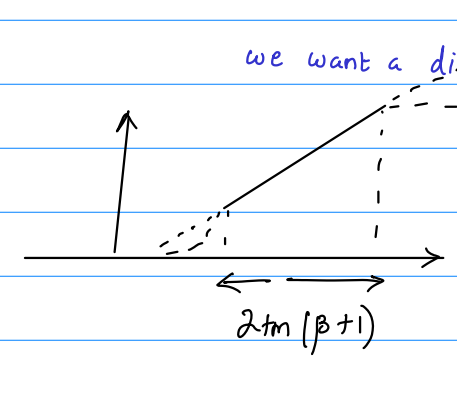
Ⓐ 

$A_c \cdot \left(2\pi f_c + 2\pi k_f\, m(t)\right) \cdot \cos(\ )$ → ED

Balanced FM demodulator

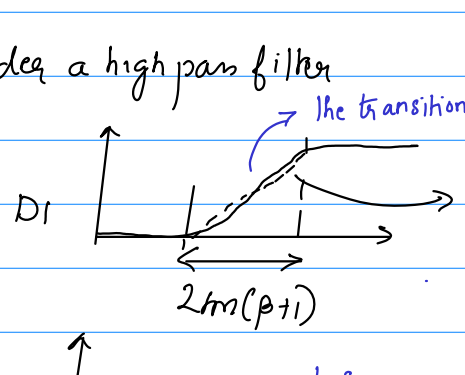
how is → d/dt → done?

FM $2 f_m (1+\beta)$ B/W

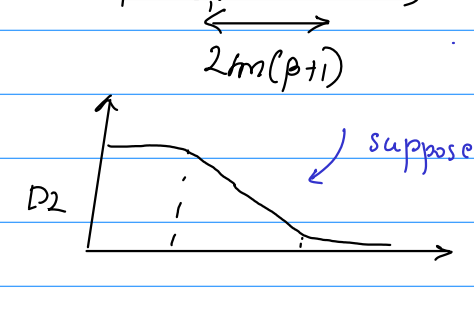


we want a differentiator like response over the pass band of the FM signal.

consider a high pass filter

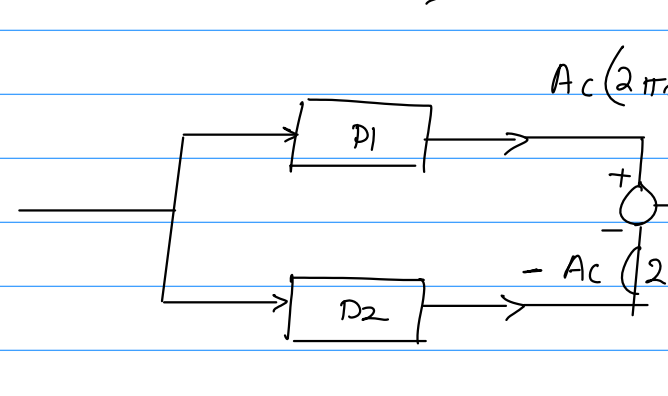


in a practical implementation, the response can be approximated as $a_0 + a_1 (f-f_0) + a_2 (f-f_0)^2 + a_3 (f-f_0)^3$ etc.



suppose we can obtain such a filter with the response being $a_0 - a_1 (f-f_0) + a_2 (f-f_0)^2 + \dots$ etc

$A_c(2\pi f_c + 2\pi k_f\, m(t)) \cos(\cdot)$

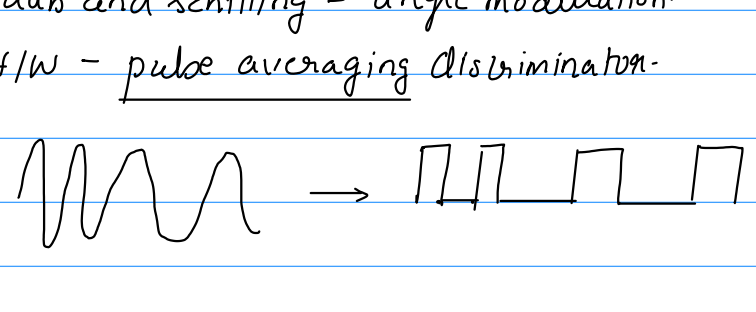


some of these non-linear terms will get cancelled out

$- A_c\left(2\pi f_c + 2\pi k_f\, m(t)\right) \cos(\cdot)$.

Taub and Schilling – angle modulation.
H/W – pulse averaging discriminator.

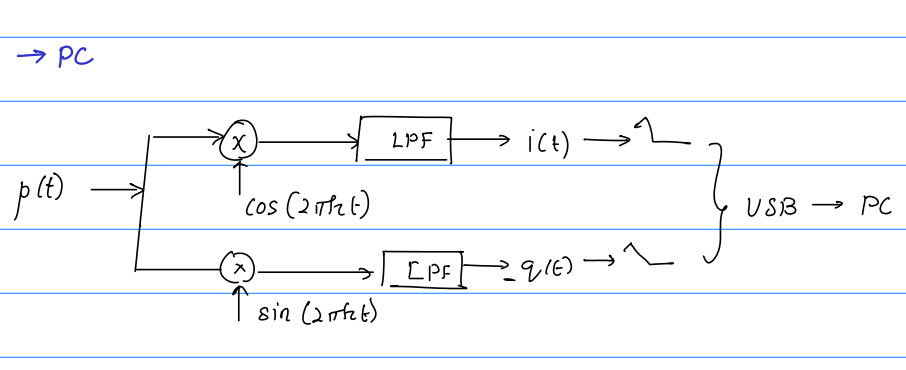
Reading assignment.



Demonstration of FM demodulation – using complex baseband.

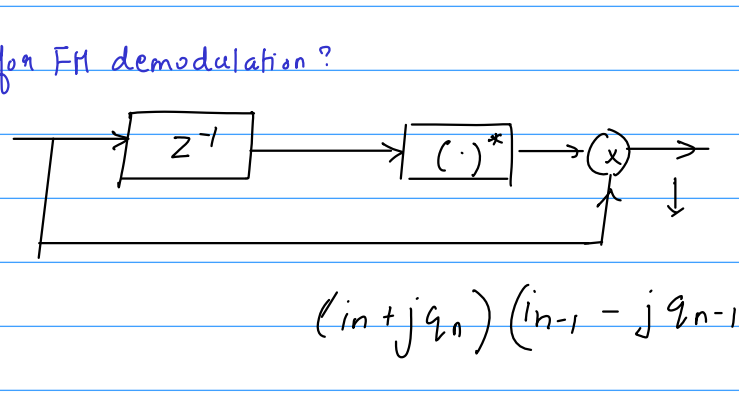
USB → PC

$p(t)$



how can we use this for FM demodulation?

$\begin{pmatrix} i_n \\ q_n \end{pmatrix} = i_n + j q_n$



$e^{j(\ ) m_n}$ → angle $\propto m_n$

$(i_n + j q_n)(i_{n-1} - j q_{n-1})$

our FM signal is $A_c \cos\left(2\pi f_c t + 2\pi k_f \int_0^t m(a)\,da\right)$

$= \mathrm{Re}\left\{ A_c e^{j 2\pi k_f \int_0^t m(u)\,du} \cdot e^{j 2\pi f_c t} \right\}$

↓ discrete time

$\left(A_c e^{j 2\pi k_f \sum_1^n m(k) \Delta_k}\right)\left(A_c e^{-j 2\pi k_f \sum^{n-1} m(k) \Delta_k}\right)$

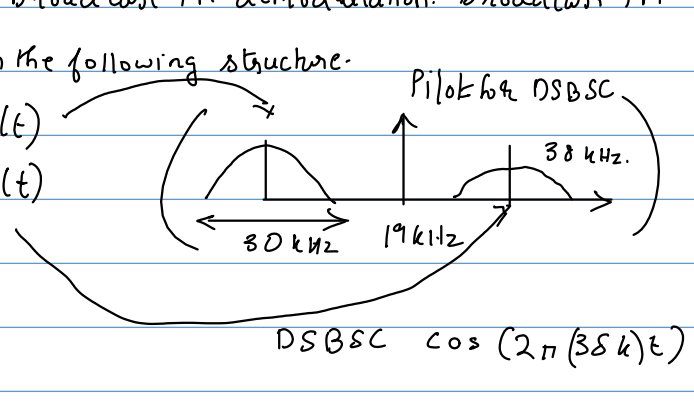
A sampled complex BB method ↦ $= A_c e^{j 2\pi k_f m(n) \Delta_k}$.

We will use RTL-SDR to demonstrate broadcast FM demodulation. Broadcast FM contains a stereo signal transmission with the following structure.

$L(t)$, $R(t)$ } 15 KHz

$L(t) + R(t)$

$L(t) - R(t)$



DSBSC $\cos(2\pi (38k) t)$

Refer Taub and Schilling / Upamanyu Madhow for stereo FM.