21/8/13

Lec 9

Intermodulation

$x(t) = A_1 \cos\omega_1 t + A_2 \cos\omega_2 t$

$y(t) = \alpha_1 x(t) + \alpha_2 x^2(t) + \alpha_3 x^3(t)$

fund 1) $\omega = \omega_1$: $\left(\alpha_1 A_1 + \frac{3}{4}\alpha_3 A_1^3 + \frac{3}{2}\alpha_3 A_1 A_2^2\right)$

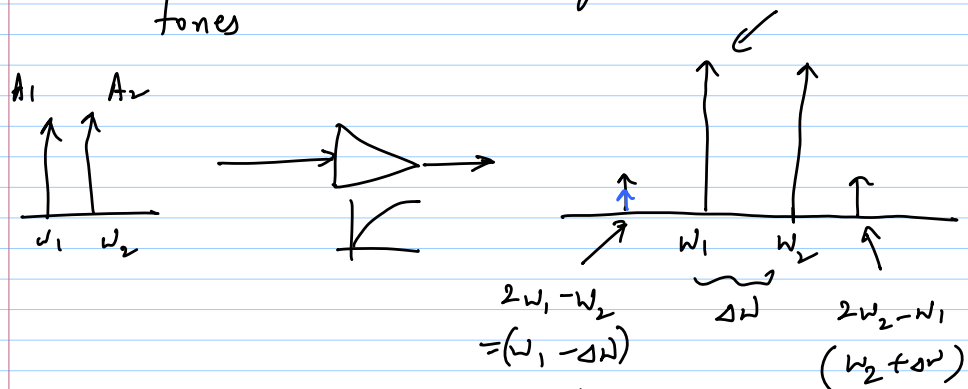
2) $\omega = \omega_2$: . . .

3) $\omega = \omega_1 \pm \omega_2$: $\alpha_2 A_1 A_2$

4) $\omega = 2\omega_1 \pm \omega_2$: $\frac{3\alpha_3 A_1^2 A_2}{4}$

5) $\omega = 2\omega_2 \pm \omega_1$: $\frac{3\alpha_3}{4} A_1 A_2^2$

* ω_1 & ω_2 are closely spaced in-band tones



→ IM_3 component could fall on top of desired signal.

→ IM distortion = $\frac{IM_3}{\text{fund}} = \frac{\frac{3}{4}\alpha_3 A_1 A_2^2}{\alpha_1 A_1}$ (dBc)

choosing A_1 & A_2 is important

→ dB (lin) = 20 log (linear) ←

dB – relative qty.

dBm – measure of Power (absolute)

$P_0 = 1W$

$P_{dBm} = 10 \log\left(\frac{P_0}{1mW}\right)$

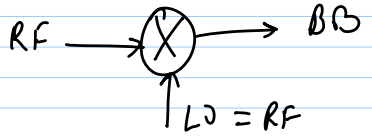
$= 30$ dBm

1-dB compression point)

IM_3 / IIP_3

IM_2 / IIP_2)

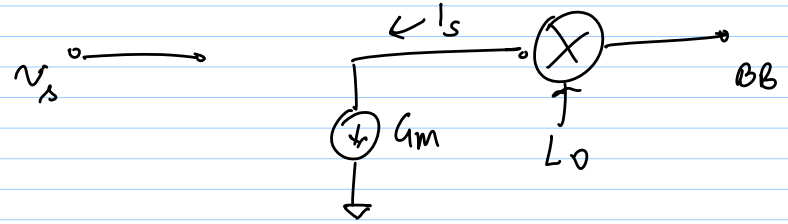
Super heterodyne Rx



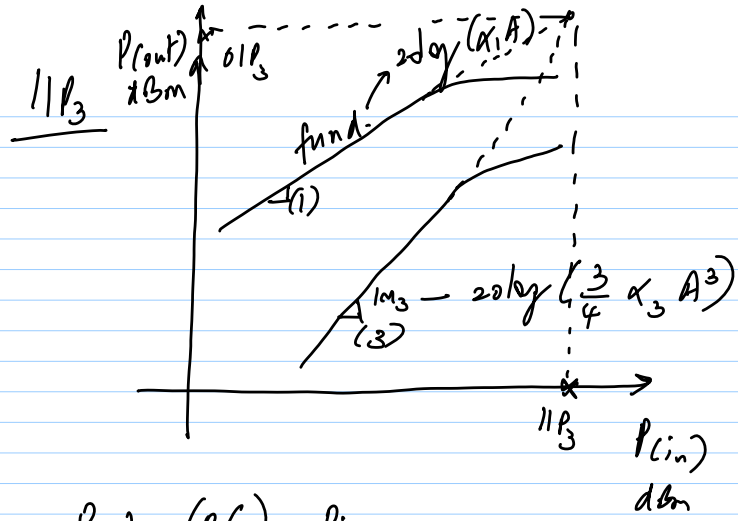
$\omega_1 \pm \omega_2$

$(\omega_1 - \omega_2)$ → falls in DC

Active mixer



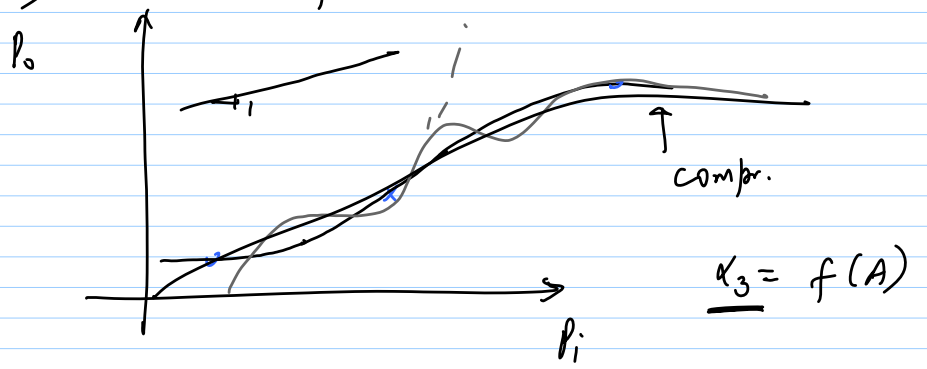
IIP_2 → Symmetry (mismatch)



$P_{out} = (PG) \cdot P_{in}$

$P_{out}|_{dBm} = P_{in_{dBm}} + (PG)_{dB}$

1) Use 2 tones w/ equal ampl. A
2) extrapolate fund. & IM_3 curves @ low P_{in}
3) point of intersection = (IIP_3, OIP_3)

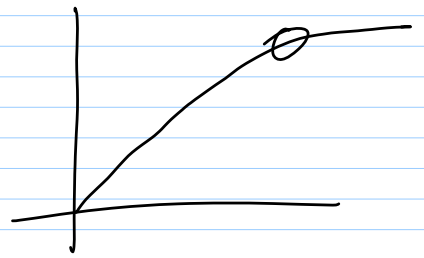


$\alpha_3 = f(A)$

Expression for IIP_3

$$\left|\alpha_1 A_{IIP_3}\right| = \left|\frac{3}{4}\alpha_3 A^3_{IIP_3}\right|$$

$$A_{IIP_3} = \sqrt{\frac{4}{3}\left|\frac{\alpha_1}{\alpha_3}\right|}$$



Method to measure IIP3

A_{in} = input ampl.

output ampl. = A_{ω_1,ω_2}

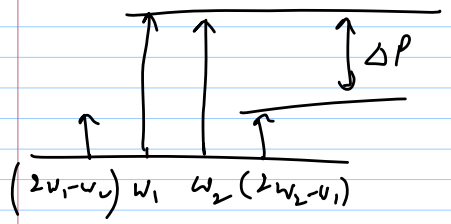
IM_3 ampl. = A_{IM_3}

$$\frac{A_{\omega_1,\omega_2}}{A_{IM_3}} = \frac{\alpha_1 A_{in}}{\frac{3}{4}\alpha_3 A_{in}^3} = \frac{4}{3}\,\frac{|\alpha_1|}{|\alpha_3|}\cdot\frac{1}{A_{in}^2}$$

$$= \frac{A_{IP_3}^2}{A_{in}^2}$$

$$20\log A_{\omega_1,\omega_2} - 20\log A_{IM_3} = 20\log\left(A_{IP_3}^2\right) - 20\log\left(A_{in}^2\right)$$

$$20\log A_{IP_3} = 20\log A_{in} + \frac{1}{2}\left[20\log A_{\omega_1,\omega_2} - 20\log A_{IM_3}\right]$$



$$IIP_3\big|_{dBm} = P_{in}\big|_{dBm} + \frac{\Delta P\big|_{dB}}{2}$$