EE511 Lecture 17 AM and Super Heteradyne

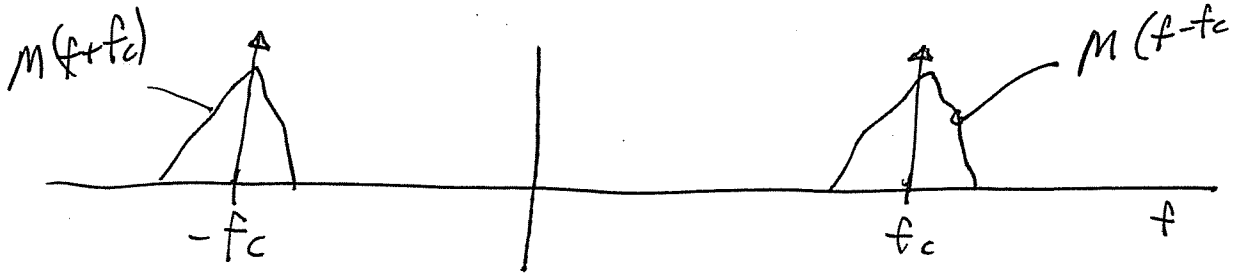
AM Modulation

The AM signal is given by

$$s(t) = A_c\,(1 + m(t))\cos 2\pi f_c t$$

where $m(t) > -1$

$$S(f) = A_c\left(\delta(f) + M(f)\right) * \mathcal{F}\{\cos\}$$



AM does not suppress the carrier

Def: % modulation Let $A_{max} = \max\{A_c(1+m(t))\}$

$A_{min} = \min\{A_c(1+m(t))\}$

A_c represents no modulation or $m(t) = 0$

% positive modulation $= \frac{A_{max} - A_c}{A_c} \times 100 = \max\{m(t)\} \times 100$ (2)

% negative modulation $= \frac{A_c - A_{min}}{A_c} = -\min(m(t)) \times 100$

% modulation

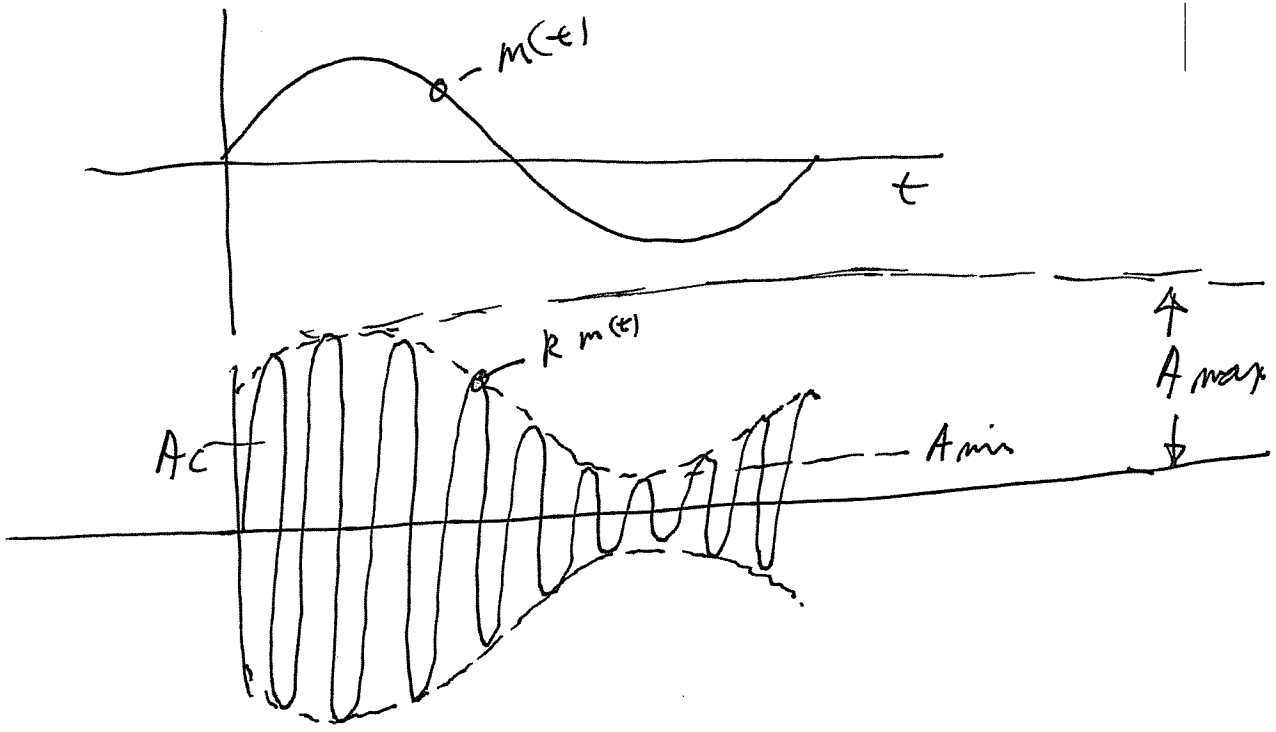
$$\frac{A_{max} - A_{min}}{2A_c} \times 100 = \frac{\max\{m(t)\} - \min\{m(t)\}}{2} \times 100$$

EX: What is the % mod of

$(1 + k\cos 2\pi f_m t)\cos 2\pi f_c t$ for $k = 1$

$A_{max} = 1 + 1 = 2$, $A_{min} = 1 - 1 = 0$

% mod $= \frac{2 - 0}{2} \times 100 = 100\%$



Modulation efficiency

$$E = \frac{\text{information signal power}}{\text{total power}} \times 100\%$$

$$= \frac{\langle m^2(t) \rangle}{1 + \langle m^2(t) \rangle} \times 100\%$$

The highest possible efficiency is 50% where $m(t)$ is a square wave and at 100% mod.

Normalised peak envelope power (PEP).

$$P_{pep} = \frac{A_c^2}{2}\left\{1 + \max\{m(t)\}\right\}^2$$

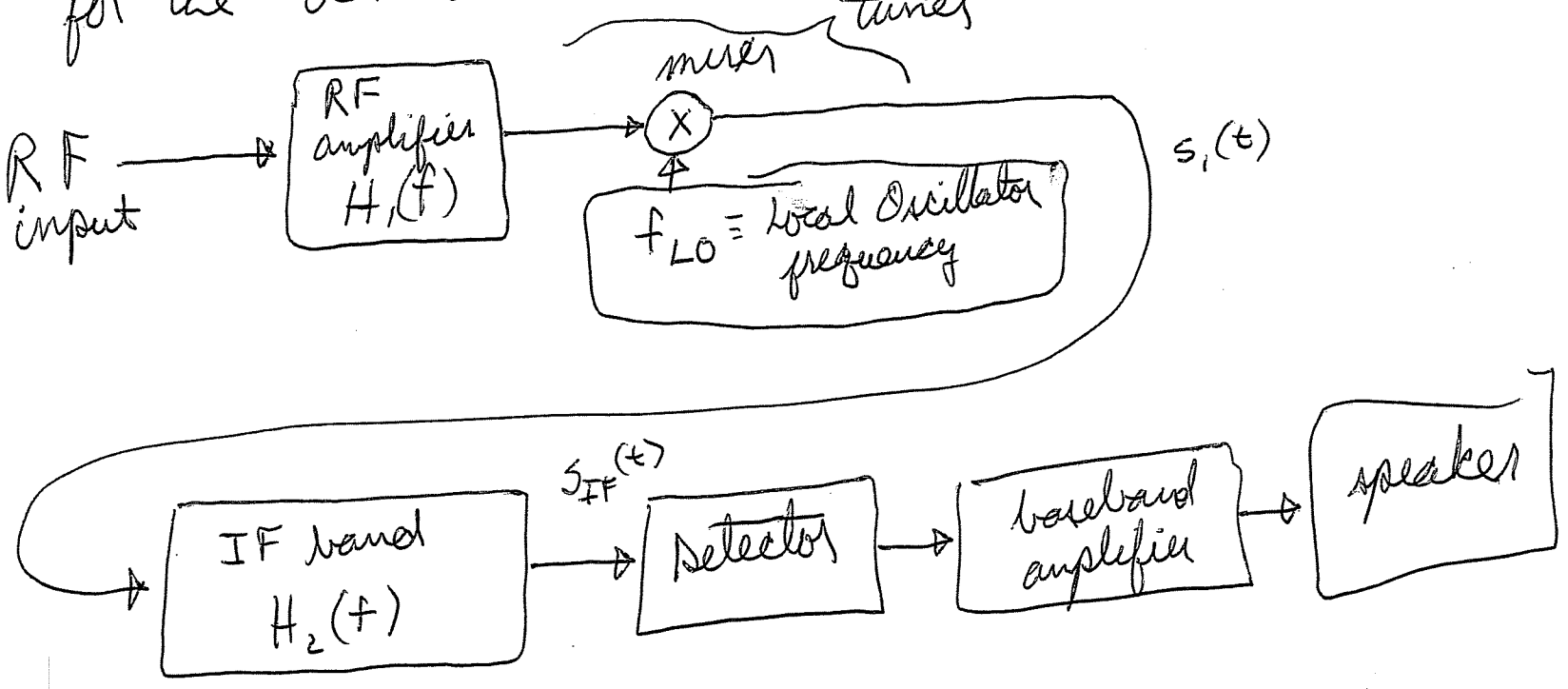
$\frac{A_c^2}{2}$ is the carrier power

$\frac{1}{2} A_c^2 \max\left(m(t)\right)^2$ is maximum modulation power

read the super heterodyne receiver

EE511 Lecture 17A Super Heterodyne Receiver

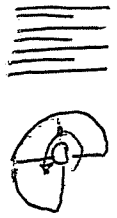
Practical receiver demodulate using an intermediate frequency (IF). This allows most of the electronics for the demodulation to be optimized at the IF.



Example

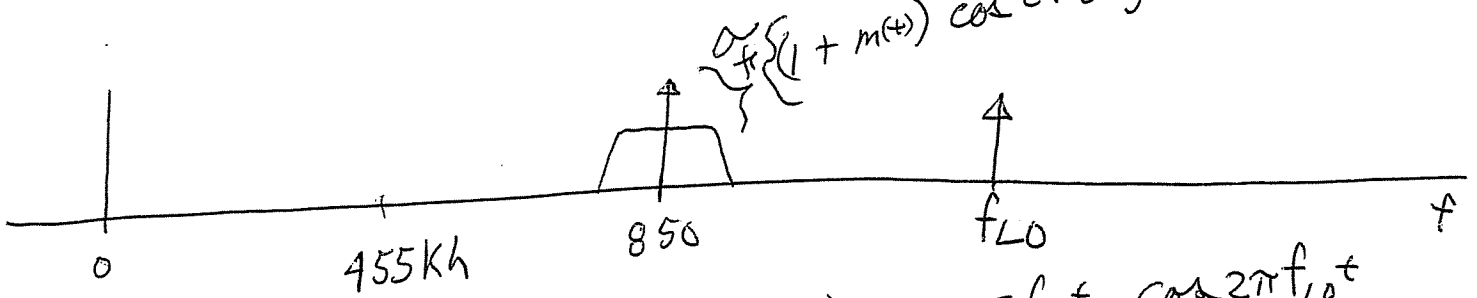
AM signal @ $f_c = 850$ KHz

f_{LO} on high side of f_c



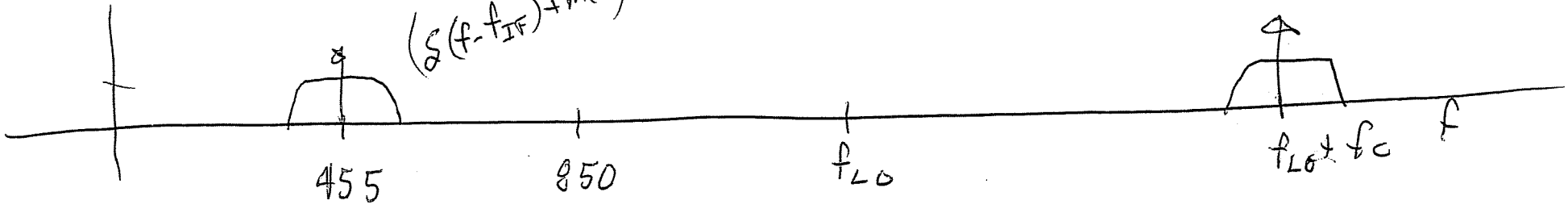
let $f_{IF} = 455$ KHz

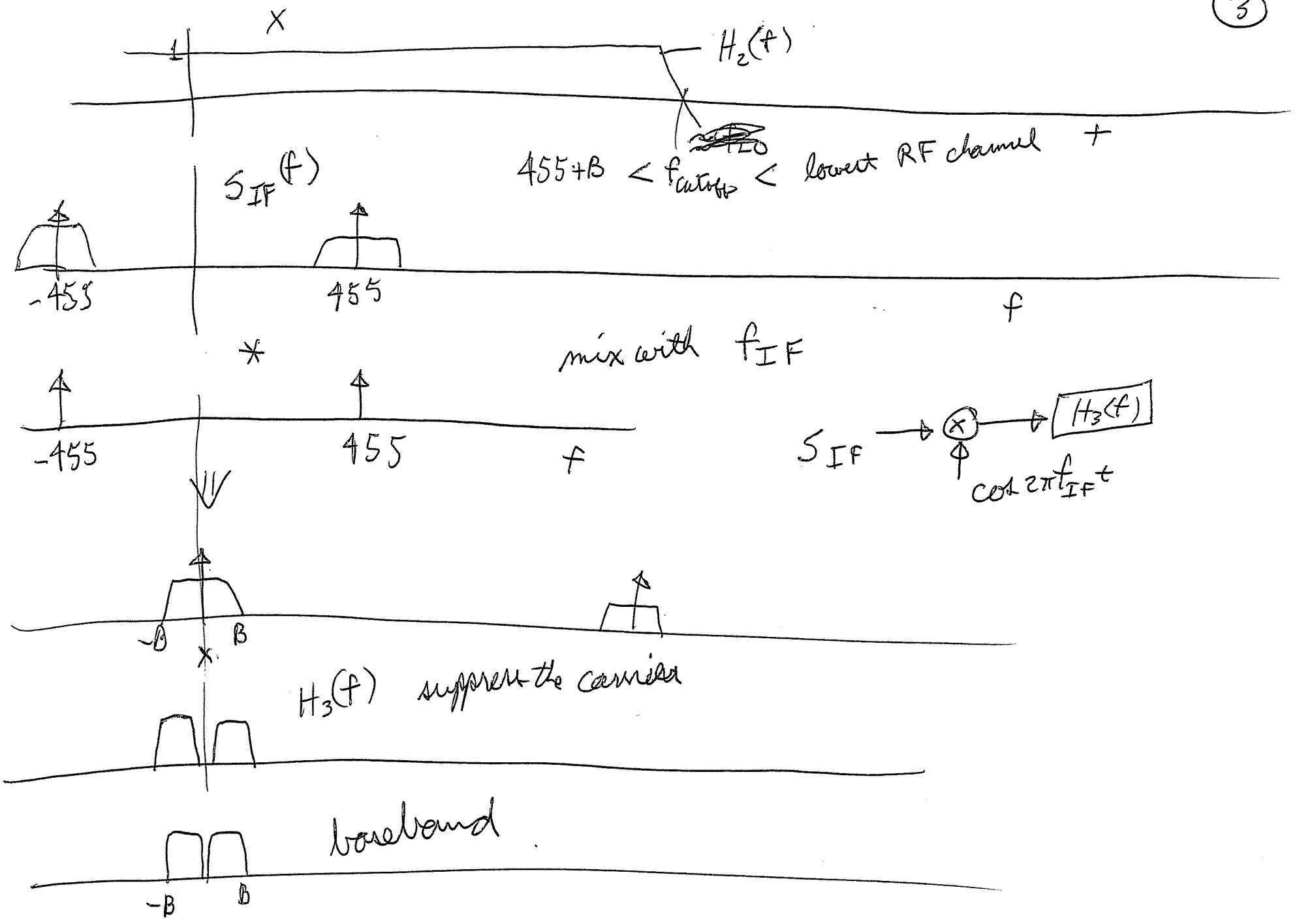
$f_{LO} = 850 + 455 = 1305$ KHz when tuned



mixed with $f_{LO} = (1 + m(t)) \cos 2\pi f_c t + \cos 2\pi f_{LO} t$

$\cos A \cos B = \frac{\cos(A-B) + \cos(A+B)}{2}$




X
1
$H_2(f)$
LO
$455+B < f_{cutoff} <$ lowest RF channel +
$S_{IF}(f)$
-455
455
f
mix with f_{IF}
*
-455
455
f
S_{IF}
X
$H_3(f)$
$\cos 2\pi f_{IF} t$
-B
B
X
$H_3(f)$ suppress the carrier
baseband
-B
B