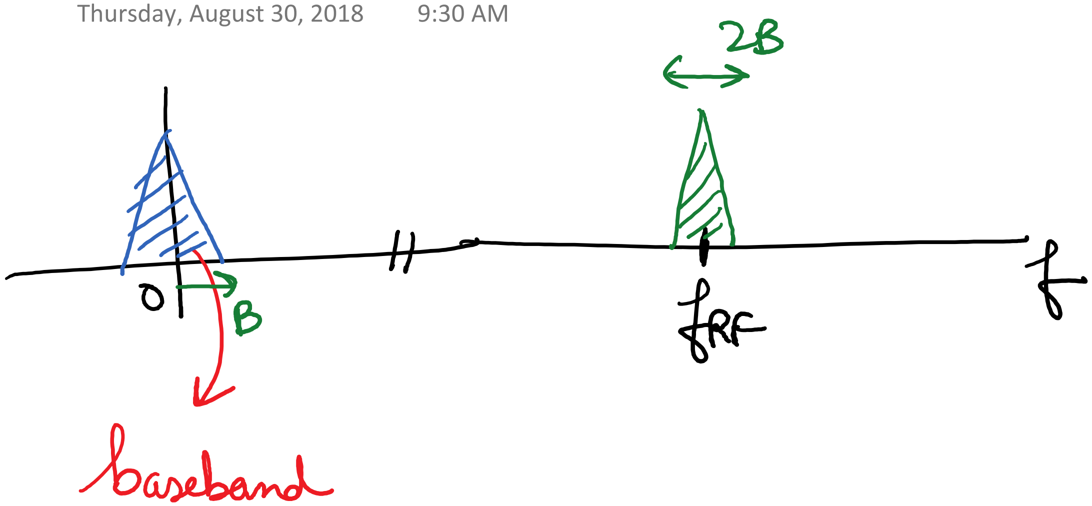
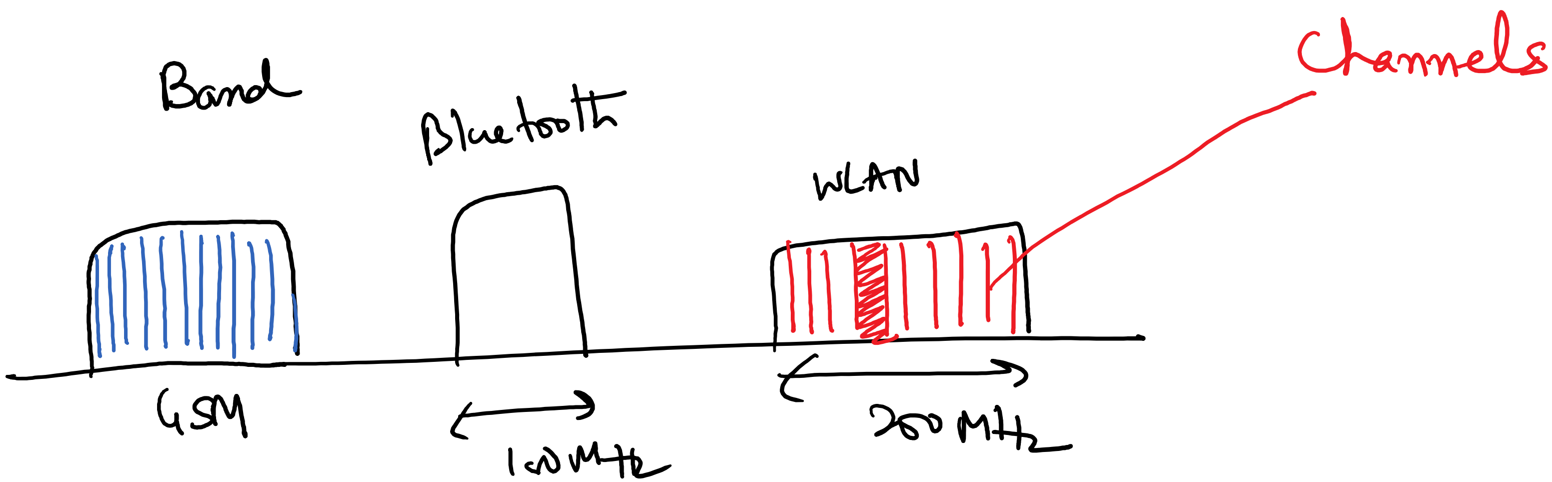
ECE 513 - Lecture 4

Thursday, August 30, 2018 9:30 AM

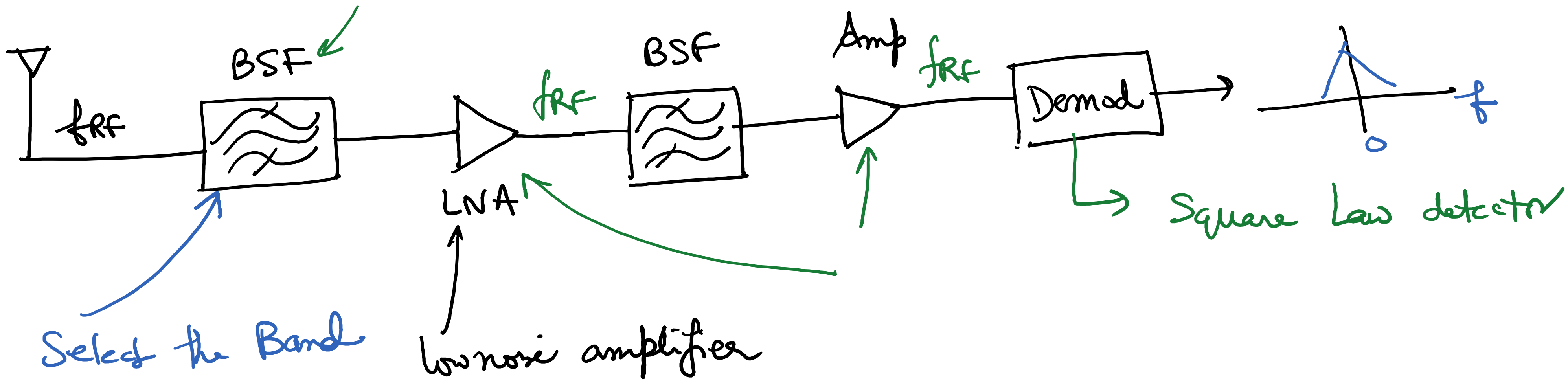


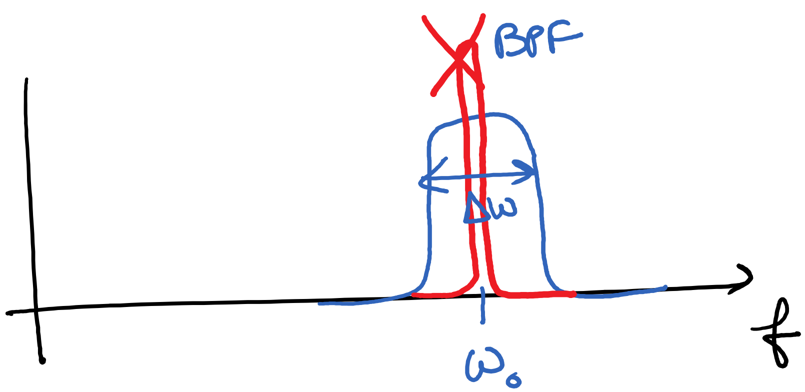


Thursday, August 30, 2018 9:36 AM

Receiver Architectures

① Tuned homodyne or Direct Detection Reciever



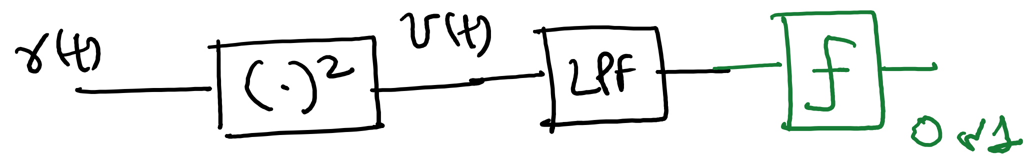


$$Q = 2\pi \frac{\omega_0}{\Delta\omega}$$

Quality factor

$Q < 25$

Square Law Detector



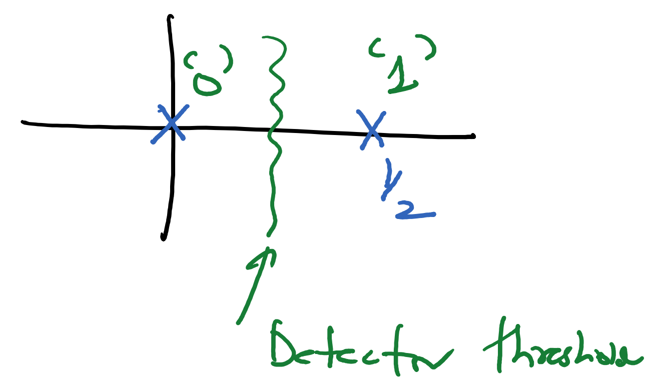
$$s(t) = m(t)\cos\omega_c t$$

$$r(t) = s(t) = m(t)\cos\omega_c t$$

$$v(t) = m^2(t)\cos^2\omega_c t = \frac{m^2(t)}{2}\left[1+\cos(2\omega_c t)\right]$$

↓ LPF

$$\frac{1}{2}m^2(t) \longrightarrow \frac{1}{2}m(t)$$



Thursday, August 30, 2018 9:52 AM

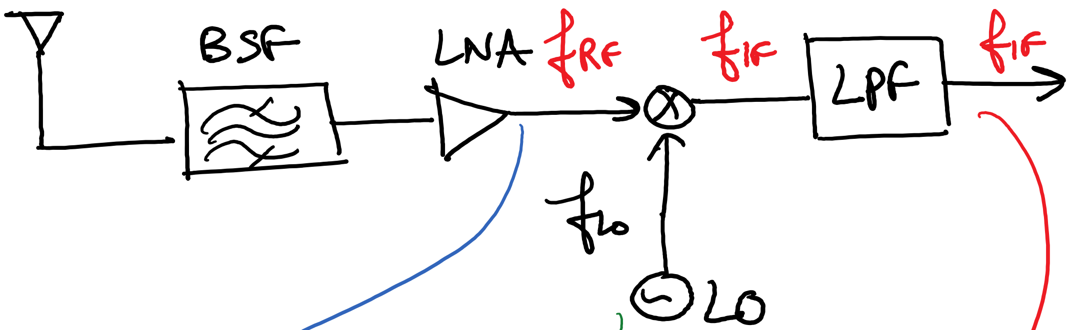
high RF gain has stability issues

* Need 50-60 dB gain at RF frequency
  - ↳ the whole receive chain before detection should be linear
  - ↳ channel selection is very difficult at high RF/carrier frequencies
    - ↳ limited Q of BPF.
    - ↳ selectivity issue.

Heterodyne Architecture

Thursday, August 30, 2018 9:54 AM

* Year 1906



local oscillator

LPF

$$A\cos(\omega_{RF}t)\cdot\cos(\omega_{LO}t) = \frac{A}{2}\left[\cos((\omega_{RF}+\omega_{LO})t) + \cos((\omega_{RF}-\omega_{LO})t)\right]$$

$$\Rightarrow \frac{A}{2}\cos(\omega_{IF}t) = \frac{A}{2}\cos((\omega_{RF}-\omega_{LO})t) = \frac{A}{2}\cos((\omega_{LO}-\omega_{RF})t)$$

$$f_{IF} = f_{RF} - f_{LO} \Big\} \Rightarrow f_{RF_1} = f_{IF} + f_{LO}$$

$$f_{IF} = f_{RF} - f_{LO}$$

$$f_{IF} = f_{LO} - f_{RF}$$

$$\Rightarrow \quad f_{RF_1} = f_{IF} + f_{LO}$$

$$f_{RF_2} = f_{LO} - f_{IF}$$

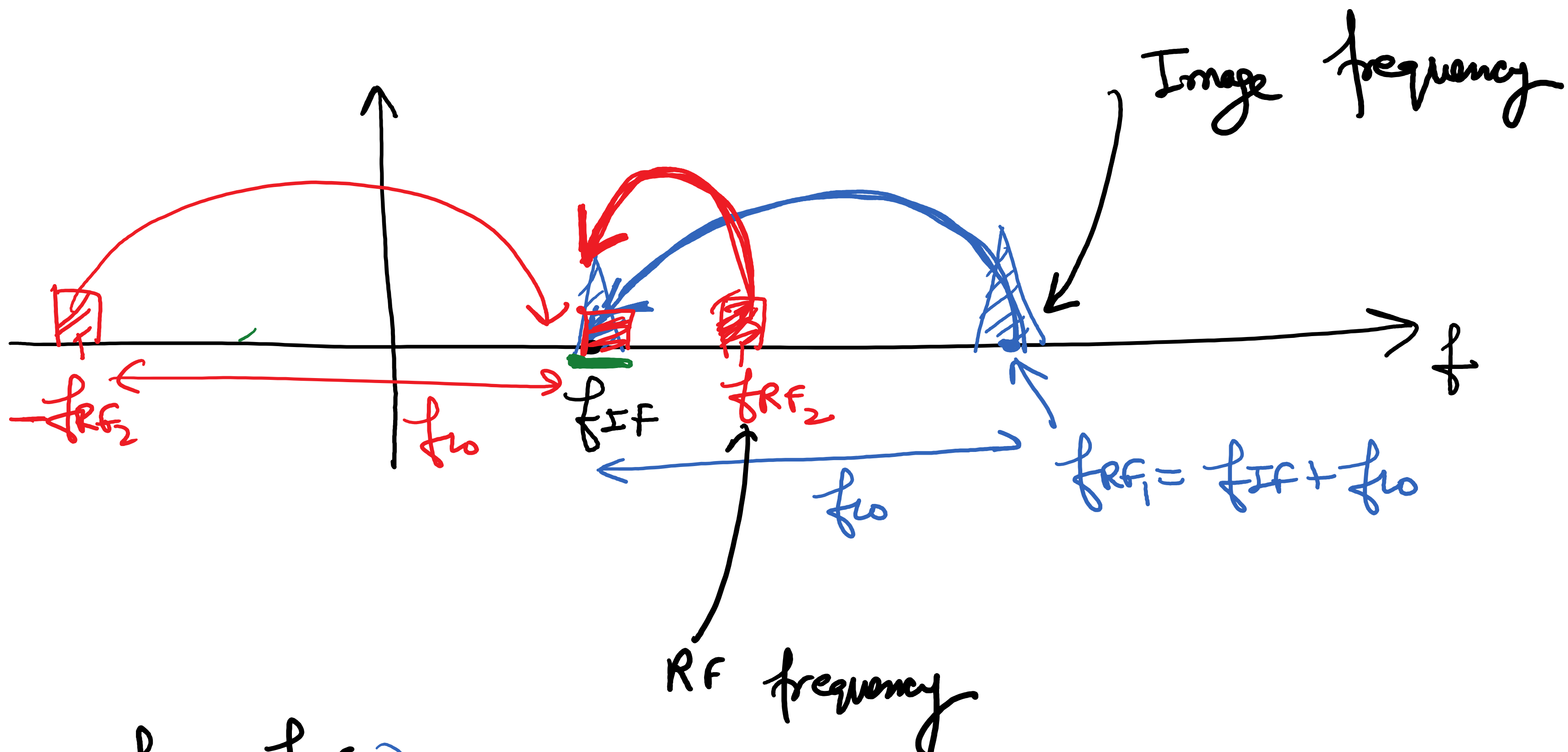
Two possibilities for f_{RF}

$f_{RF_1} = f_{LO} + f_{IF}$

$f_{RF_2} = f_{LO} - f_{IF}$

$\cos \omega_{LO} t$

$= \cos(2\pi f_{LO} t)$

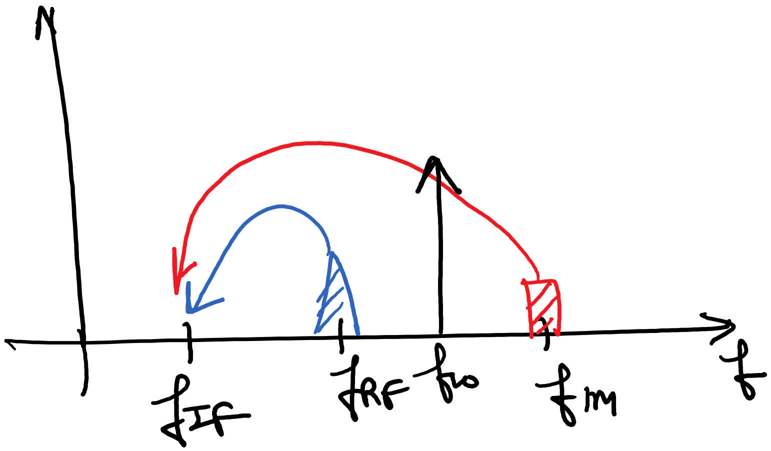


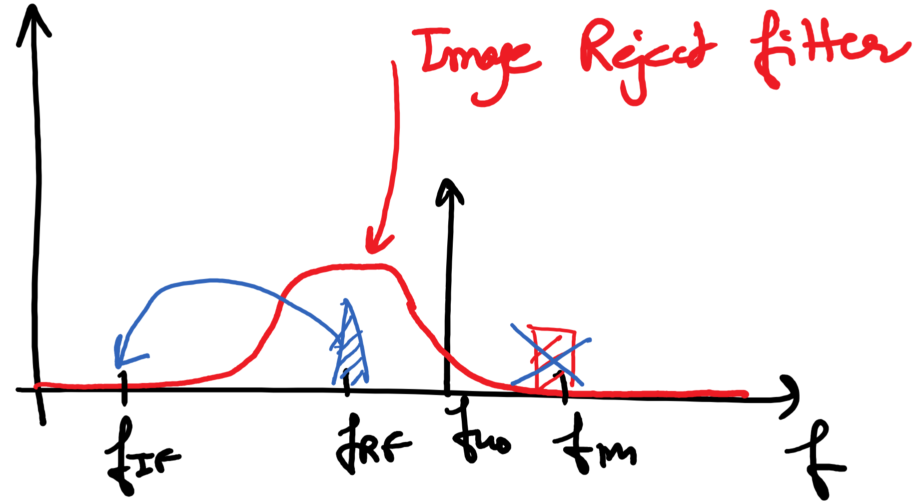
$f_{RF} = f_{LO} - f_{IF}$

$f_{IM} = f_{LO} + f_{IF}$ $\rightarrow$ $f_{IM} = 2f_{LO} - f_{RF}$

$$f_{IM} = f_{LO} + f_{IF} \quad \Big\} \rightarrow \quad f_{IM} = 2f_{LO} - f_{RF}$$

$$f_{LO} = \frac{f_{RF} + f_{IM}}{2}$$



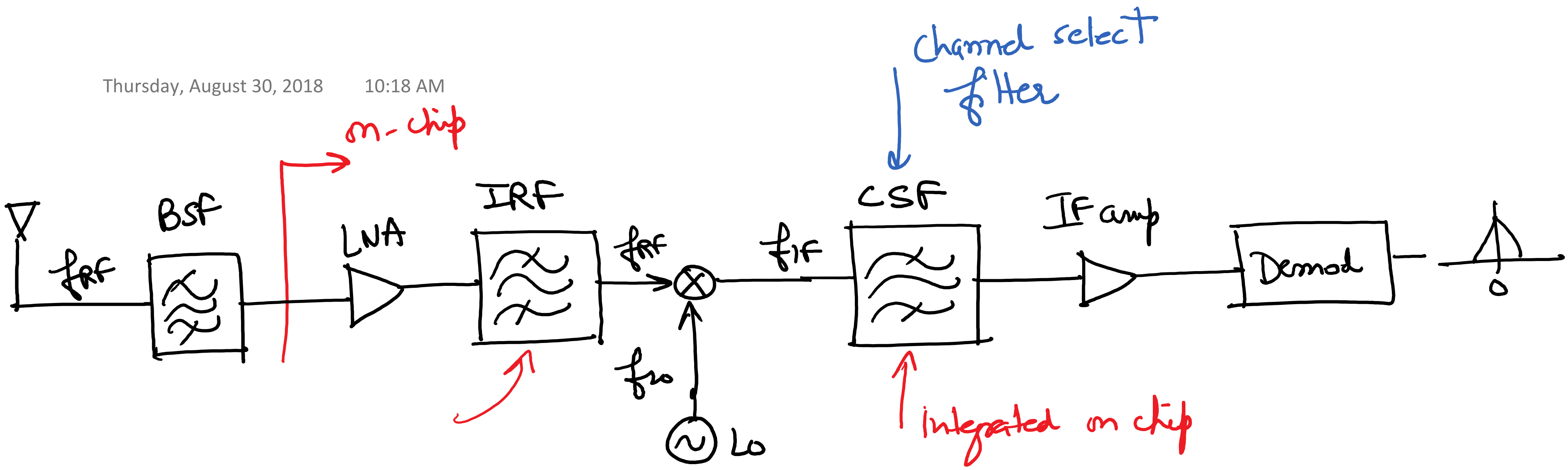


* RF frequency is translated to an intermediate frequency (f_{IF})

↳ use single or two-step down conversion

* The image reject filter (IRF) allows the signal in the desired RF channel while attenuating the signals at the image frequency (f_{IM}).

Thursday, August 30, 2018 10:18 AM



Two options:

1) fixed LO frequency → each RF channel is down converted to a different IF frequency

2) Tunable LO frequency → RF channel of interest is translated to a fixed IF frequency

↳ more common

↳ Don't need a variable CSF

ASK
FSK
PSK → QAM

After IRF the RF Signal is

$$A(t)\cos(\omega_{RF}t + \alpha(t))$$

multiplied by $\cos(\omega_{LO}t)$

at IF frequency,

$$S_{IF}(t) = A(t)\cos(\omega_{RF}t + \alpha(t)) \cdot \cos(\omega_{LO}t)$$

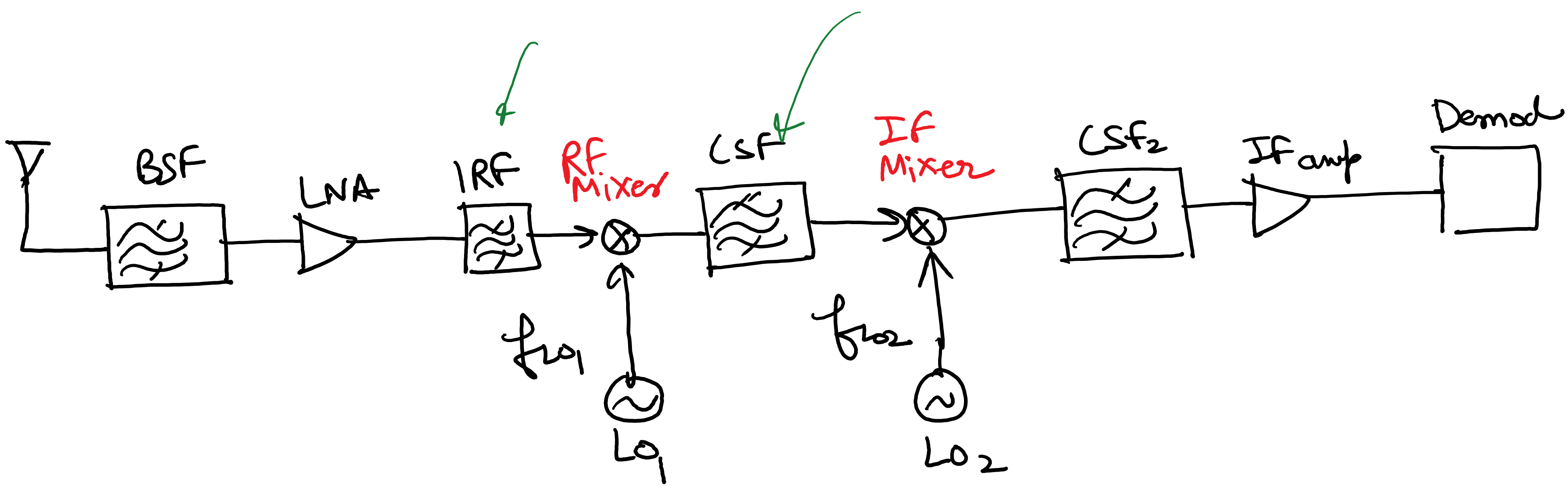
↓ LPF

$$\frac{A(t)}{2} \cdot \cos(\omega_{IF}t - \alpha(t))$$

↳ Both magnitude and phase are translated to IF frequency.

Thursday, August 30, 2018 10:33 AM

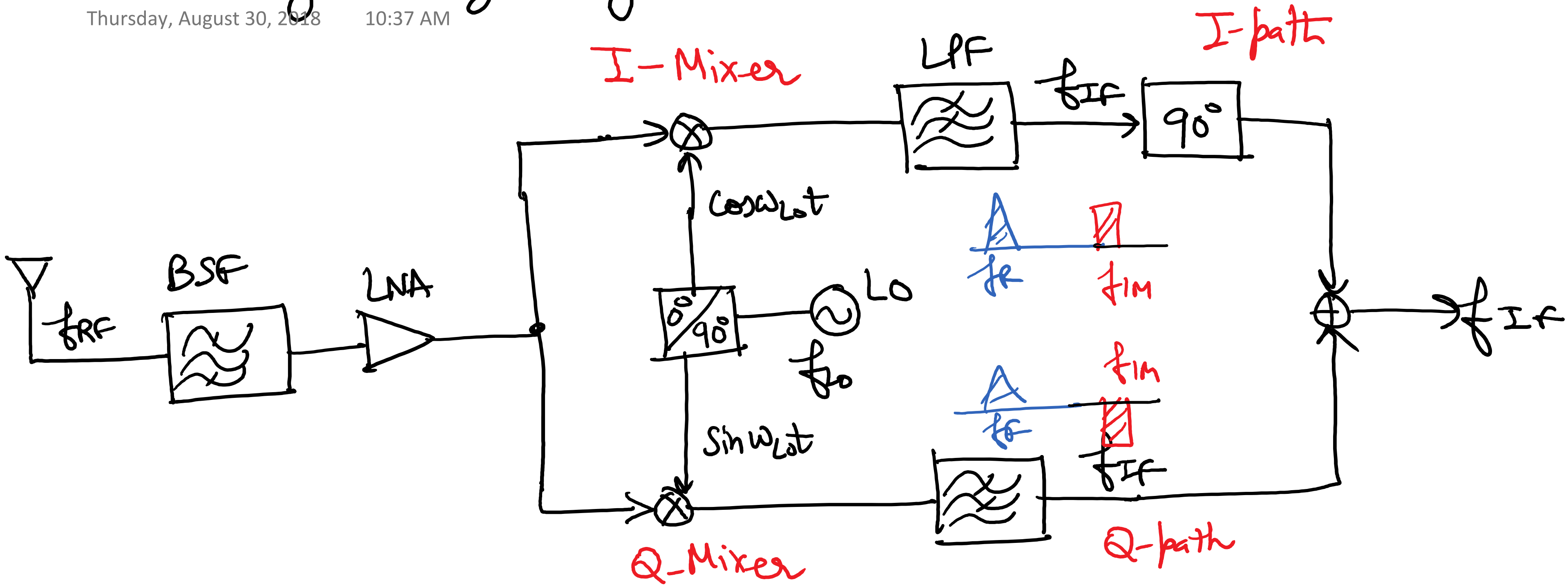
Dual Conversion



↳ Eases tradeoff between the IRF and CSF requirements.

Hartley Image Reject Receiver

Thursday, August 30, 2018 10:37 AM



Hartley

& Weaver

Read up in the Book