Comm, cleanup
  - slope detector
  - IQ demod.
  - ASK/AN or FSK/FM

Mixers
  - passive vs. active
  - conversion gain
  - linearity
  - noise temp

Phase noise
  - what is
  - conversion to voltage
  - spectrum

Comm example
  - do spreadsheet
  - direct down

Some topics to clean up about comm systems — more demodulation

- IQ demodulation

\[
\begin{align*}
M & \\
I & \\
Q & \\
\frac{1}{2} & \\
\frac{1}{2} & \\
\frac{1}{2} & \\
\text{relies on demod having same phase as mod. or I leaks into Q}
\end{align*}
\]

- FM demodulation

\[
\text{L} \text{LL uses phase detector e.g.: } \ \text{V}_{\text{o}}
\]

\[
\text{I} \text{ can also use slope detector to change amp by frequency}
\]

- Very non-linear

\[
\text{L} \text{ sample it and let software/dsp do frequency counting}
\]

Shift keying is digital modulation
  - ASK is passive
  - FSK is active

AM:
  - \( M \)

ASK:
  - \( m(t) \)

FM:
  - smooth change in \( f 

FSK:
  - digital changes in \( f \)
Mixers

- 2 types: active vs. passive - different needs
  - passive more popular b/c of higher linearity

- Important specs: conversion gain - \( G = \frac{P_{@\text{IF}}}{P_{@\text{RF}}} \)

  \( L \) conversion gain is negative in passive mixers

  \( L \) may depend on \( L_0 \) level, esp. @ small \( L_0 \), will vary w/ \( f_{LO} \)

- Isolation

  \( I_{\text{RF-LO}} = \frac{P_{@\text{RF}}}{P_{@\text{LO}} \mid \text{no signal}} \)

  \( P_{\text{IF-LO}} = \frac{P_{@\text{IF}}}{P_{@\text{LO}} \mid \text{no signal}} \)

  \( L \) how much \( L_0 \) leaks into other ports

  \( L \) big deal b/c \( L_0 \) often very high power

  \( L \) re-ordinates out of antenna & creates intermodulation - bad!

- Linearity - mixers have \( I_{\text{IP}2} \) & \( I_{\text{IP}3} \)

  \( L \) \( I_{\text{IP}2} \) is a really big deal in direct downconversion

  b/c mixer feeds baseband directly

- Noise temperature/Noise figure

  \( L \) for passive noise temp is \( (1/\text{Loss} - 1) T \) like any other lossy passive

  \( L \) Noise figure is tricky b/c it can depend on the signal @ RF

\[ \begin{align*}
\text{M} \times \uparrow \uparrow & = \text{M} \quad \text{M} \quad \text{double side band (DSB) signal} \\
\text{tricky architecture} & \Rightarrow \uparrow \quad \text{A} \quad \text{single side band (SSB) signal}
\end{align*} \]

\( L \) when mixing down get noise from image, desired band \& mixer itself

\( L \) but may only get signal from 1 sideband

\( L \) both SSB \& DSB Noise figures exist, be careful
Comm. system analysis example

- FM signal w/ nearby blocker received by antenna

\[ \omega_n = 1 \text{kHz} \]
\[ \Delta \omega = 100 \text{kHz} \]

- pick an architecture — let's go direct down conversion

\[ 0 \ 1 \ 2 \ 3 \ 4 \ 5 \ 6 \ 7 \]

- Analyze w/ a table

<table>
<thead>
<tr>
<th>stage</th>
<th>description</th>
<th>( P_{\text{signal}} )</th>
<th>( P_{\text{blocker}} )</th>
<th>( P_{\text{INJ}} )</th>
<th>( T_{\text{i}n} )</th>
<th>( f_{\text{i}} )</th>
<th>( f_{\text{out}} )</th>
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<td>0</td>
<td>Tx</td>
<td>0 dBm</td>
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<td></td>
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<td>190 kHz</td>
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<td>Path loss</td>
<td>-80 dBm</td>
<td>-60 dBm</td>
<td></td>
<td></td>
<td>210 kHz</td>
<td></td>
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<tr>
<td>2</td>
<td>RX antenna</td>
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<td>-60 dBm</td>
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<tr>
<td>3</td>
<td>Amp</td>
<td>-38 dBm</td>
<td>-20 dBm</td>
<td>based on TIP3</td>
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<td>based on ( \mu )</td>
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<tr>
<td>4</td>
<td>BPF</td>
<td>-35 dBm</td>
<td>-60 dBm</td>
<td>same</td>
<td>( \approx 420 \text{kHz} )</td>
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Calculate system temp @ end