6. RADIO CIRCUITS AND SYSTEMS

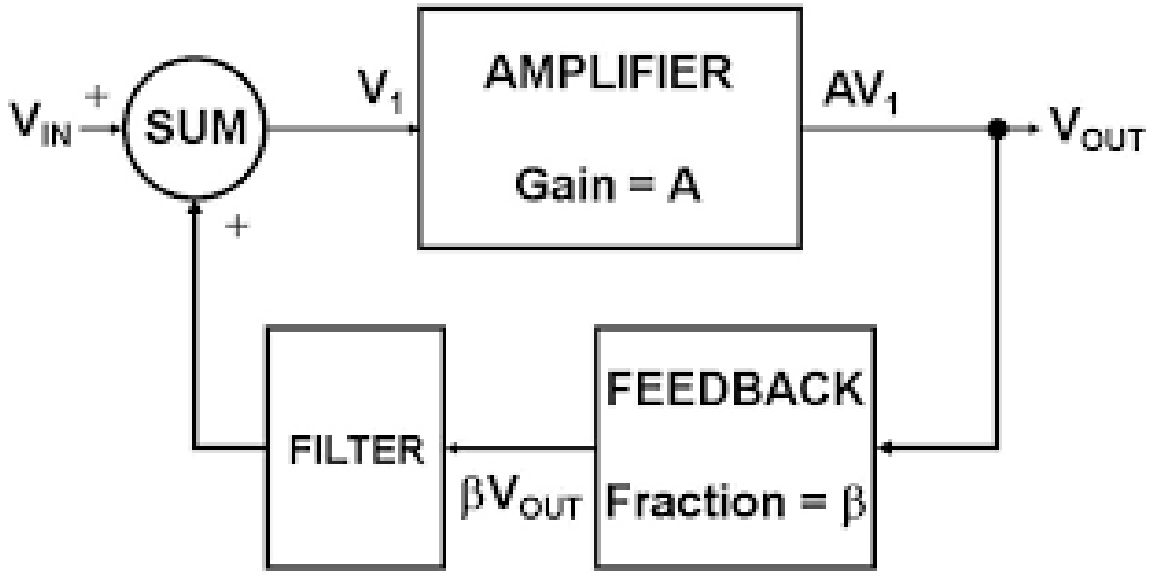
Chapter 6.2
Signal Processing

ARRL Amateur Extra Class

Oscillator circuits

Need three pieces:

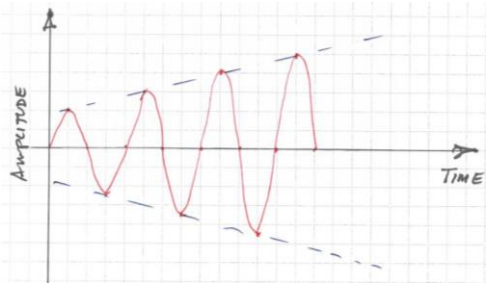
- Amplifier
- Feedback
- Filter

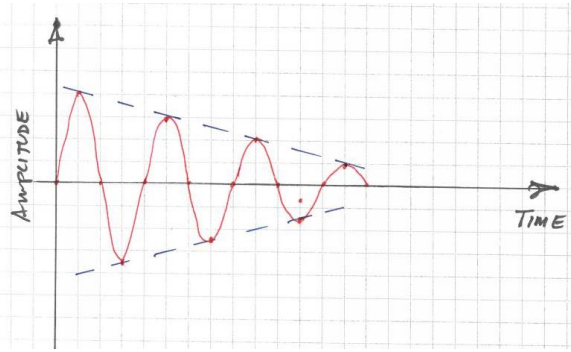


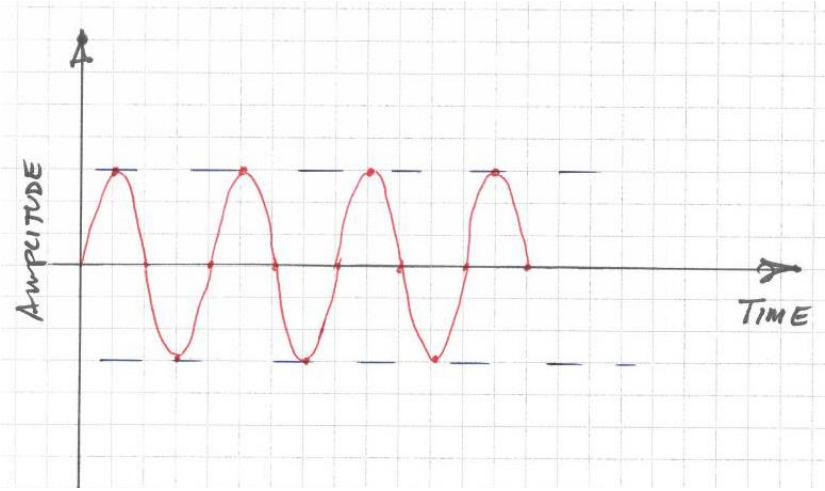
Oscillator Feedback

Feedback

- Positive
- Negative
- Neutral







Oscillator (in)stability

Instability

- Temperature changes
- Leads too long/in the wrong place
- Capacitive/inductive impedances
- Circuit layout
- Unchecked positive feedback

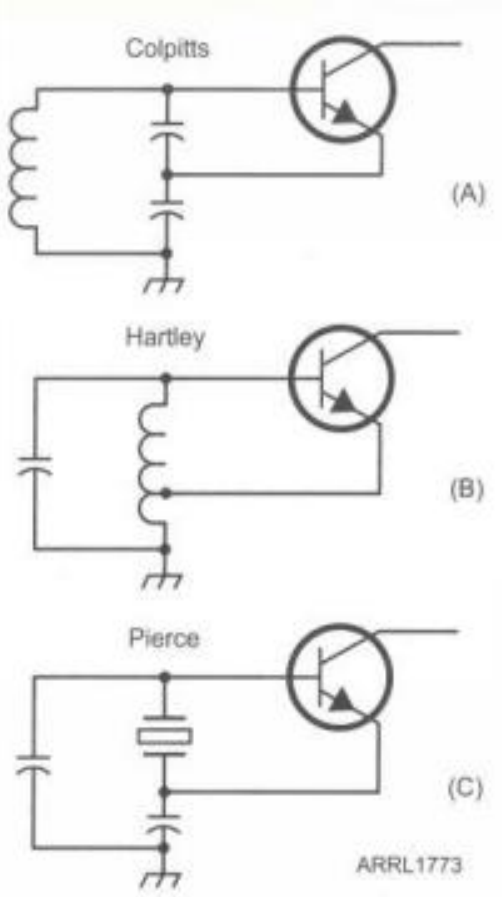
Need **Neutralization :** Controlled feedback

Oscillator Types

Three types of oscillators

- **Colpitts**
  Reactive divider using Capacitors
- **Hartley**
  Reactive divider using tapped inductor
- **Pierce**
  Quartz crystal – most stable

Colpitts/Hartley easy to make adjustable – VFO



Oscillator Crystals

Piezoelectric material

Crystalline material sandwitched between two metal plates

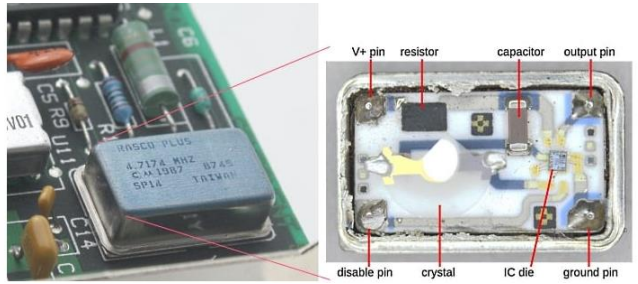
Resonant at a specific frequency

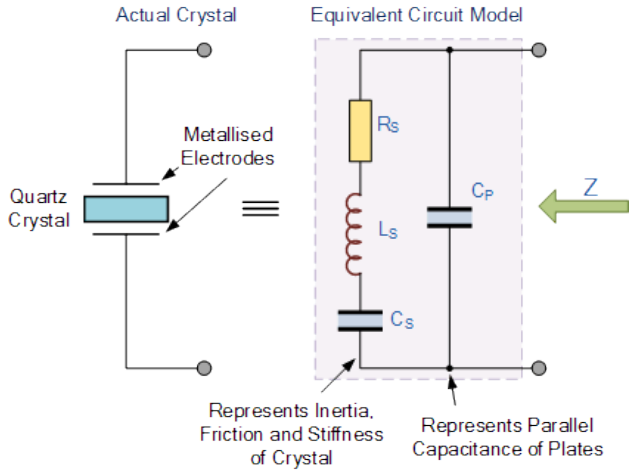
Equivalent to a LCR circuit

Stable over time & temperature

Need correct external capacitance

Oscillators:





Oscillator problems

Instability

Microphonics

- Frequency affected by vibrations
- Also issue with tubes

Thermal drift

Age

Murphy's Law:

"Amplifiers oscillate. Oscillators don't."

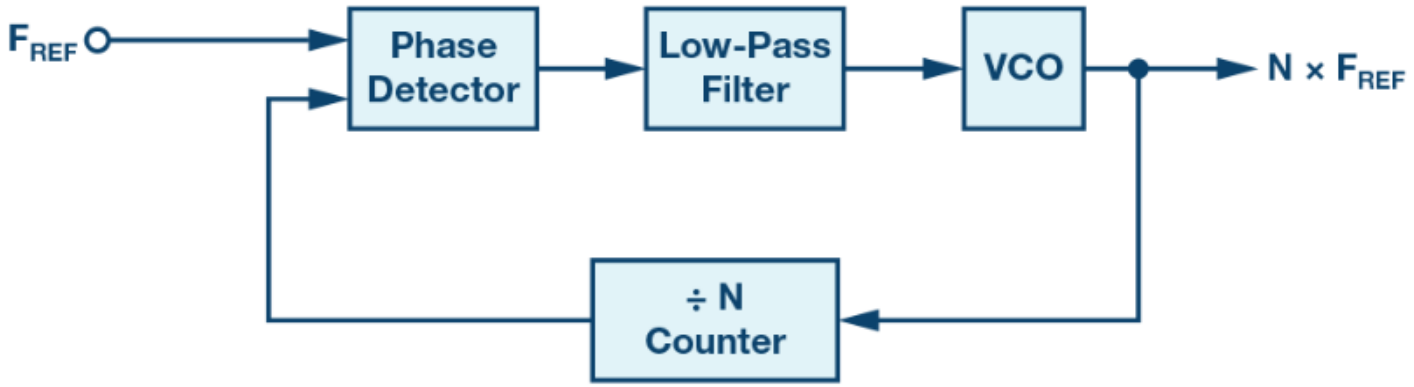
PLL

Phase Locked Loop

Using a stable reference to tune an adjustable oscillator.

Electronic ”servo control” of the VCO

Can be used for FM modulation/demodulation



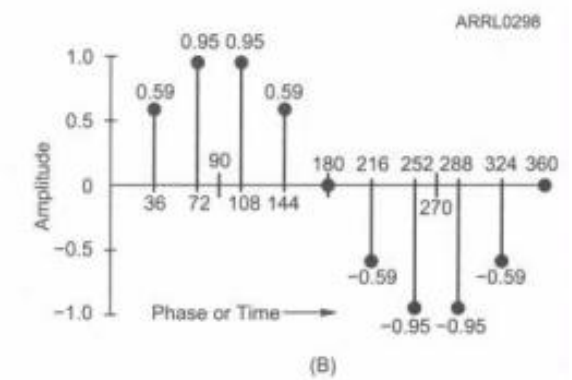
Modern Oscillators

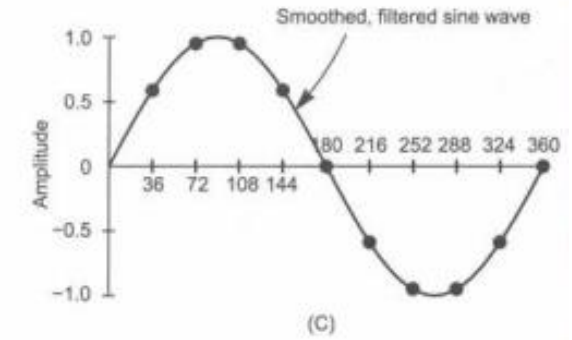
Frequency Synthesis

DDS - Direct Digital Synthesis

Creating waveform with Digital-to-Analog converters

- Single crystal + processor + math
- Approximation – not perfect
- Creates byproducts (spurs)
- Needs filtering





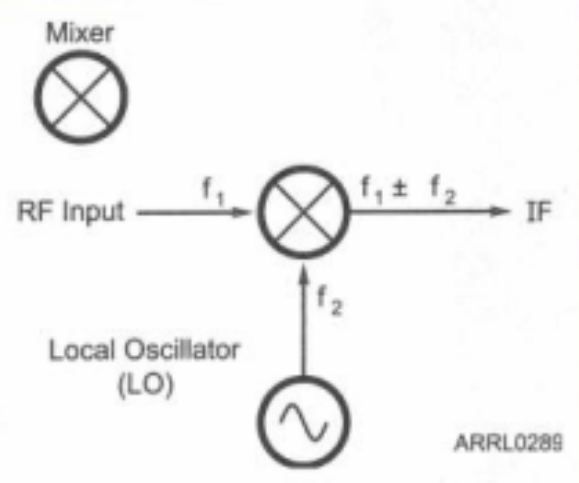
Mixers

Used to change the frequency of a signal

Outputs the *sum and the difference* of two inputs

Useful in a receiver

Mix RF input with LO to produce IF
=> Single IF regardless of band!



Keep levels under control

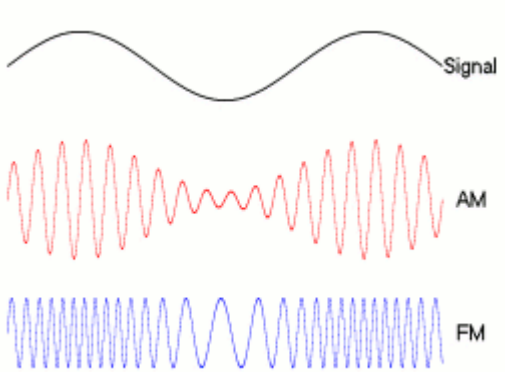
Strong signals may overload causing spurious signals
IMD ; InterModulation Distortion

Modulation

Adding information to an unmodulated signal (carrier)

The modulation method is what we call a ”mode”.

- FM, AM, SSB, CW



Baseband = the bandwidth of the information

- Voice frequency range
- Data rate

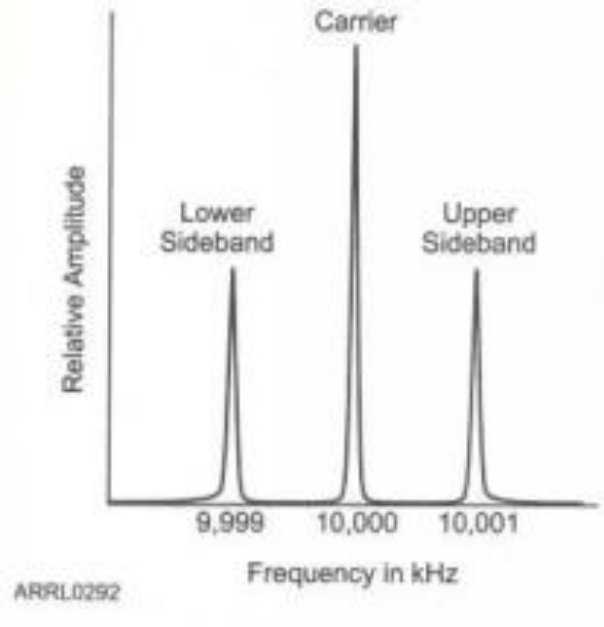
Modulation – AM/Sideband

AM - Amplitude Modulation

Carrier + both sidebands

SSB - Single SideBand

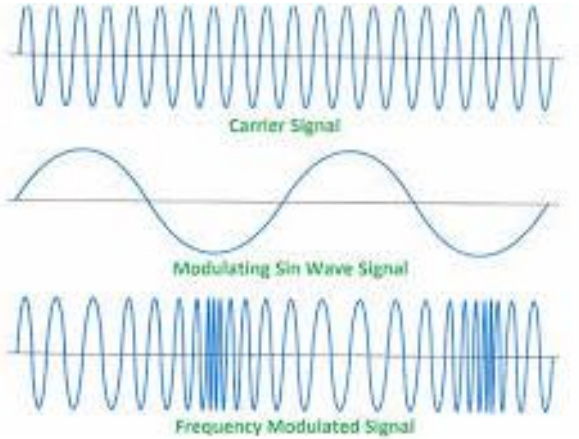
Remove carrier & one sideband



Modulation – FM/PM

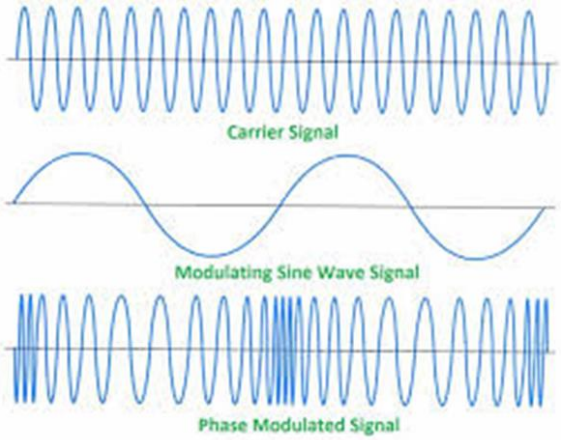
FM - Frequency Modulation

Vary the carrier frequency with the information signal



PM - Phase Modulation

Vary the phase with the information signal



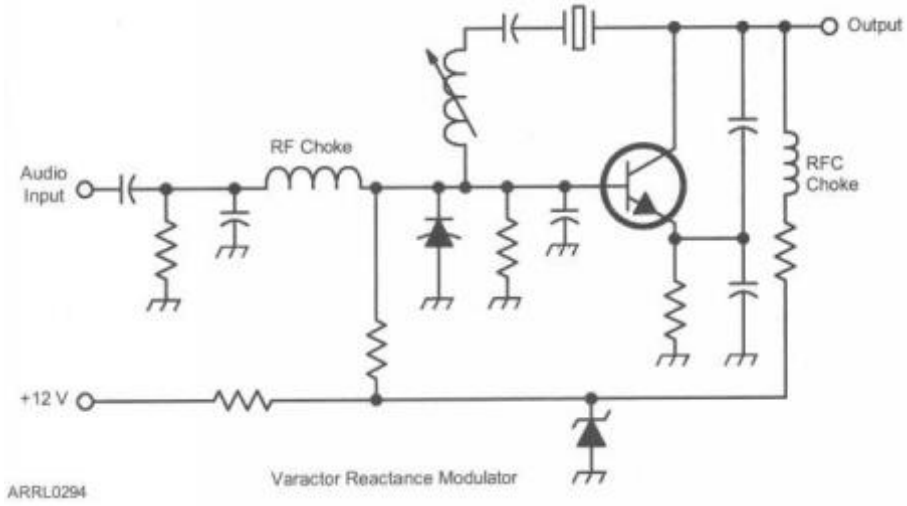
Modulation – FM/PM

”Direct” FM modulator

Reactance Modulator where the input signal directly affects the carrier frequency.

Example, using a Varactor Diode

”Indirect” FM modulator use a phase modulator.



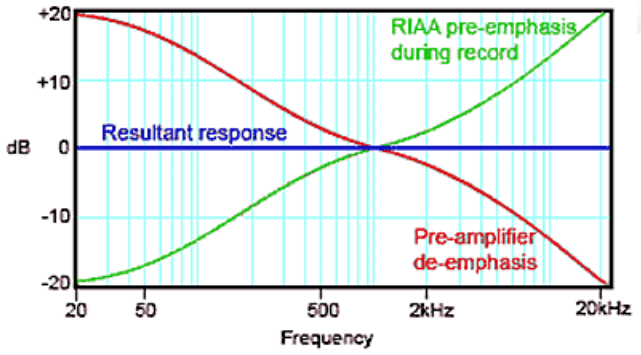
Modulation - Emphasis

In FM, higher frequencies have lower energy.

Needs boosting to sound good.

Pre-emphasis (Tx) -- De-emphasis (Rx)

FM bandwidth set by limiting amplitude



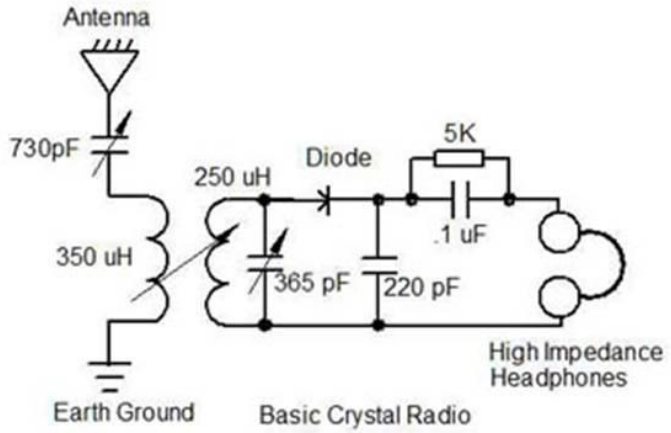
PM bandwidth depends on phase, set by limiting max frequency (low pass filter)

Demodulation

Detector – directly extracts the baseband signal from a modulated signal.

Example; Diode Detector

SSB, use **product detector**



Demodulator – reverses the modulation process

More precicely reproduce the signal

FM, use **discriminator**

QUESTIONS?

ONLINE EXAM REVIEW AND PRACTICE QUESTIONS:

http://www.arrl.org/examreview