



# Chapter 5 Radio Equipment

Building Blocks  
Transmitters, Receivers  
Station Installation, Interference



**ARRL** *The national association for  
AMATEUR RADIO*

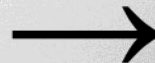
# Fundamental Circuits - Oscillators

An *oscillator* produces a single frequency sine wave for use as an input to other circuits.

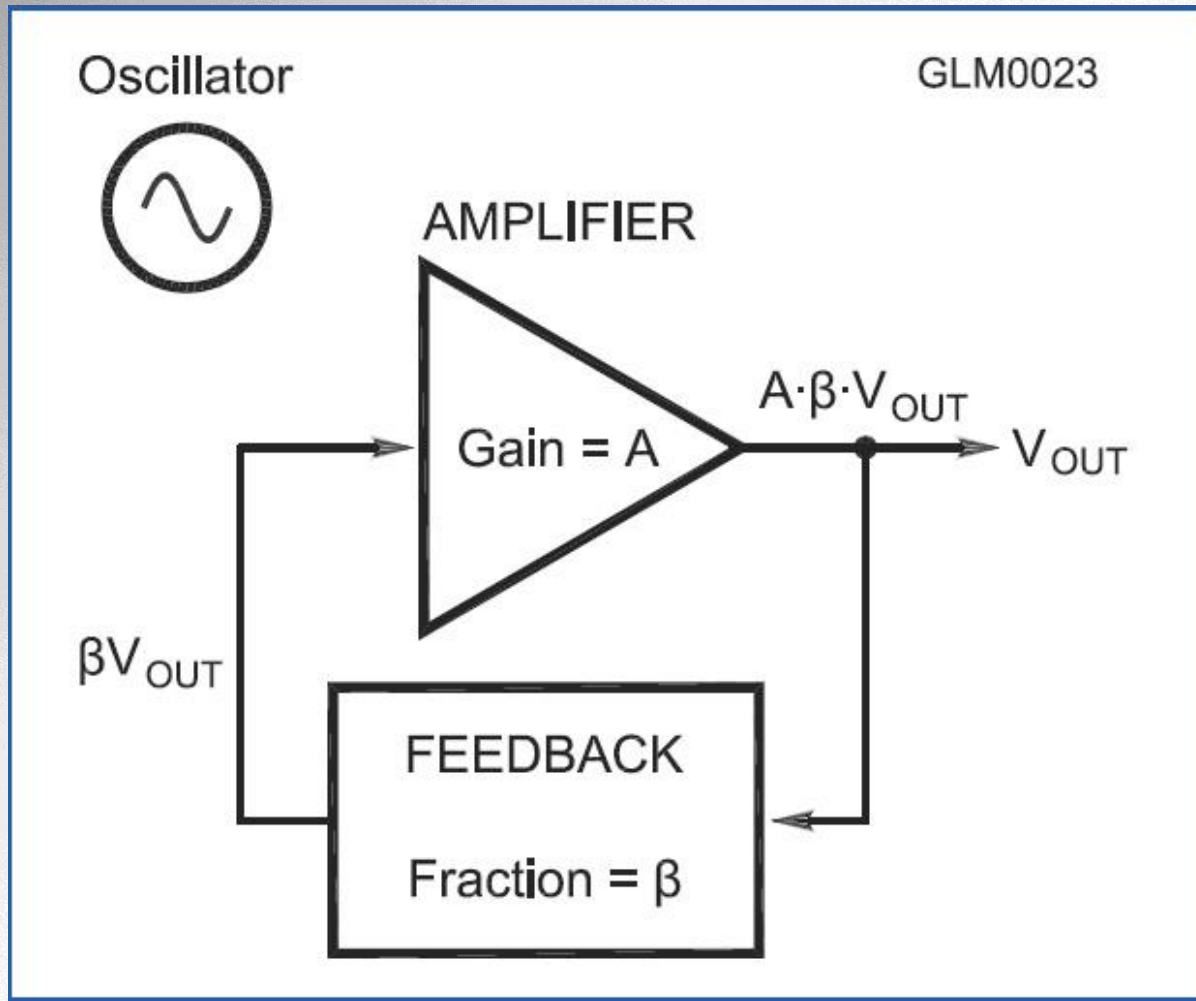
- An amplifier with a resonant filter *feedback network*
- Positive feedback greater than unity for oscillation
- Network can be Resistance-Capacitance or Inductance-Capacitance – RC or LC
- In *Variable Frequency Oscillator* – VFO – C or L can be varied
- A quartz crystal can act like an LC resonant circuit at one frequency.
- Other methods: PLL and DDS



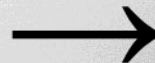
**ARRL** The national association for  
AMATEUR RADIO



# Oscillator Symbol and Circuit



**ARRL** The national association for  
AMATEUR RADIO

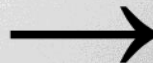




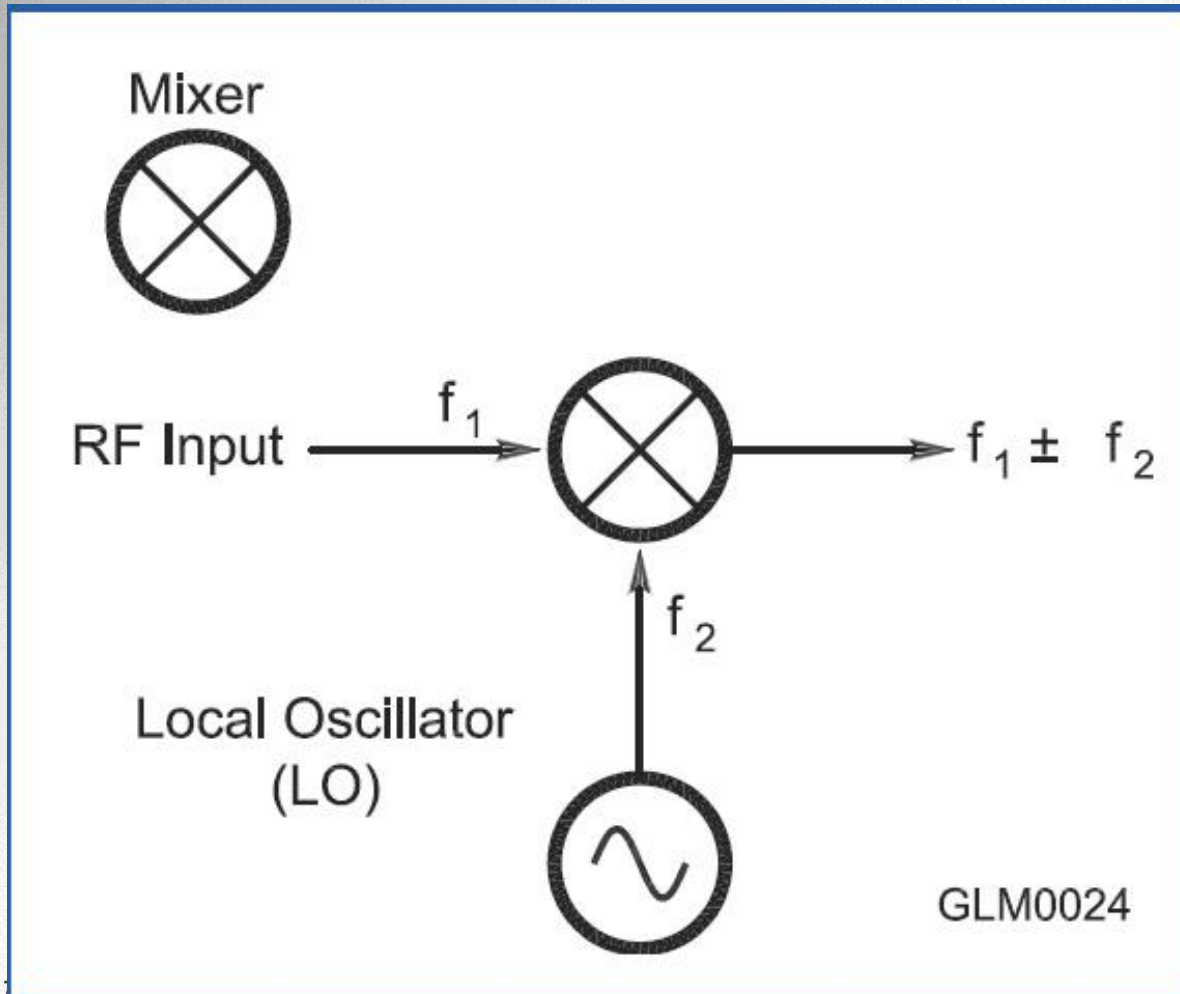
# Fundamental Circuits - Mixers

In a Mixer, the voltage of one wave is **multiplied** by the voltage of the other wave.

- Do not confuse this mixer with an audio mixer where input voltages are **added** together.
- Mixing is also called heterodyning
- Mixing produces new “**product**” frequencies at the sum and difference of the input frequencies.
- The output will also contain the input frequencies unless they are suppressed or filtered out.
- Usually a filter selects only one of the mixer output frequencies.



# Mixer Symbols and Signals



GLM0024



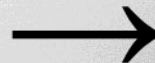
**ARRL** AMATEUR RADIO



# Fundamental Circuits - Multipliers

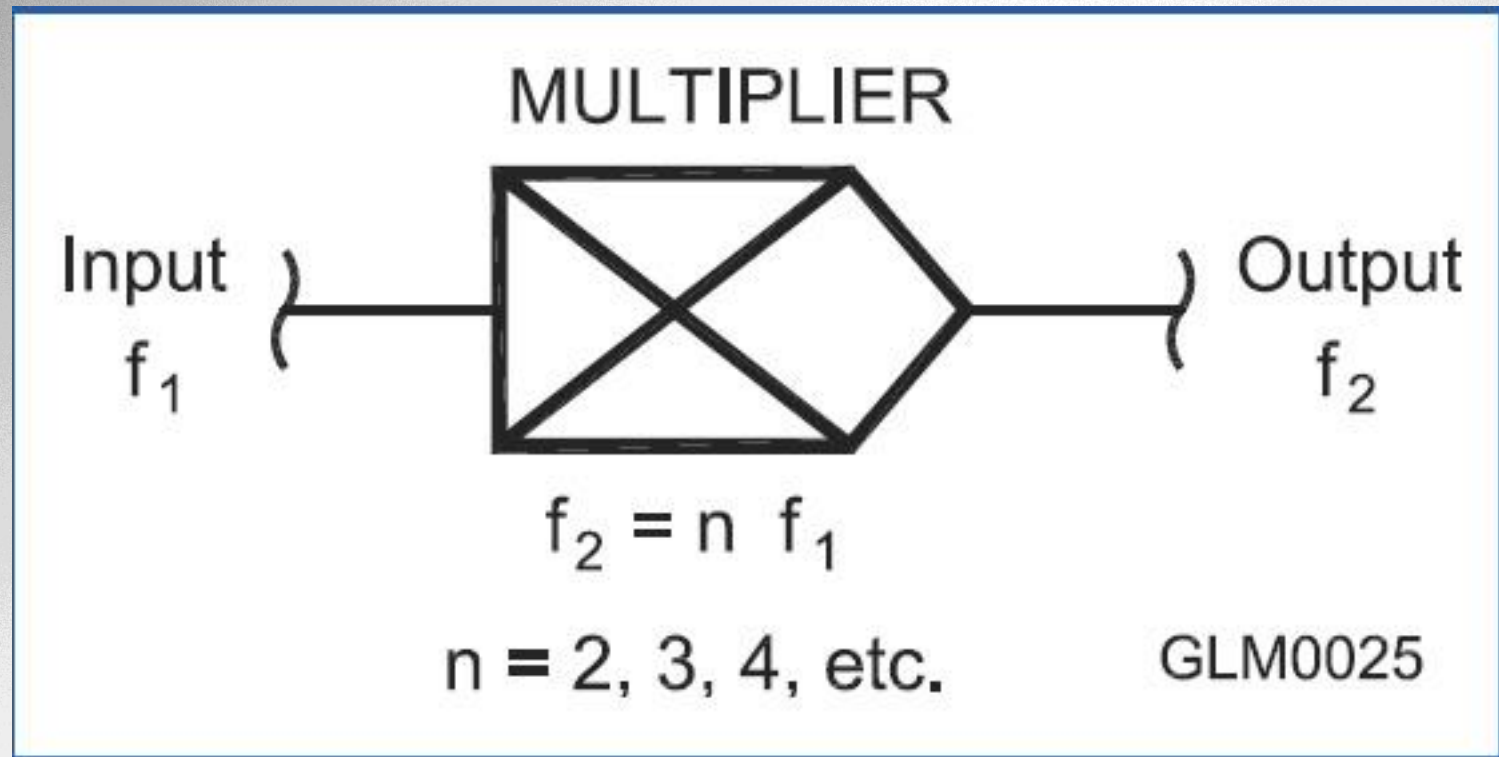
The output of a Frequency Multiplier is a signal which is a *harmonic* of the input frequency.

- Not the same type of multiplication used in mixers
- Amplifier driven to distortion produces harmonics.
- Resonant LC circuits are used to select the desired harmonic
- Multipliers may be cascaded for large frequency ratios. 7MHz => 2X => 5X => 3X => 210MHz
- Multipliers are called “Doubler”, “Tripler”, ... etc.
- Used to multiply a stable oscillator to a higher band.





# Multiplier Symbol and Inputs



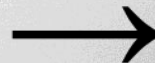
**ARRL** The national association for  
AMATEUR RADIO



# Fundamental Circuits – Modulators

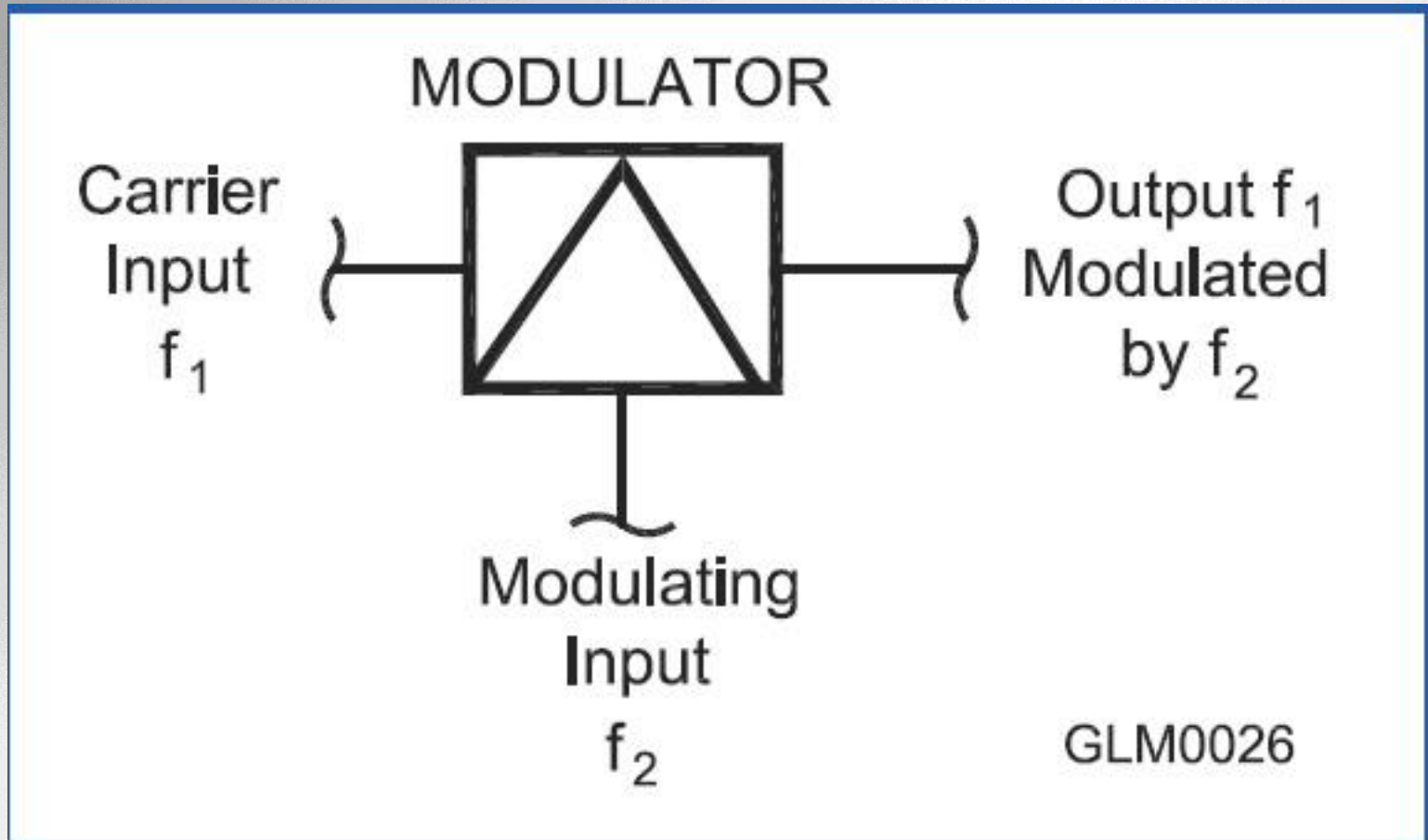
Modulators, like mixers, perform a multiplication of one signal by another.

- Amplitude modulation – voltage is multiplied by a voltage
- Frequency modulation – frequency is multiplied by a voltage.
- Modulation creates new frequencies just like mixing.
- Balanced modulators cancel out one of the input frequencies, usually the carrier.





# Modulator Symbol and Signals



GLM0026



**ARRL** The national association for  
AMATEUR RADIO



# Amplitude Modulation Methods

Historical method is to apply modulating voltage to plate or grid of a high-level amplifier.

Low level method uses a mixer in *balanced modulator* configuration.

If **F1** is the modulating signal and **F2** is the carrier:

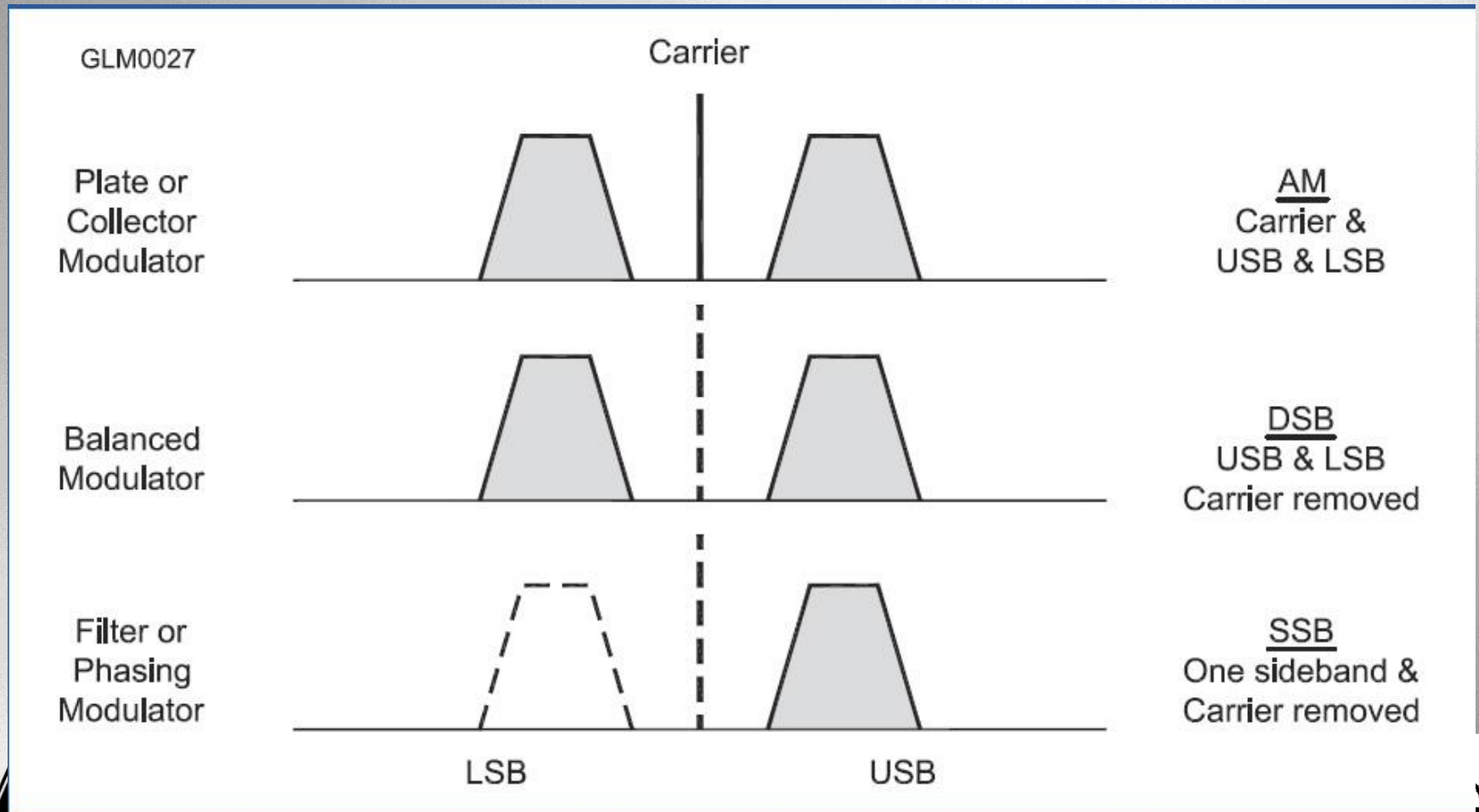
- Balance in the mixer output can eliminate the carrier frequency **F2**, leaving **F2 + F1** and **F2 – F1** – the **USB** and **LSB**. (**F1** is too low in frequency to be RF.)
- For double sideband with carrier, some **F2** can be added in by unbalancing the mixer.



**ARRL** The national association for  
AMATEUR RADIO



# Comparing AM to SSB





# Frequency Modulation Methods

FM and PM are equivalent if the audio for PM has high frequency de-emphasis. Which one is used depends on the design. Both are called *angle modulation* because changing the frequency causes a change to the phase angle.

- FM is produced by a reactance modulator in the Oscillator.
- PM is produced by a reactance modulator in an amplifier stage.
- The phase of the carrier will vary but the average frequency is not changed



**ARRL** The national association for  
AMATEUR RADIO

