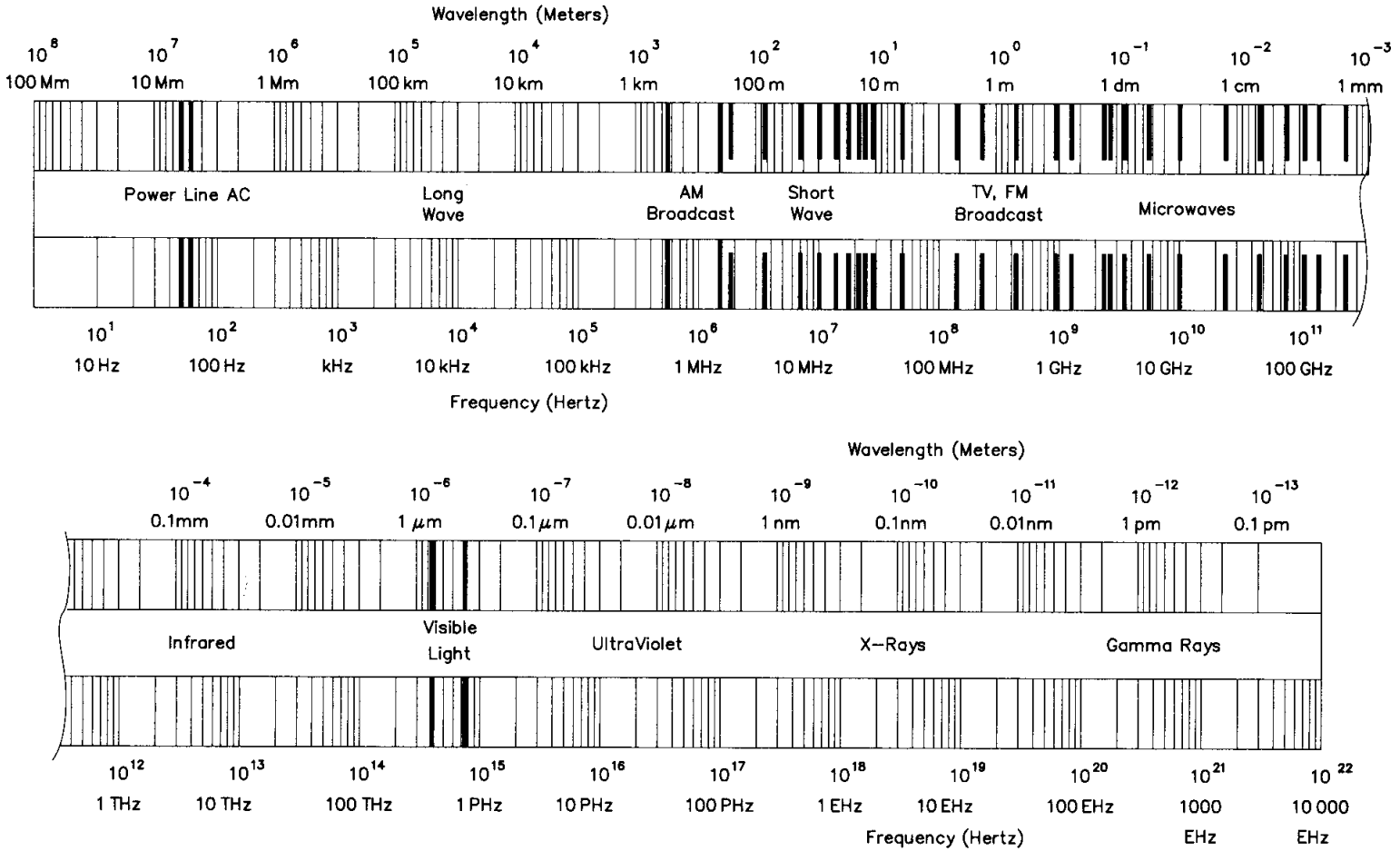
Test Equipment

- Voltmeter - an instrument that is used to measure voltage.
  - It is used in parallel with a circuit to be measured.
  - a series resistor extends the range of the meter.
- Ammeter - an instrument used to measure amperage in a circuit.
  - It is hooked up in series with the circuit to be tested.
  - A shunt resistor (in parallel w/meter) extends the range of the meter.
- Multimeter - combines the functions above with resistance and others to make a versatile piece of test equipment.
- Wattmeter - a device that measures power coming from a transmitter through the antenna feed line. A directional wattmeter measures forward and reflected power. Wattmeters generally are useful in certain frequency ranges
- Signal Generator - a device that produces a stable, adjustable low level signal (AF or RF). It can be used to tune circuits.

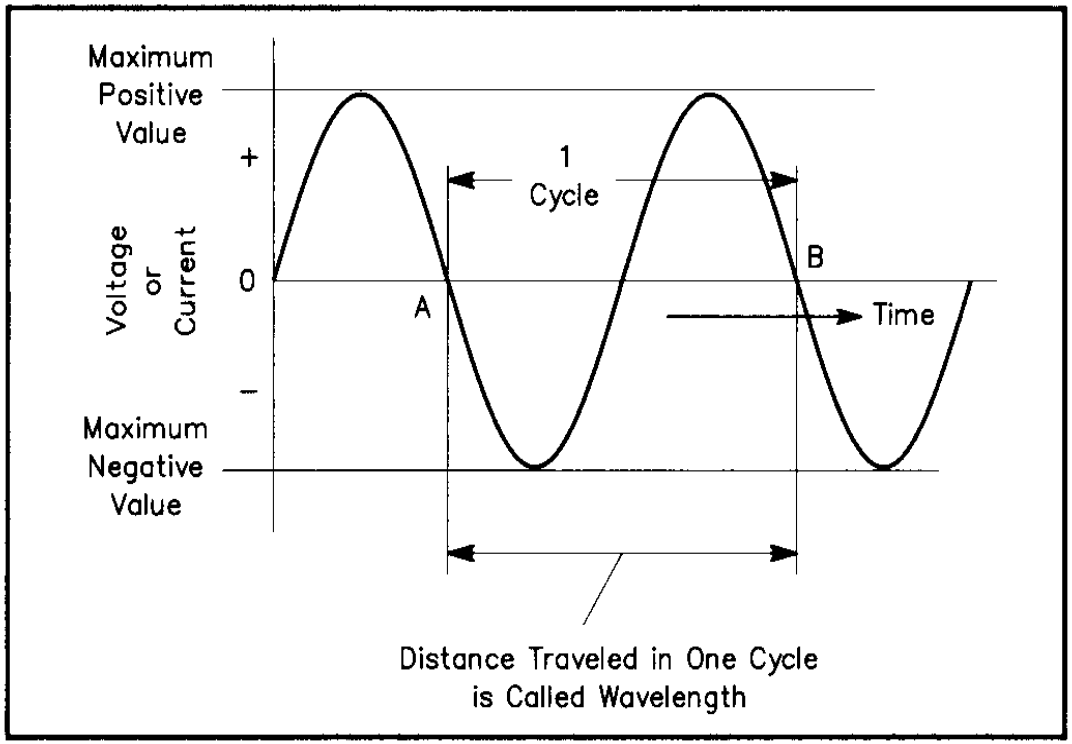
Chapter 2 (T3, T8)

- Radio and Signal Fundamentals
- Modulation
- Radio Equipment Basics

Electromagnetic Spectrum

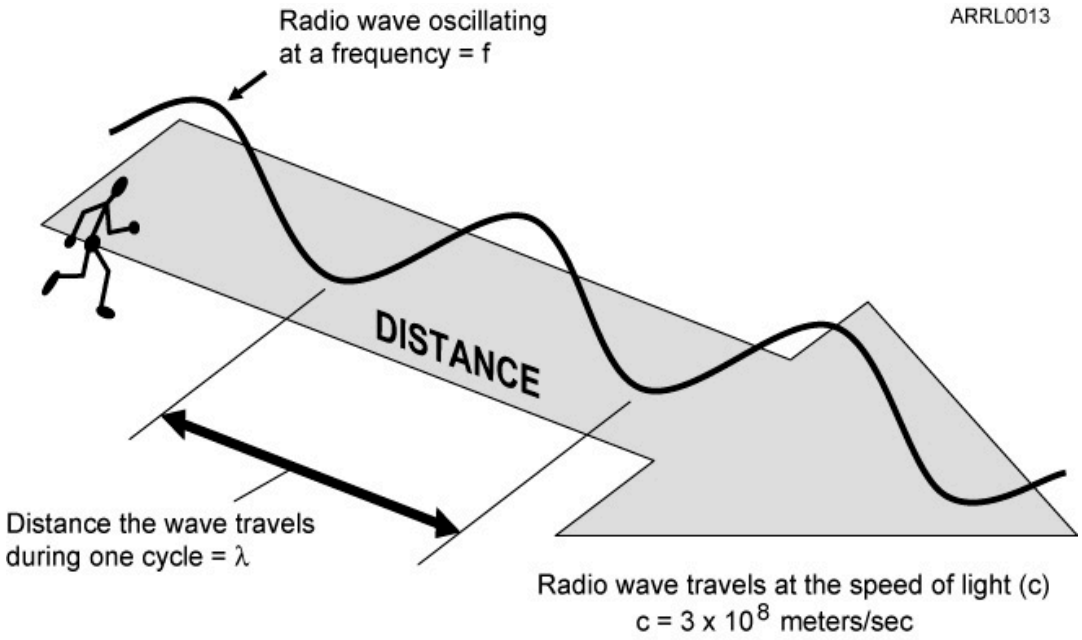


Frequency and Wavelength



- Frequency is measured in cycles per second.
- The unit of frequency is Hertz (Hz)
- Audio frequency is 20 Hz to 20,000 Hz (20 kHz)
- Radio frequency is above 20,000 Hz (20 kHz)
- Radio frequency and wavelength are related:
  - $c = f\ (Hz) \times \lambda\ (meters)$
  - c (speed of light) = 3×10^8 m/sec
  - $\lambda\ (meters) = 300 / f\ (MHz)$

Frequency and Wavelength



$\lambda = c/f = 300 / f$ in MHz

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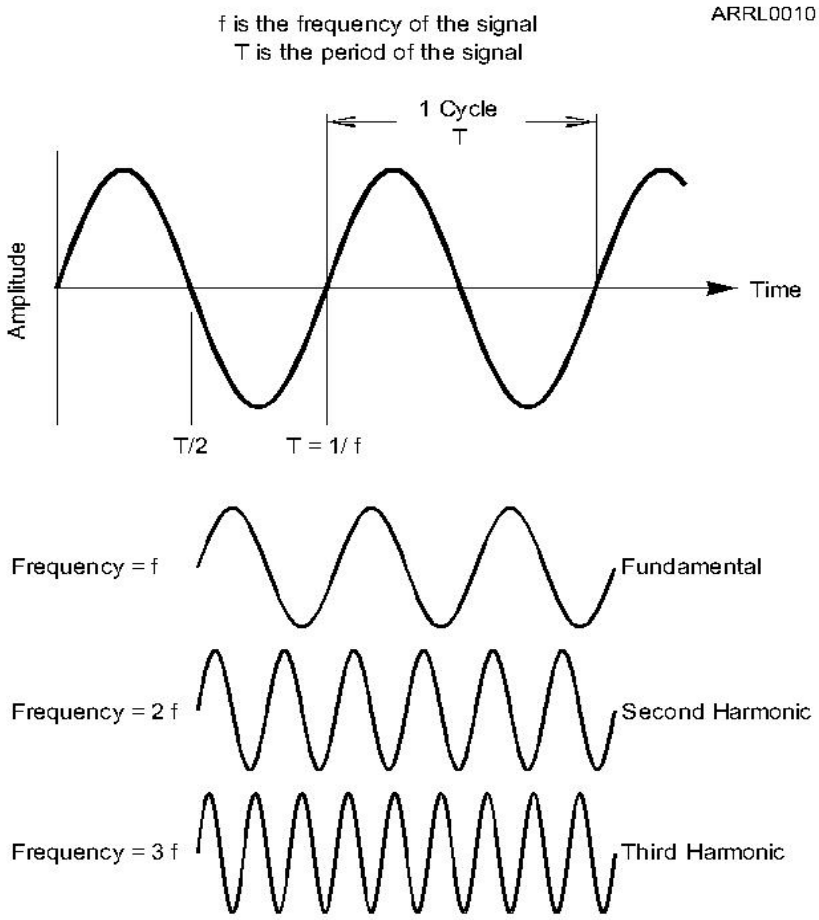
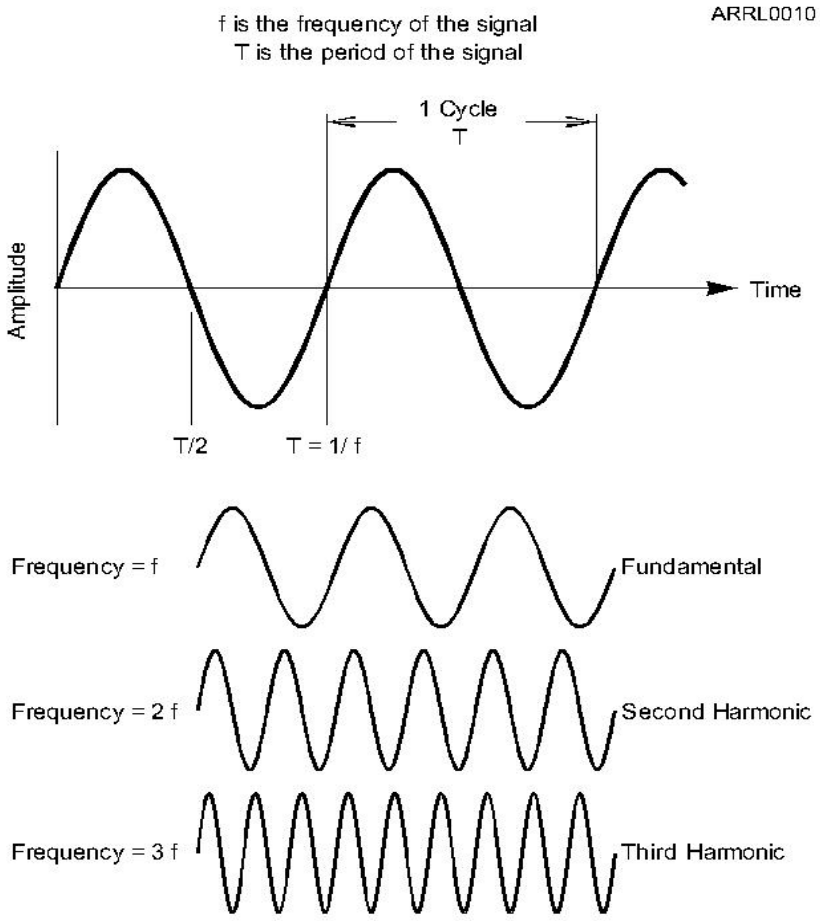
Frequency and Wavelength



- Harmonics – at multiples of the fundamental frequency.

Frequency and Wavelength



Harmonics – at multiples of the fundamental frequency.

RF = Radio Frequency (all)

VLF = 3-30 KHz

LF = 30 – 300 KHz

MF = 300 KHz- 3 MHz

HF = 3-30 MHz

VHF= 30-300 MHz

UHF = 300 MHz – 3 GHz

SHF = 3 GHz – 30 GHz

EHF = 30 GHz – 300 GHz

Modulation

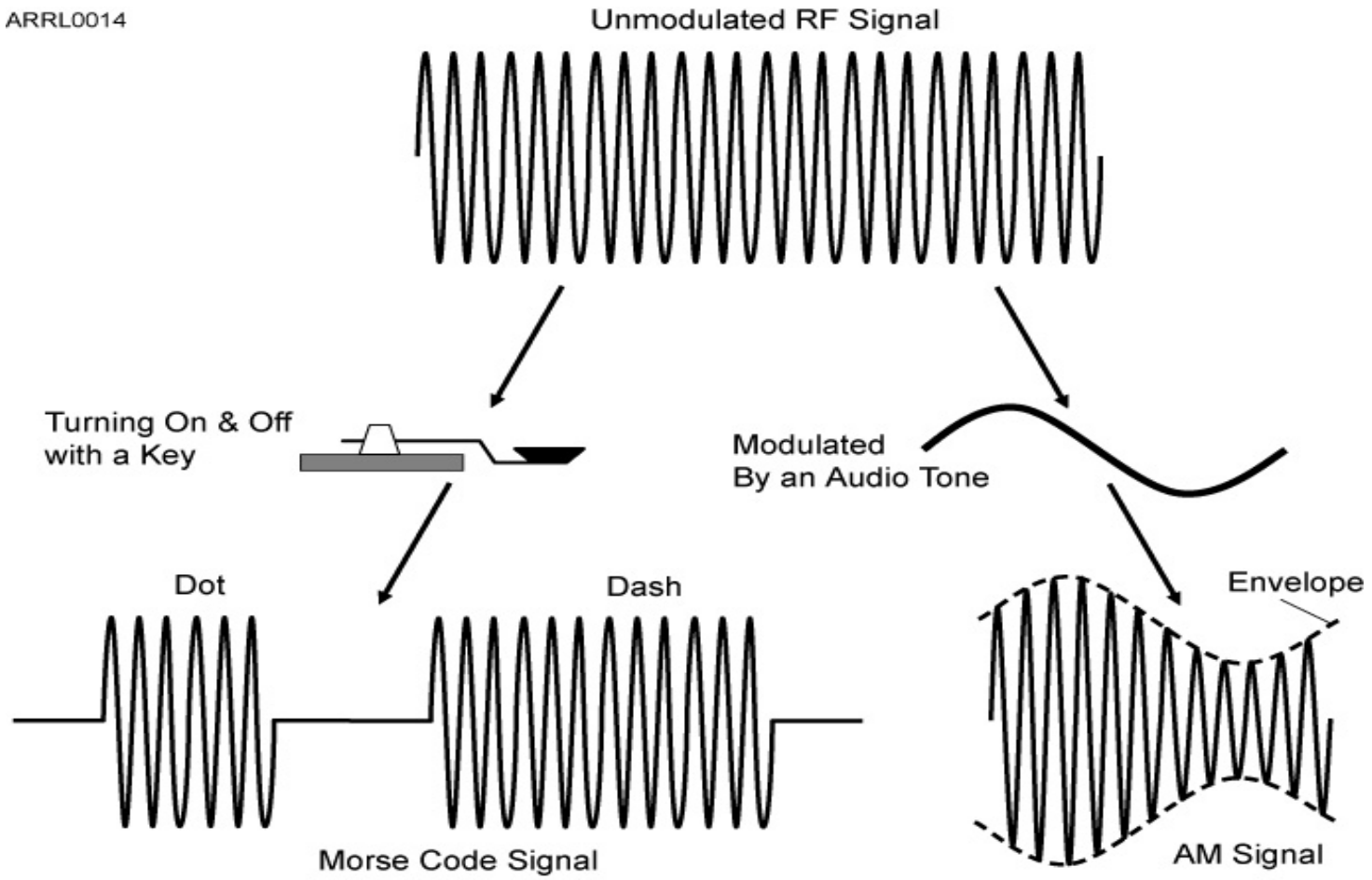
- To transmit information we must modulate a radio signal. That means to vary the radio wave's frequency, phase or amplitude.
- Radio frequencies can be generated by :
  - crystal oscillators
  - variable frequency oscillators

Continuous Wave (CW)

- CW is a communications mode transmitted by off/on keying of an RF signal.
- The coding of the is called the International Morse code.
- We sometimes say "dah" for the dash and "dit" for the dot. A dash lasts twice as long as a dot.

Dit-dit-dah-dit dit-dit-dah dah-dit !

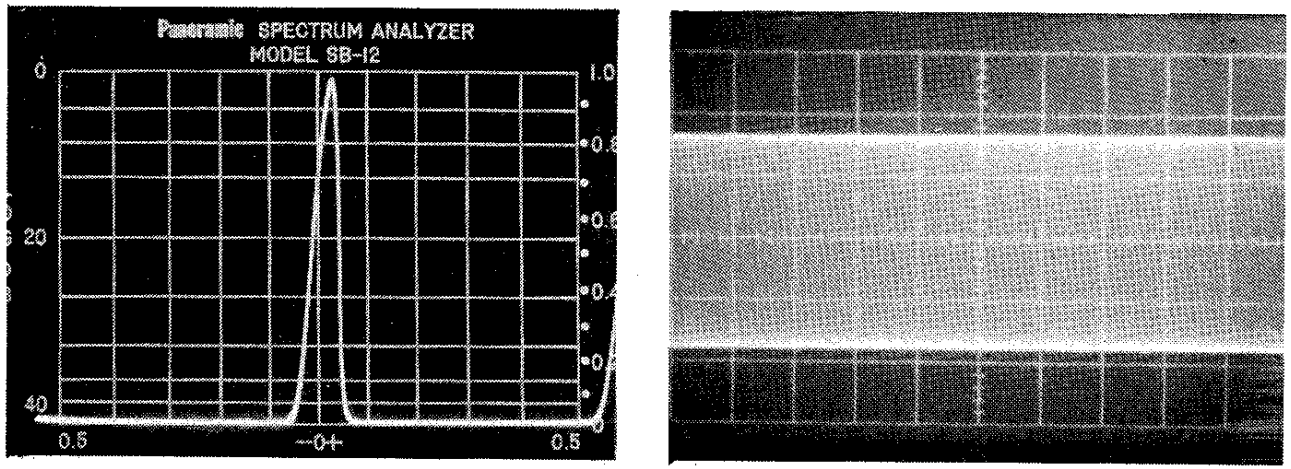
Continuous Wave (CW)



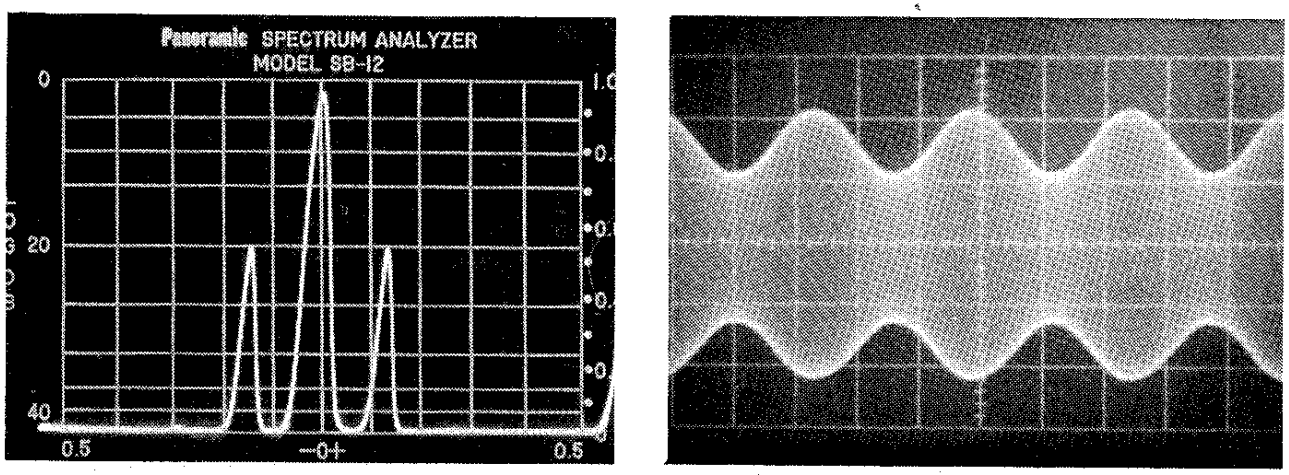
Amplitude Modulation and SSB

- At constant frequency, the power of the carrier is modulated in proportion to audio volume (pressure).
- In the frequency domain, there are upper and lower sidebands and the carrier frequency.
- Single sideband filters out all but one sideband. This puts more power to the actual modulated signal.

Amplitude Modulation and SSB

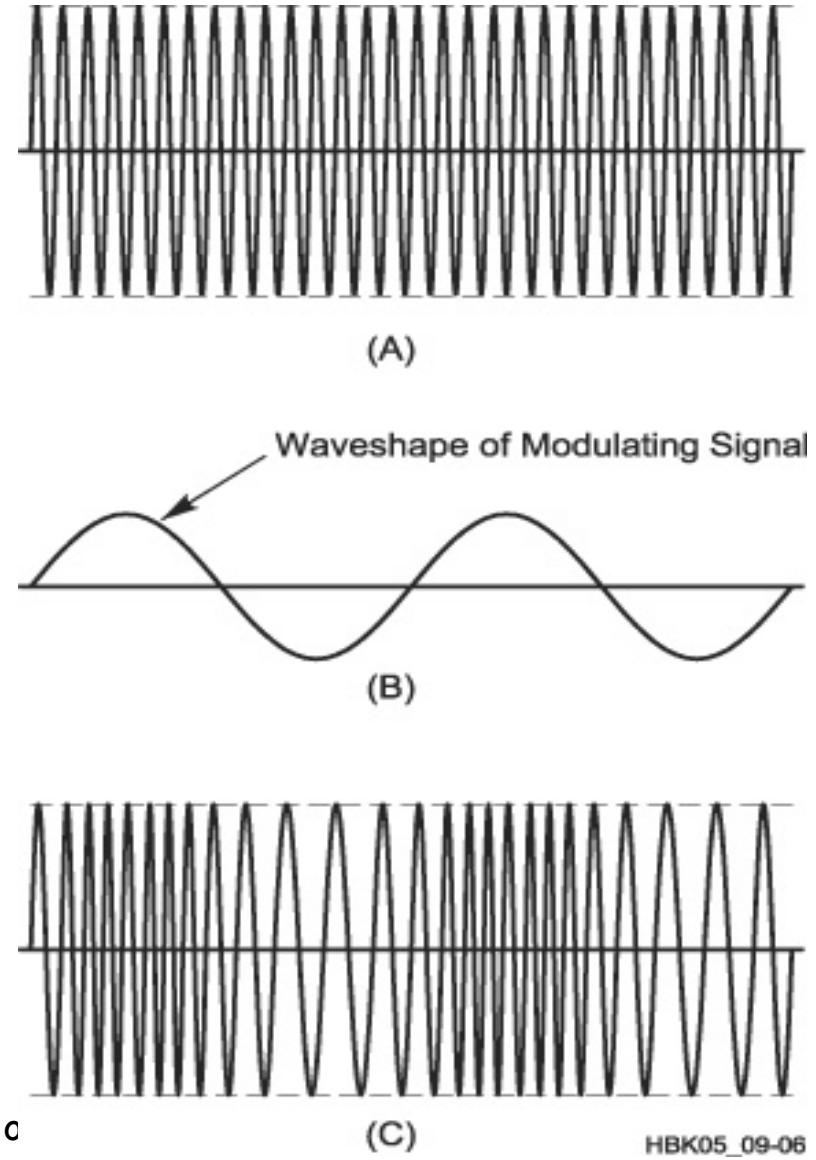


(A)



Frequency Modulation (FM)

- The amplitude of the RF signal is held constant, but the frequency is varied in proportion to the shape of the audio wave.
- FM Signals are the cleanest. They are the modulation mode of choice for VHF and UHF voice communications.
- Requires a carrier higher frequency than speech!



Spurious Emissions

- Any signal that is emitted outside the band on which you are operating (it's your responsibility to fix it!)
- Common types include:
  - Parasitic oscillation (tube type amplifiers).
  - Removal of shields from transmitter.
  - Harmonics.
  - Splatter.

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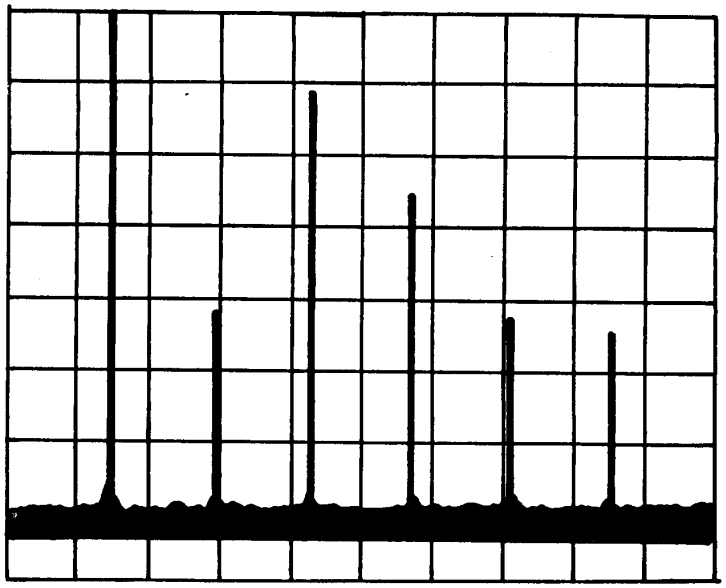
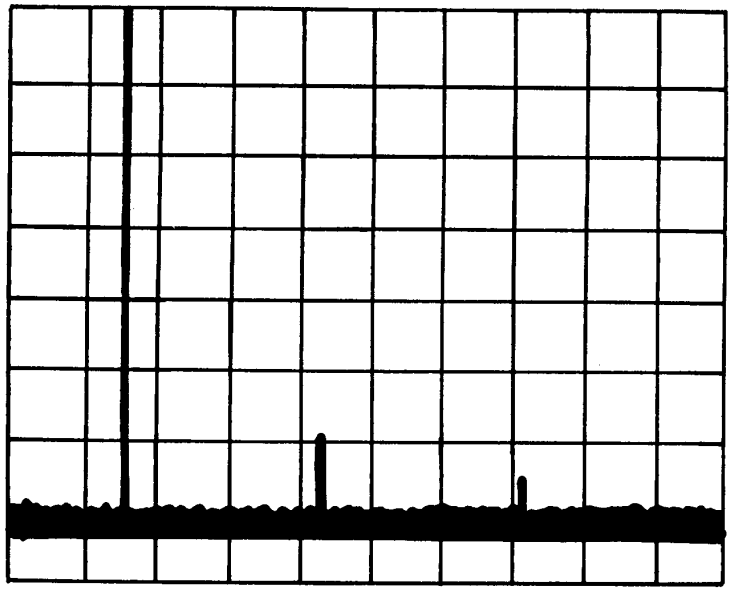
Spurious Emissions - Harmonics

(multiples of a given frequency)



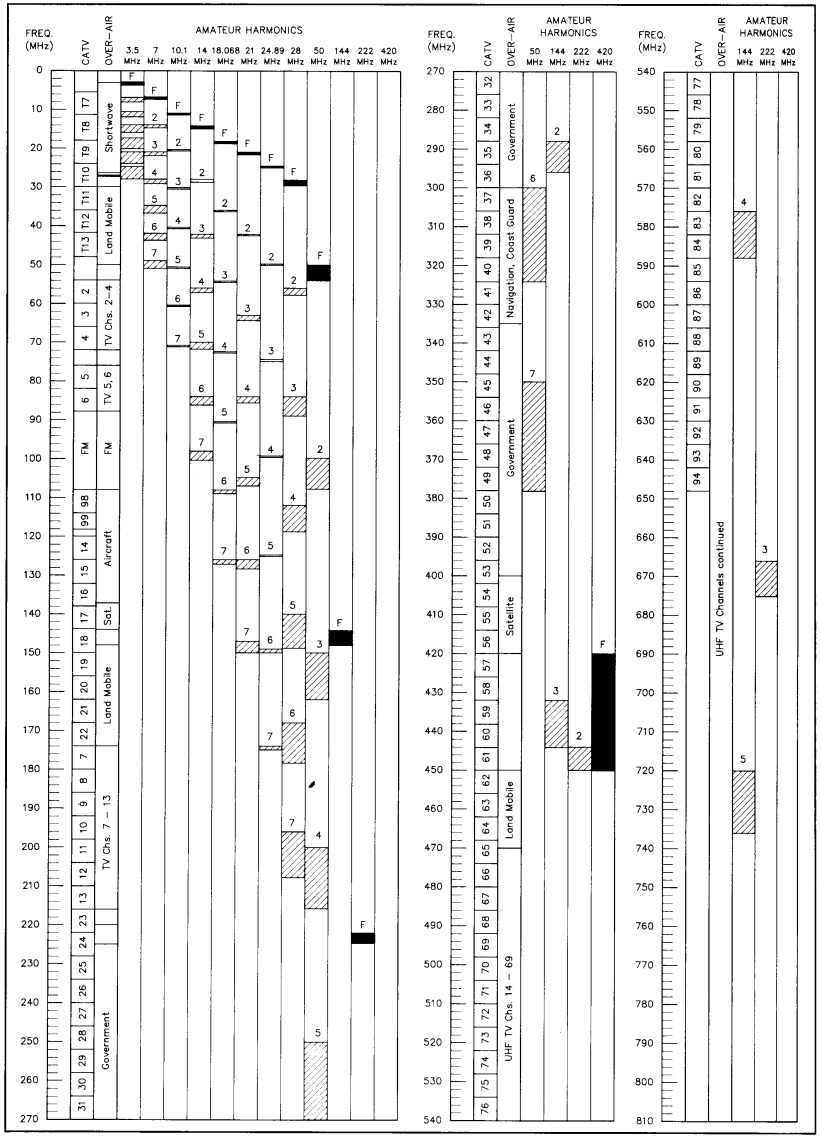
(A)

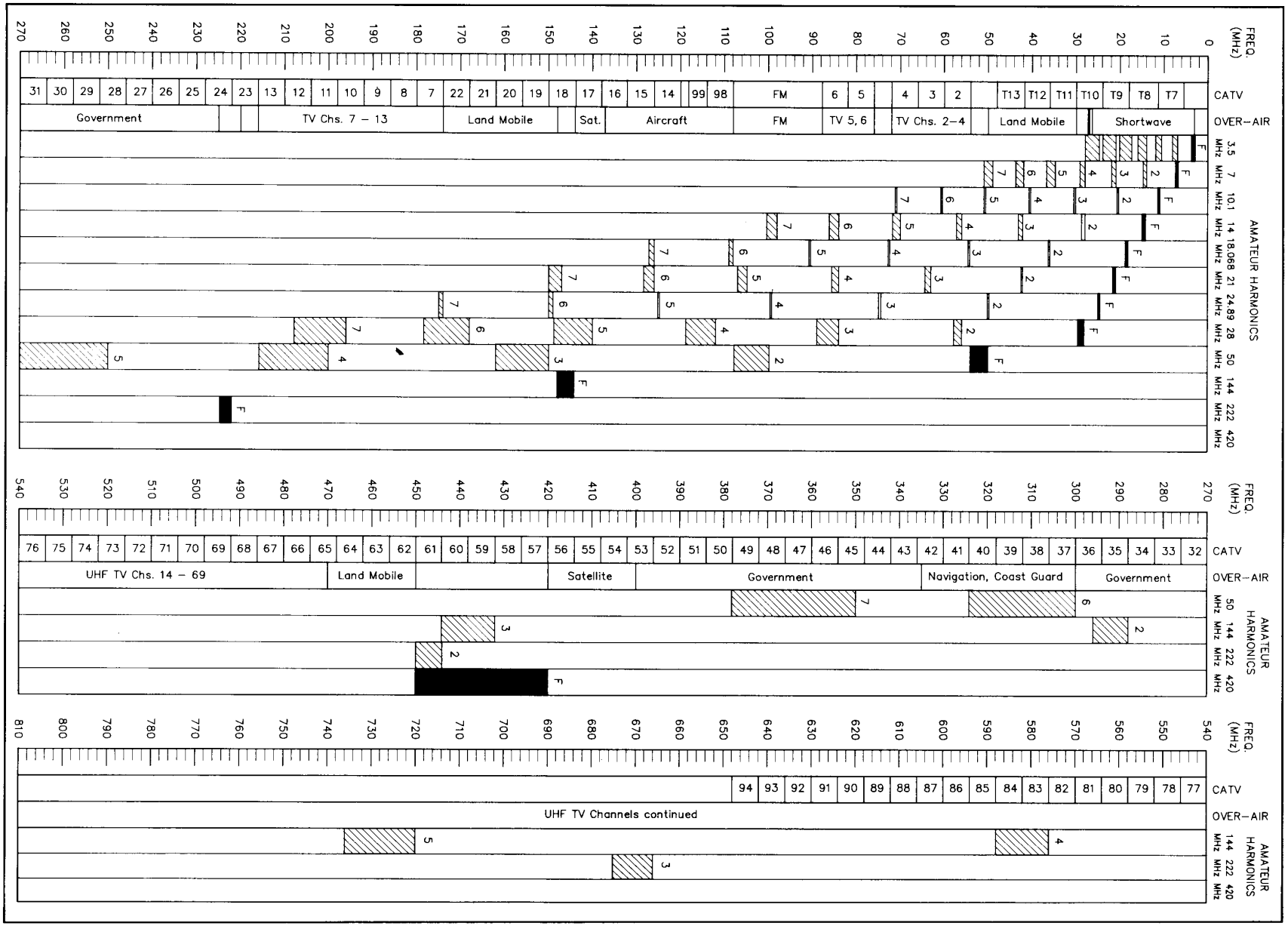


(B)

Harmonics Cause Interference

- Occur at definite intervals.
- Show up as interference on specific channels or as herringbone.
- Use low pass filter on transmitter and high pass on TV.
- You are responsible to clean up your signal.
- Can be caused by multi-band antennas and poorly tuned transmitters.





F is the fundamental frequency, 2 is twice that frequency, etc.

Receiver (Front End) Overload

- Affects all channels, usually with dramatic effect.
- There is nothing that can be done to the transmitter, you must prevent the signal from entering the receiver.
- For cable systems, inspect for loose connections and broken shields.
- For non cable systems, use a high pass filter.

Spurious Emissions - Splatter

- Splatter is caused by improper adjustment of the transmitter resulting in interference with nearby frequencies.
- Sources could be:
  - talking too loud into microphone
  - microphone gain too high
  - excessive speech processing

Signal Purity and Stuff

- Your RF can get into the power lines as well. There are ac power line filters which can be installed.
- You should also be careful of signal purity - stable in frequency and pure in tone. There are some things that you can readily hear.
- Key clicks are caused by rapid rise in transmitter output. Can cause interference several kHz on either side of your frequency. They can be taken out with a key click filter.
- Chirping is caused by transient voltage changes which let your frequency change slightly when keying.
- Hum - can come from poorly filtered power supplies.

Emissions Standards

- Bandwidth - measure of how much space your signal takes up.
  - CW < SSB < FM
- RTTY Sending Speed
  - 28 - 50 MHz 1200 baud
  - 50 - 222 MHz 19,600 baud
  - > 222 MHz 56,000 baud
- RTTY Frequency Shift
  - < 50 MHz 1000 Hz
  - > 50 MHz No Limit
- Authorized Digital Bandwidth
  - 50-222 MHz 20 kHz
  - 222-450 MHz 100 kHz

Emission Types and Bandwidth

- CW (continuous wave) is narrowest - 250 Hz filter is useful
- RTTY is next widest (about the same as CW); a 500 Hz filter is useful
- SSB has a wider bandwidth, often uses a 2800 Hz filter.
- FM is the widest, about 15 kHz

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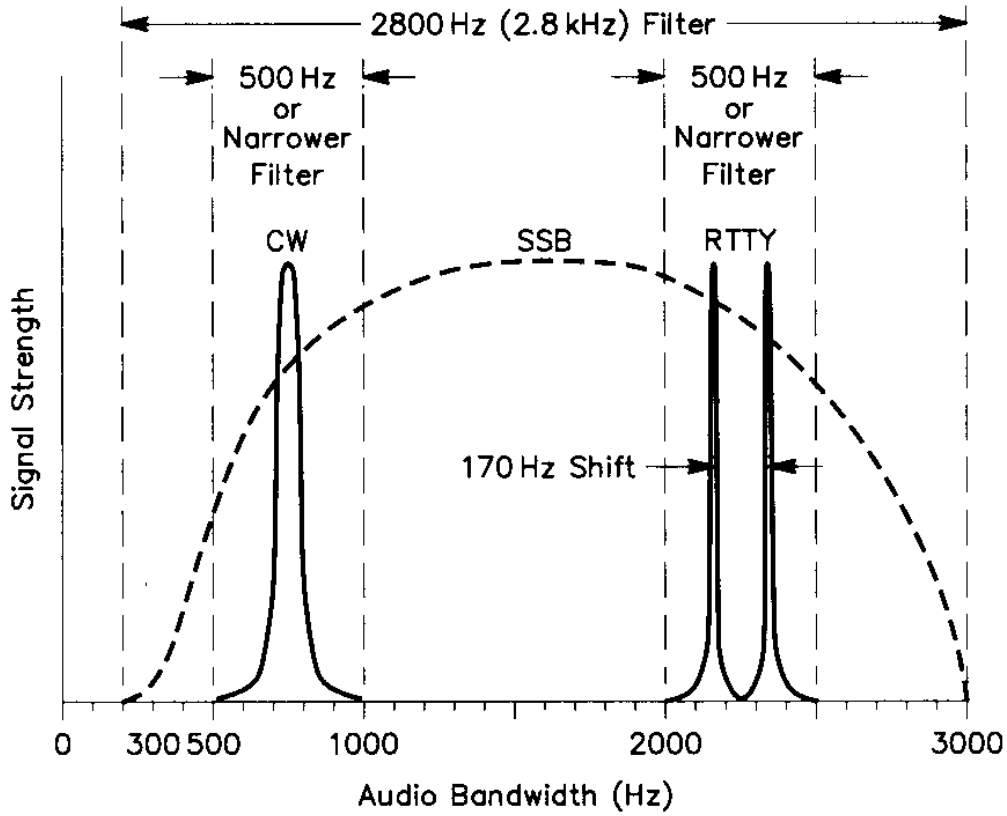
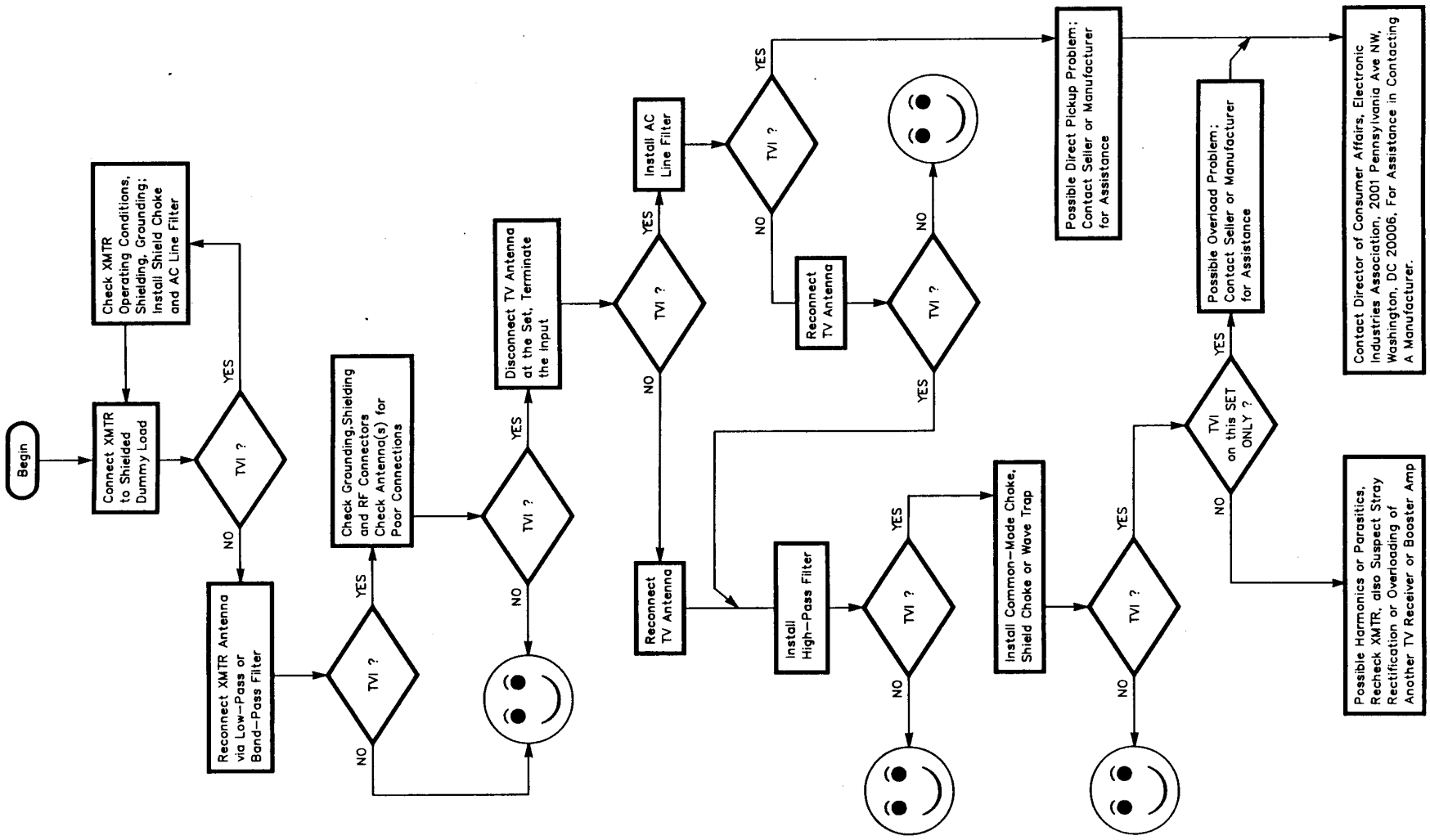
Relative Bandwidths & Receiver Filters




Begin
Connect XMTR to Shielded Dummy Load
TVI ?
YES
NO
Check XMTR Operating Conditions, Shielding, Grounding; Install Shield Choke and AC Line Filter
Reconnect XMTR Antenna via Low-Pass or Band-Pass Filter
TVI ?
YES
NO
Check Grounding,Shielding and RF Connectors Check Antenna(s) for Poor Connections
TVI ?
YES
NO
Disconnect TV Antenna at the Set, Terminate the Input
TVI ?
YES
NO
Install AC Line Filter
TVI ?
YES
NO
Reconnect TV Antenna
Possible Direct Pickup Problem; Contact Seller or Manufacturer for Assistance
Contact Director of Consumer Affairs, Electronic Industries Association, 2001 Pennsylvania Ave NW, Washington, DC 20006, For Assistance in Contacting A Manufacturer.
Reconnect TV Antenna
TVI ?
YES
NO
Install High-Pass Filter
TVI ?
YES
NO
Install Common-Mode Choke, Shield Choke or Wave Trap
TVI ?
YES
NO
TVI on this SET ONLY ?
YES
NO
Possible Overload Problem; Contact Seller or Manufacturer for Assistance
Possible Harmonics or Parasitics, Recheck XMTR, also Suspect Stray Rectification or Overloading of Another TV Receiver or Booster Amp

Some Other Stuff

- True Forward Power = forward power reading - reflected power reading. This can be used to indicate the SWR of your antenna system.
- Marker generator - a high stability oscillator that produces specific frequencies which are used to calibrate receivers and transmitters.
- WWV and WWVH can also be used to calibrate receivers, as well as other things.