

# Advanced Amateur Radio Licence: Part IV

## Antenna Matching

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# Outline

Overview

Getting to the antenna

Antennas

Thinking about it from a transmission point of view

- ▶ Generate the RF signal: RF amp (covered last time)
- ▶ Send it to an antenna: transmission line. You might need an antenna tuner and or and impedance matching antenna feed too.
- ▶ Radiate it: Antennas, radiation, etc

... obviously reception is the reverse.

- ▶ Remember commandment VII of the ten commandments of electrical safety

*Work thou not on energized equipment without proper procedures, for if thou dost so, thy shipmates will surely be buying beers for thy widow and consoling her in ways not generally acceptable to thee.*

<http://goatlocker.org/resources/nav/safety.htm>

- ▶ The business end of an RF amp is a hazardous place to be when it is on.
- ▶ Installations should be physically secured, to protect the curious.
- ▶ Transmitter should be off (and maybe lockout) when working on waveguides, feed horns, etc.

## Antenna tuner

- ▶ Generally suitable for 50 ohm input
- ▶ L type: for high output impedance. Small matching range
- ▶ II type: matches low to high impedance. One inductor and two caps or vice versa. Wide matching range.
- ▶ II-L type: like II but with greater harmonic suppression.
- ▶ Series / transformer types. Matches low to high impedances.

# Transmission Line / Waveguide

- ▶ RF moves slower (typical,  $2/3$  speed) along transmission line than air. Velocity factor is speed of signal in line / speed of light in vacuum. Dielectric is the determining factor.
- ▶ a quarter-wave stub shows impedance the opposite of what it actually is. (Shorted - high impedance, open - low impedance)
- ▶ a half-wave stub shows impedance the same as what it really is. (Shorted - low impedance, open - high impedance)
- ▶ a *waveguide* is like a pipe for RF. Works best at high frequencies, acts as a high pass filter.
- ▶ *stripline* Conductor sandwiched between two dielectrics. Like a flattened coax.
- ▶ *microstripline* printed circuit transmission line. Generally a conducting strip separated from a ground plane on the other side of the board. Relatively poorly shielded.
- ▶ Lots of useful info at

<http://www.microwaves101.com/encyclopedia/transmission.cfm>

## Antenna feed

- ▶ Gamma match: unbalanced feed - coax braid to the center, and center conductor along one side via a capacitor with an adjustable parallel rod.
- ▶ T match: like two gamma matches, one on each side.
- ▶ Stub match: a short section of line open or shorted connected across the feed line at a specific distance from the antenna feed point.

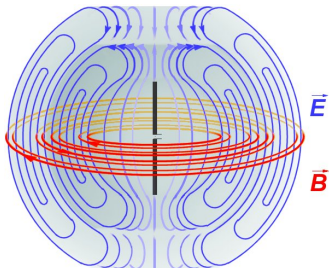
# The Half wave Dipole

- ▶ Normally fed in the middle
- ▶ The current is highest in the center and lowest at the ends
- ▶ The voltage is highest at the end and lowest in the middle.
- ▶ The impedance is highest at the end and lowest in the middle.
- ▶ When calculating the physical length, it is *shorter* than the wavelength in free space. Use 95% on the test.



# The Half wave Dipole

cont.



[https://en.wikipedia.org/wiki/File:Felder\\_um\\_Dipol.jpg](https://en.wikipedia.org/wiki/File:Felder_um_Dipol.jpg)

- ▶ Theoretical gain 2.1 dBi
- ▶ If it is horizontal less than a half wavelength above ground, ground reflection distorts the radiation pattern and there is little directivity
- ▶ above  $1 \lambda$  above ground impedance  $75\Omega$

# The Yagi-Uda



<https://en.wikipedia.org/wiki/File:Montreal-tower-top.thumb2.jpg>

- ▶ Only one driven element, one reflector, and one or more directors
- ▶ Takeoff angle decreases with increasing height - less than 30degrees preferred for long distance.

# Polarization

- ▶ Electromagnetic waves have both a magnetic and electric field, at right angles.
- ▶ Orientation of the electric field determines the polarization
- ▶ Orientation of radiating elements determines orientation of electric field, and thus polarization
- ▶ obvious types, horizontal, and vertical.
- ▶ line of sight communication will work best when polarization matches.
- ▶ Circular polarization can be either left handed or right handed. Crossed dipole and dual helical antennas can generate both.

# Radiated power

- ▶ Effective radiated power (ERP)
  - ▶ is Transmitter output power less line loss plus antenna gain.
  - ▶ line loss and antenna gain in dB can be added and subtracted, then dB converted to a multiplier as 3dB is 2x
- ▶ Radiation resistance
  - ▶ is the equivalent resistance that would dissipate the radiated power.
  - ▶ the Radiation resistance as a fraction of the total resistance is the antenna efficiency.
  - ▶ affected by antenna location, nearby objects and conductor length / diameter ratio