VHF 2-meter Asymmetrical Hatted Vertical Dipole (AHVD) Antenna

Design and Assembly Tutorial

02-04-2017

The Goal

From the RADIO

Producing as much POWER

Radiating off of the ANTENNA

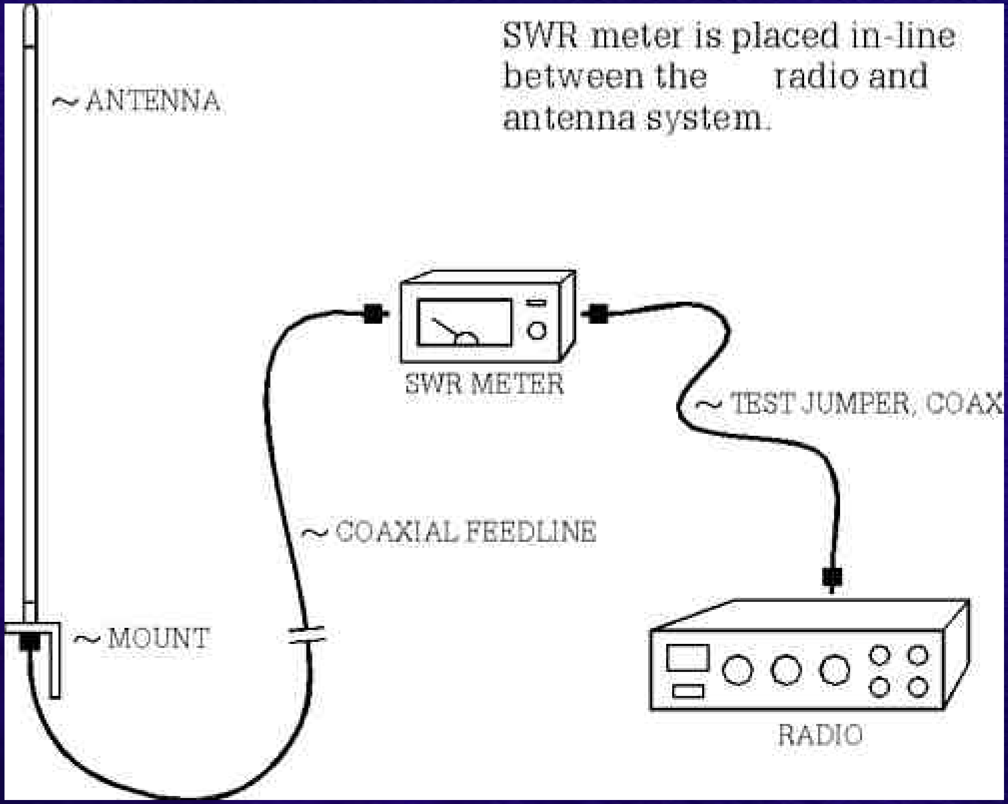
In a Focused PATTERN

Allowing the Target RECEIVER

To get the Greatest SIGNAL

Basic Signal Transmission System

From Radio through the Coaxial Feedline to the Antenna Elements



Best Measurement Tool

SWR / Power Meter

SWR = Standing Wave Ratio
Power Measured in Watts
Loss Measured in Decibels (dB)

SWR Meter basically shows How Much Power is being LOST in the System

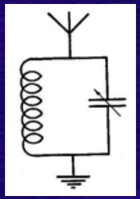
Goal – 1 to 1 Ratio (1:1) – No Power Lost

How is Power Lost in the System?

Two Primary Losses

1) Physical Resistance - Dissipated as Heat

2) Reflected Power – Out of Phase Negating Power



Antenna System Appears as THE RESISTER in a Tuned Radio Final
Additive Components MUST achieve a Balanced Load = 50 Ohms

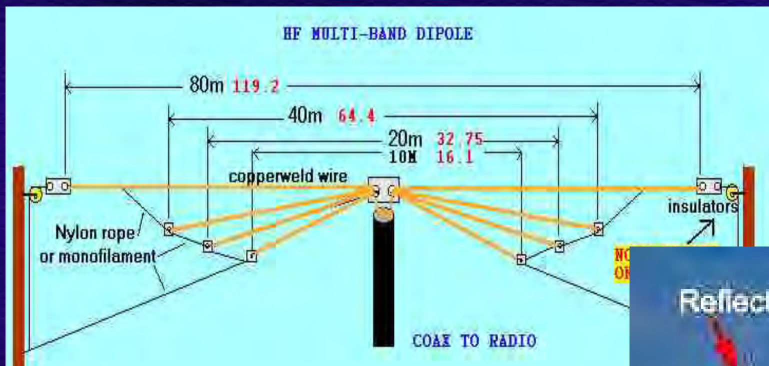
Three Primary Areas of Losses

1) Feedline	Physical Resistance Material / Construction & Length Example: Connections ~ -1dB Loss per
2) Antenna Construction	Negating Reflective Power (Impendence) Elements Material / Configuration Elements Length
3) Feed Point Mismatch	Negating Reflective Power (Impendence) Point where Feedline Connects to Antenna

Goal – Realize Greatest Amount of Power on Antenna Elements

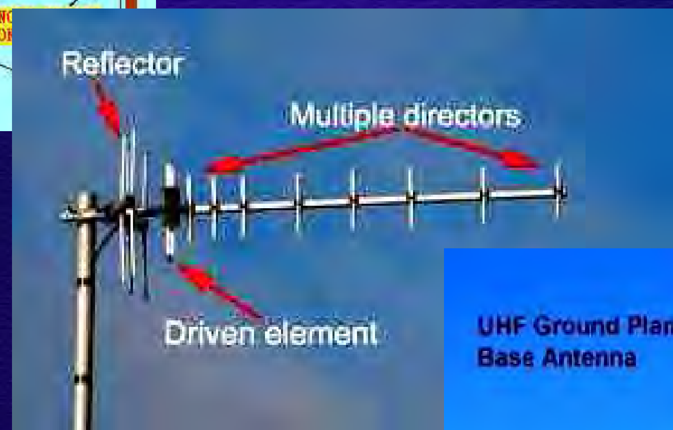
Types of Antennas

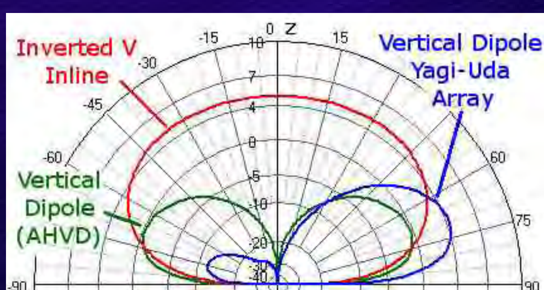
There are Many Types of Antennas



Horizontal Dipole

Yagi





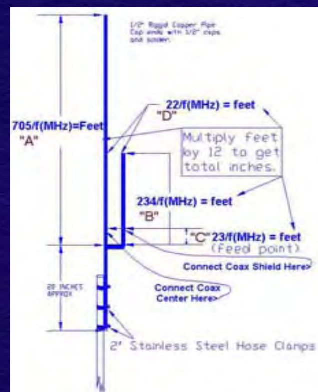
Vertical Dipole

Goal – Design & Build Inexpensive UHF Vertical Dipole Antenna

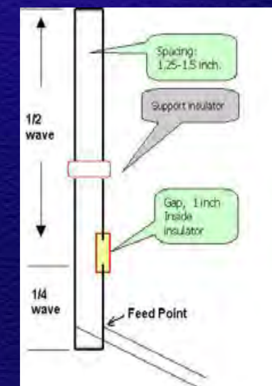
Types of Vertical Antenna

There are Many Single Band Vertical Antenna Types

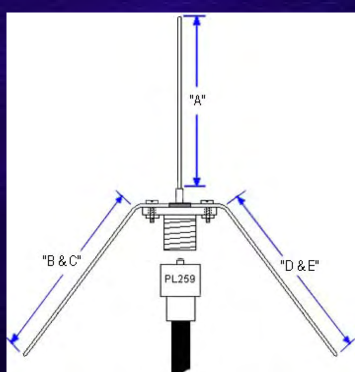
J-Pole



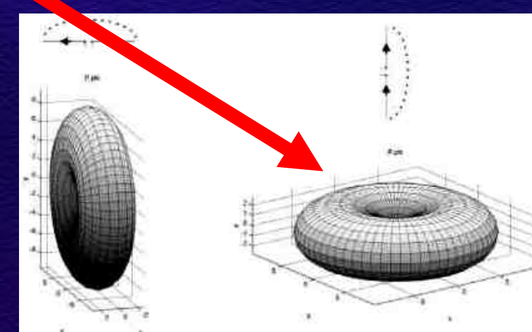
Slim Jim



Asymmetrical Hatted Vertical Dipole (AHVD)

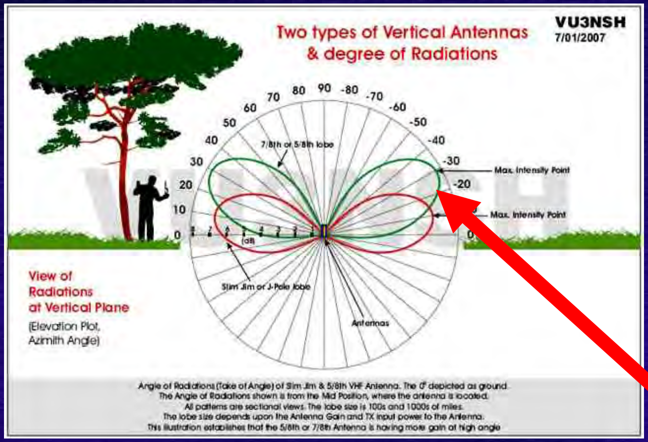


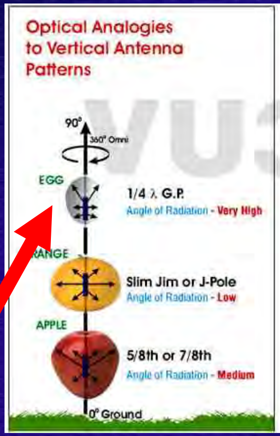
Radiation Pattern

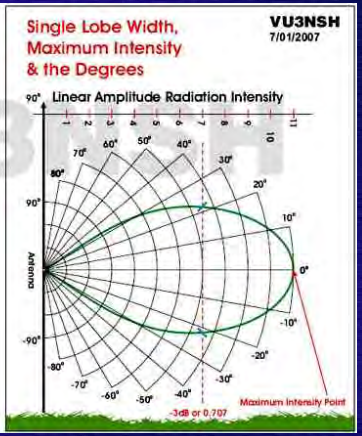


Horizontal **Vertical**

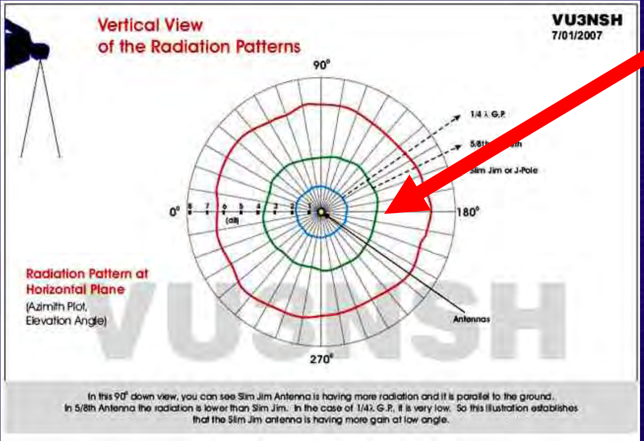
Choosing Best Radiation Pattern

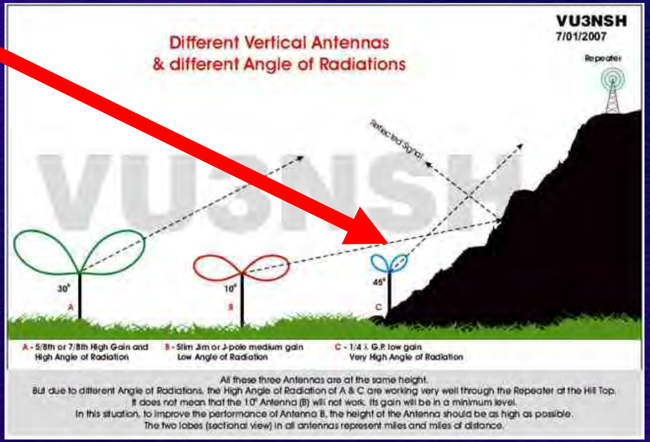






AHVD

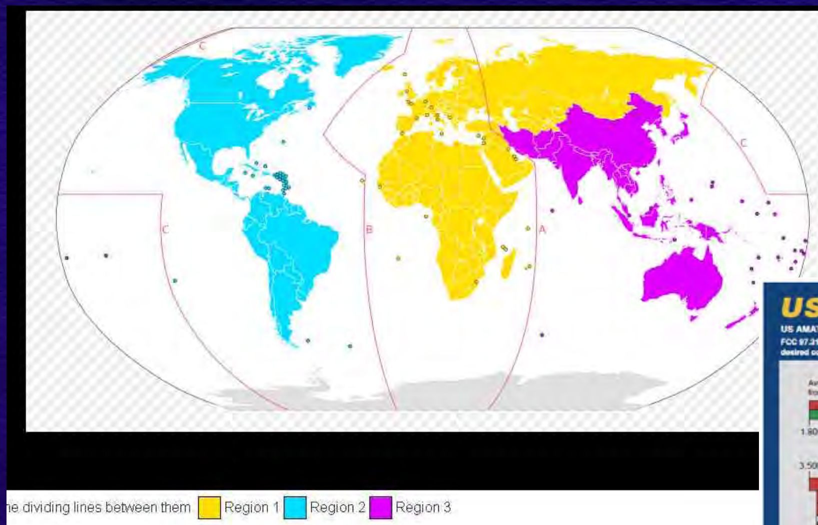




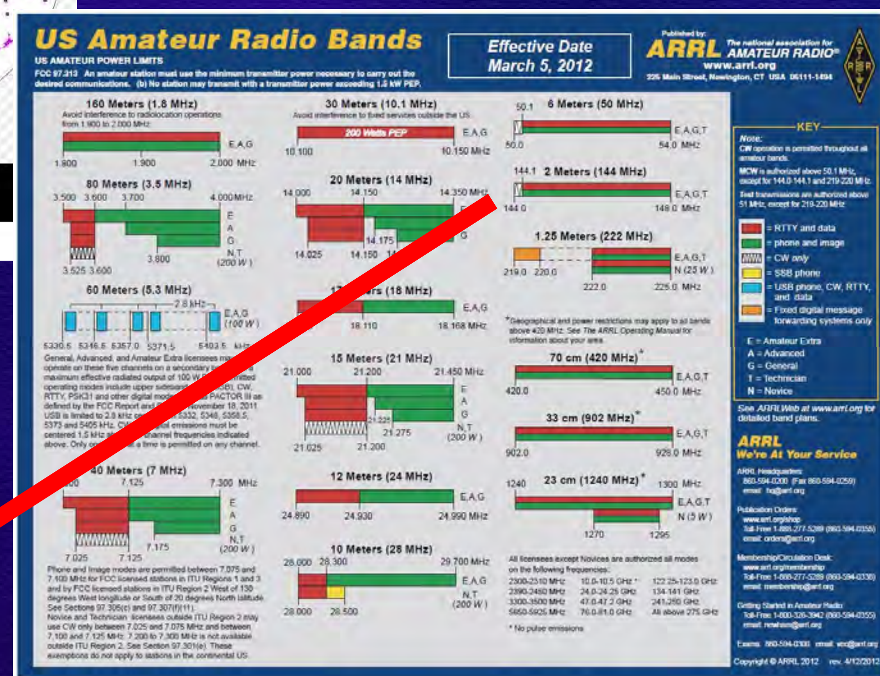
Goal – Selecting Best Radiation Pattern for Repeater Application

Designing to the ITU Region 2 VHF Band

Tuning Physical Antenna to Focused Radio Band Frequencies



Region 2 – North / South America



Amateur Radio Band Plan (FCC Dictated)

2-meter VHF

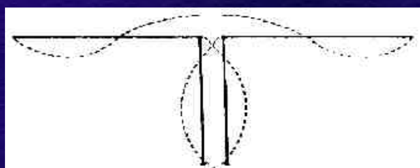
144MHz to 148MHz

Goal – Design to VHF Band Center 146.000 MegaHertz (MHz)

Sizing the Antenna Elements

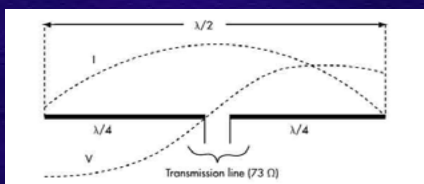
Antenna Sizing is Based on Operating Band Wave Length

Popular Standing Wave Antenna Configurations are 1, ½, & ¼ Wave Lengths



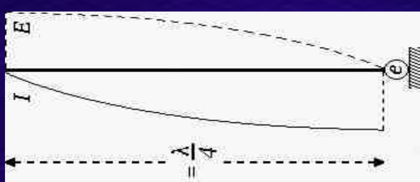
1 Full Wave Length

L (inches) = (984 / Freq in MHz) * 12



½ Half Wave Length

L (inches) = (468 / Freq in MHz) * 12



¼ Quarter Wave Length

L (inches) = (234 / Freq in MHz) * 12

Calculate for ¼ Wave Length Midpoint VHF Frequency 146 MHz

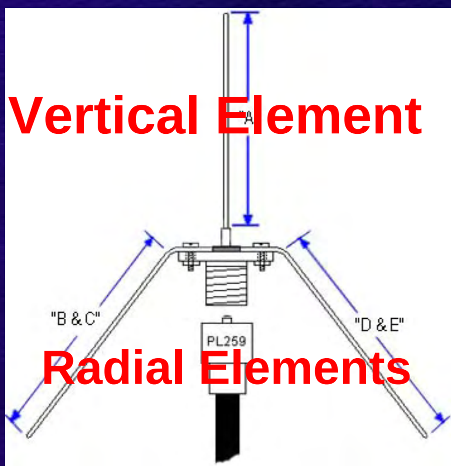
(234 / 146 MHz) * 12 = **19.23 Inches** or 48.88 cm

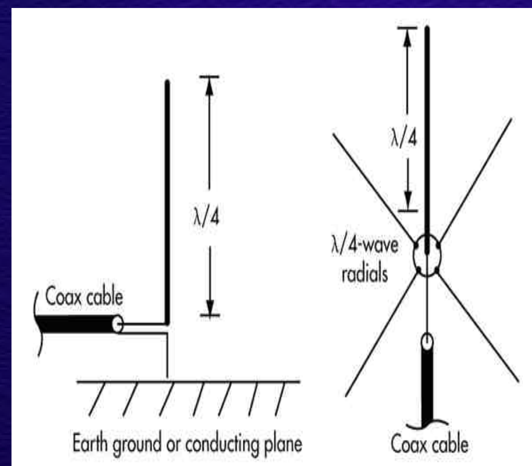
Goal – Realize Full Standing Wave with Power Provided

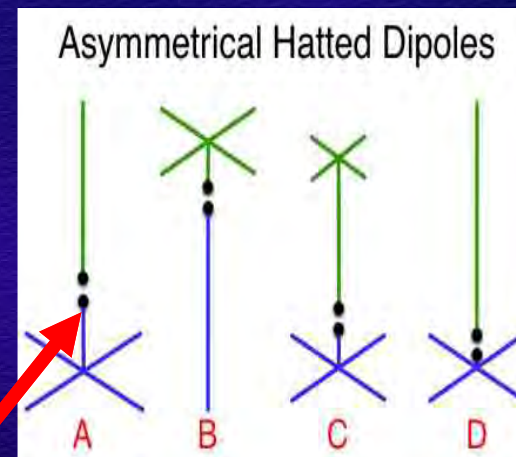
AHVD Characteristics Considerations

AHVD Antennas Exhibit Unique Characteristics

The Vertical Element Length should be Shorter than the Radials Element Length to present a 50 Ohms Resistive Value







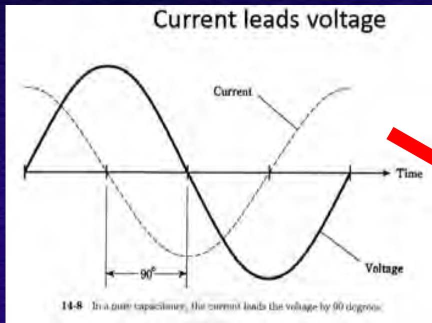
Inverted Hatted Diapole

Height Above Ground also Effects Presented Resistance

Test Different Element Lengths against Best SWR Results

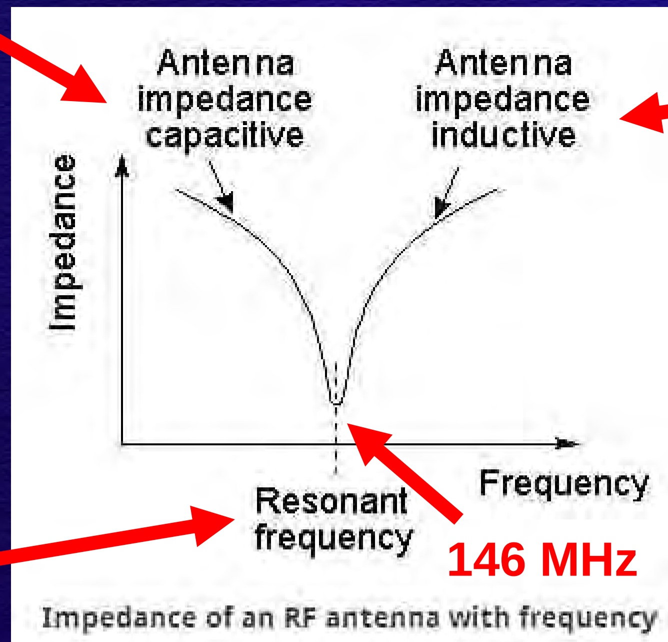
Goal – Determine Element Lengths Presenting 50 Ohms Resistance

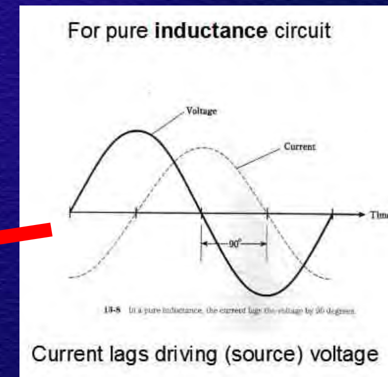
Physically Tuning the Elements



Capactive Impedance

Current Leads Voltage

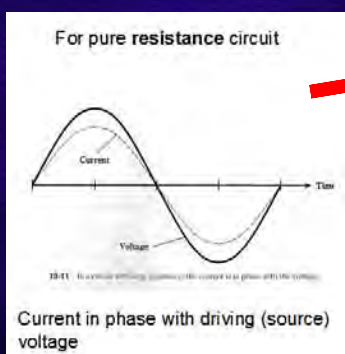




Inductive Impedance

Current Lags Voltage

Resistance



When Properly Electrically Tuned
Capacitive Cancels Inductive Impendence
Leaving Pure Resistance

Goal – Physically Tune Elements for Resonate Frequency 146 MHz

AHVD Antenna Assembly

Constructing the Antenna

SO-239 Connector Assembly

Transmission Line Feed Point

Soldered Radial Connection Joints

Radial Elements Connection Points

Assembled AHVD Antenna

Disassembled AHVD Antenna

Compact and Ready for Travel

Variable Antenna Tuner with SWR Meter

Use to Tweak Resonant Frequency of Antenna

2-Meter Repeater Output Frequency	Standard Input Frequency Offset
145.1 MHz - 145.5 MHz	-600 kHz
146.0 MHz - 146.4 MHz	+600 kHz
146.6 MHz - 147.0 MHz	-600 kHz
147.0 MHz - 147.4 MHz	+600 kHz
147.6 MHz - 148.0 MHz	-600 kHz

Example: Antenna is Physically Tuned to 146 MHz and Repeater is on 146.88 MHz this device allows you to skew Electronically the Resonant Frequency of the Antenna to YOUR Transmitting Frequency Resonance of 146.28 MHz (146.88 MHz – 600 kHz)

Antenna Design Elemental Definitions

Important Basics Narrative

Antenna System

Consists of the Feed Line to the Antenna and the Antenna Elements.

Radio Frequency (RF) Transmitter (Source)

The “Final” of a Transmitter is a Tuned LCR (Inductor/Capacitor/Resistor) Circuit with the Antenna System the Resistor Component.

Power Dissipation Due to Loss

The GOAL is Optimize (elimination of Attenuation/Impedance) the Radio Frequency (RF) Antenna System (Load) so that it shall Radiate all of the Power presented by the Radio Transmitter (Source) into free space. Optimal Power Radiation is achieved when Source Resistance equals, or “Matches”, Antenna System Resistance (or Feed Impedance). When Successful there shall be the highest amount of Current Flowing throughout the System and thereby producing the Highest Level of Power Radiation into space. In the case of a VHF 2-meter Asymmetrical Vertical Hatted Dipole (AVHD) Antenna, 50 Ohms Resistance is optimal.

Antenna Impedance

A combined Complex resistive force made up from Resistance, Capacitance, and Inductance. Loss Resistance is measured as a Real Value while Capacitive and Inductive are Imaginary (Virtual Reflective Radiation) Values.

Impedance = Physical Resistance + Reflective Radiation Resistance

Physical Resistance (DC & AC Losses as Heat)

Real Value derived from the current attenuation of the combination of Direct Current (e.g, Physical Cable Type and Gage, Feedline Construction, Connectors, Joints [like cold solders/crimps]), and at higher frequencies Alternating Current (e.g., Skin Effects).

Reflective Radiation Resistance

Virtual Value derived from Inductive Reactance (if Source Frequency is Above the Antenna Resonant Frequency) or Capacitive Reactance (if Source Frequency is Below the Antenna Resonant Frequency).

Antenna Resonance

A Radio Frequency (RF) Antenna is a form of tuned circuit consisting of inductance and capacitance, and as a result it has a Resonant Frequency. This is the frequency where the capacitive and inductive reactances Cancel each other Out. When the Source Frequency equals, or "Matches", the Antenna Resonate Frequency the RF Antenna appears purely Resistive, the resistance being a combination of the Physical Resistance and the Reflective Radiation Resistance (in this case 50 Ohms!).

Antenna Bandwidth

Most Radio Frequency (RF) Antenna designs are operated around the allocated Band's center resonant point. This means that there is only a limited bandwidth over which an RF antenna design can operate efficiently. Outside this area the levels of reactance rise to values causing the amount of reflected power to increase so high that it Attenuates the resulting Radiated Power towards Zero.

Standing Wave Ratio (SWR)

Standing waves are voltage and current distribution patterns along a transmission line. If the characteristic impedance (Zo) of the line matches the generator (transmitter) output impedance and the antenna load, the voltage and current along the line is constant. With impedance matched, maximum power transfer occurs.

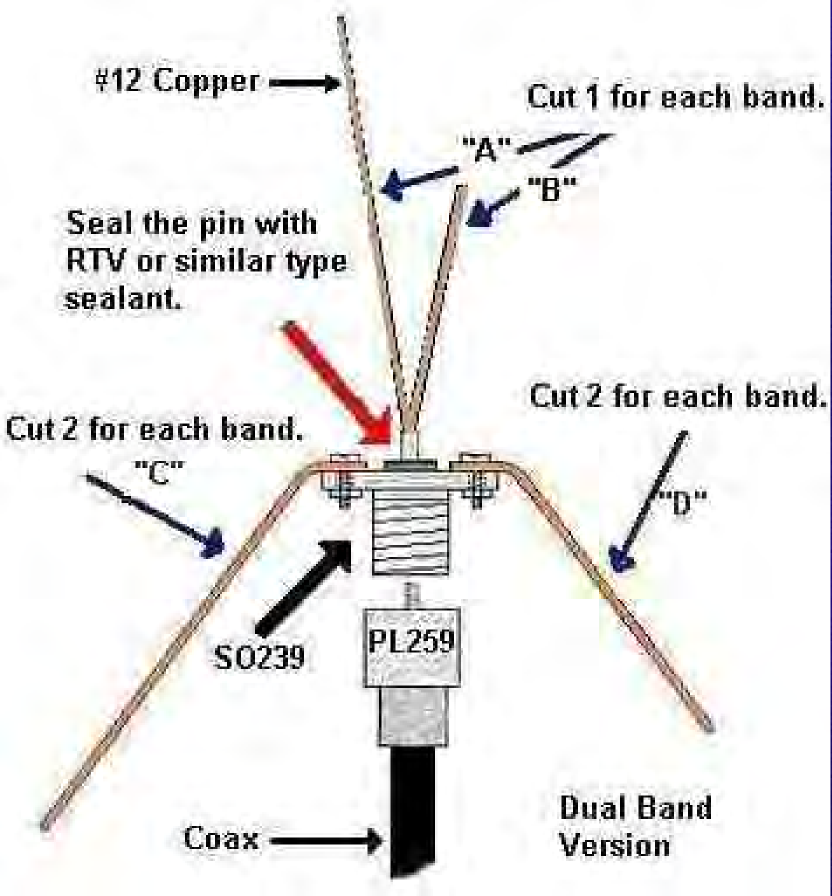
If the antenna load is not matched to the line impedance, not all of the transmitted power is absorbed by the load. Any power not absorbed by the antenna is reflected back down the line, interfering with the forward signal and producing variations of current and voltage along the line. These variations are the standing waves.

The ideal SWR is 1:1. An SWR of 2 to 1 indicates a reflected power of 10%, meaning that 90% of the transmitted power gets to the antenna. An SWR of 2:1 is generally regarded as the maximum allowable for the most efficient system operation.

Multiband Vertical Antennas

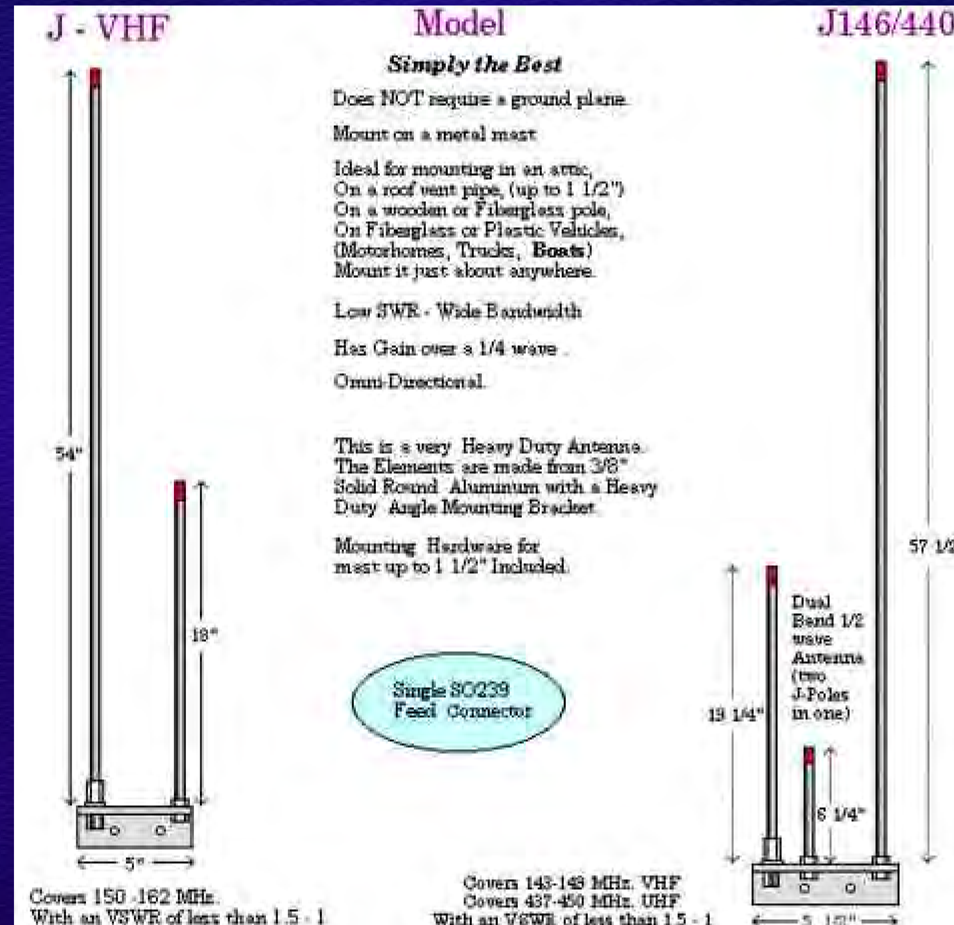
Examples of Future Projects

VHF / UHF Multiband AHVD



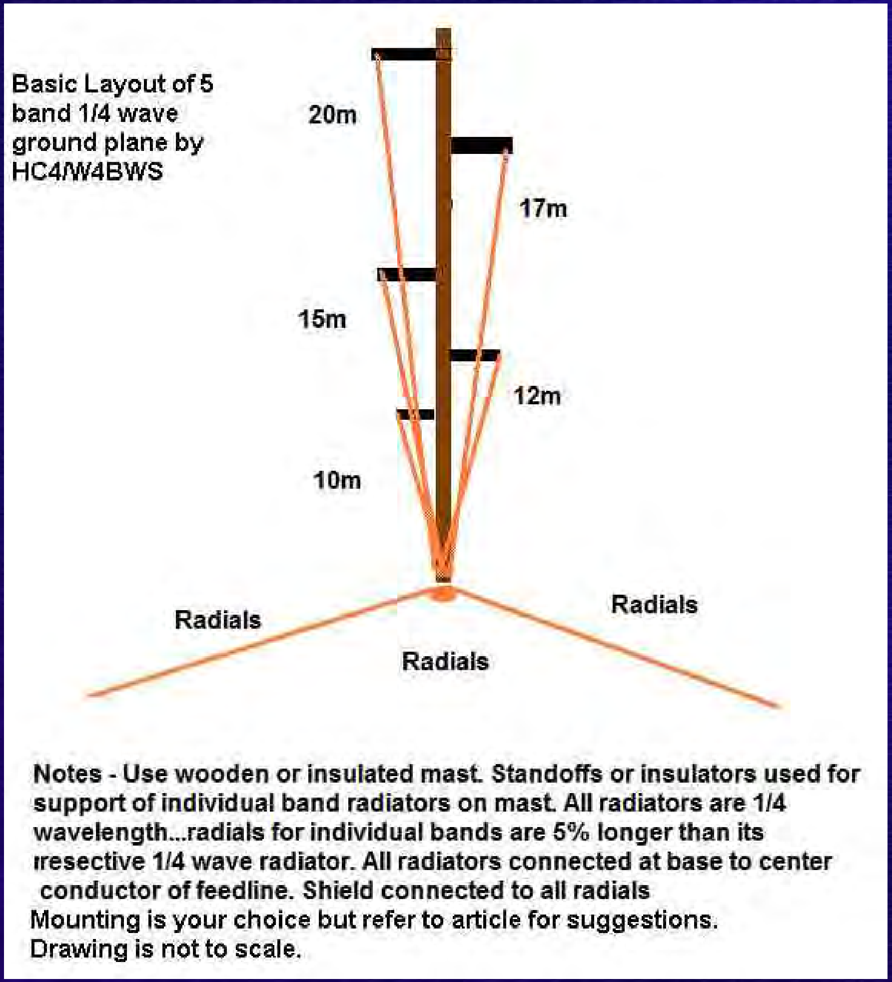
¼ (Quarter) Wave

VHF / UHF Multiband Vertical



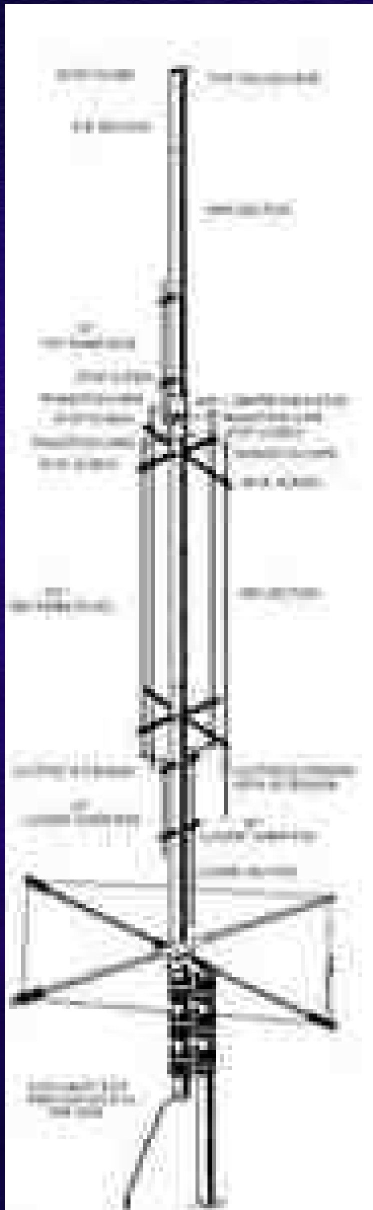
¼ (Quarter) Wave

Multiband HF Vertical



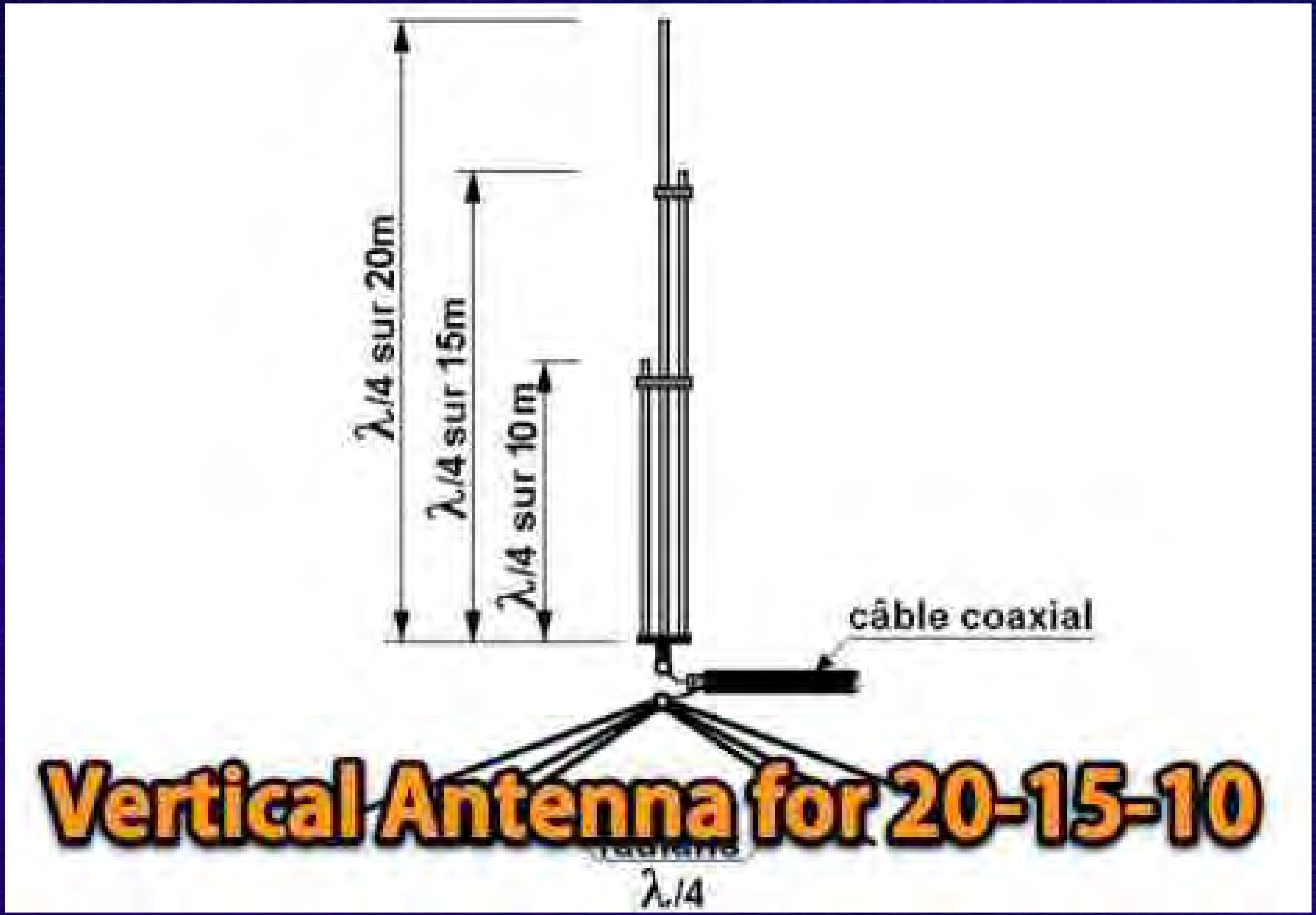
¼ (Quarter) Wave

Multiband HF Vertical



¼ (Quarter) Wave Hatted

Multiband HF Vertical



¼ (Quarter) Wave

It's Just a Place to Start

73

Sources

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