Antennas

Basic Amateur Radio Course

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What do Antennas actually do?

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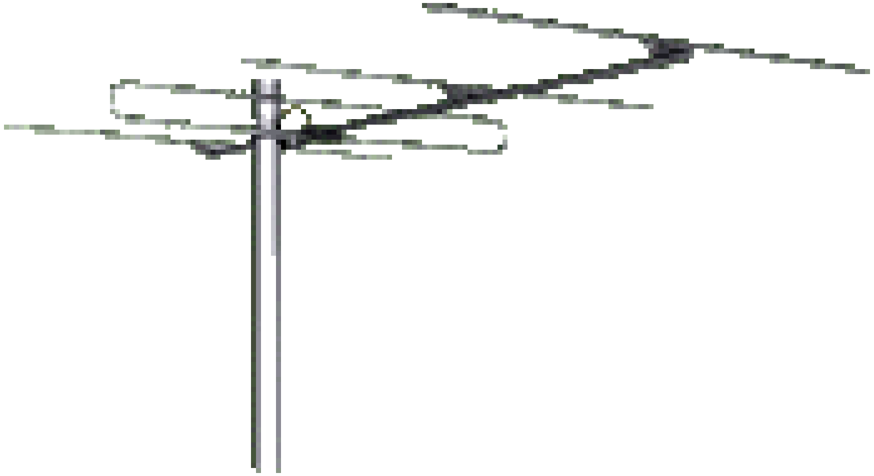
- They convert **Radio Frequency (RF)** energy from the transmitter into **radio waves** which are in turn **radiated** by the antenna into space.



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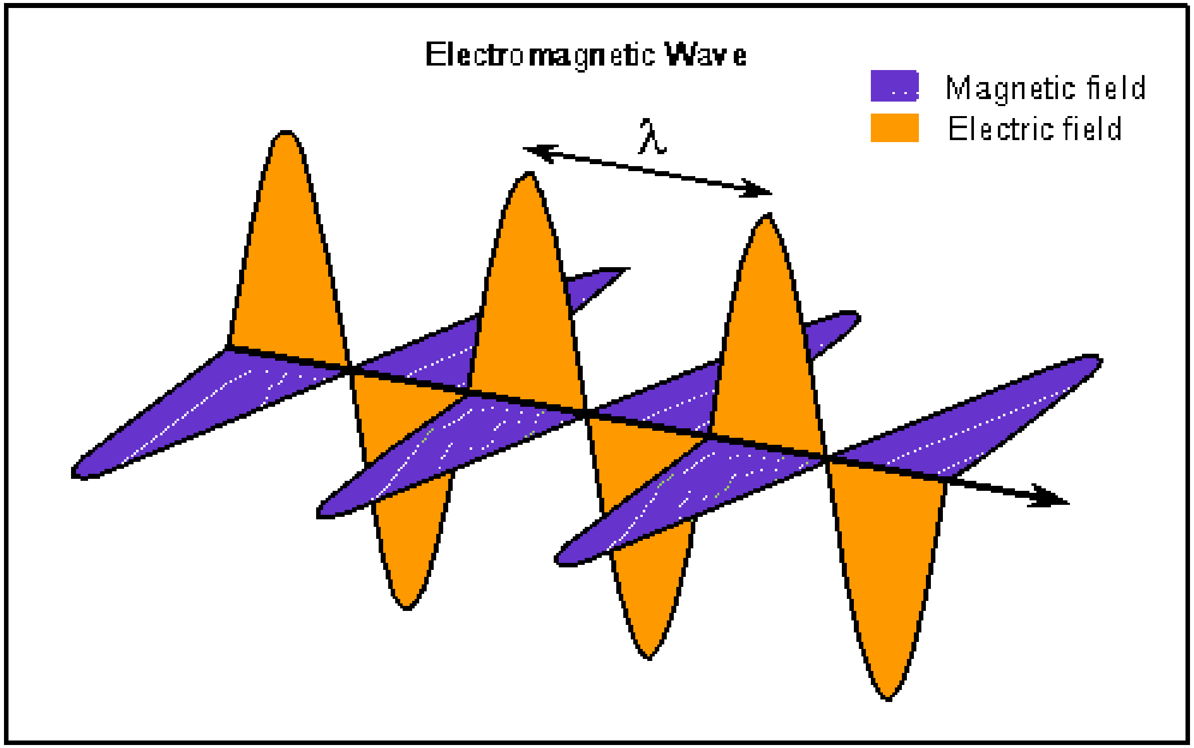
What do Antennas actually do?

- They convert **Radio Frequency (RF)** energy from the transmitter into **radio waves** which are in turn **radiated** by the antenna into space.
- They also convert **radio waves** from free space into **electrical current** which is transformed into information by the radio.

Electromagnetic Waves



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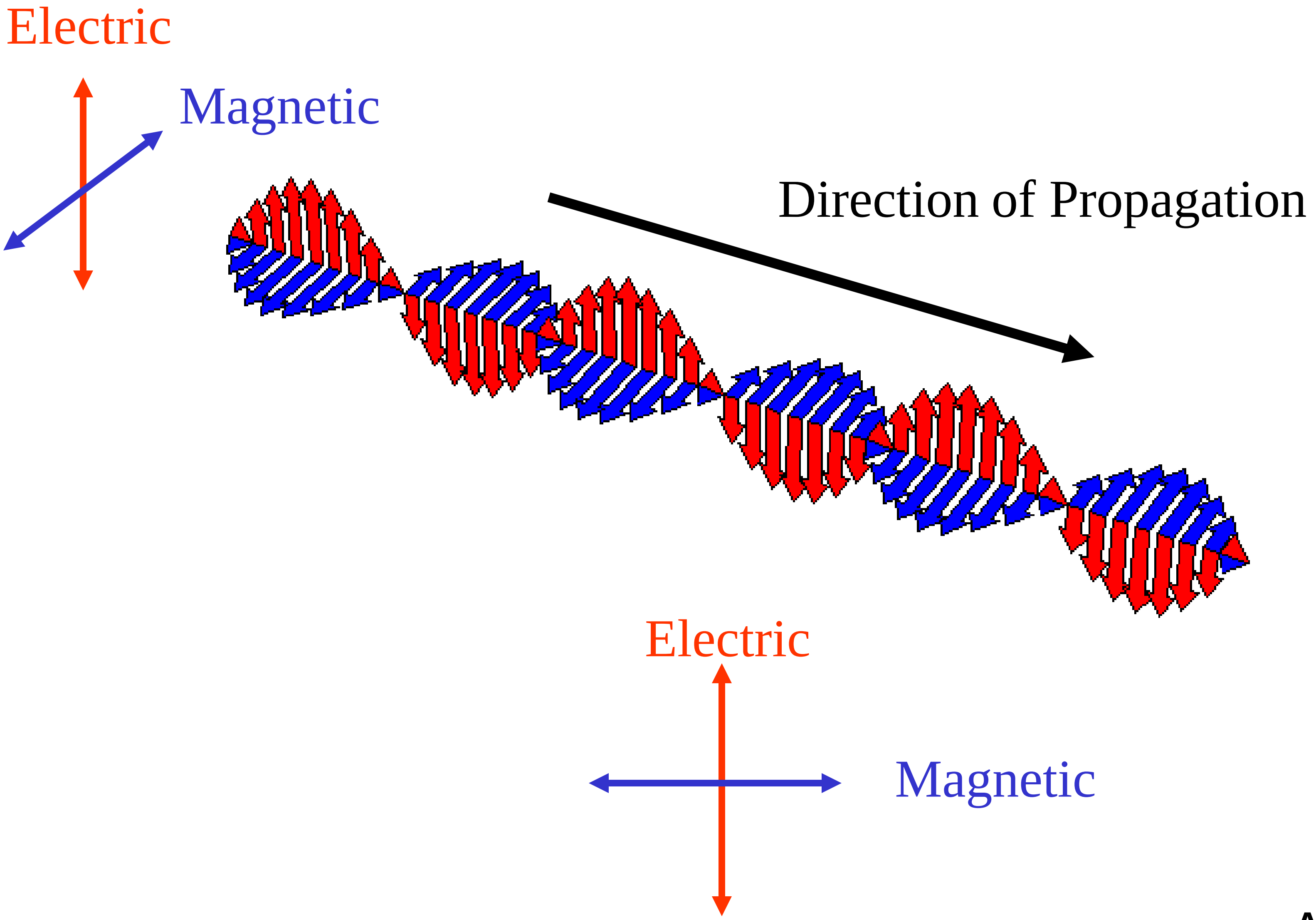
Electromagnetic Waves

- Composed of an **Electric Field (“E”)** and a **Magnetic Field (“H”).**
- **E and H fields are transverse** – ie: they are at right angles to the direction of propagation of the wave.
- **E and H fields** are **mutually perpendicular.**
- The two fields are **in phase.**
- **Velocity** of an EM Wave is the **speed of light.**
- **Polarization** of the **EM wave** is defined by the orientation of the **E field.**
- **Circular Polarization** is also possible.



Electric

Magnetic

Direction of Propagation

Electric

Magnetic

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Antenna Impedance

- Just as with Transmission Lines, Antennas have an **Impedance** at their **Feedpoint.**
- Consists of at least two, sometimes three components:
  - **Ohmic Resistance**;
  - **Radiation Resistance**; and
  - **Reactance.**

Ohmic Resistance

- This is a **measure of the RF energy** that is **transformed into heat** instead of being radiated as an electromagnetic wave.
- Caused by the **actual ohmic losses** in the wire or metal that makes up the antenna.
- Also caused by ohmic losses from **nearby conductors, including the earth.**
- Also referred to as **Heat Loss.**
- A **resistor** with the same value as the Ohmic resistance would **radiate the same amount of heat.**

Radiation Resistance

- This is a measure of the **RF energy** that is **actually transmitted** into free space by the antenna.
- Radiation Resistance **decreases** as antennas are made **physically smaller**.
- Usually much **greater than Ohmic Resistance**, but can be small in physically small antennas.
- A **resistor** with the same value as the Radiation Resistance would **absorb the same amount of energy as is radiated by the antenna.**

Antenna Efficiency

- Naturally, the **greater the percentage of RF energy that is radiated** as an EM wave, the **more efficient the antenna**.

- **Efficiency =** $\mathbf{R_{rad} / R_{rad} + R_{ohmic}}$

- As long as $\mathbf{R_{rad}}$ **is relatively larger than** $\mathbf{R_{ohmic}}$ the antenna will be **reasonably efficient.**

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Reactance (1)

- At **Resonance**, antenna **feedpoint impedance is purely resistive**, ie: it is composed of the sum of Radiation Resistance and Ohmic Resistance.
- If **used on any other frequency** however, **Reactance** becomes a component of feedpoint impedance.
- *Reactance – The opposition to the flow of Alternating Current (AC) in a circuit by storage in an electric field (for a capacitor) or a magnetic field (by an inductor). Measured in ohms.*

Reactance (2)

- **Below the Resonant Frequency**, feedpoint impedance consists of resistance and **capacitive reactance.**
- **Above the Resonant Frequency**, feedpoint impedance consists of resistance and **inductive reactance.**

Reactance (3)

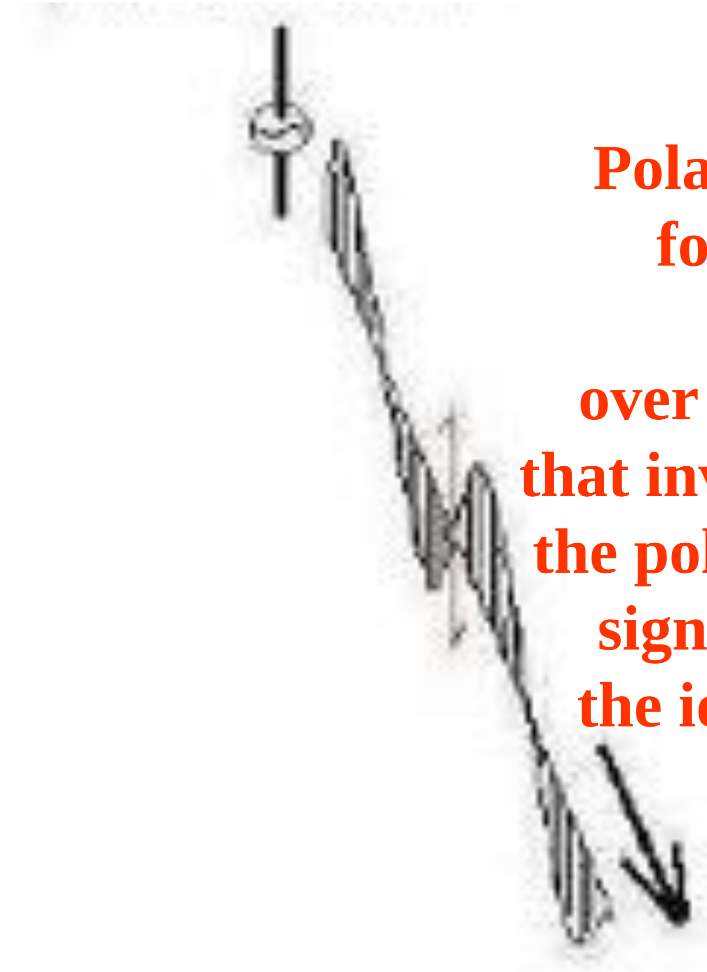
- **Reactance** does not absorb or radiate power, but can cause an **impedance mismatch** between the antenna and feedpoint.
- Reactance **can be eliminated** using capacitance or inductance, leaving just the resistive component.
- **An antenna does not have to be resonant to radiate!**

Typical Antenna Impedances

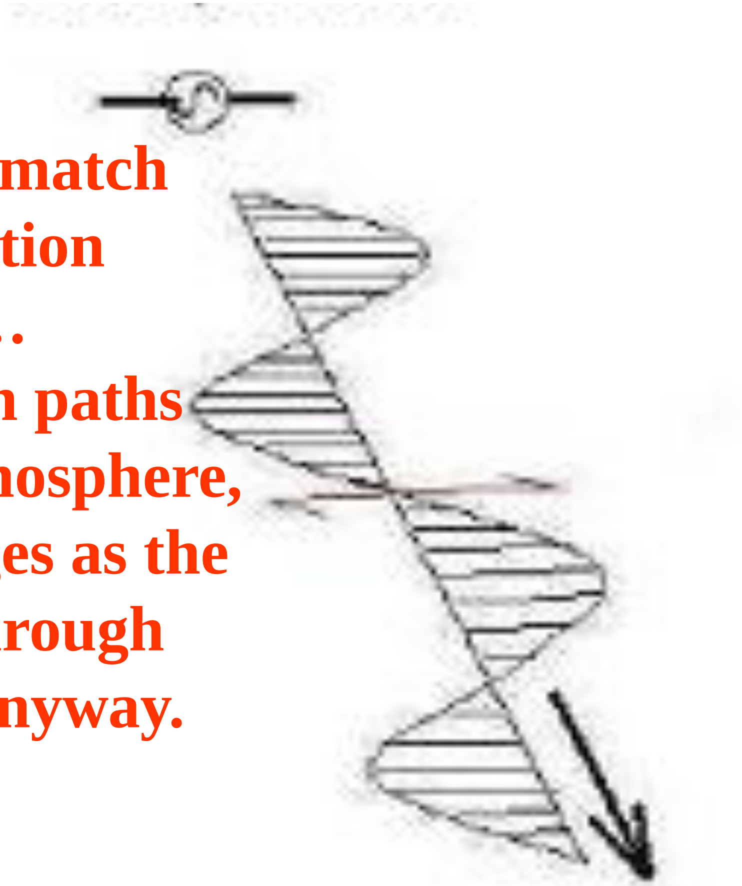
- Dipole, free space: 73 Ohms
- Inverted V: 50 Ohms
- Folded Dipole: 300 Ohms
- Yagi Driven Element: 25 Ohms
- Quarter Wave vertical: 36 Ohms
- Rhombic: 600 Ohms

Antenna Polarization

Vertical Polarization

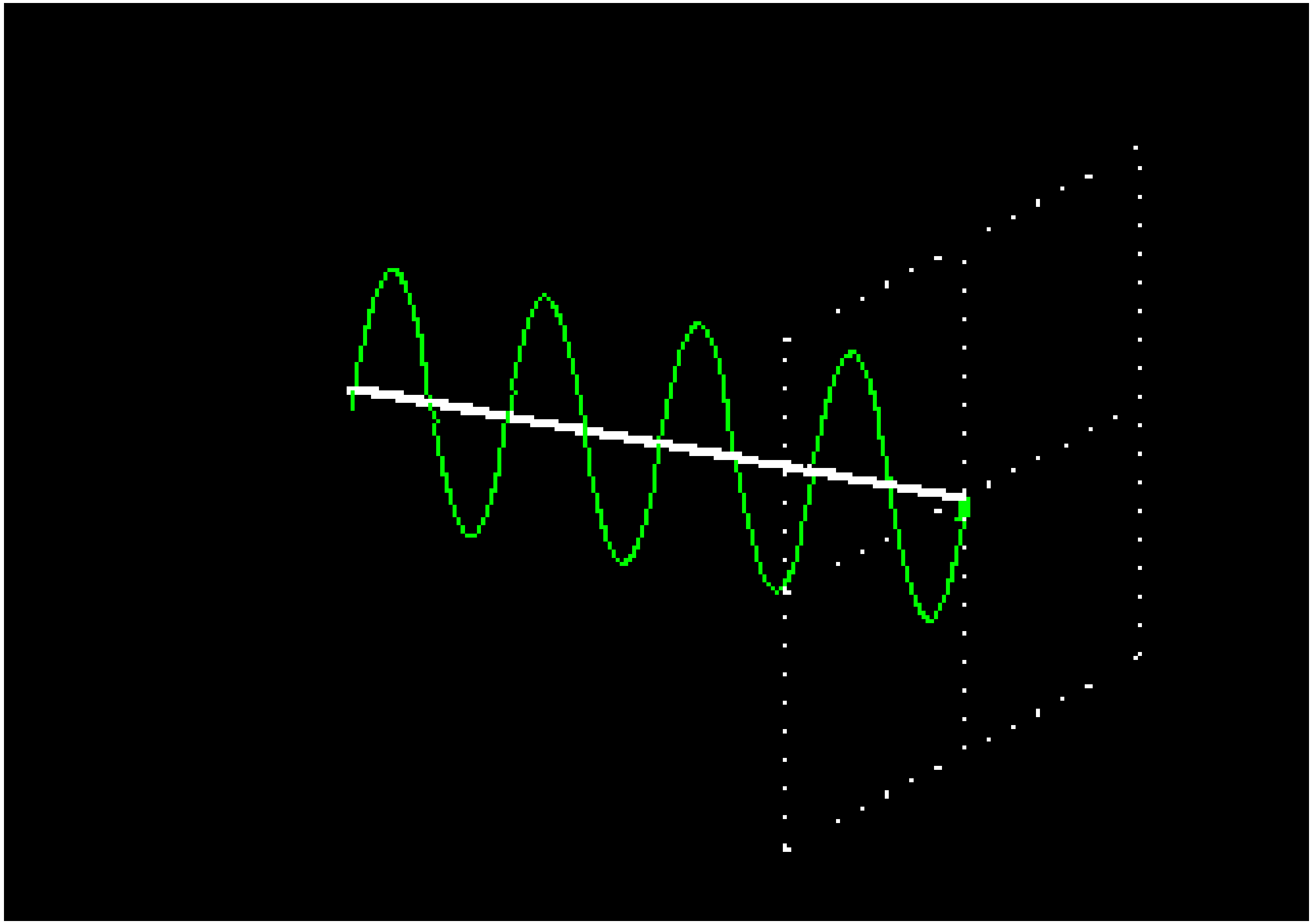


Horizontal Polarization



Polarity should match
for best reception
EXCEPT…
over propagation paths
that involve the ionosphere,
the polarity changes as the
signal travels through
the ionosphere anyway.

Vertical Polarization



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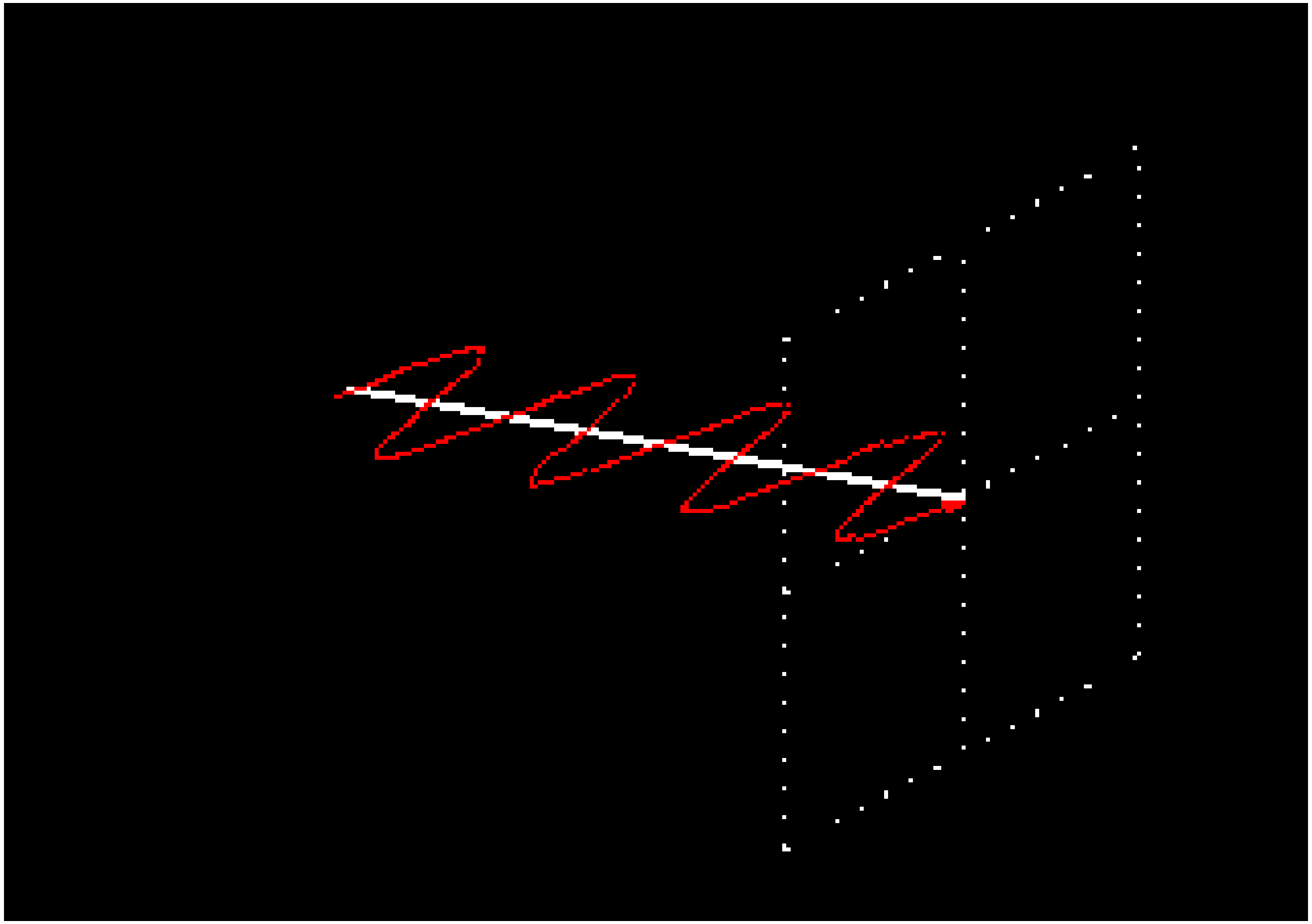
Horizontal Polarization



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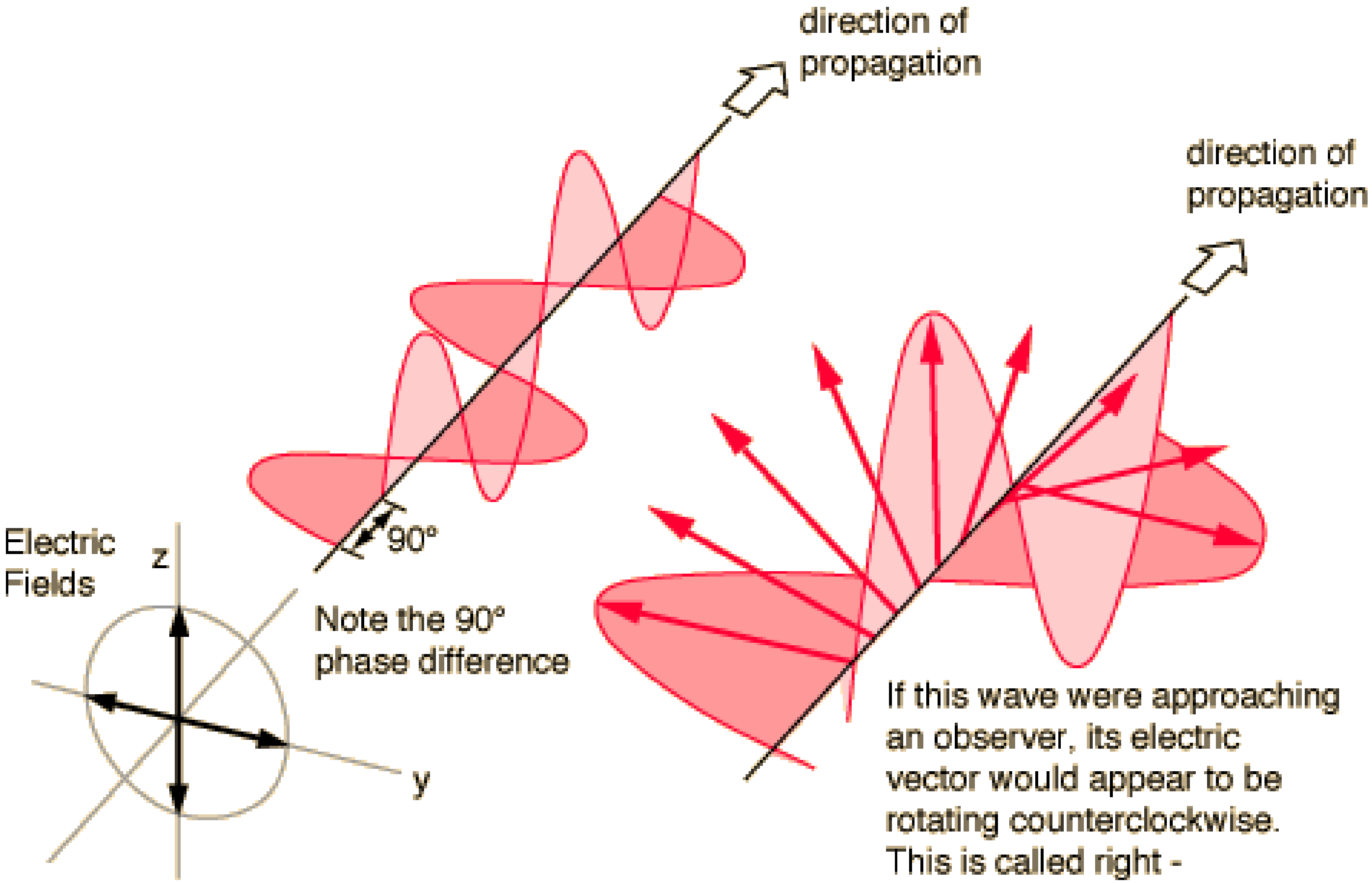
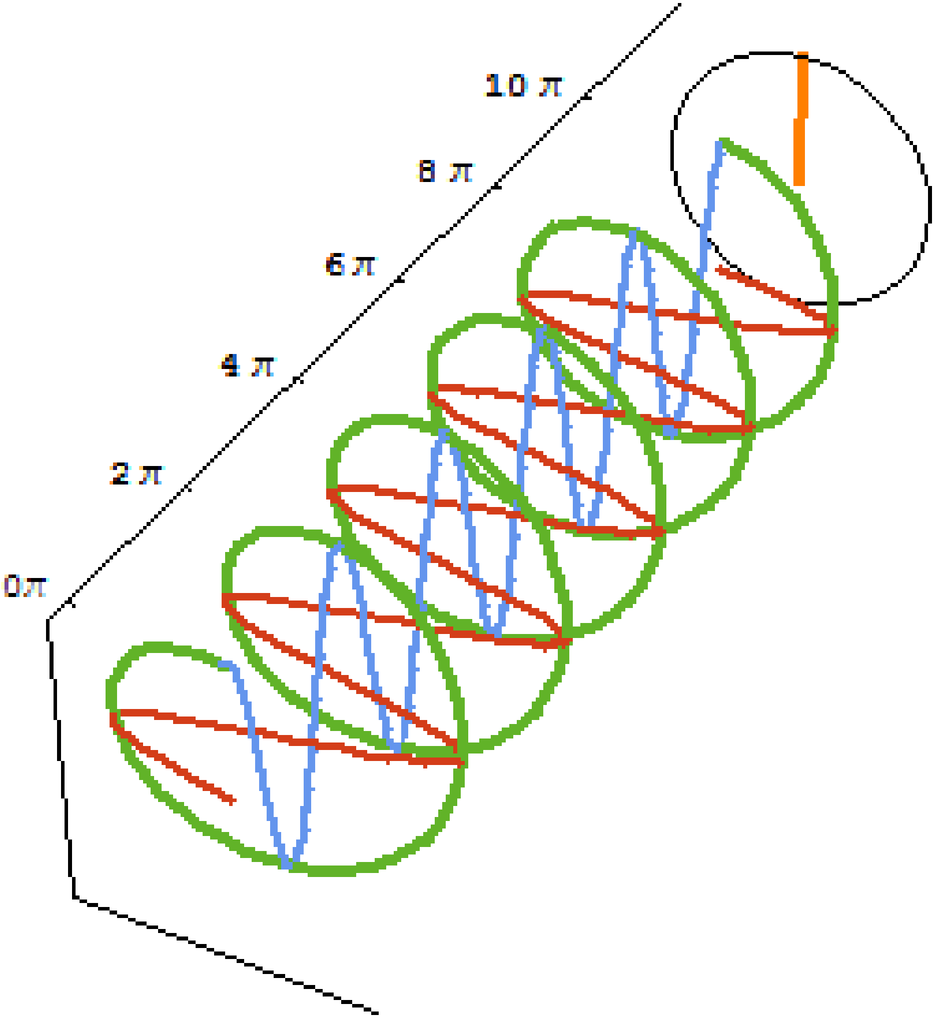
Circular Polarzation



Note the 90° phase difference

If this wave were approaching an observer, its electric vector would appear to be rotating counterclockwise. This is called right - circular polarization.

Circular Polarzation



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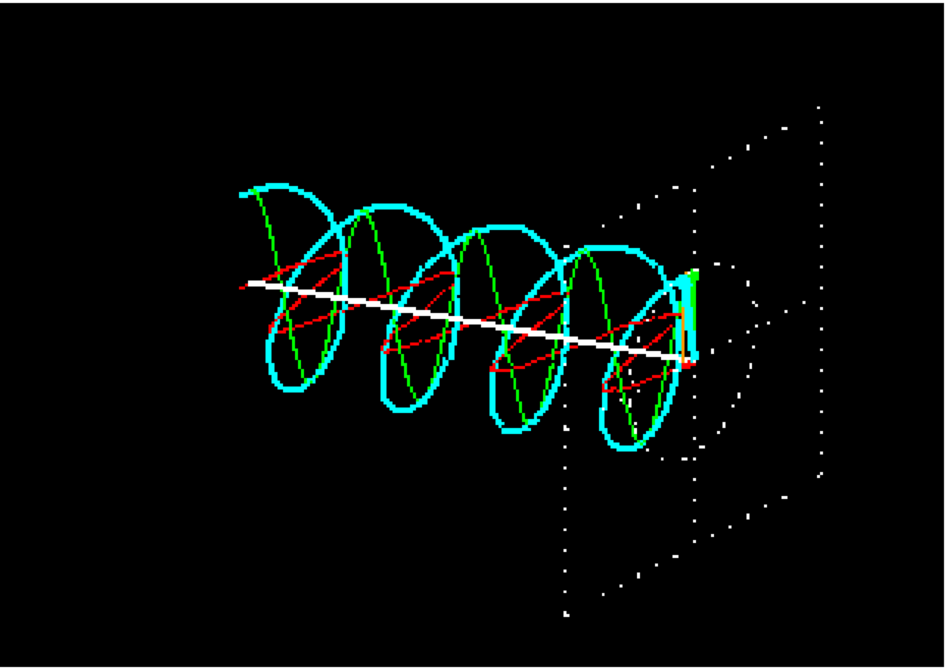
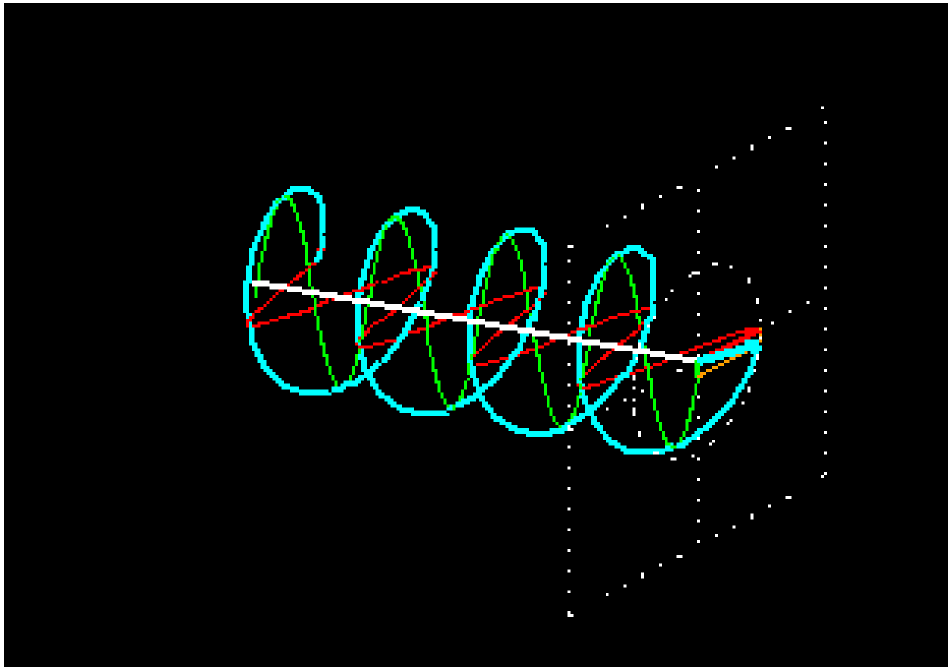
Circular Polarzation



Left-Hand Circular Polarization



Right-Hand Circular Polarization

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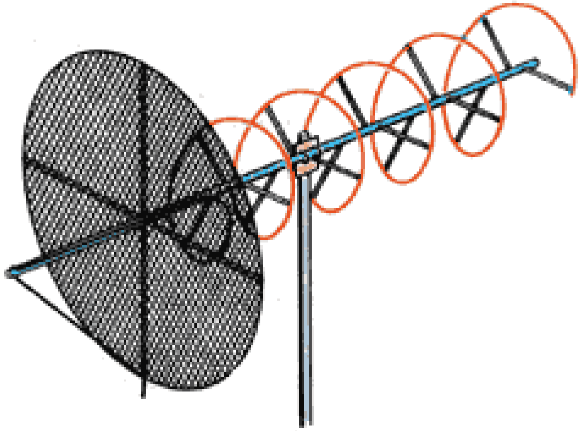
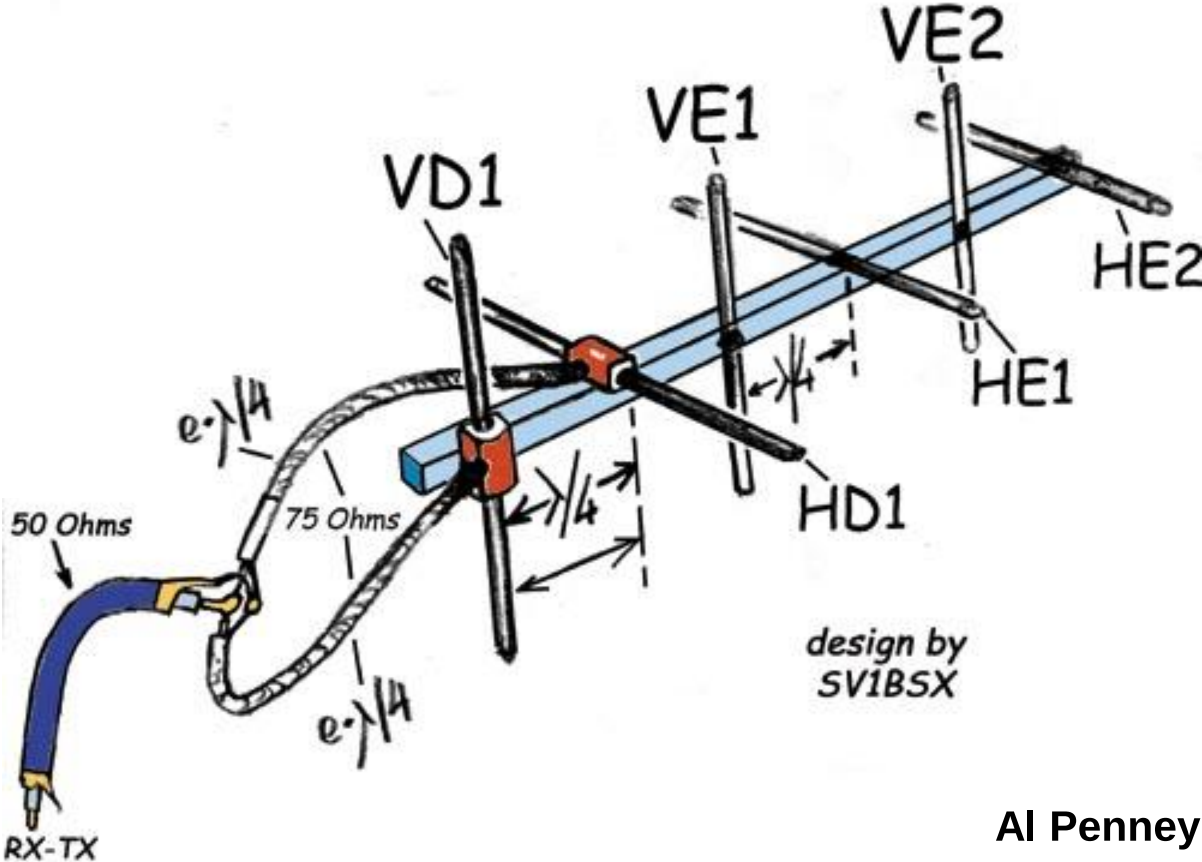
Circular Polarization Methods

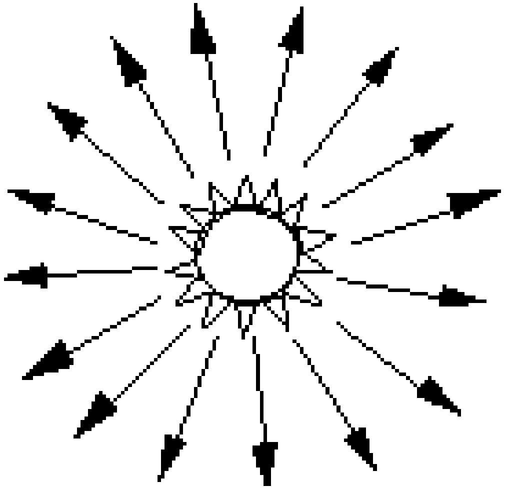




design by SV1BSX

Isotropic Radiator

- An **imaginary** perfect antenna that **radiates equally well in all directions.**
- Used as a **base of comparison** for real antennas.
- Imagine the Sun.



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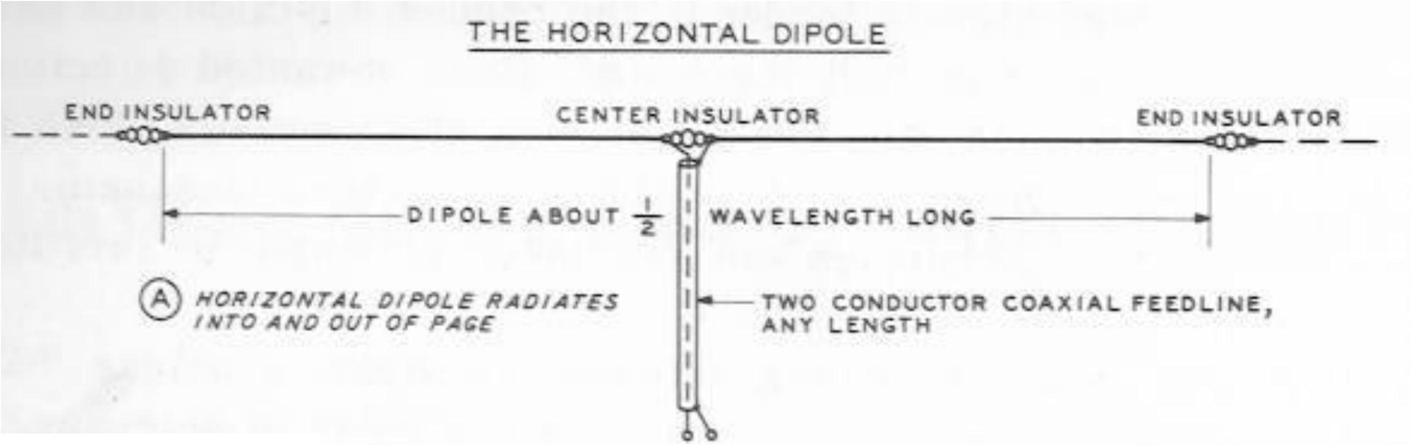
Dipole Antenna (1)

- The **half-wave dipole** antenna is an **efficient** and commonly used **practical antenna.**
- It is also used as a **comparison antenna** for gain measurements, using the term **dBd.**
- Because it **does not radiate equally well** in all directions though, it has **2.15 dB gain** compared to an isotropic antenna.
  - *Therefore Gain of a Dipole Antenna dBd = 2.15 dBi*
  - *Note that this is in free space – the presence of the Earth will change the radiation pattern of a dipole.*

Dipole Antenna (2)



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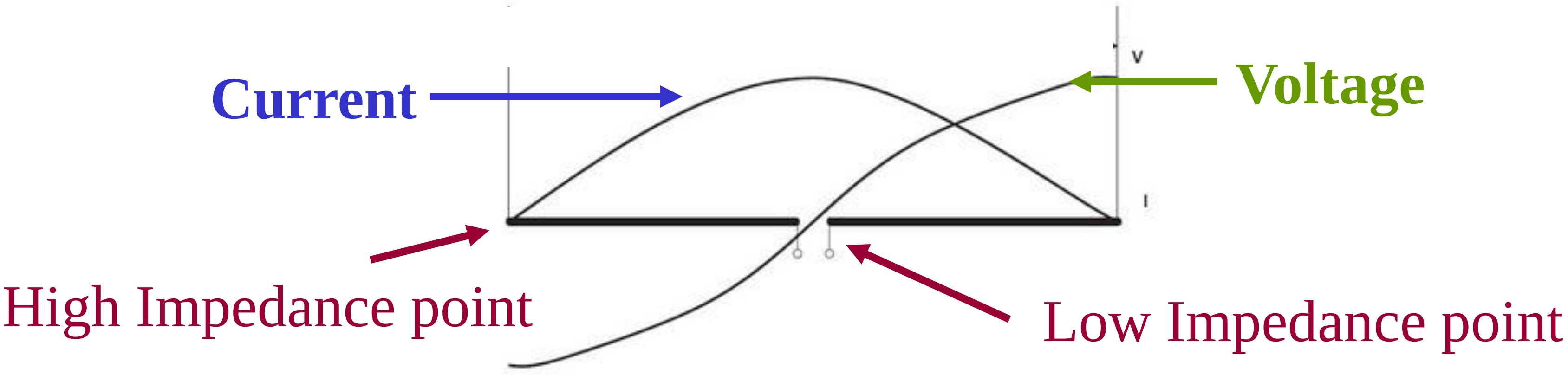
Dipole Antenna (3)



Current

Voltage

High Impedance point

Low Impedance point

Figure. Half-Wave Dipole Antenna

- **Antenna current** is **high in the center** of the dipole, and **low at the ends.**
- **Voltages** are **high at the ends** of the dipole, and **low in the center.**
- **Center is a Low Impedance point**, while the **tips are High Impedance points.**

Antenna Gain

- A measure of the **antenna’s ability to concentrate the radiated signal** into a beam.
- Defined as the **ratio between the power** required by a **reference antenna** to produce a signal at a given location to the power required by the **real antenna** to produce the same signal in the same location.
- Always indicated as a **comparison to a standard reference antenna**, usually an **Isotropic Antenna**, or a **Dipole Antenna.**
- Gain is measured in **Decibels (dB).**

Decibels (1)

- The **ratio of two power levels** can be expressed using **decibels.**
- Antenna Gain = 10 Log Power $_{\text{ref ant}}$ / Power $_{\text{real ant}}$
- When using decibels, gain can be **added and subtracted.**
- Despite (or actually because of!) the logarithms, this is actually a **very simple system to use!!**

Decibels (2)

- Every **3 dB change double or halves** the power.
- Every **10 db change** increases or decreases the power by **10 times.**

- *Example: An amplifier advertises that it can increase your transmit power by 6 db. If your transmitter is 50 watts, what is the output power of the amplifier?*
  - 6 db is 3 db + 3 db.
  - The first 3 db doubles your power: 50 watts x 2 = 100 watts
  - The second 3 db doubles it again: 100 watts x 2 = 200 watts

Decibels (3)

- *Example: Your feedline has 3 db loss on 2 meters. The antenna, a long boom Yagi, has a gain of 13 db compared to an isotropic antenna. If your transmitter power is 150 watts, what is your effective radiated power?*
  - 3 dB loss in the feedline = 150 watts/2 = 75 watts
  - 13 dB gain in the antenna = 10 db + 3 db
  - 10 db gain gives 75 watts x 10 = 750 watts
  - Next 3 dB gain gives 750 watts x 2 = 1500 watts
- Therefore, 150 watts into this particular antenna system is the equivalent of 1500 watts into an isotropic antenna.

Decibels (4)

- Another way to do this is to add the gain and loss of each component, and apply it to the transmitter power:
  - -3 dB + 13 dB = 10 dB gain overall compared to an isotropic antenna.
  - 10 dB gain with 150 watt transmitter gives
    150 watts x 10 = 1500 watts compared to an isotropic antenna.
- So the answer is the same no matter how the dB calculations are made.

Decibels (5)

dB	**Power Chng**
1	1.25
2	1.58
3	2.0
4	2.5
5	3.15
6	4.0
7	5.0
8	6.3
9	8.0

dB	**Power Chng**
10	10.0
11	12.6
12	15.8
13	20.0
14	25.1
15	31.6
20	100
30	1,000
40	10,000

Radiation Patterns

- Most antennas **do not transmit/receive equally well in all directions,** either in azimuth or in elevation above the horizon.
- To illustrate this behavior, we use **radiation plots.**

Radiation Patterns

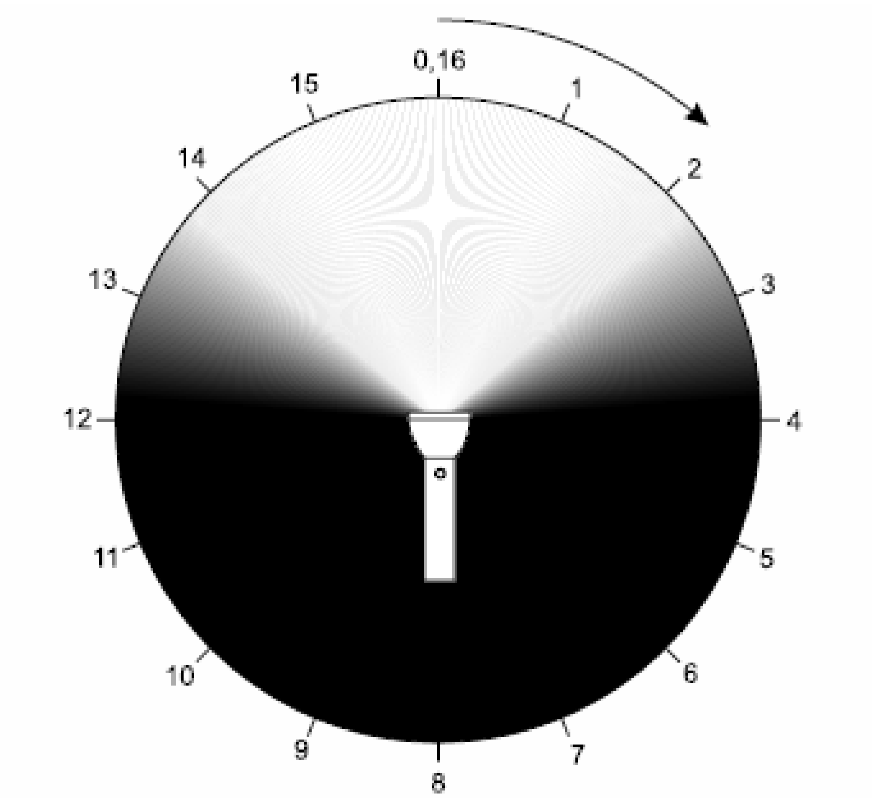


Fig 9—The beam from a flashlight illuminates a totally darkened area as shown here. Readings taken with a photographic light meter at the 16 points around the circle may be used to plot the radiation pattern of the flashlight.

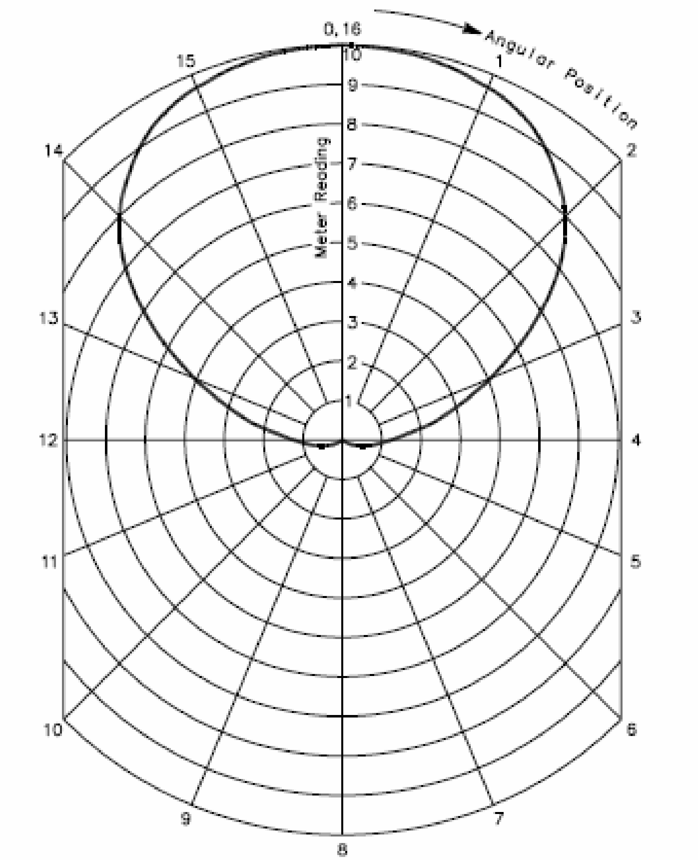
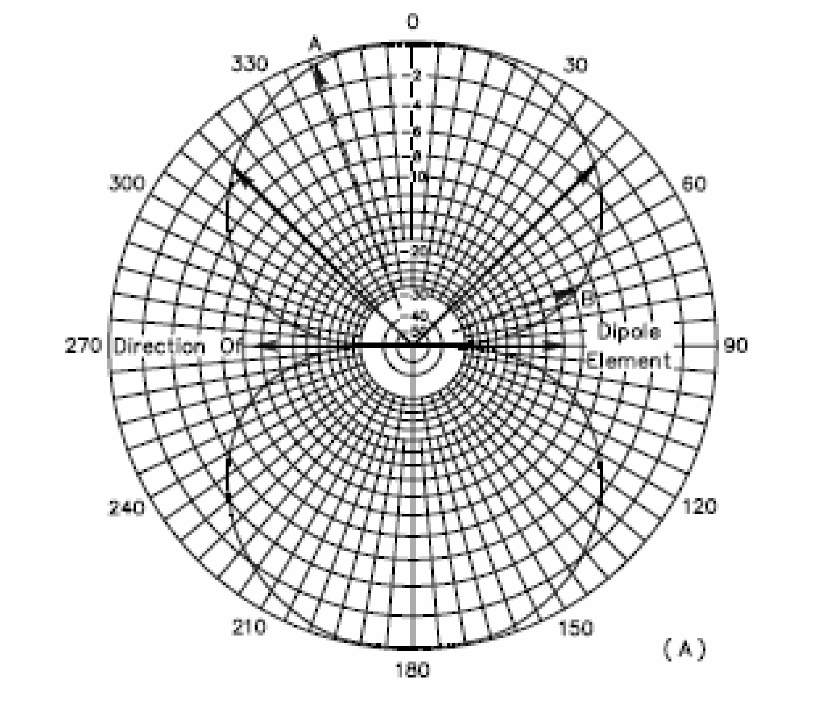
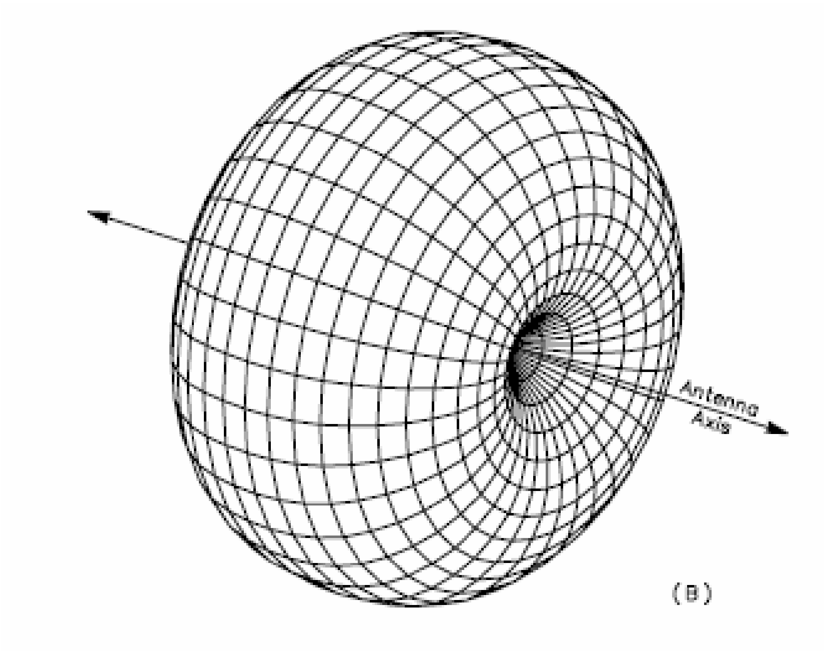


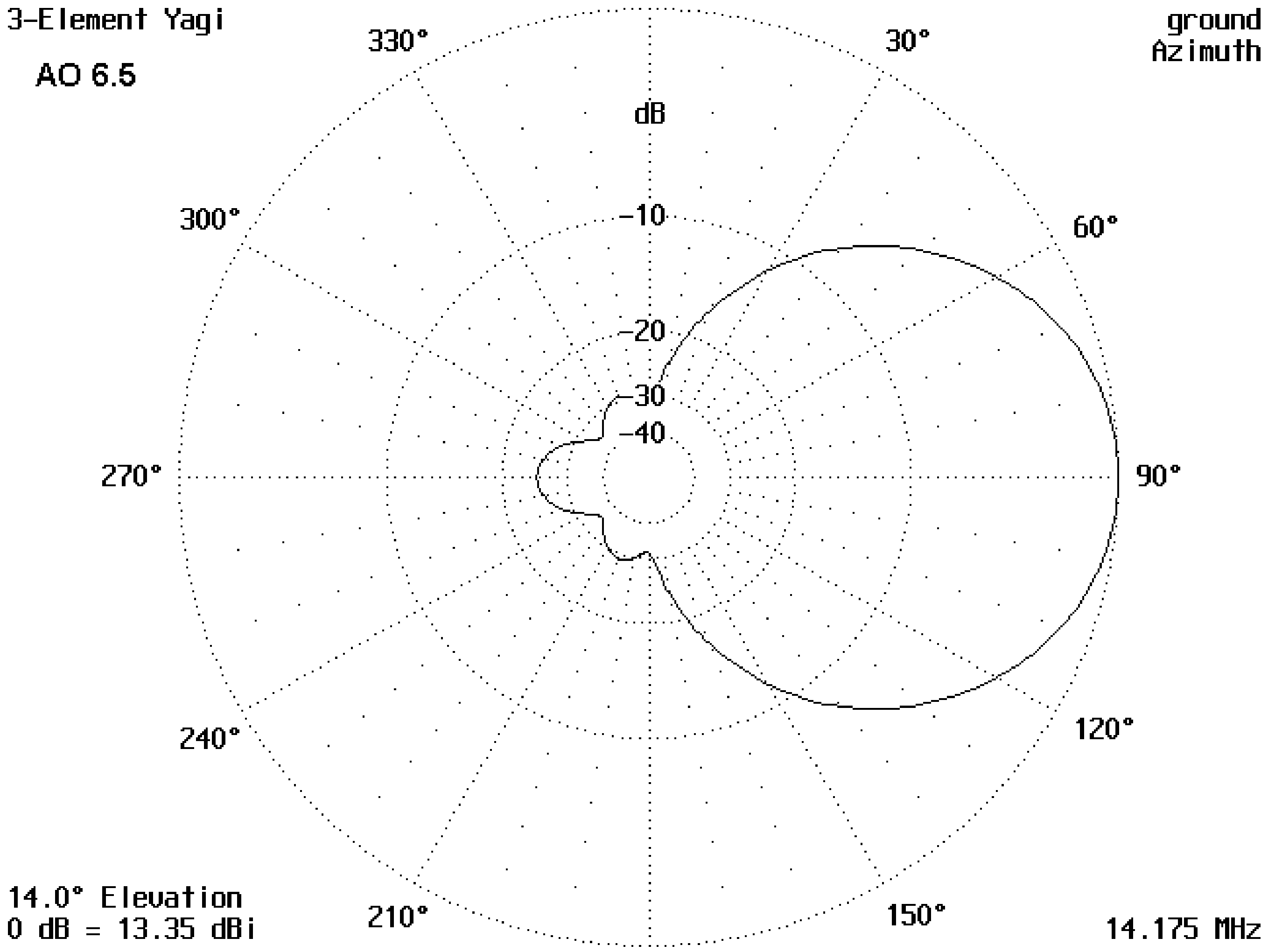
Fig 10—The radiation pattern of the flashlight in Fig 9. The measured values are plotted and connected with a smooth curve.

Dipole Radiation Plot
(in Free Space)





Radiation Pattern – 3 Element Yagi



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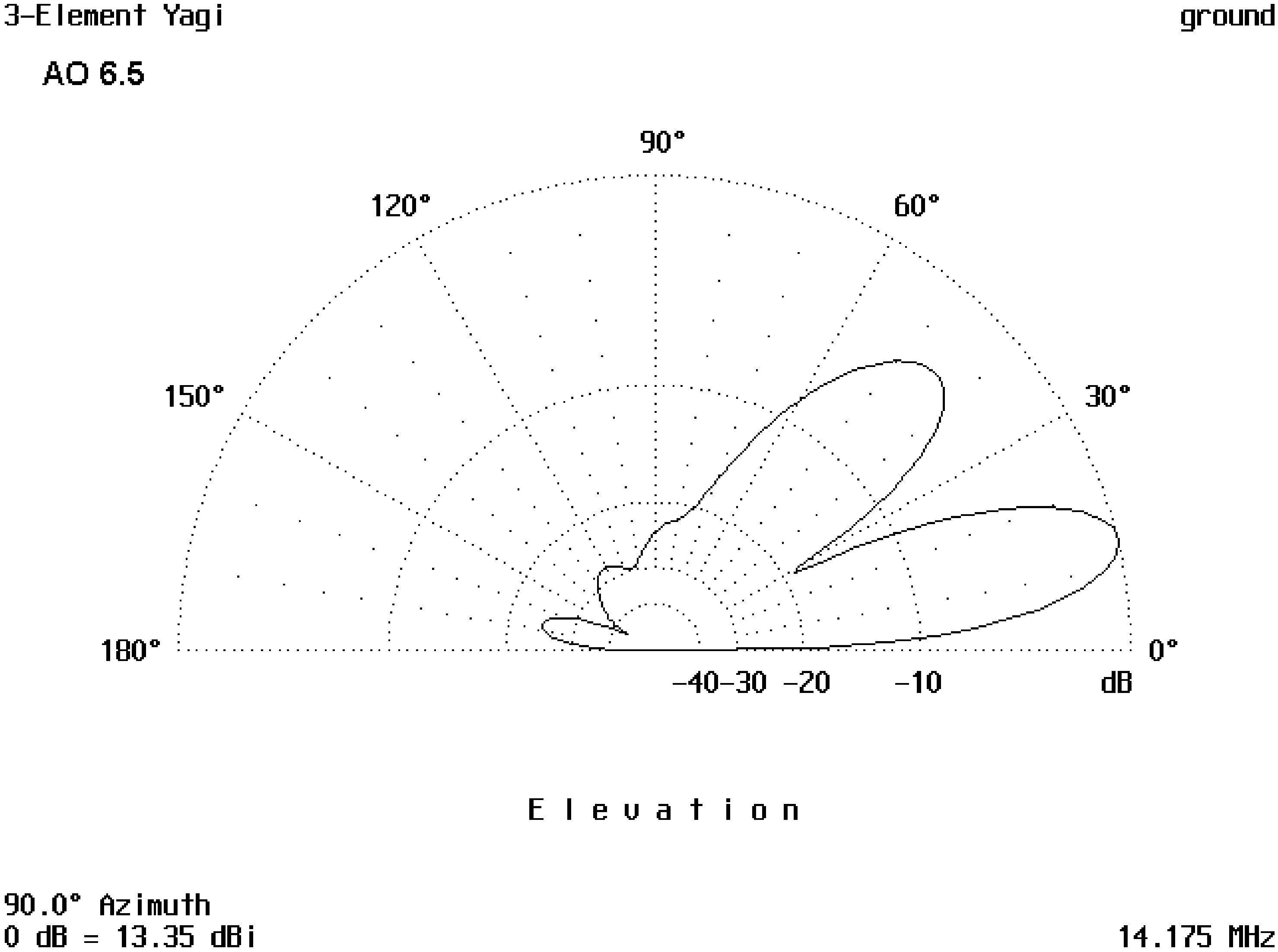
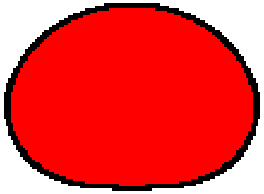
Radiation Pattern – 3 Element Yagi



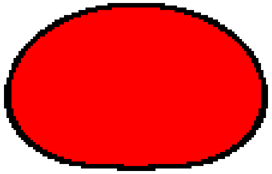
Real Life Antennas…

- In **real life** however, we have to consider the **effect of the Earth** on the **antenna pattern.**
- Energy **reflected off the ground** reinforces the antenna’s radiation pattern in some areas, and weakens it in others.
- A **dipole over salt water** might have as much as **6 dB gain** over a dipole in free space!
- The lesson to be learned here is that before comparing gain figures, you must ensure that you have **taken everything to the same baseline!**

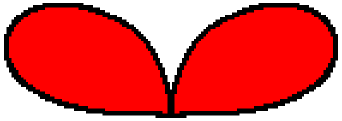
Effect of Height on a Dipole Antenna Radiation Pattern



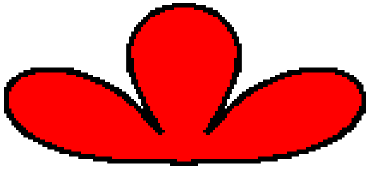
1/8λ high



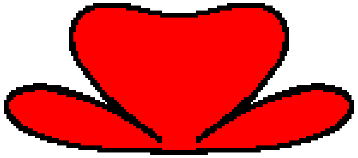
1/4λ high



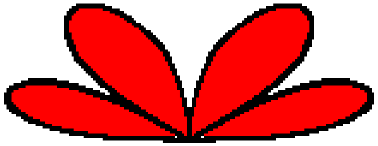
1/2λ high



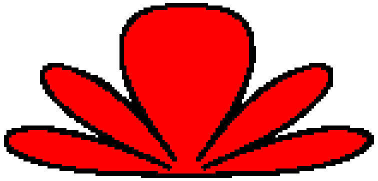
5/8λ high



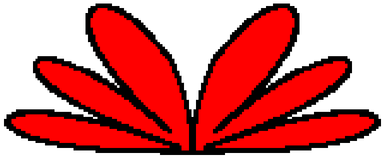
7/8λ high



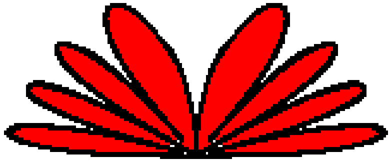
1λ high



1.25λ high

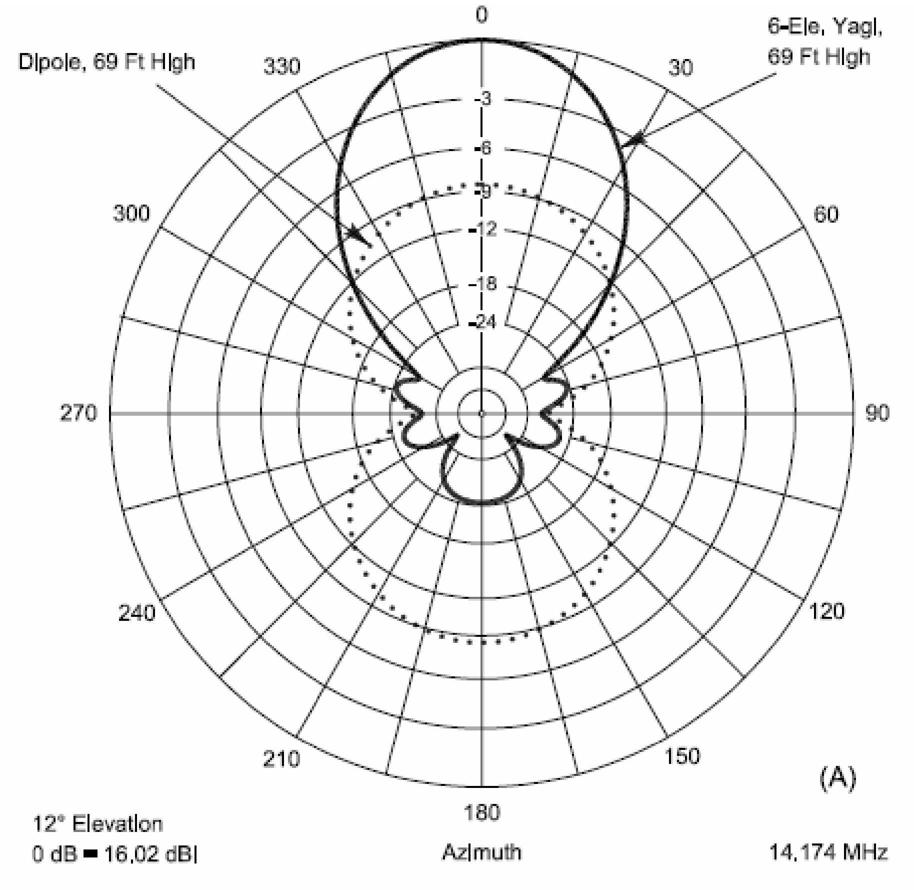


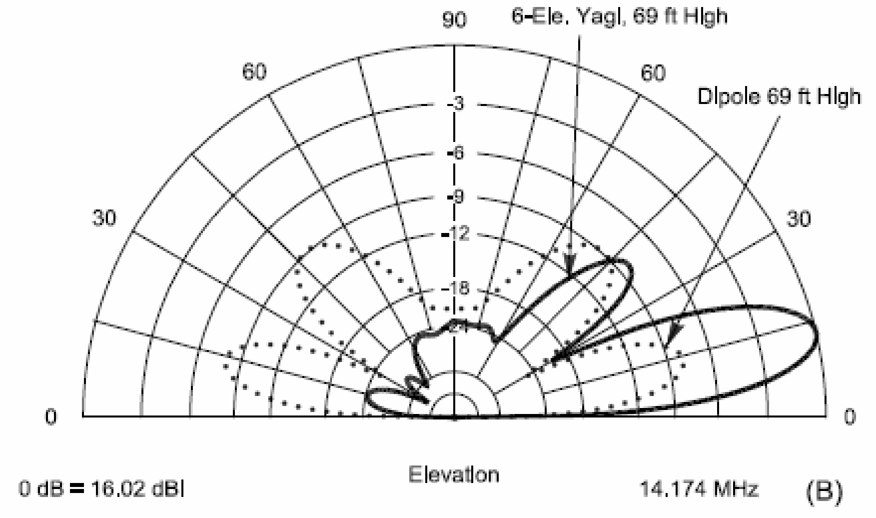
1.5λ high



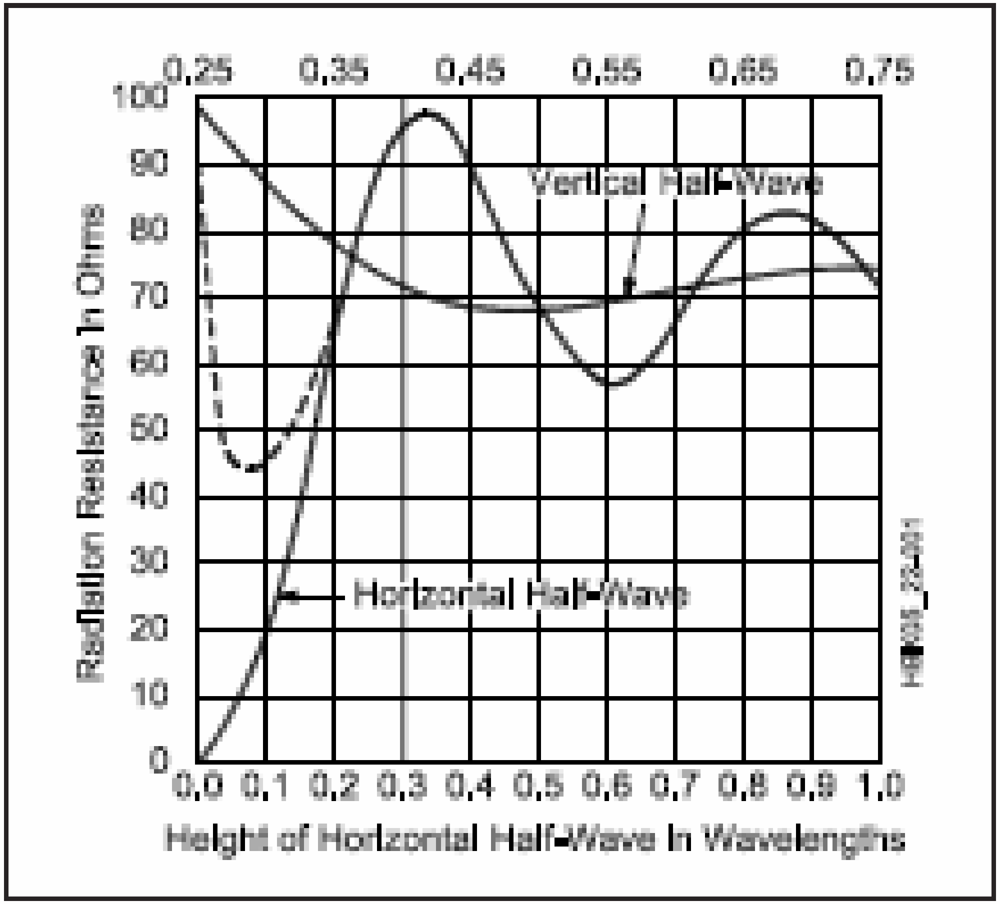
2λ high

6 Element Yagi vs Dipole





Effect of Height on a Dipole Antenna Impedance



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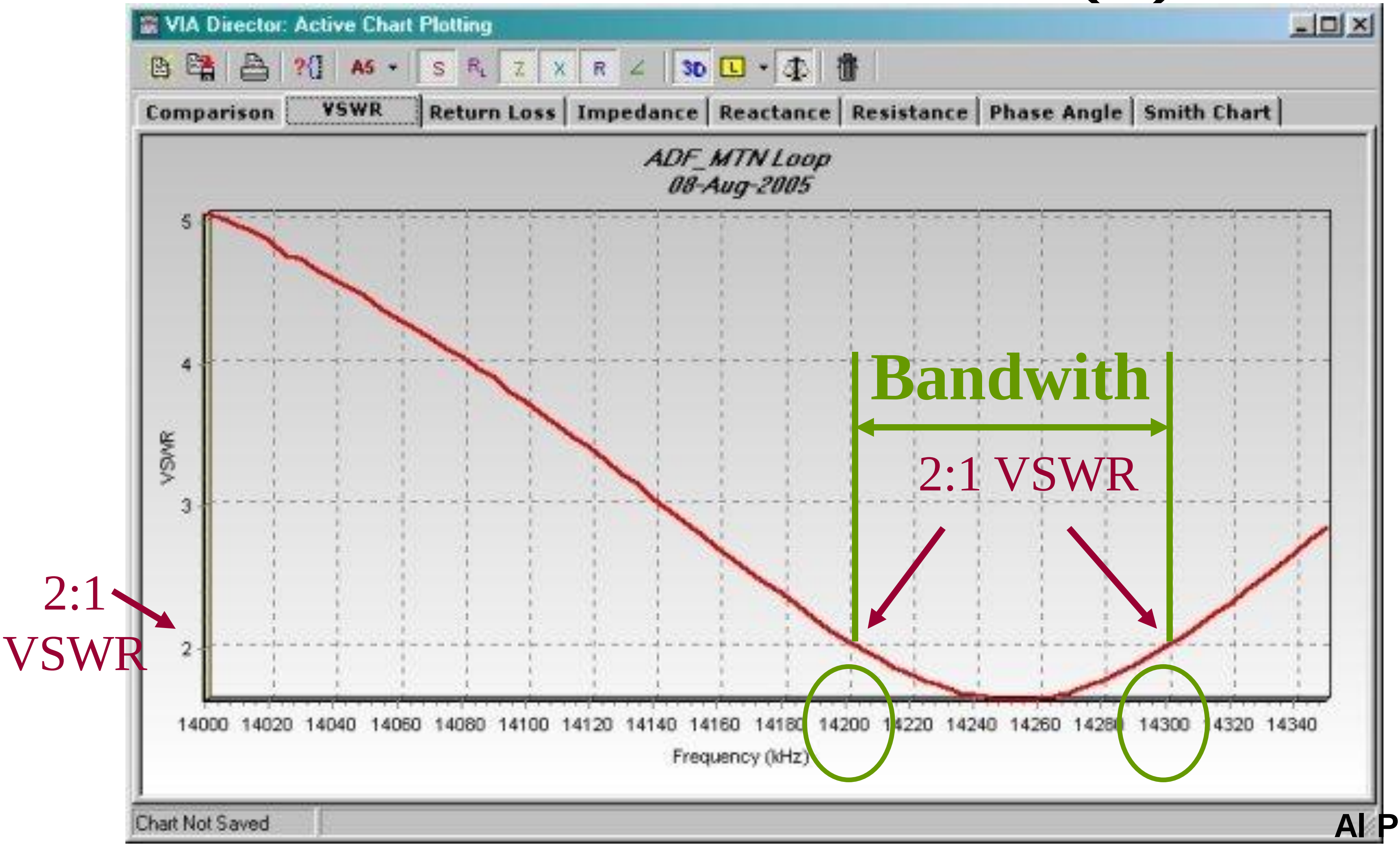
Antenna Bandwith (1)

- Defined as the **frequency span** where **VSWR is 2:1 and below.**
- For a given antenna, a **larger diameter** of the antenna wire/tubing will give greater bandwith.
- Difficult for a single dipole to cover the entire 80 meter band for example (3.5 – 4.0 MHz).

Antenna Bandwith (2)



Bandwith

2:1 VSWR

2:1 VSWR

Antenna Length (1)

- In free space wavelength **λ (meters) = 300/f (MHz).**
- But, the electrical length of a conductor is affected by:
  - **Speed of EM wave** in that conductor;
  - **Diameter/length ratio** of the conductor; and
  - **End effect of the insulators.**
- All these factors **tend to shorten the antenna** with respect to free space.
- On VHF and UHF antennas, the last factor does not affect antenna length appreciably.
- Therefore need to use **different equations for HF and VHF/UHF antenna lengths.**

Antenna Length (2)

- **Above 30 MHz:**
  - – λ (meters) = 300 / freq (MHz)
  - – λ /2 (meters) = 150 / freq (MHz)
- **Or**
  - – λ (feet) = 984 / freq (MHz)
  - – λ /2 (feet) = 492 / freq (MHz)

Antenna Length (3)

- **Below 30 MHz:**
  - λ (meters) = 286 / freq (MHz)
  - λ /2 (meters) = 143 / freq (MHz)
- **Or**
  - λ (feet) = 936 / freq (MHz)
  - λ /2 (feet) = 468 / freq (MHz)
- **Remember:**
  - The higher the frequency, the shorter the antenna
  - The lower the frequency, the longer the antenna.

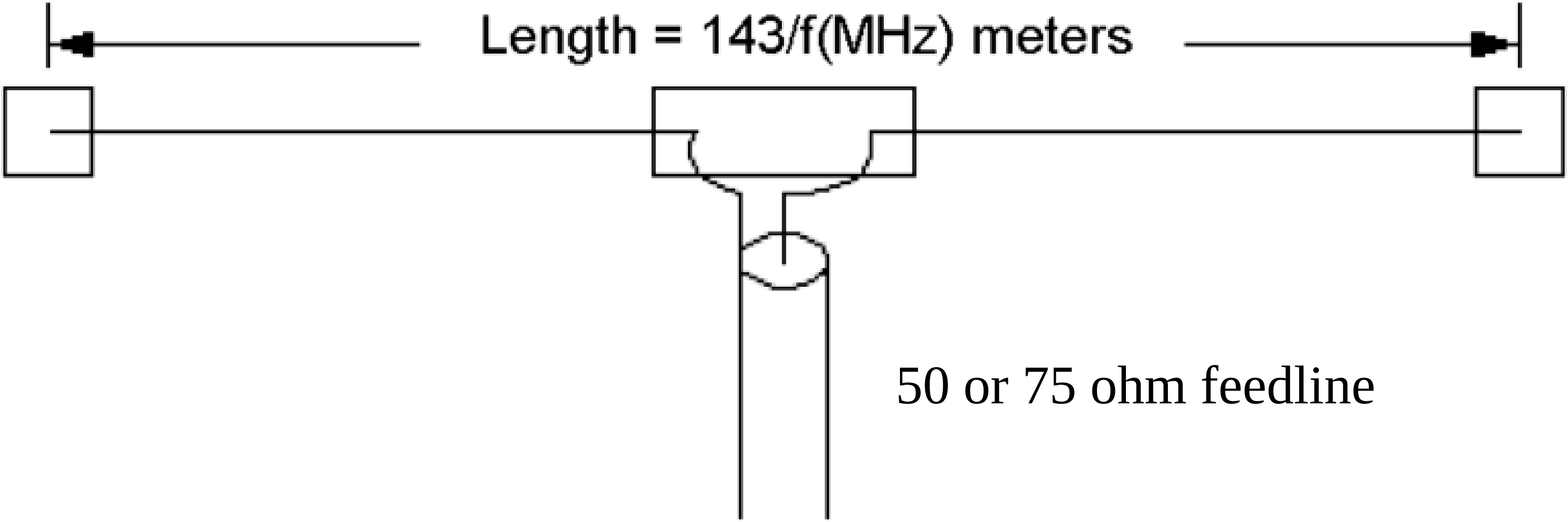
Practical Notes on Antenna Length

- Adding a **series inductor** to an antenna will **decrease** the **Resonant Frequency.**
- This is often used to make a **short vertical** antenna **appear “longer”** in an electrical sense.

Practical Dipole Antenna (1)

- Impedance approximately **73 ohms.**
- Advantages:
  - Cheap;
  - Easy to build;
  - Rugged; and
  - One feedline can serve several antennas.
- Disadvantages:
  - Narrow bandwith;
  - Requires 2 supports, sometimes 3;
  - Must be fed at center; and
  - One band only.

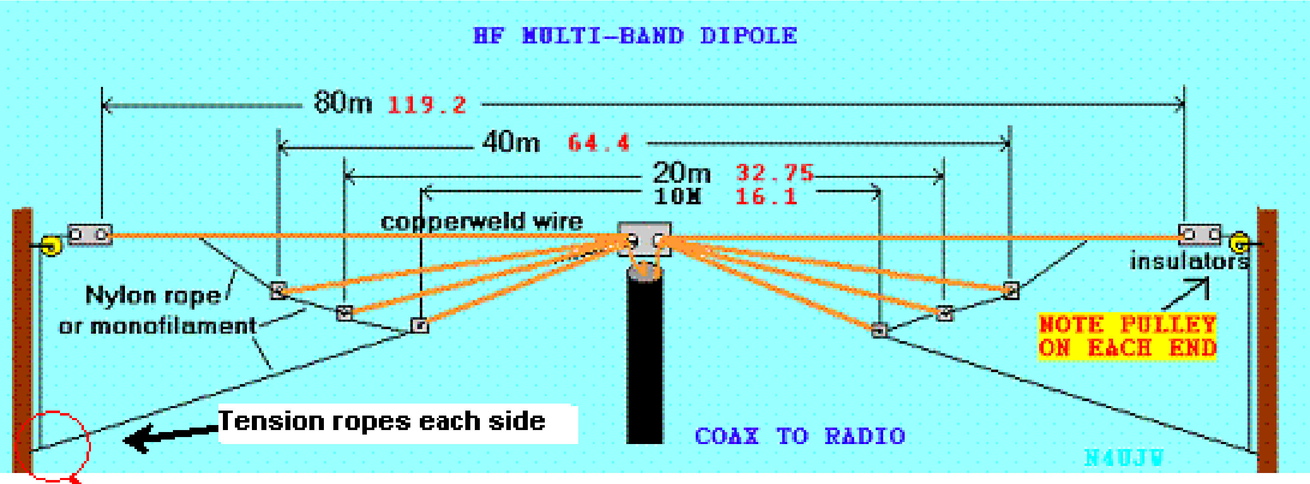
Practical Dipole Antenna (2)



50 or 75 ohm feedline

Note: Often called a Doublet Antenna

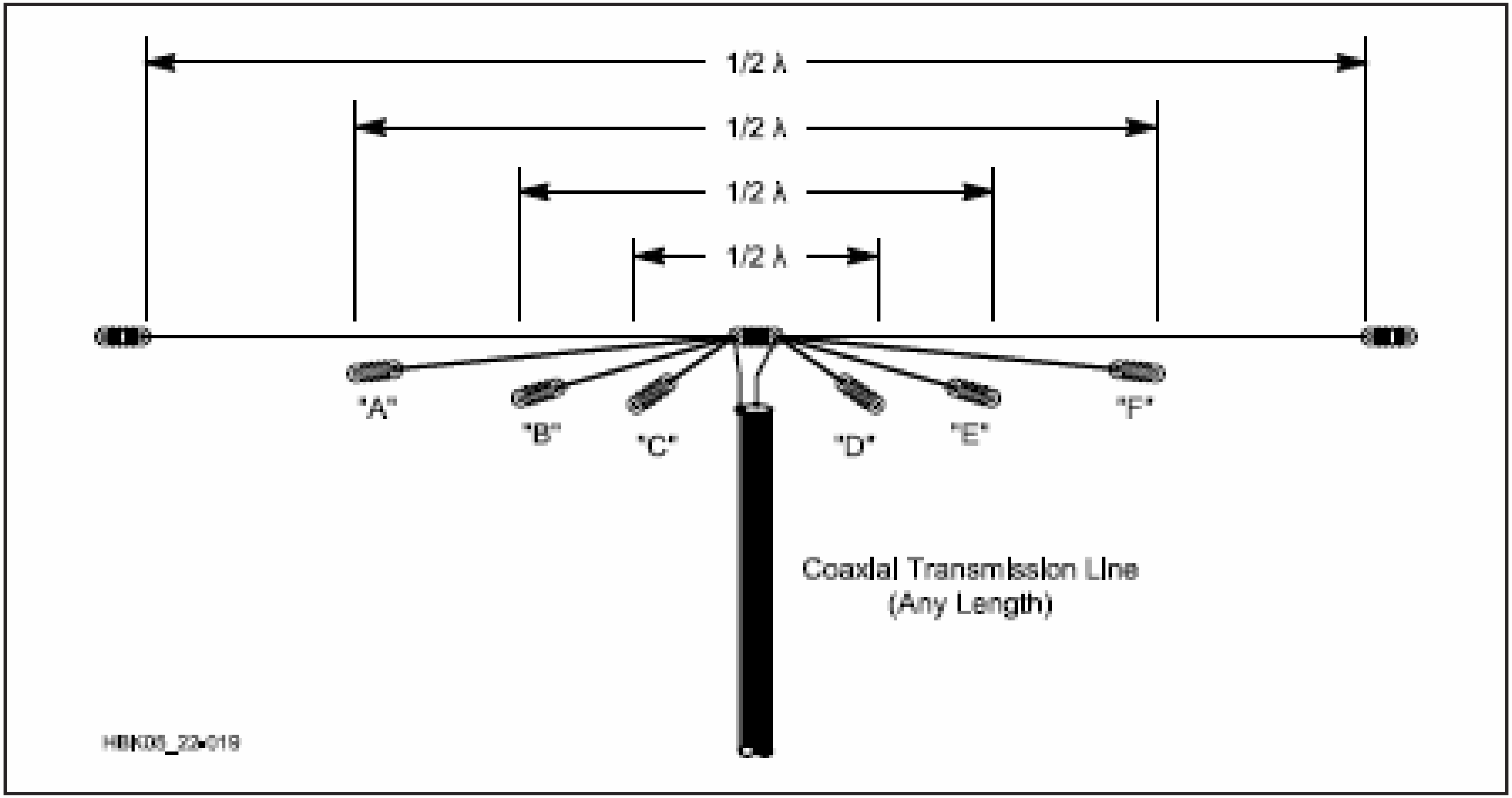
Fan Dipole



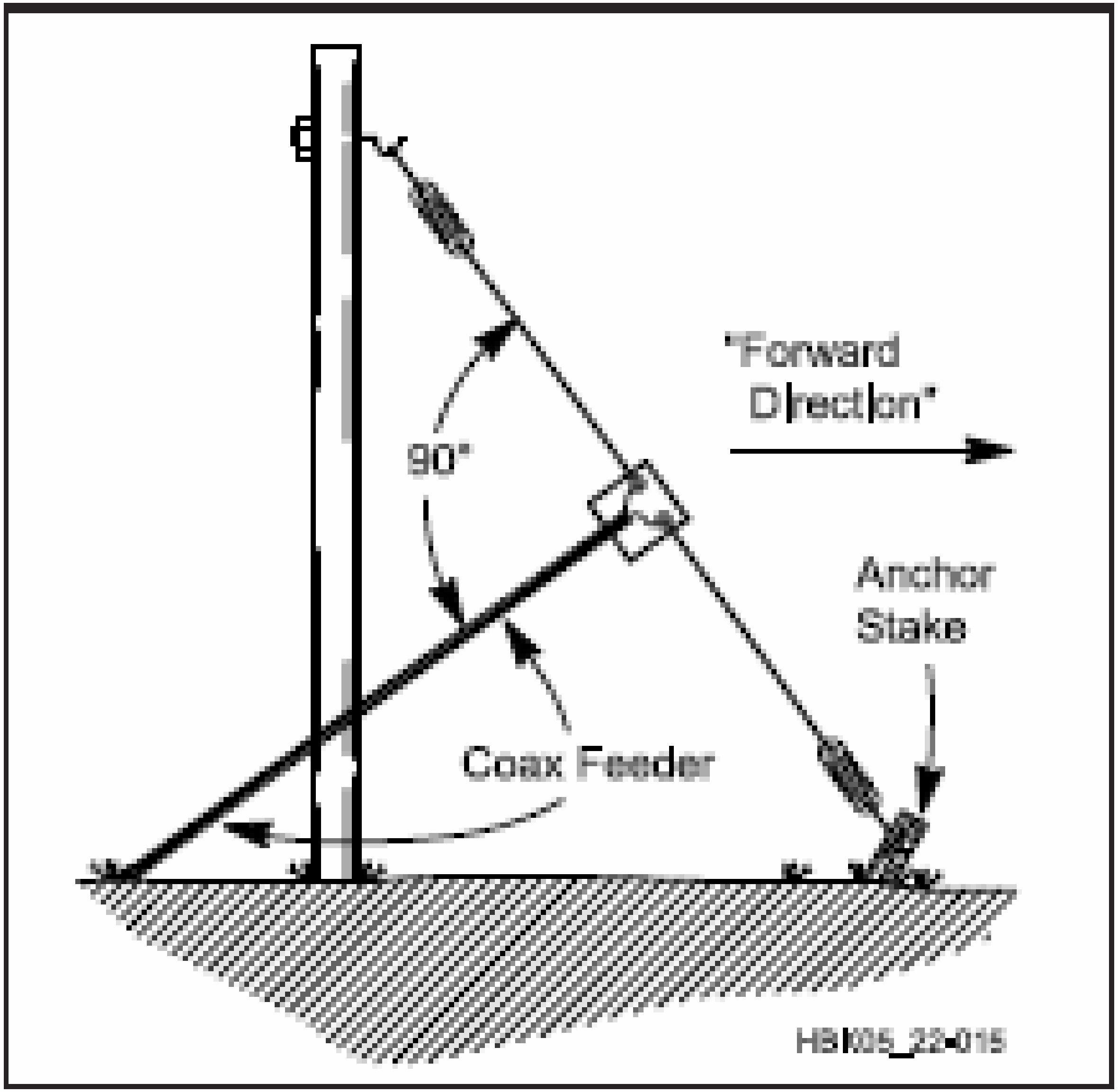
Tension rope is not tied to pully rope in picture. It is tied near location of pully rope down on supports within easy reach. It is tied last after final SWR adjustment and the antenna is in it's final position.

Suggested total lengths:
80 meters - 120 feet
40 meters - 65 to 66 feet
20 meters - 34 feet
10 meters - 17 feet

These lengths are not exact. Some tuning may be required. Use the standard formula 468 / freqmhz for total feet for each band (freq) of interest. Adjust each length longer or shorter as needed.


1/2 λ
1/2 λ
1/2 λ
1/2 λ
"A"
"B"
"C"
"D"
"E"
"F"
Coaxial Transmission Line
(Any Length)
HBK06_22-018

Sloping Dipole



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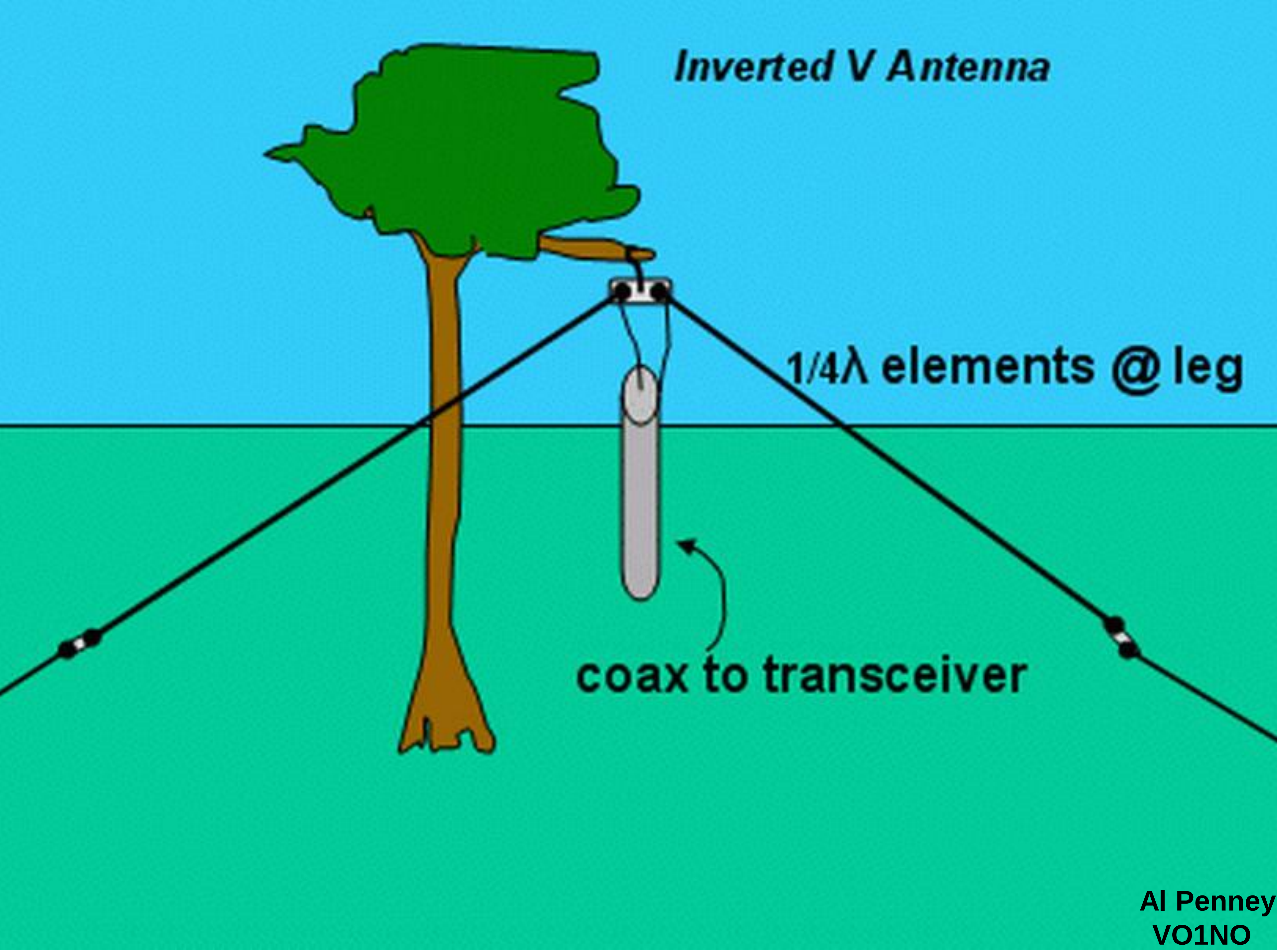
Inverted V Antenna

- Variation of the Dipole.
- Impedance approximately 50 ohms.
- Advantages:
  - Requires only one support; and
  - Provides a better match to 50 ohm coax cable.
- Disadvantages:
  - Those of a Dipole; and
  - The ends close to the ground present a safety hazard.



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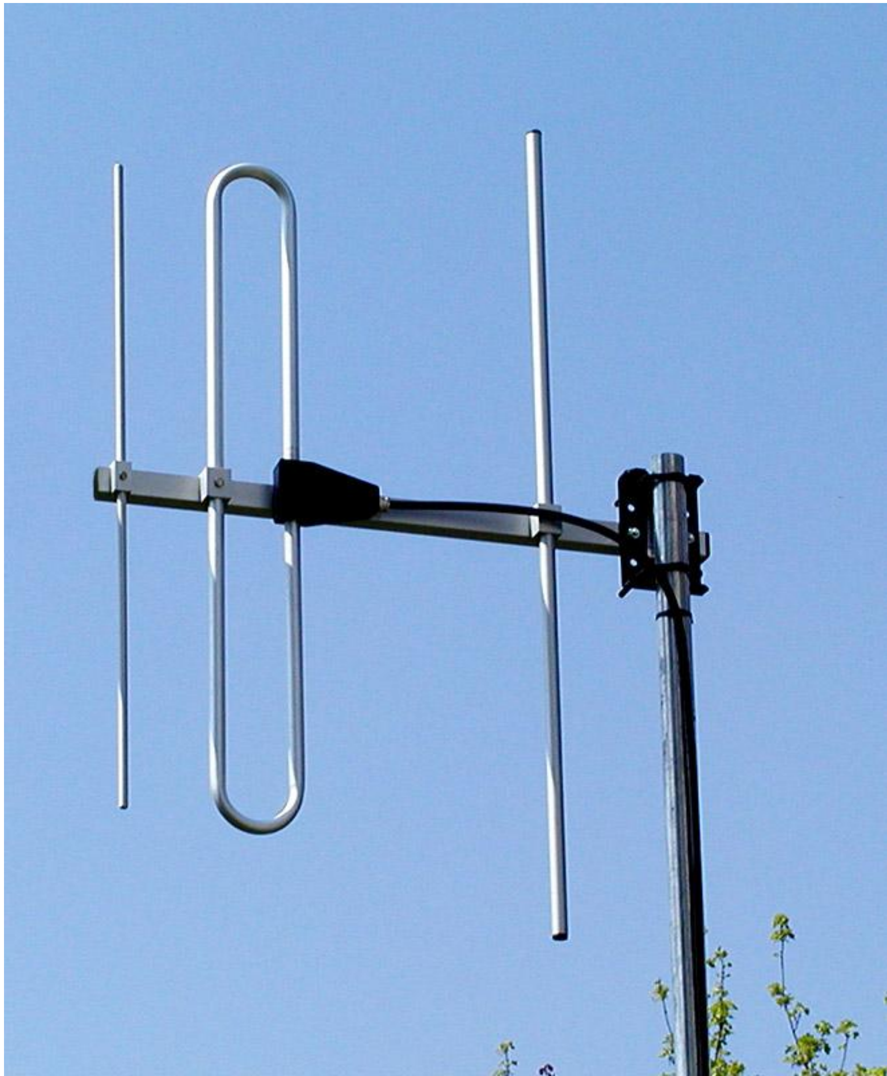
Folded Dipole

- A Full Wave Dipole that is folded back on itself.
- Impedance approximately 300 ohms.
- Usually used on VHF/UHF Yagi-Uda beams.
- Advantages:
  - Broader bandwith than a dipole;
- Disadvantages:
  - Requires 2 supports, sometimes 3 (except if VHF/UHF);
  - Must be fed at center; and
  - One band only.

Folded Dipole



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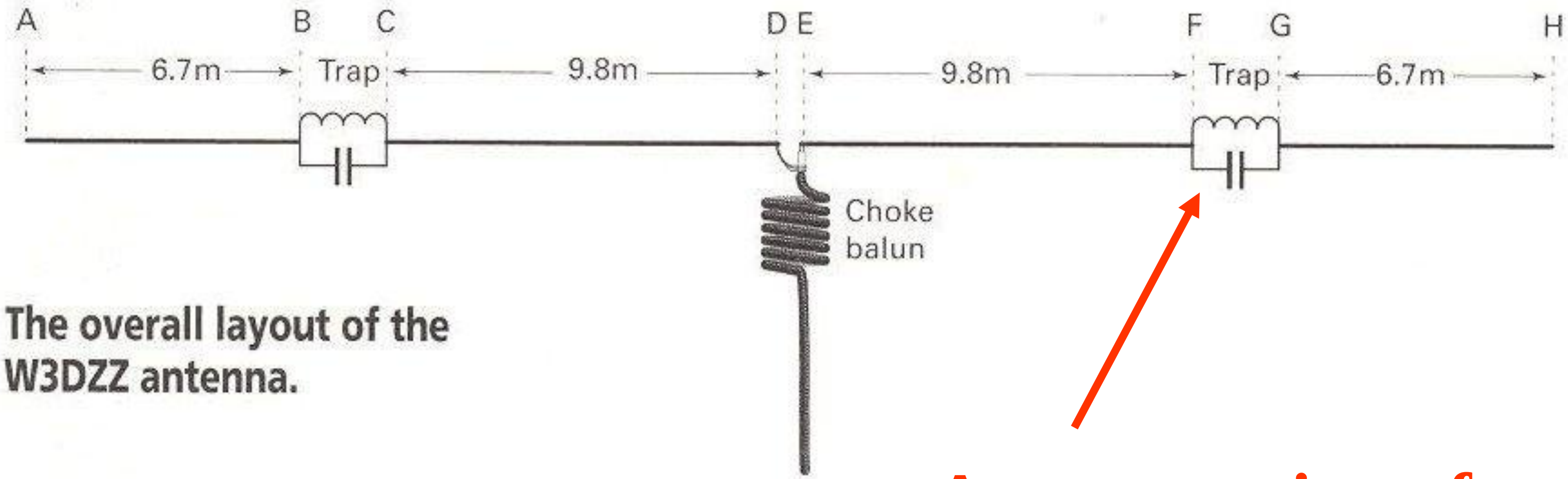
Trap Dipole (1)

- Traps isolate sections of the antenna, permitting multi-band use.
- Advantages:
  - Multi-band operation.
- Disadvantages:
  - Those of a Dipole;
  - Not as efficient as separate dipoles;
  - Weight of the traps makes it difficult to hold up;
  - Pattern can be distorted; and
  - **Can radiate Harmonics (?).**

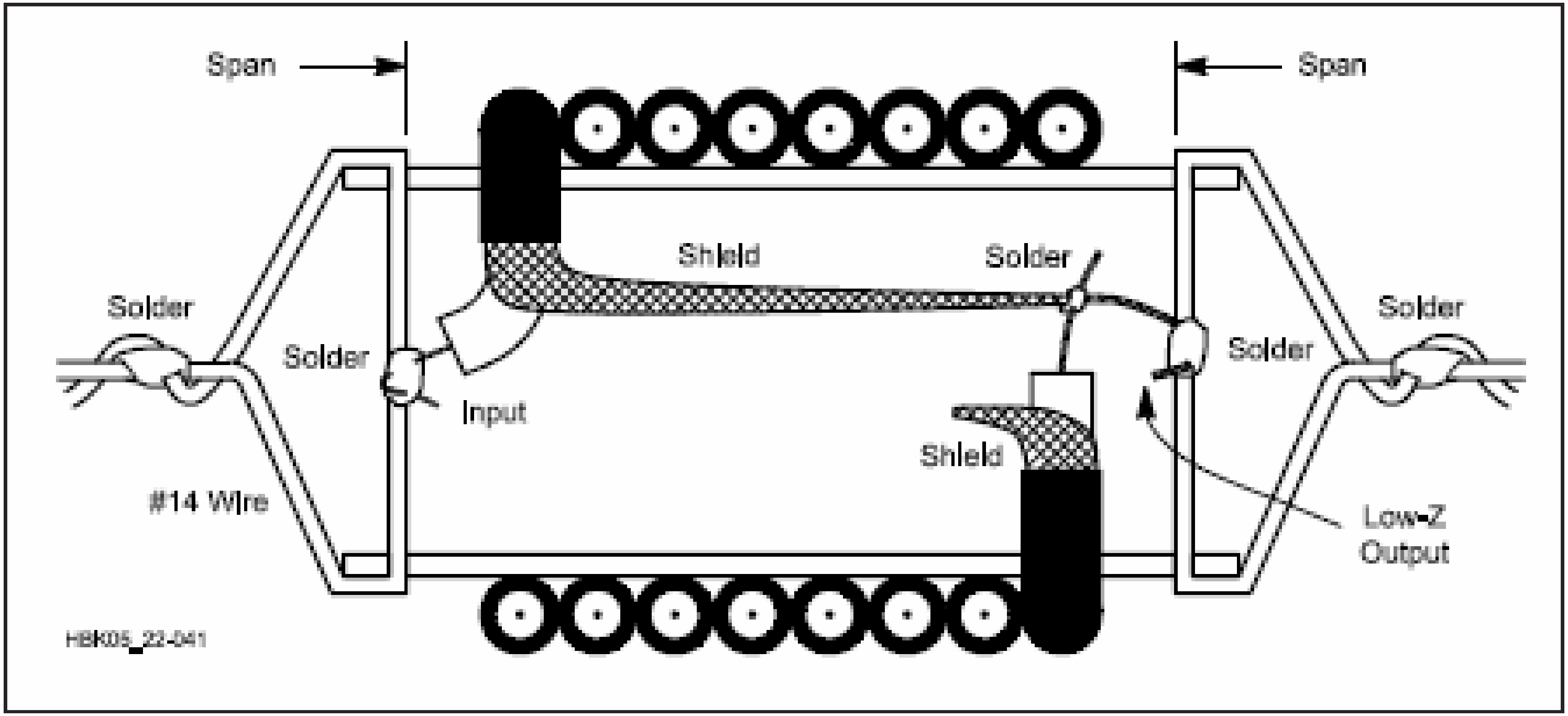
Trap Dipole (2)



The overall layout of the W3DZZ antenna.

A trap consists of a Capacitor and Inductor

Trap Dipole (3)



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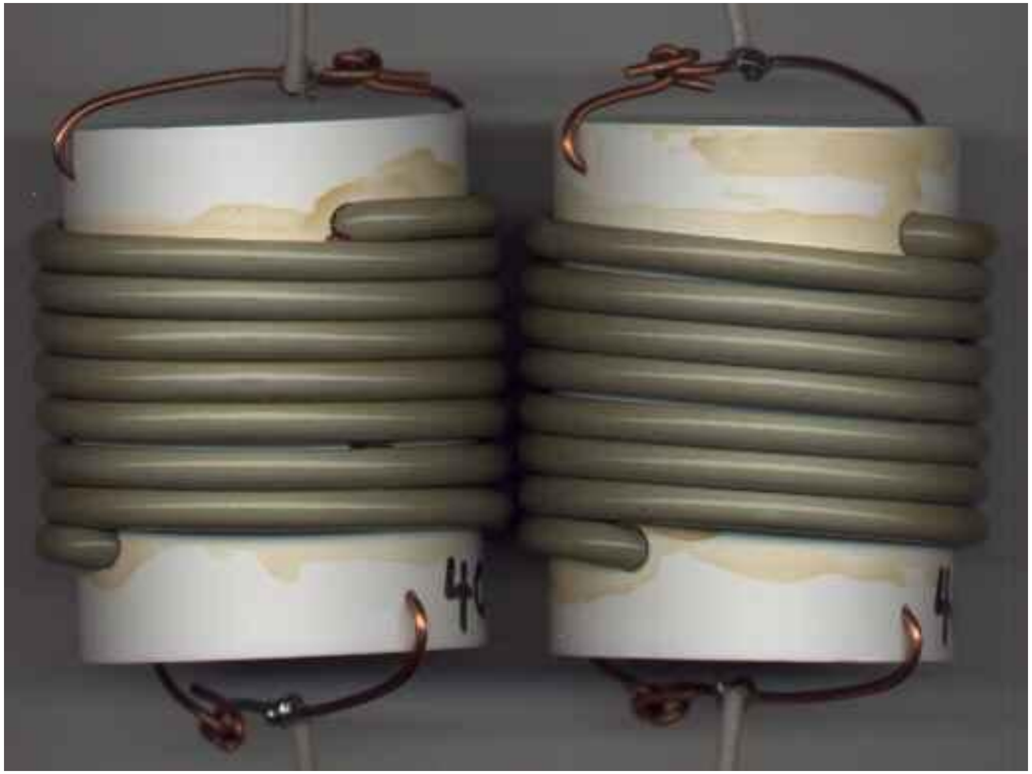
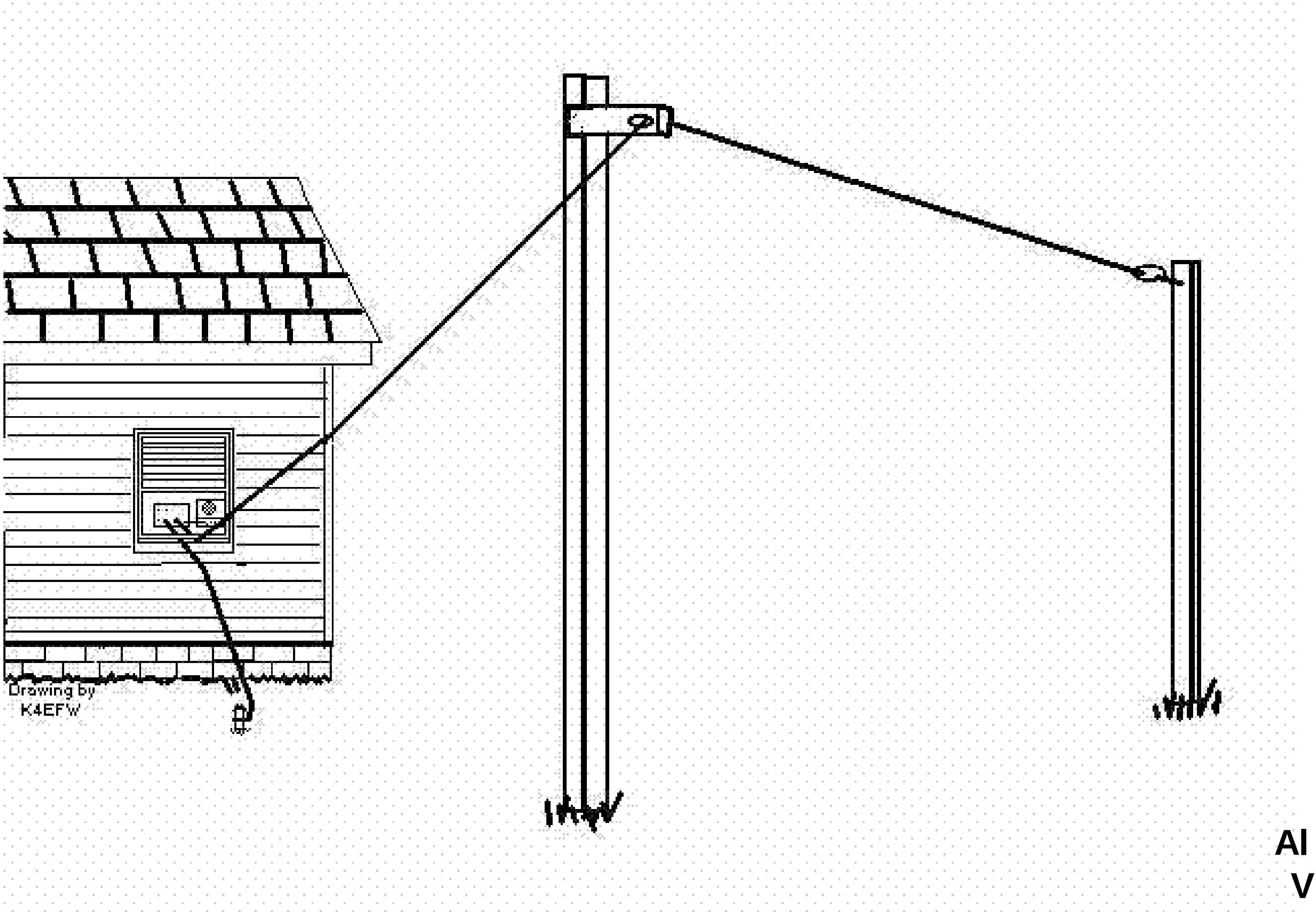
Trap Dipole (4)



End Fed Long Wire Antenna (1)

- Should be as long (at least ¾ λ) and high as possible.
- Must have a good ground.
- Advantages:
  - Multiband;
  - Can bend to fit as necessary; and
  - Feedpoint is at the end.
- Disadvantages:
  - Requires a matching unit;
  - Pattern difficult to predict;
  - High voltages on the antenna; and
  - **RF present in the shack.**

End Fed Long Wire Antenna (2)



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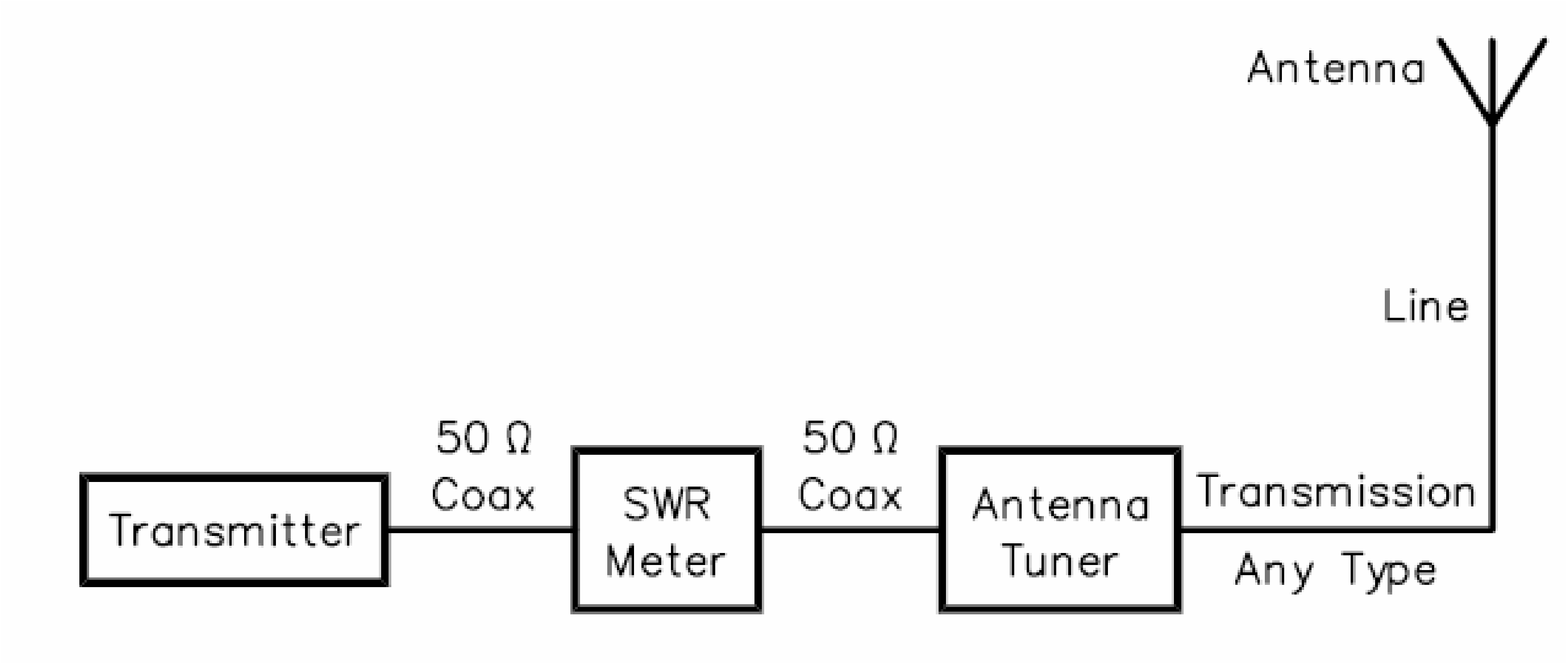
Transmatch


MFJ VERSA TUNER II
SWR SENSITIVITY
ANTENNA SELECTOR
TRANSMITTER MATCHING
INDUCTOR SELECTOR
ANTENNA MATCHING
POWER
300
FWD
MAX
COAX 1
COAX 2
WIRE BAL
COAX 2 DIRECT
BYPASS COAX
COAX 1 DIRECT
MODEL J-941D

Connecting a Transmatch



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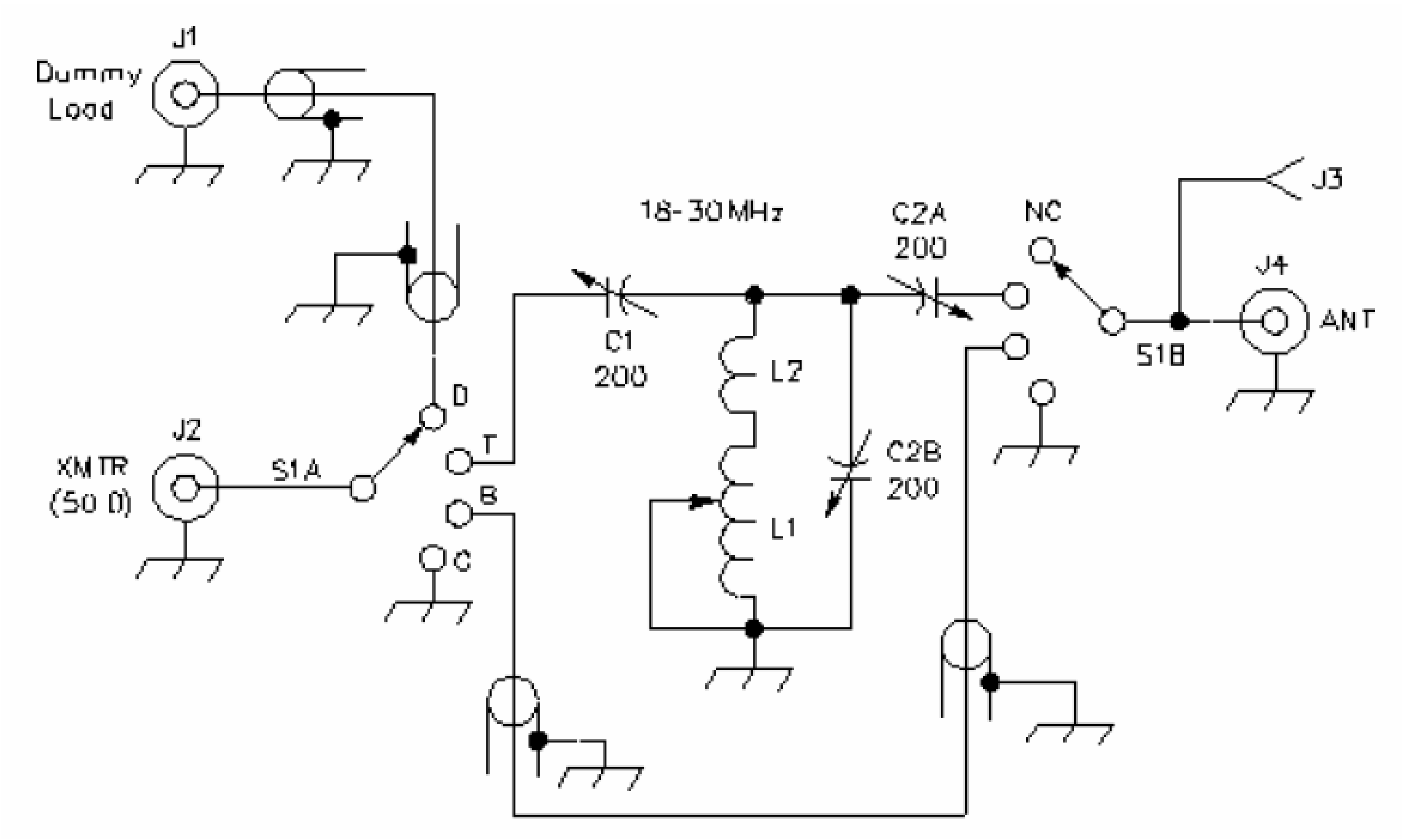
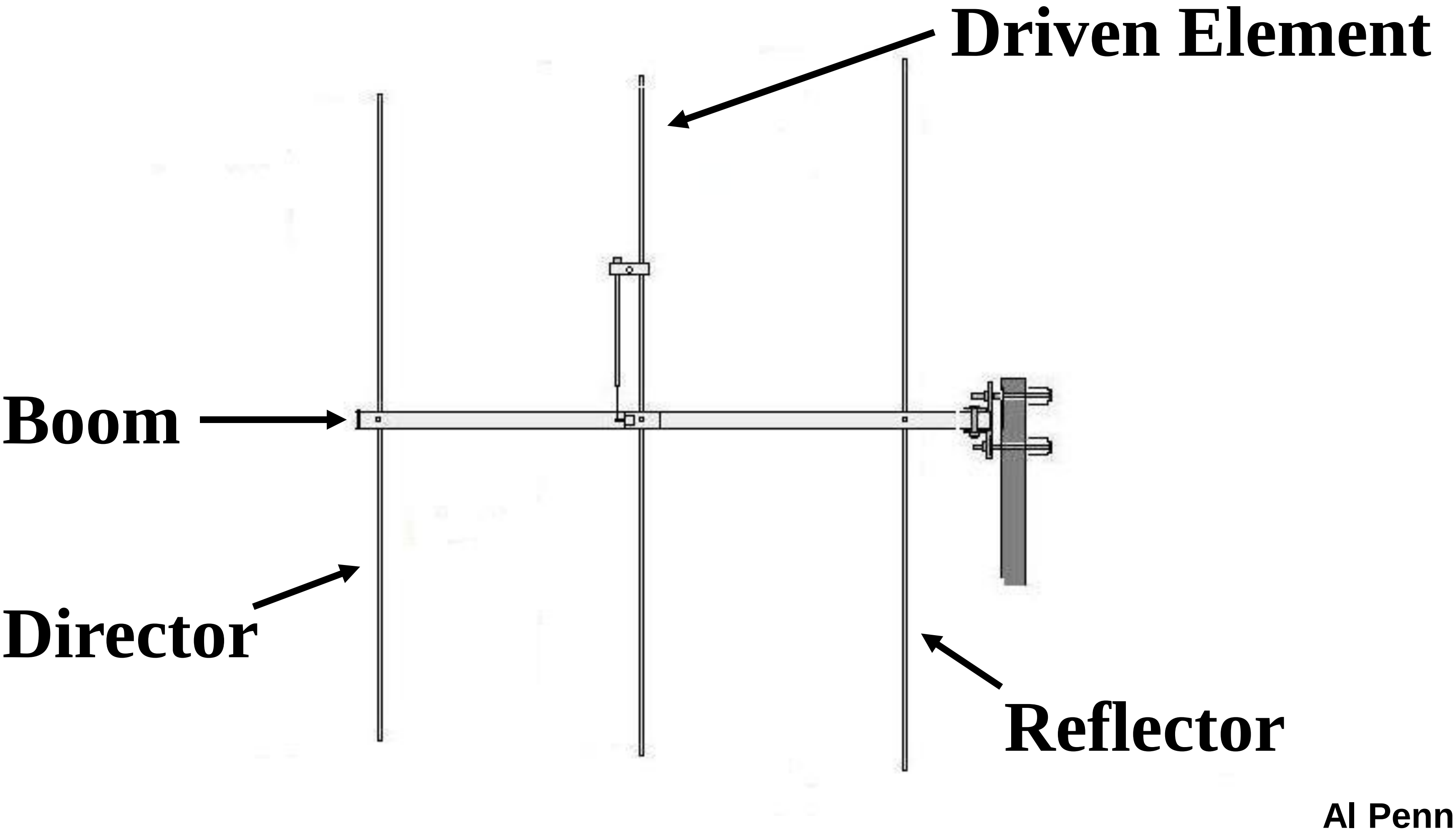
Transmatch Schematic Circuit



Yagi-Uda Antenna (1)

- Driven Element, Reflector and one or more Directors (AKA **Parasitic Elements**) give gain and directivity.
- Advantages:
  - Effective antenna;
  - Easily rotated;
  - Can be multi-band; and
  - Can be stacked for more gain.
- Disadvantages:
  - Can be expensive;
  - Requires a tower and rotator;
  - Single bearing at a time; and
  - Wind and ice an enemy!

Yagi-Uda Antenna (2)



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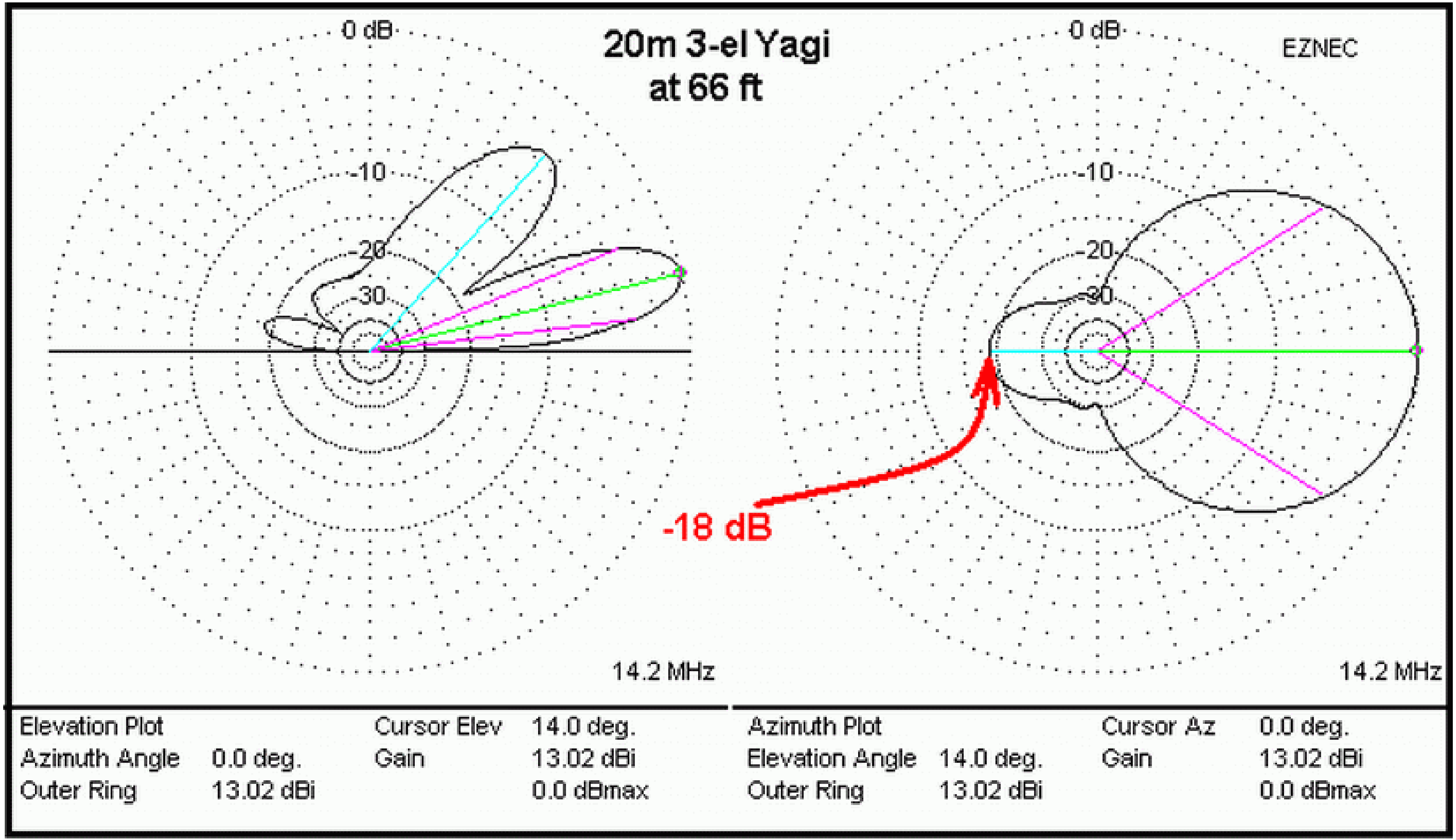
3 Element Yagi-Uda Antenna



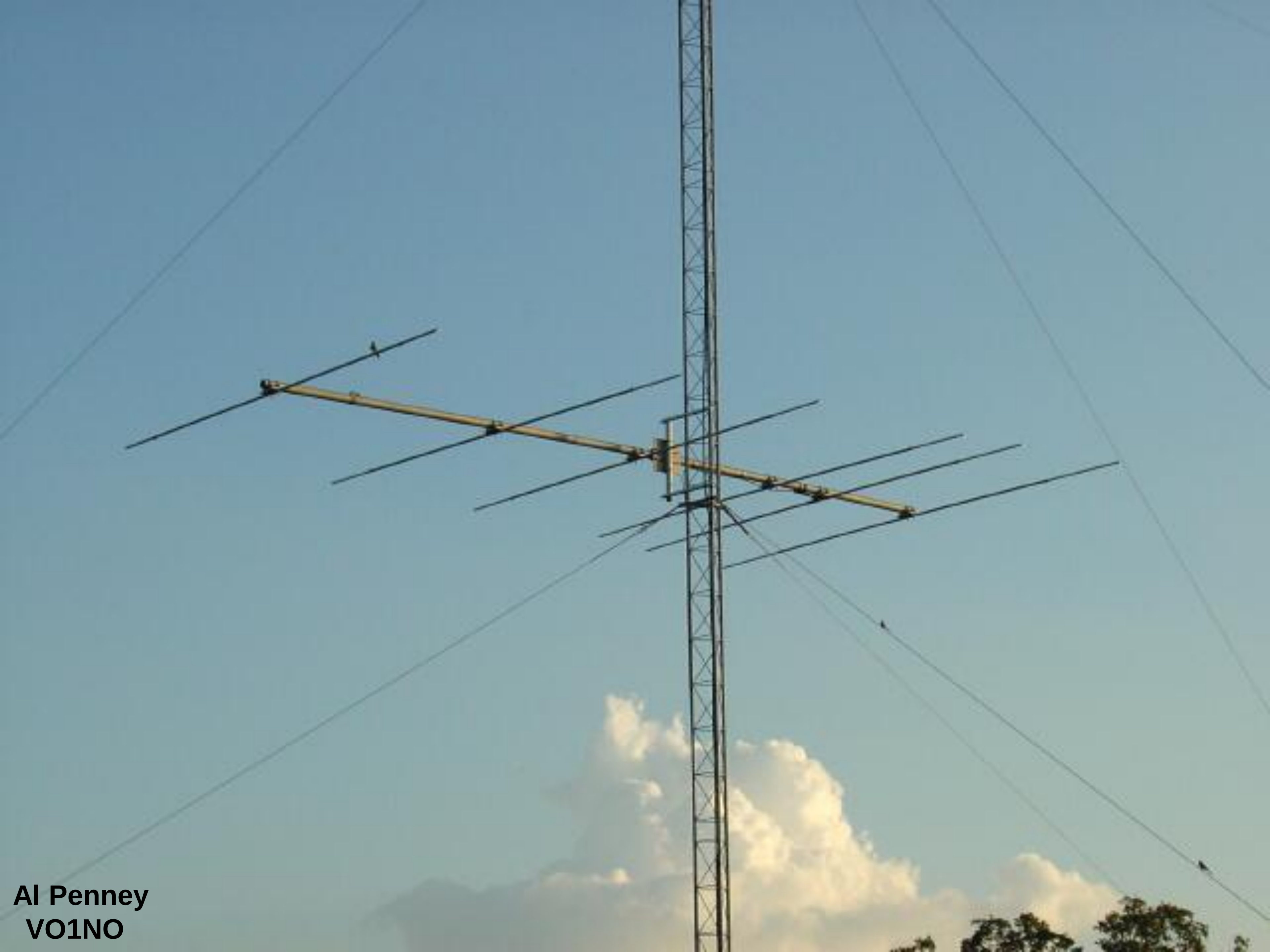
-18 dB

Elevation Plot		Cursor Elev	14.0 deg.
Azimuth Angle	0.0 deg.	Gain	13.02 dBi
Outer Ring	13.02 dBi		0.0 dBmax

Azimuth Plot		Cursor Az	0.0 deg.
Elevation Angle	14.0 deg.	Gain	13.02 dBi
Outer Ring	13.02 dBi		0.0 dBmax

Wide Element Spacing on Yagi-Uda

- **Spacing** the elements **further apart** (within reason) on a Yagi-Uda antenna gives three advantages:
  - **Greater Gain;**
  - **Less critical tuning; and**
  - **Wider bandwith.**
- Computer programs exist that will **optimize element spacing and lengths** to provide **maximum performance (0.2 wavelength spacing** is close to **optimum** for a **3-element** Yagi-Uda).



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Trapped Yagi-Uda

- Just as with dipoles, Yagi-Uda antennas can employ traps to enable the antenna to function on several different bands.
- All elements must use traps – the Driven Element, Reflector and Directors.

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Cubical Quad

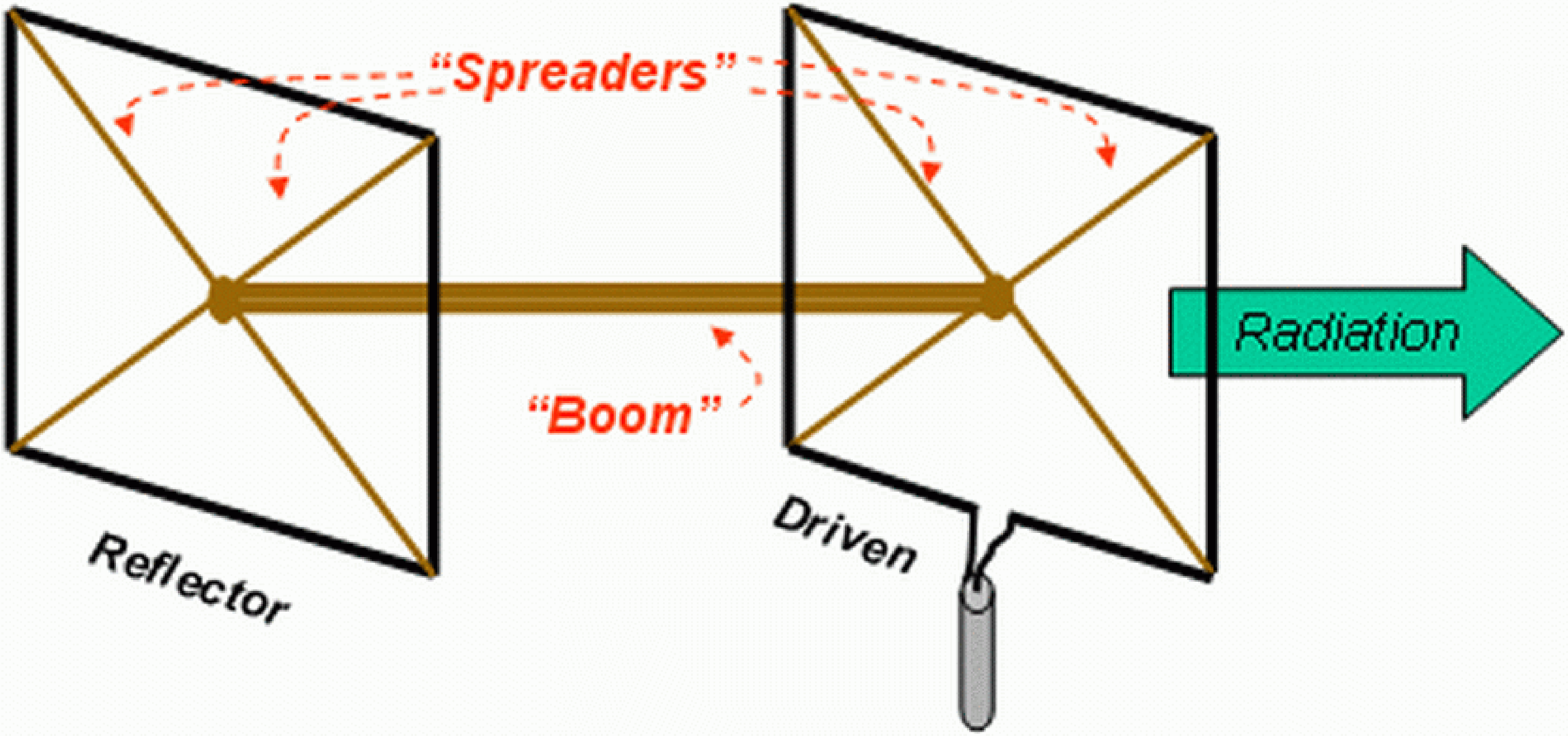
- Uses closed loops of approximately **1 wavelength.**
- Driven Element, Reflector and one or more Directors.
- Advantages:
  - Effective, has gain and directivity;
  - Easily rotated;
  - Multiband; and
  - Lighter than a Yagi-Uda.
- Disadvantages:
  - Weaker than a Yagi-Uda, 3D antenna;
  - Requires a tower and rotator;
  - Single bearing only;
  - Wind and Ice!

2-Element Cubical Quad Antenna

Typical dimensions:

Driven element = λ/4 per side; Reflector is 3% longer.

Spacing is 0.10 – 0.25 λ



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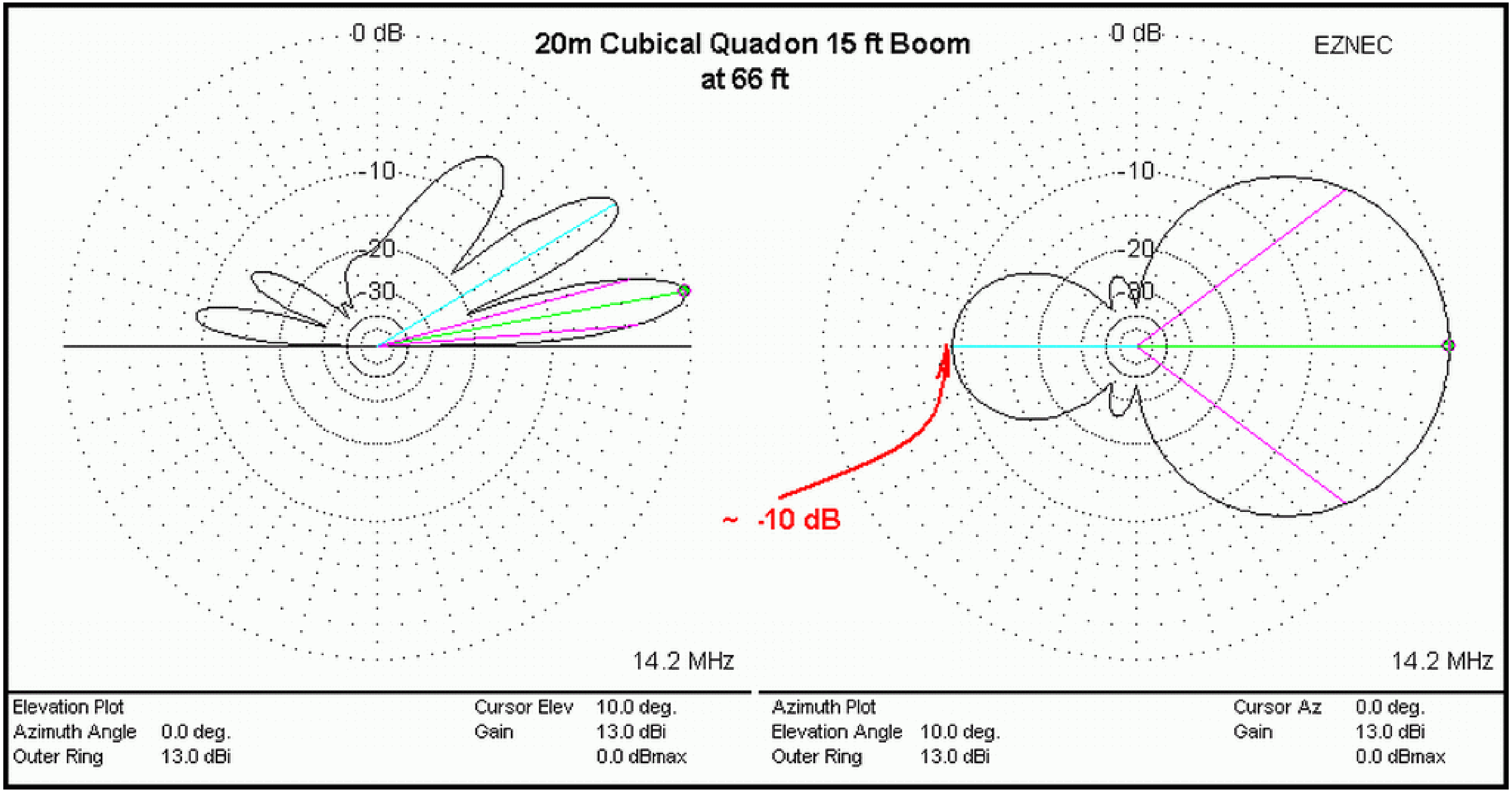
2 Element Cubical Quad



Elevation Plot
Azimuth Angle 0.0 deg.
Outer Ring 13.0 dBi

Cursor Elev 10.0 deg.
Gain 13.0 dBi
0.0 dBmax

Azimuth Plot
Elevation Angle 10.0 deg.
Outer Ring 13.0 dBi

Cursor Az 0.0 deg.
Gain 13.0 dBi
0.0 dBmax

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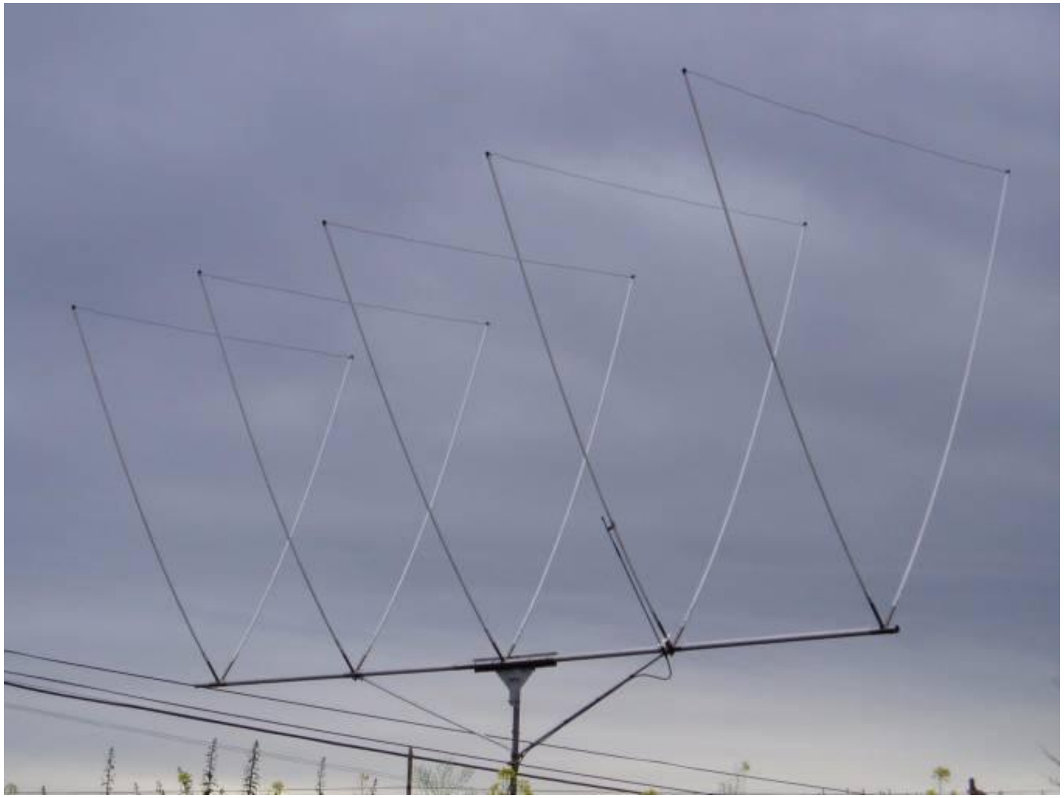
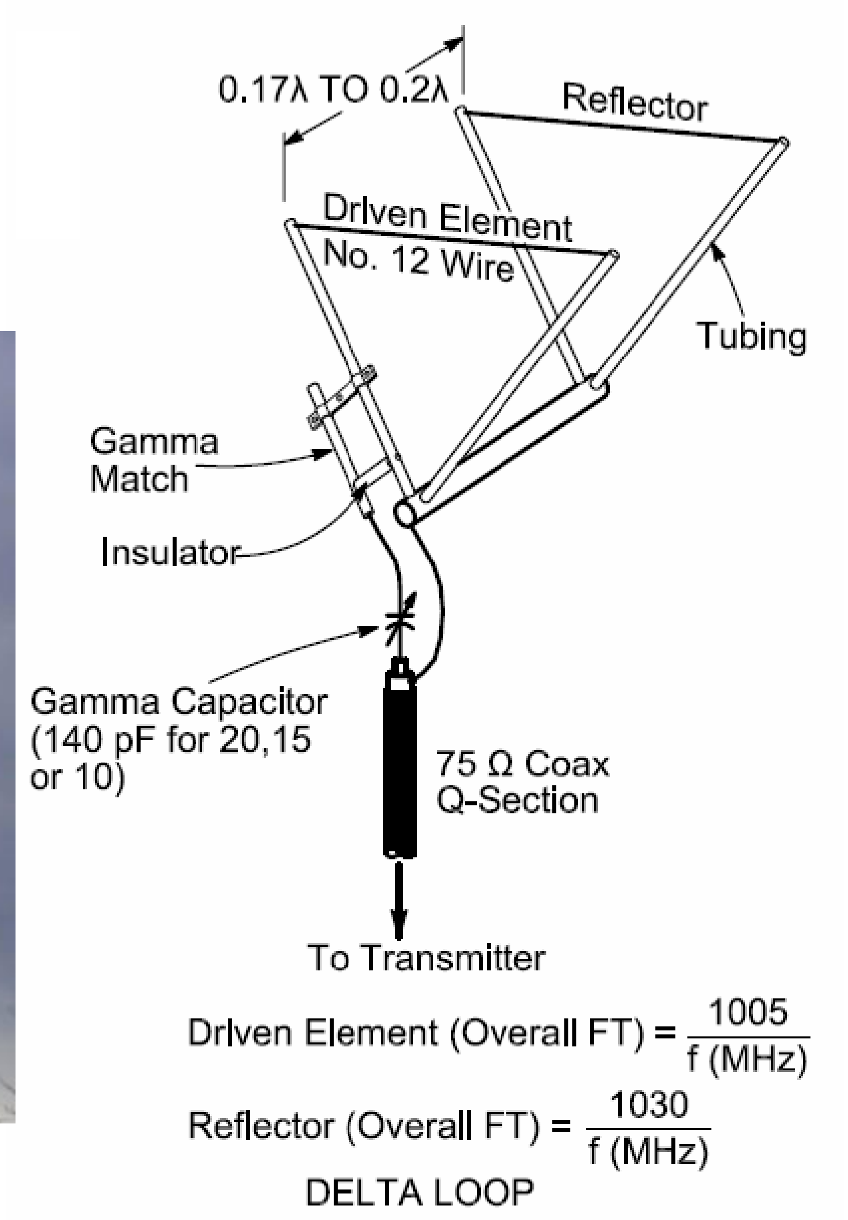
Cubical Quad Notes

- In general, the performance of a **2-element Cubical Quad** compares to a **3-element Yagi-Uda antenna.**
- **Cubical Quad polarization:**
  - Feedpoint on side **parallel** to ground: **Horizontal**
  - Feedpoint on side **perpendicular** to ground: **Vertical**
- The elements of a Quad can also be **shaped as triangles**, and called a **Delta Quad.**

Delta Quad





$$\text{Driven Element (Overall FT)} = \frac{1005}{f\,(\text{MHz})}$$

$$\text{Reflector (Overall FT)} = \frac{1030}{f\,(\text{MHz})}$$

DELTA LOOP

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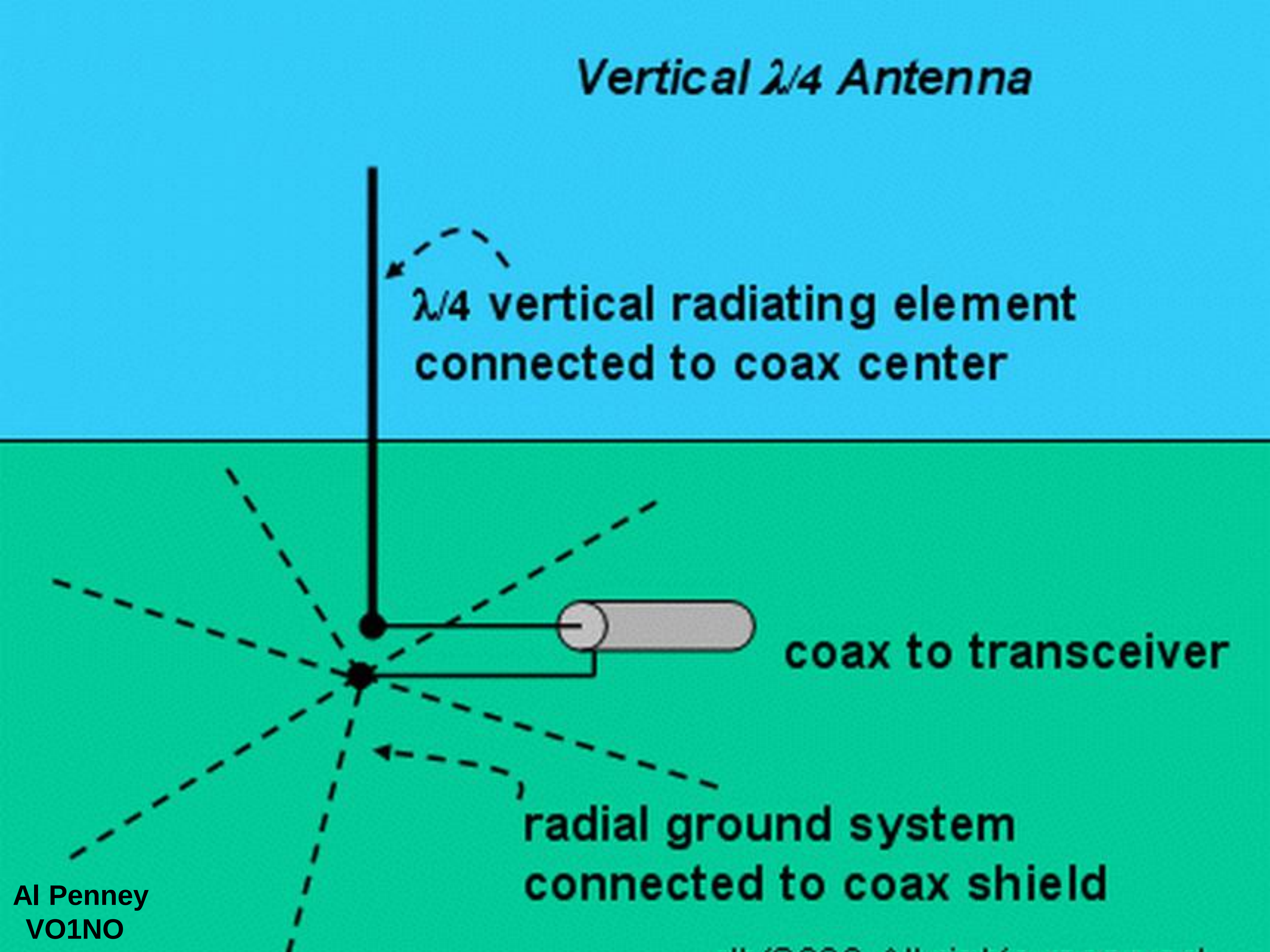
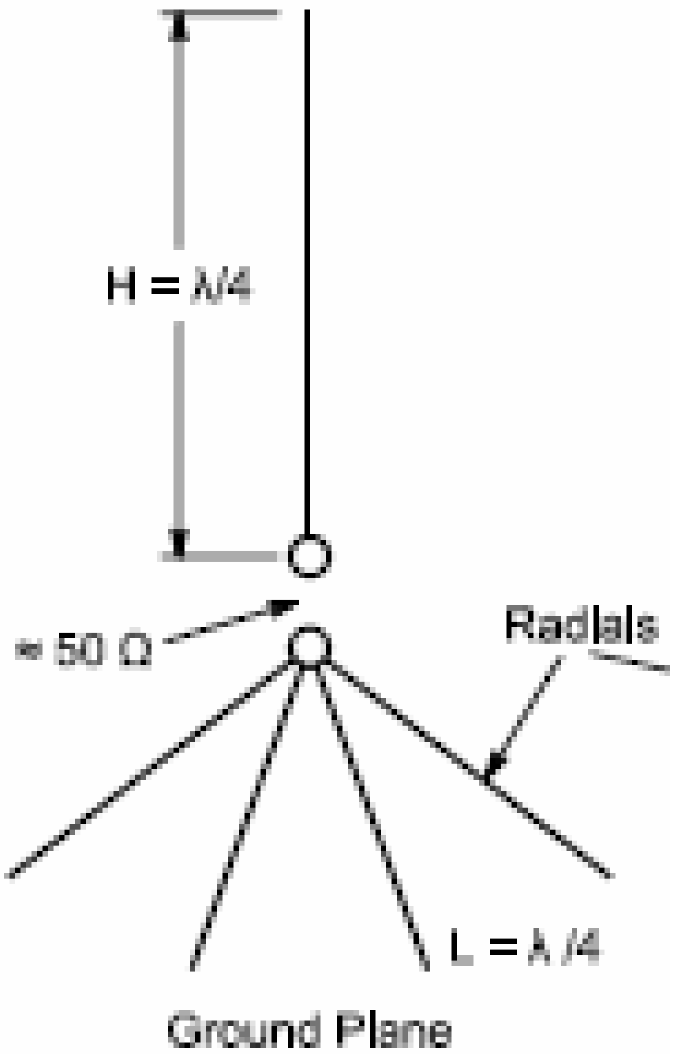
¼ Wavelength Vertical

- Omnidirectional.
- Requires a good ground (radials, groundplane).
- Can use loading coils or capacity hats to reduce height.
- Advantages:
  - Little space (?), easily disguised;
  - Omnidirectional, good groundwave coverage;
  - Low angle of radiation (with a good ground).
- Disadvantages:
  - Omnidirectional;
  - Good ground an absolute must; and
  - Susceptible to man-made noise.

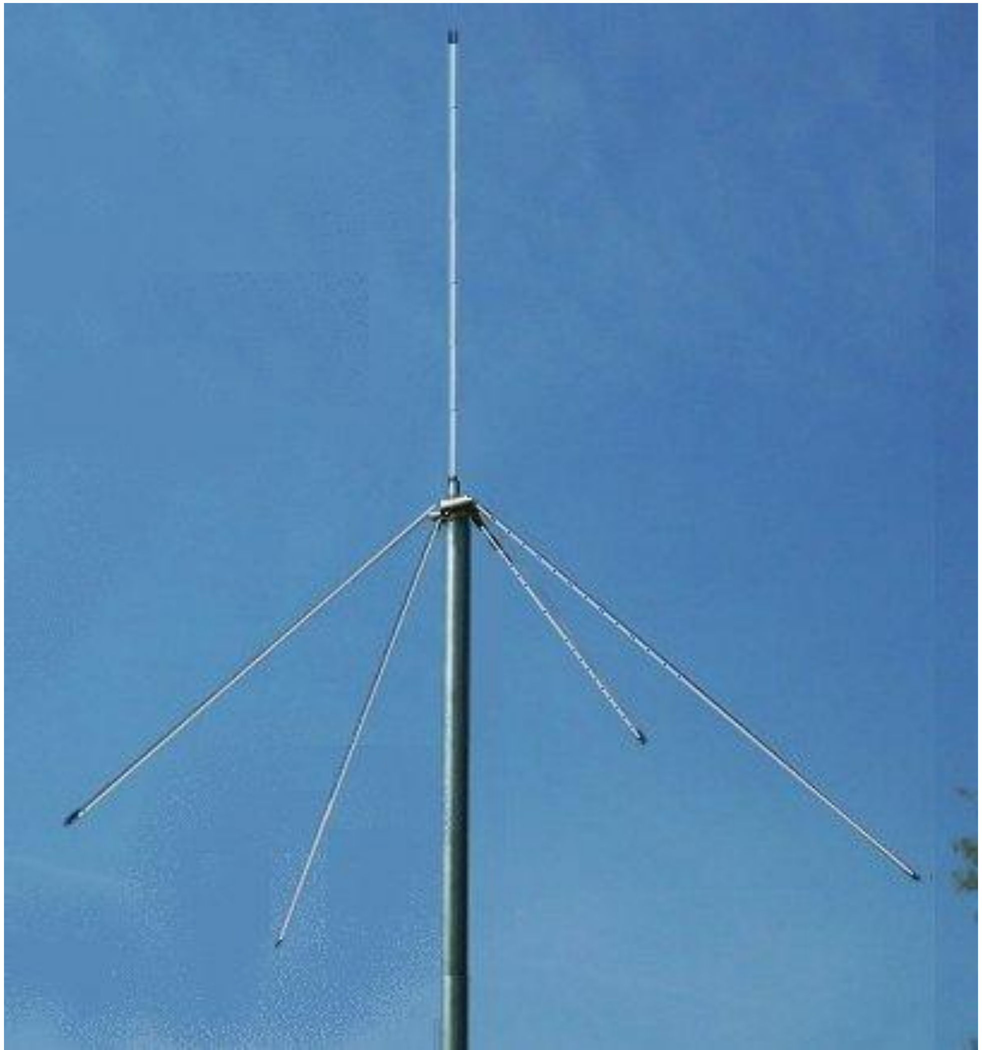

Vertical λ/4 Antenna
λ/4 vertical radiating element
connected to coax center
coax to transceiver
radial ground system
connected to coax shield

¼ Wavelength Vertical

- Theoretical impedance is ½ that of a dipole, ie: 36 ohms
- By sloping radials down however, impedance can be brought closer to 50 ohms, providing a better match to 50 ohm coax cable.



¼ Wavelength Vertical



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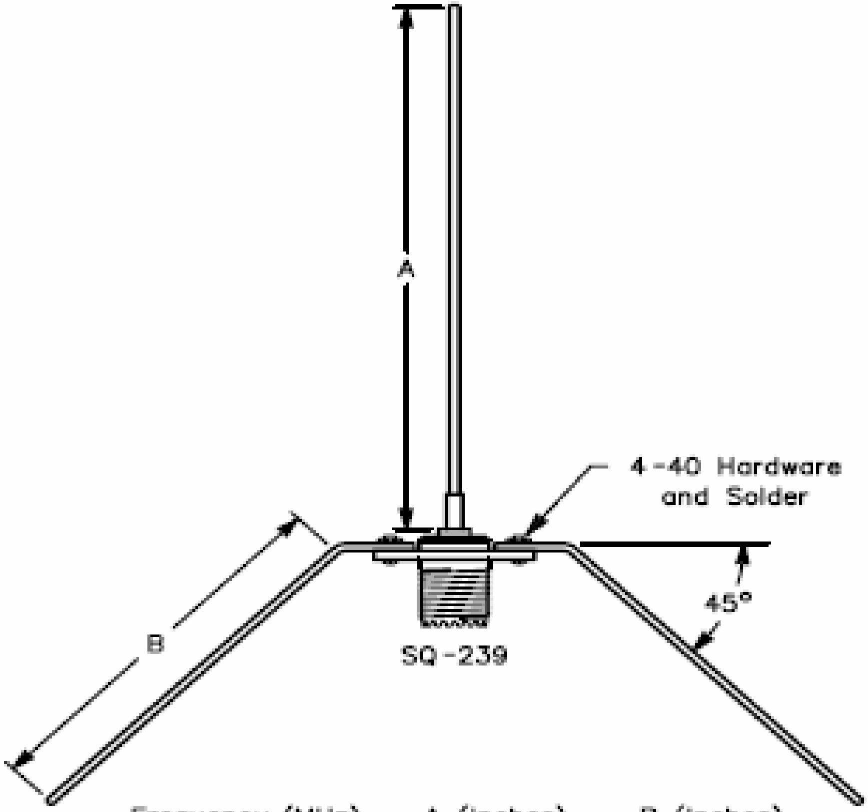
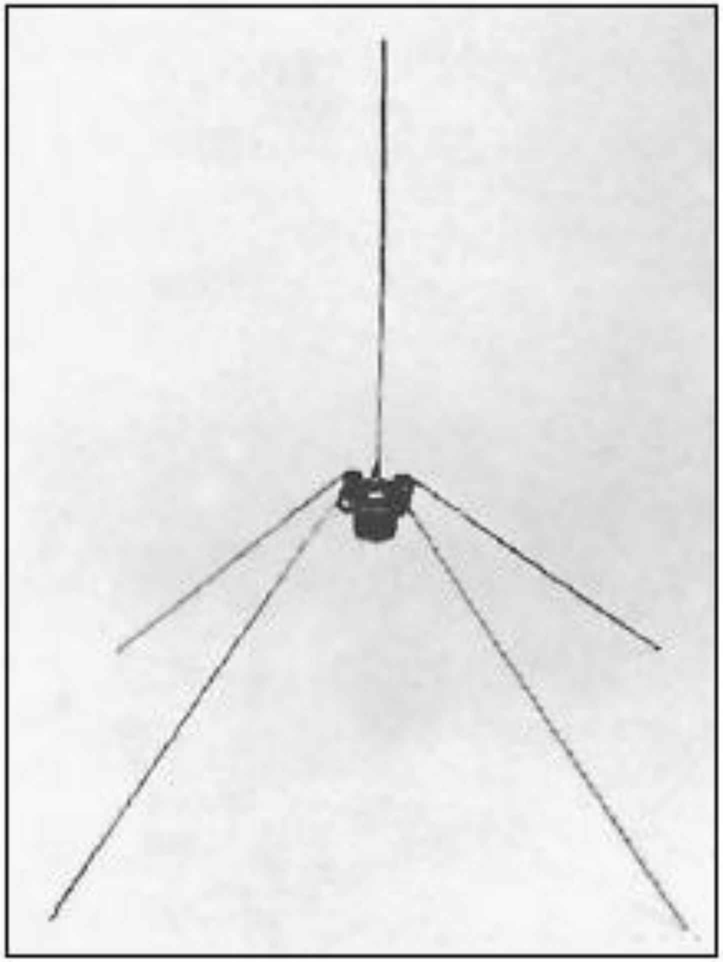
Ground Plane Vertical

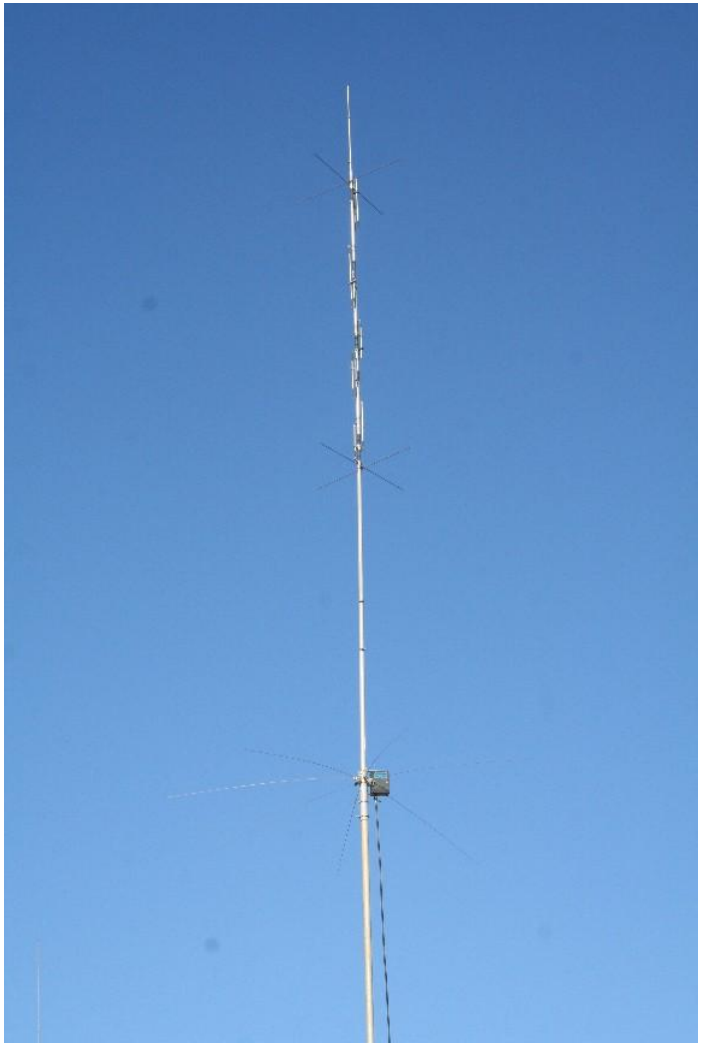


Frequency (MHz)	A (Inches)	B (Inches)
146	19-5/16"	18-11/16"
225	12-5/8"	12"
445	6-3/8"	5-3/4"



Trapped Vertical Antenna

- Just as with dipoles and Yagi-Uda antennas, traps can be added to verticals to give multiband capability.
- This example is a Cushcraft R7 vertical, covering 40m thru to 10M.

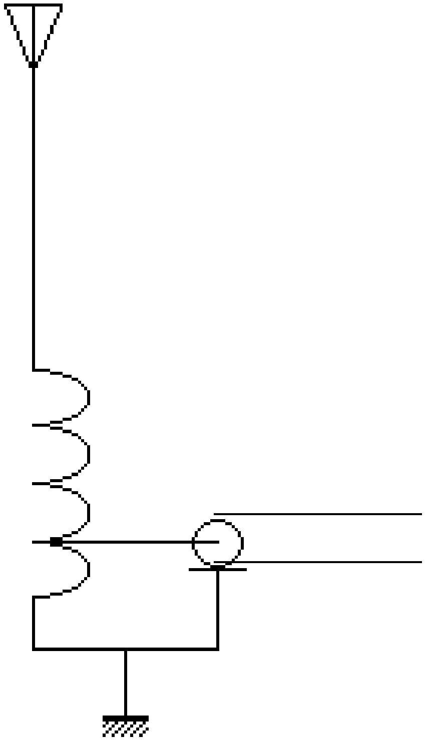


5/8 Wavelength Vertical

- **5/8 Wavelength** Vertical is **often used for mobile stations** because it (supposedly) has a **lower angle of radiation**, enabling more energy to reach distant stations (ie: **more gain**).
- *Because it has **capacitive reactance a what is used at the feedpoint to cancel that capacitive reactance?***

5/8 Wavelength Vertical

- *An* ***Inductor*** *is used at the feedpoint to cancel the capacitive reactance of the 5/8 wavelength vertical.*



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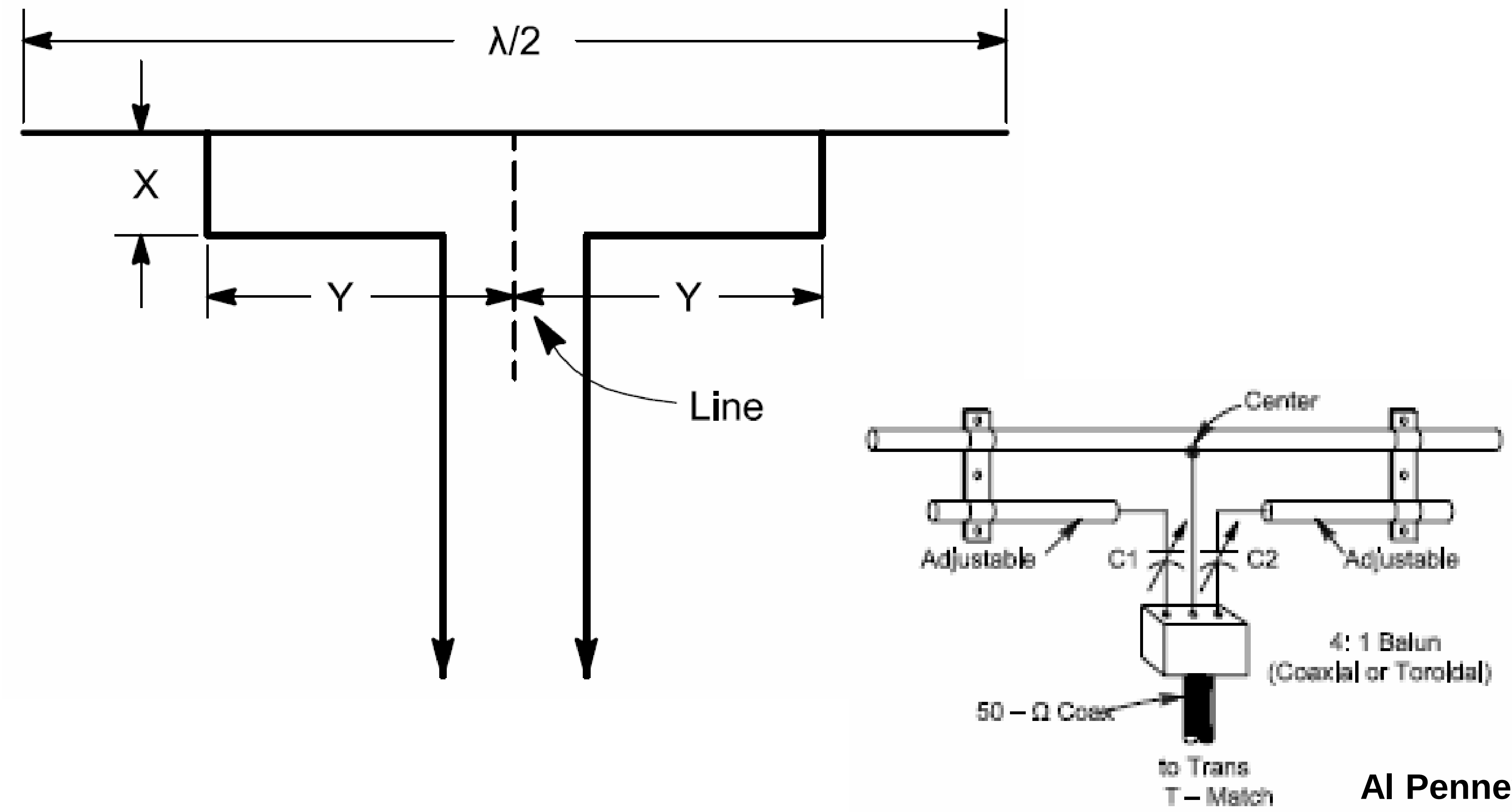
Matching Feedline to the Antenna

- There are several ways to **match the feedline** to the **feed point** of the antenna, including:
  - Attaching the coax or twinlead **directly** to the dipole element;
  - The **T-Match;**
  - The **Gamma Match**; and
  - The **Hairpin Match.**

T Match



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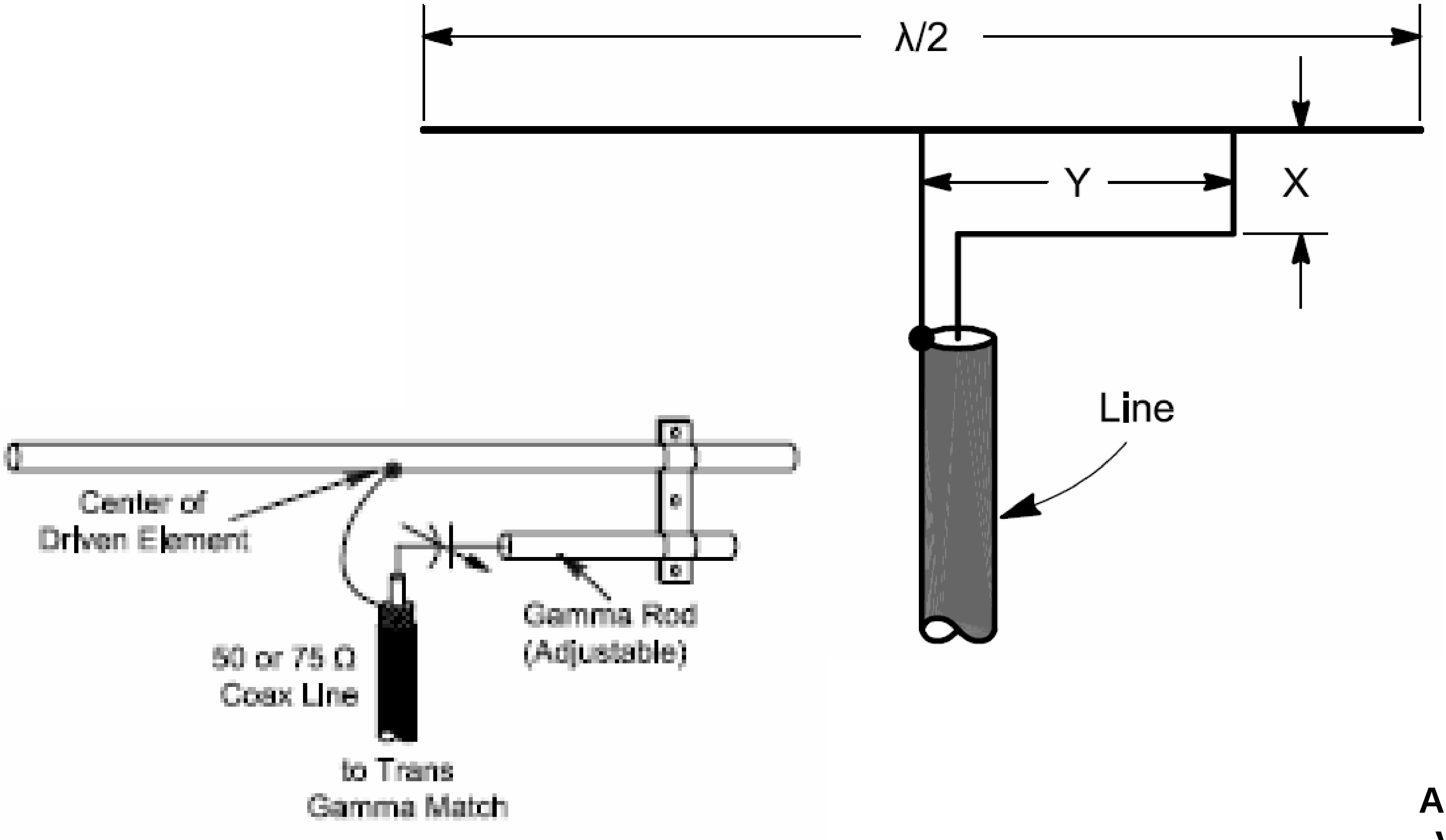
Gamma Match



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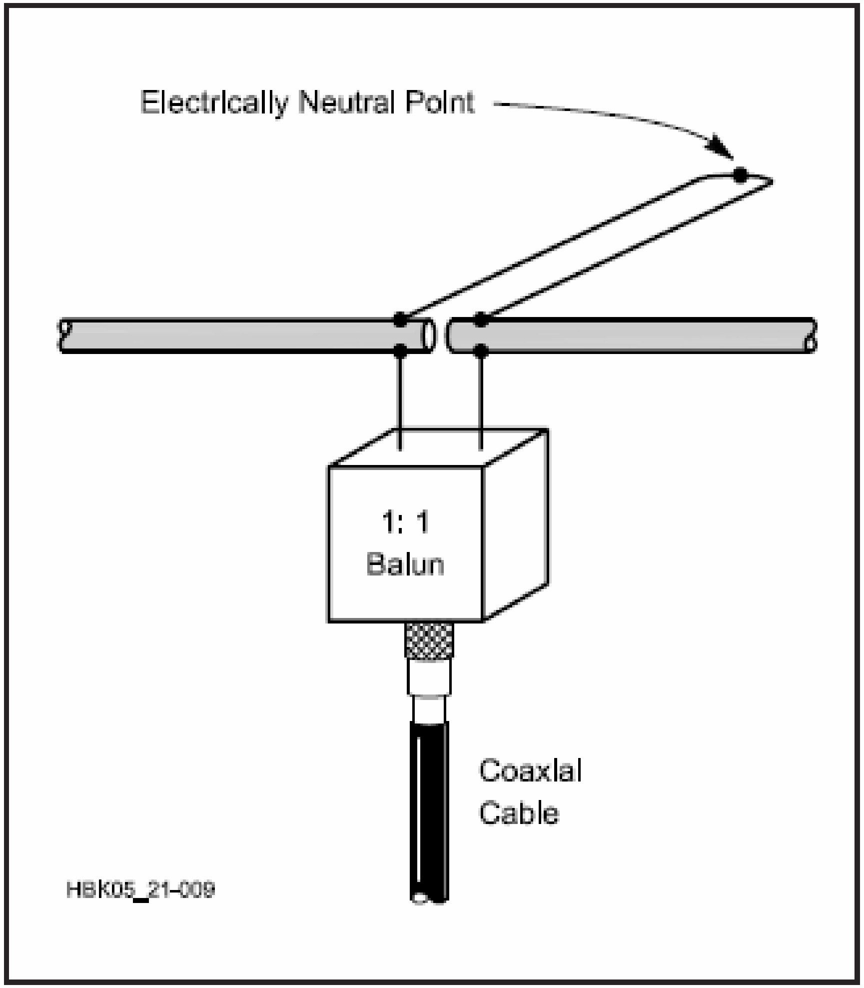
Hairpin Match



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Other interesting antennas…

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Log Periodic Antennas

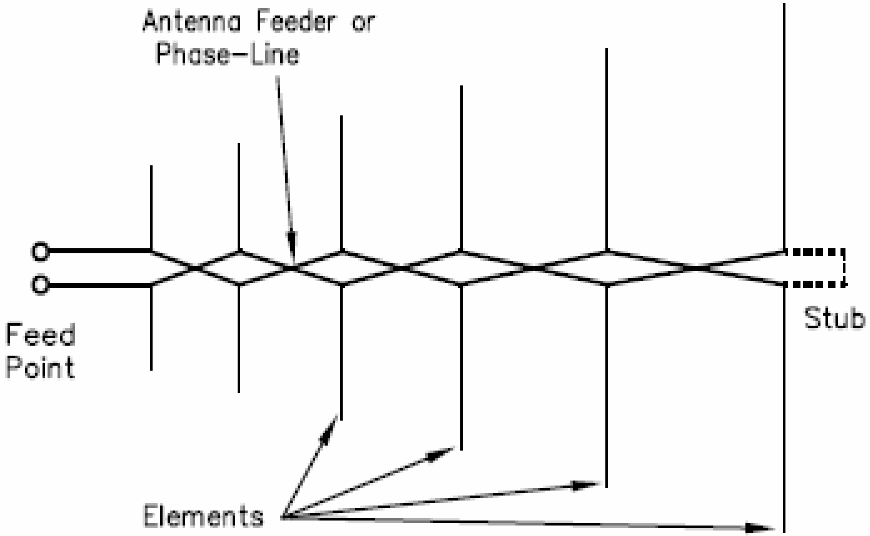

Fig 1—The basic components of a log periodic dipole array (LPDA). The forward direction is to the left in this sketch. Many variations of the basic design are possible.

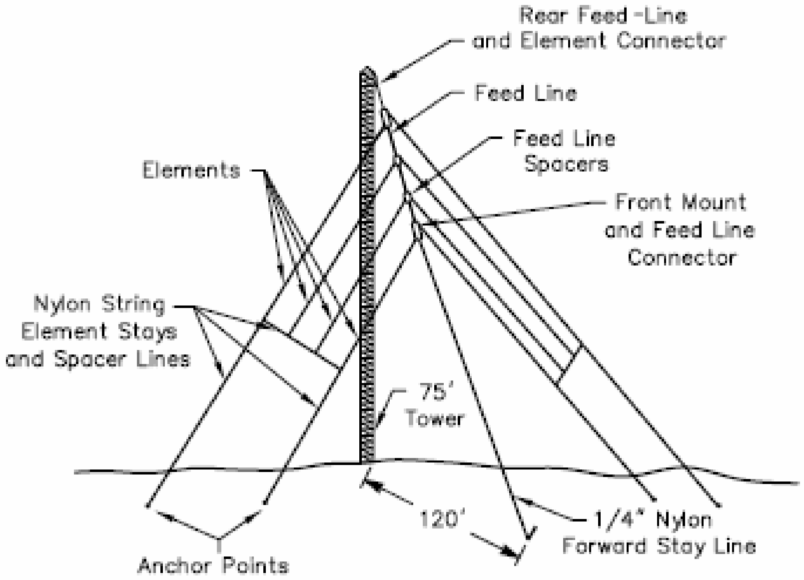

Fig 15—Typical lower-HF wire 4-element log periodic dipole array erected on a tower.

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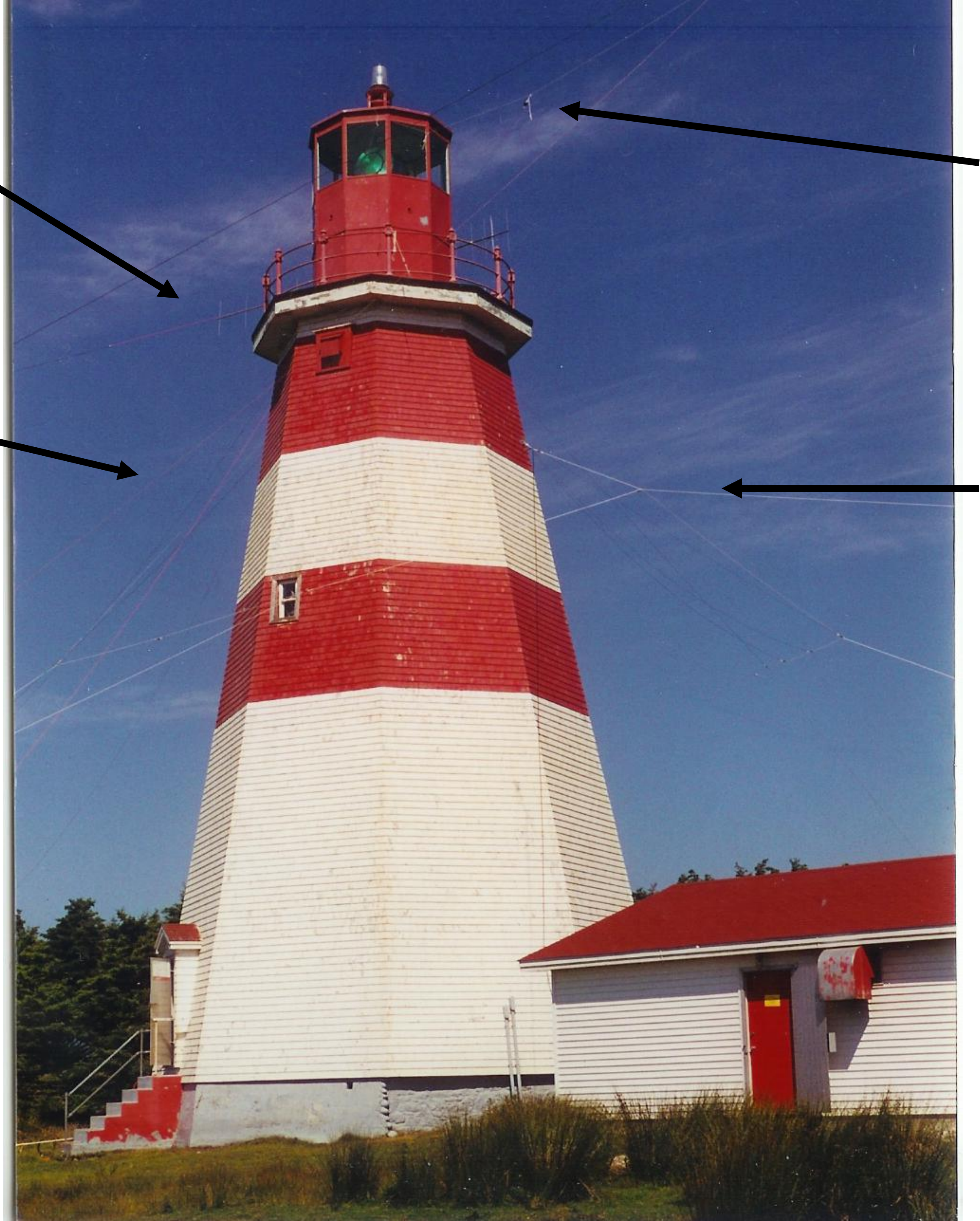


2m “boomer”

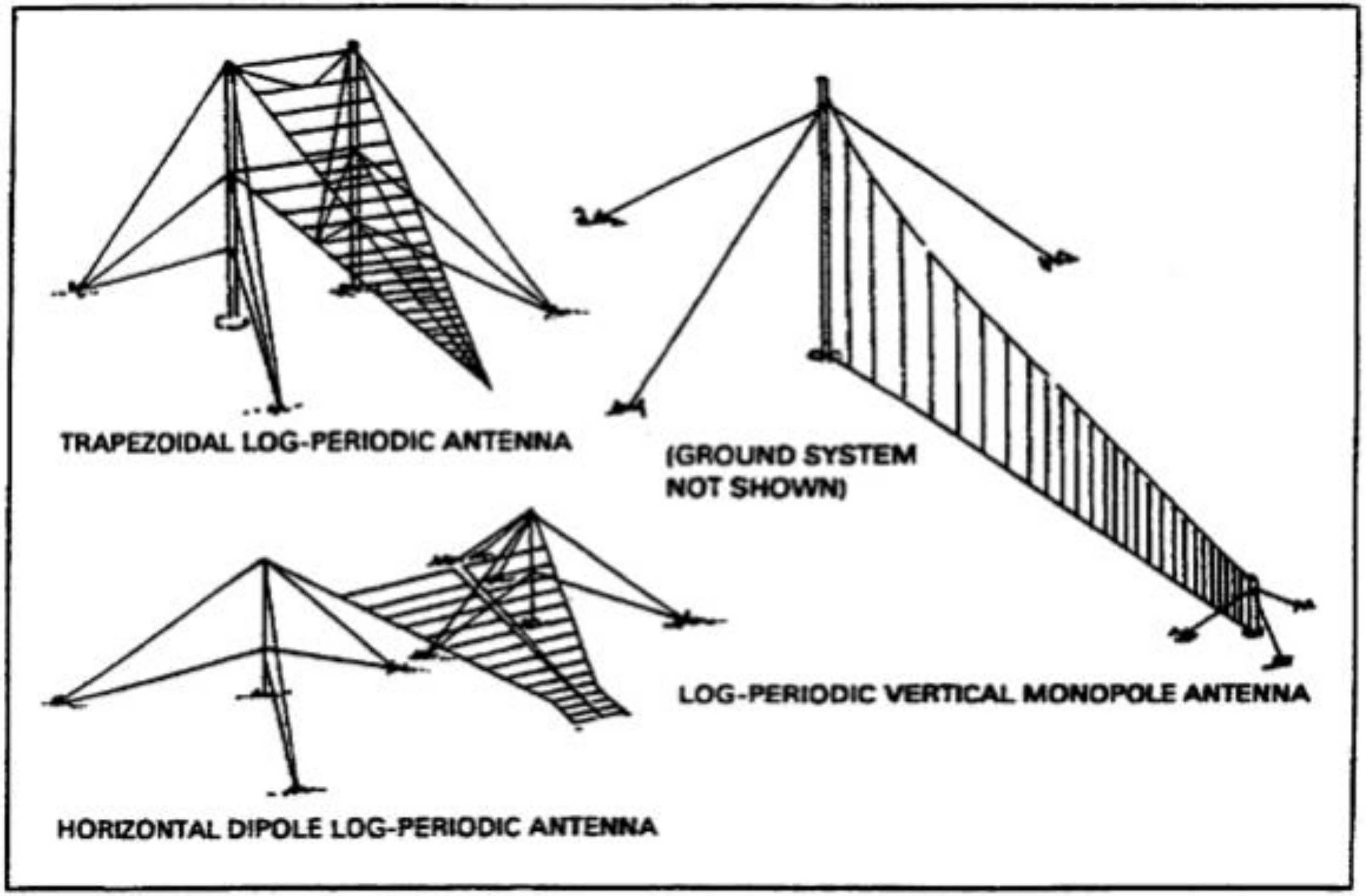
80m vertical wire Log Periodic

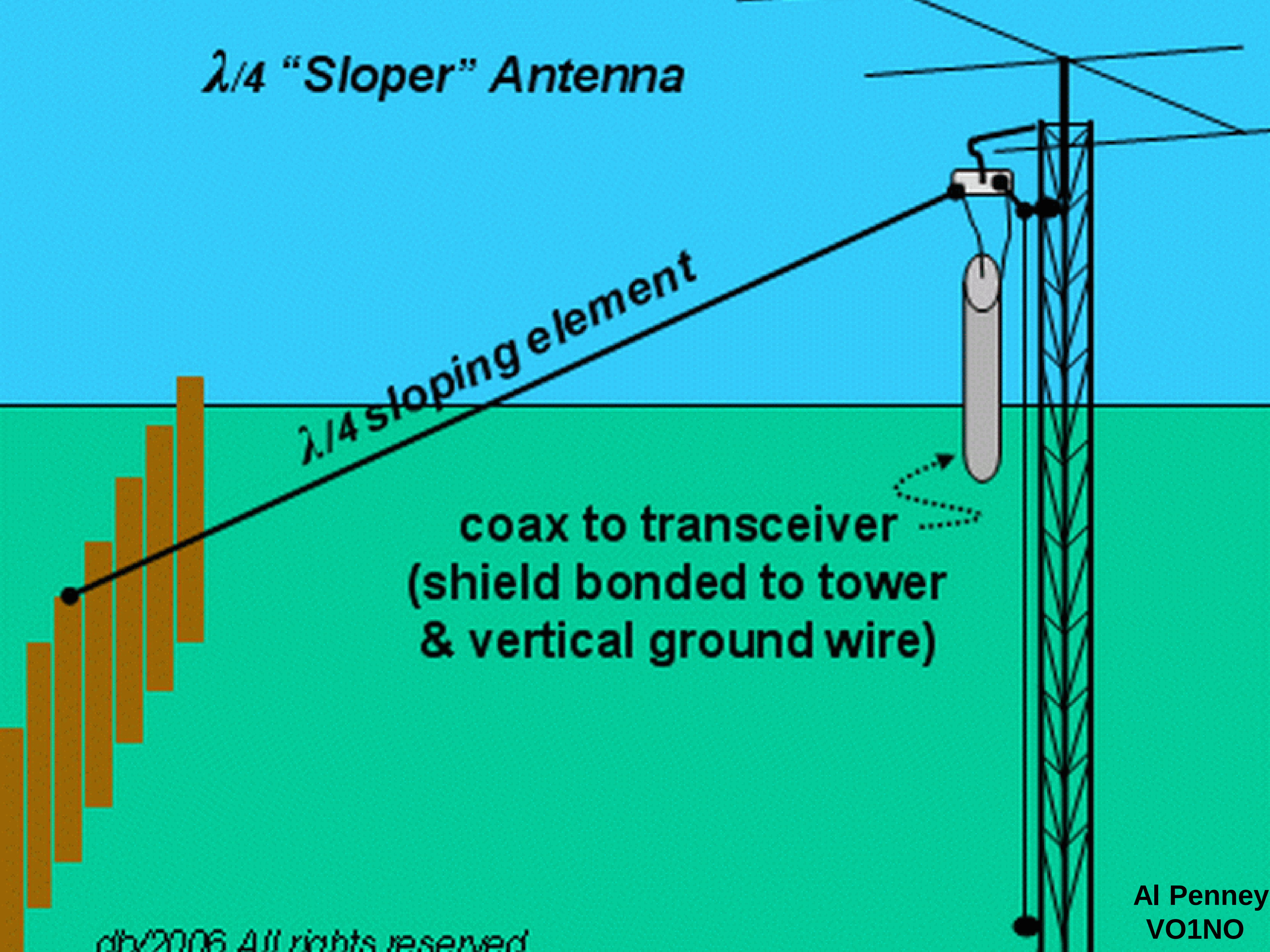
6m double Sloping Vee

40m wire Log Periodic

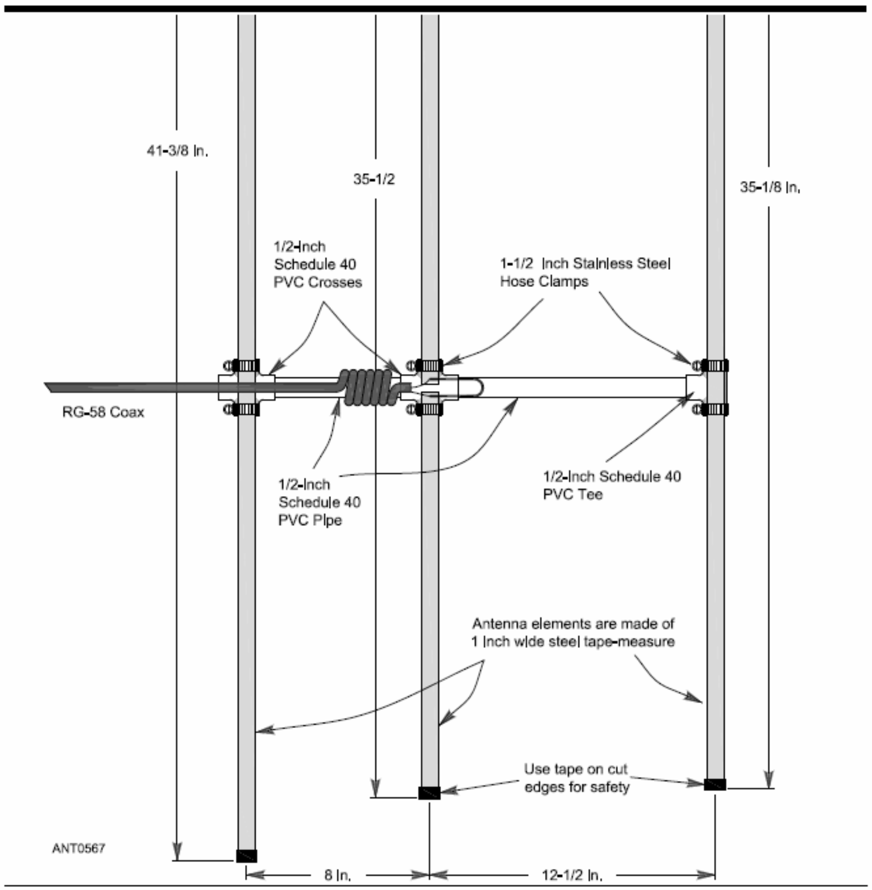
Satellite antenna array and Beverage RX antenna (out of photo)

Log Periodic Antennas




λ/4 "Sloper" Antenna
λ/4 sloping element
coax to transceiver
(shield bonded to tower
& vertical ground wire)
db/2006 All rights reserved

Tape Measure Yagi



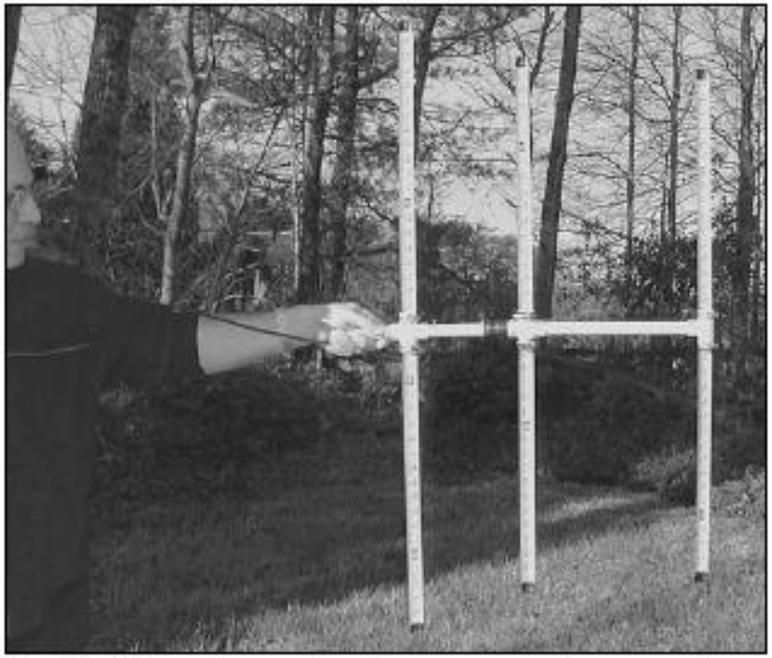


Fig 46—Photo of complete tape-measure beam, ready to hunt foxes!

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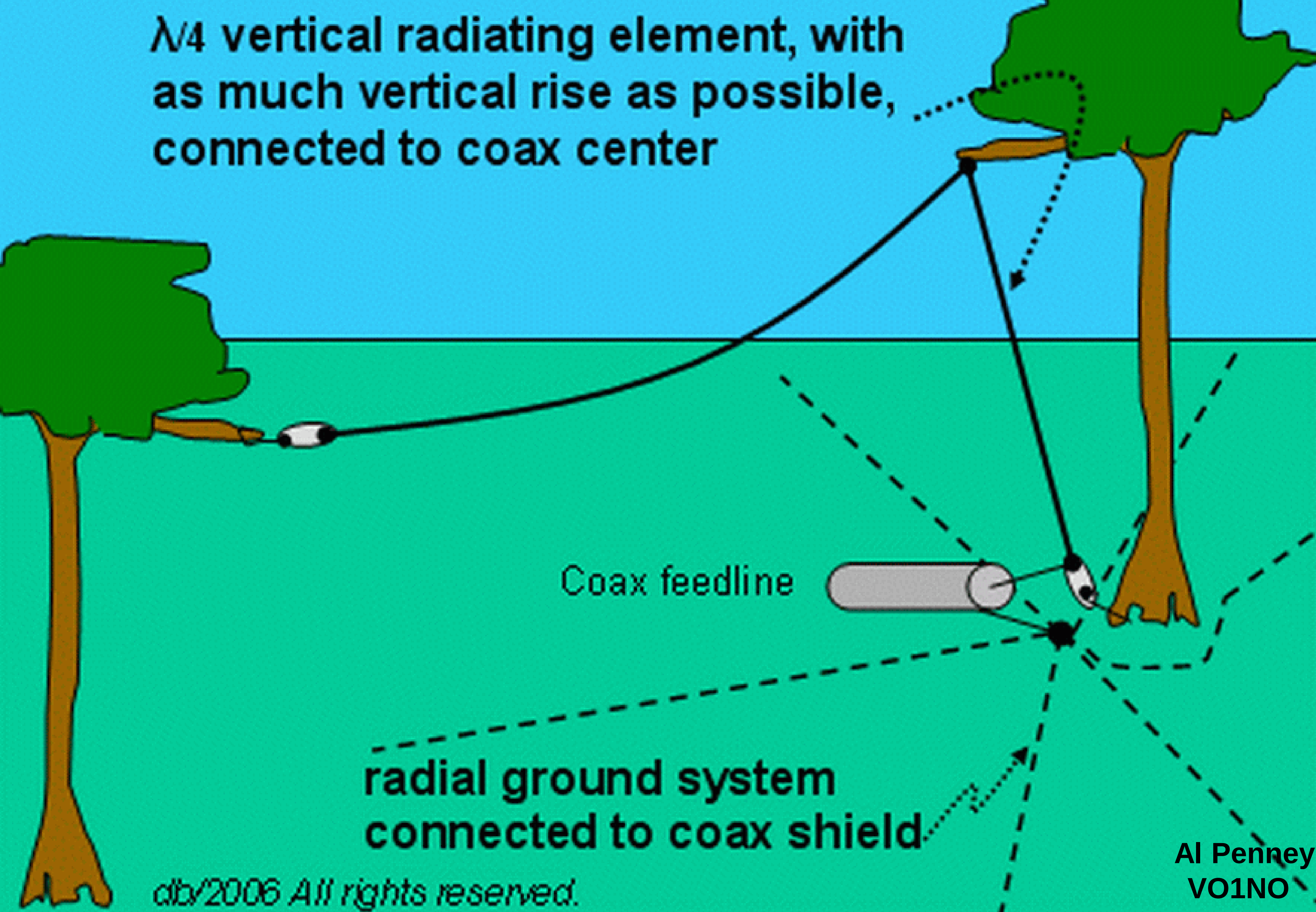
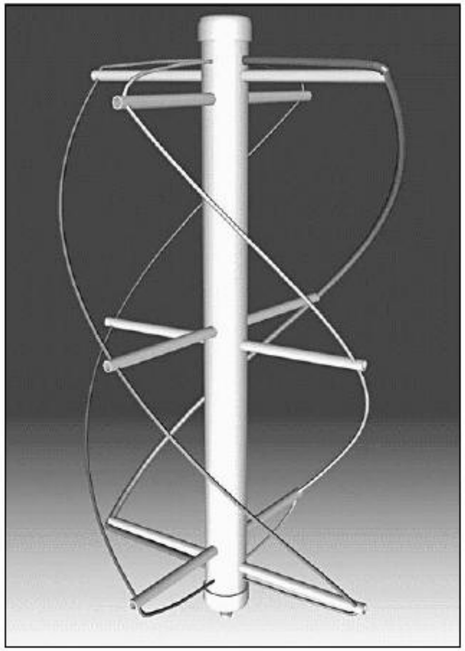
Inverted-L Antenna



λ/4 vertical radiating element, with as much vertical rise as possible, connected to coax center

radial ground system connected to coax shield

Antennas for Space Communications



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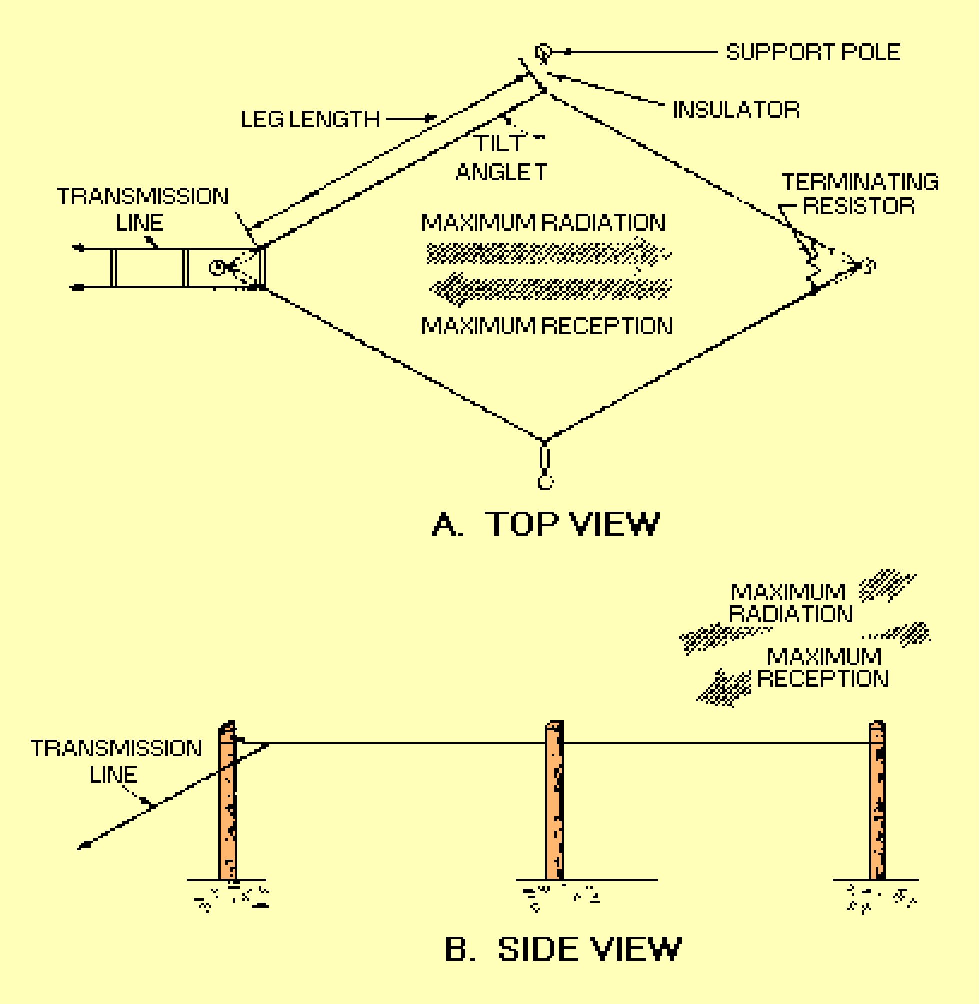
Rhombic Antenna



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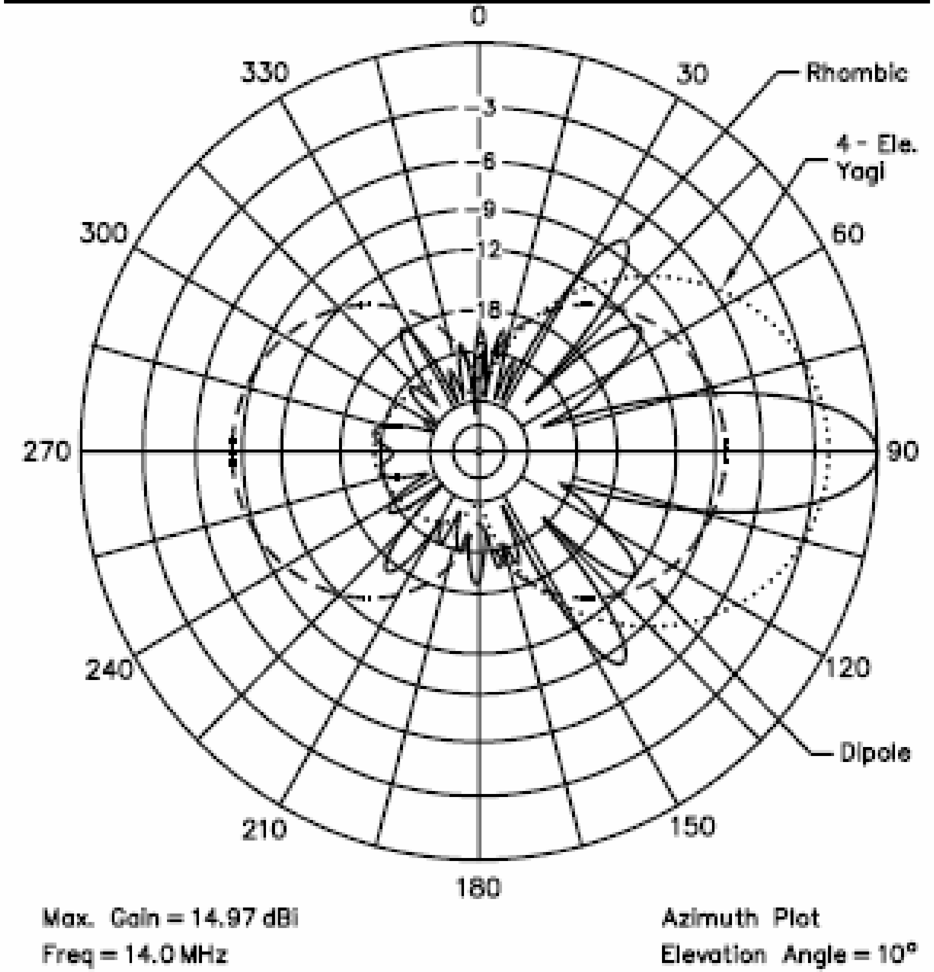

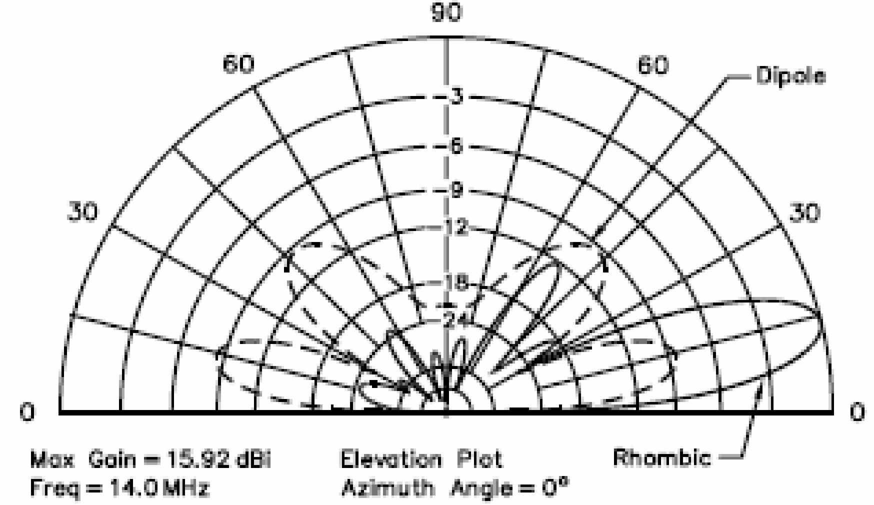

Fig 27—At left, azimuthal pattern for 3-λ (at 14 MHz) terminated rhombic (solid line) shown in Fig 26, compared with 4-element 20-meter Yagi (dotted line) on a 26-foot boom and a 20-meter dipole (dashed line). All antennas are mounted 70 feet (1 λ) above flat ground. The rearward pattern of the terminated rhombic is good and the forward gain exceeds that of the Yagi, but the frontal lobe is very narrow. Above, elevation-plane pattern of terminated rhombic compared to that of a simple dipole at the same height.

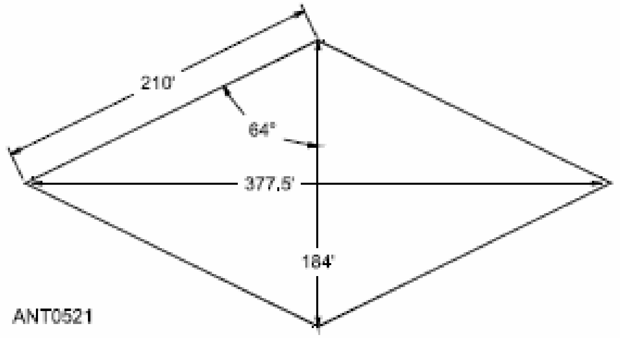

Fig 26—Rhombic antenna dimensions for a compromise design between 14- and 28-MHz requirements, as discussed in the text. The leg length is 6 λ at 28 MHz, 3 λ at 14 MHz.

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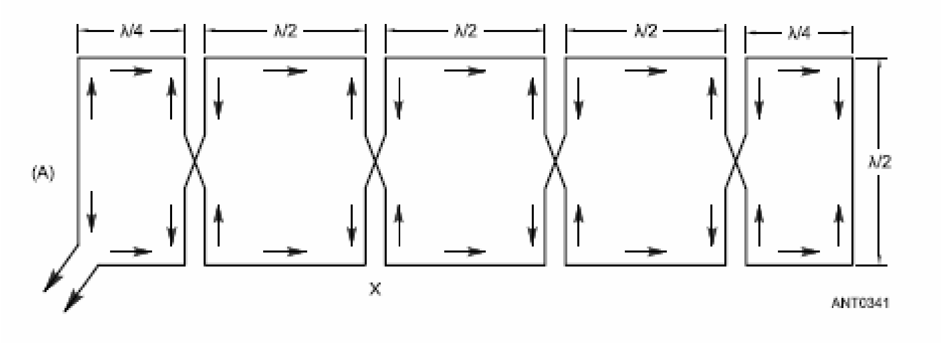
Sterba Curtain



[illegible]

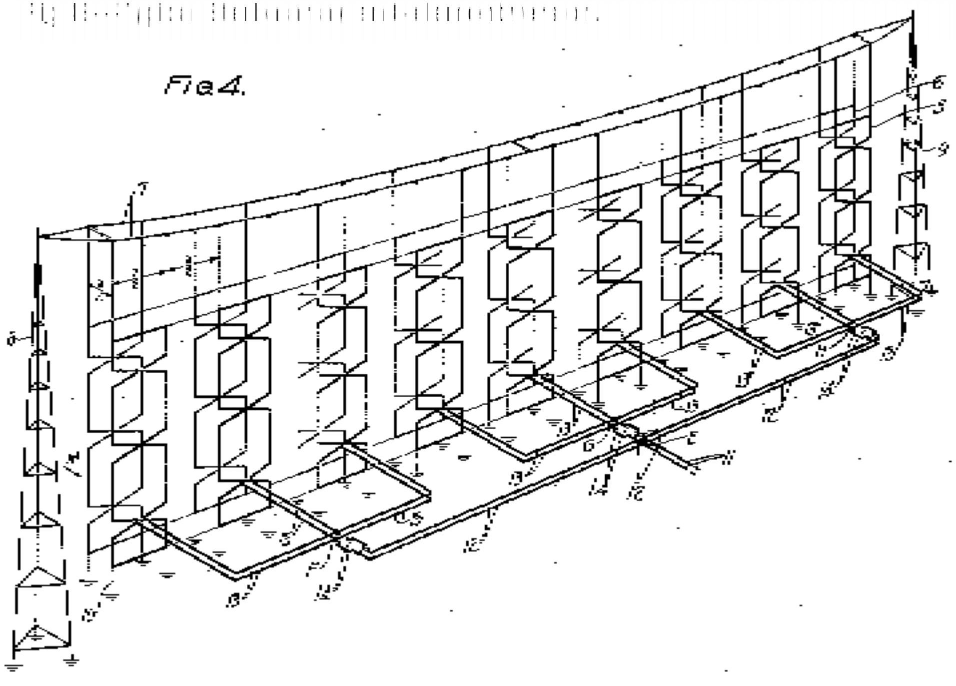


Fig.4.

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Three bay Sterba Curtain for 6m

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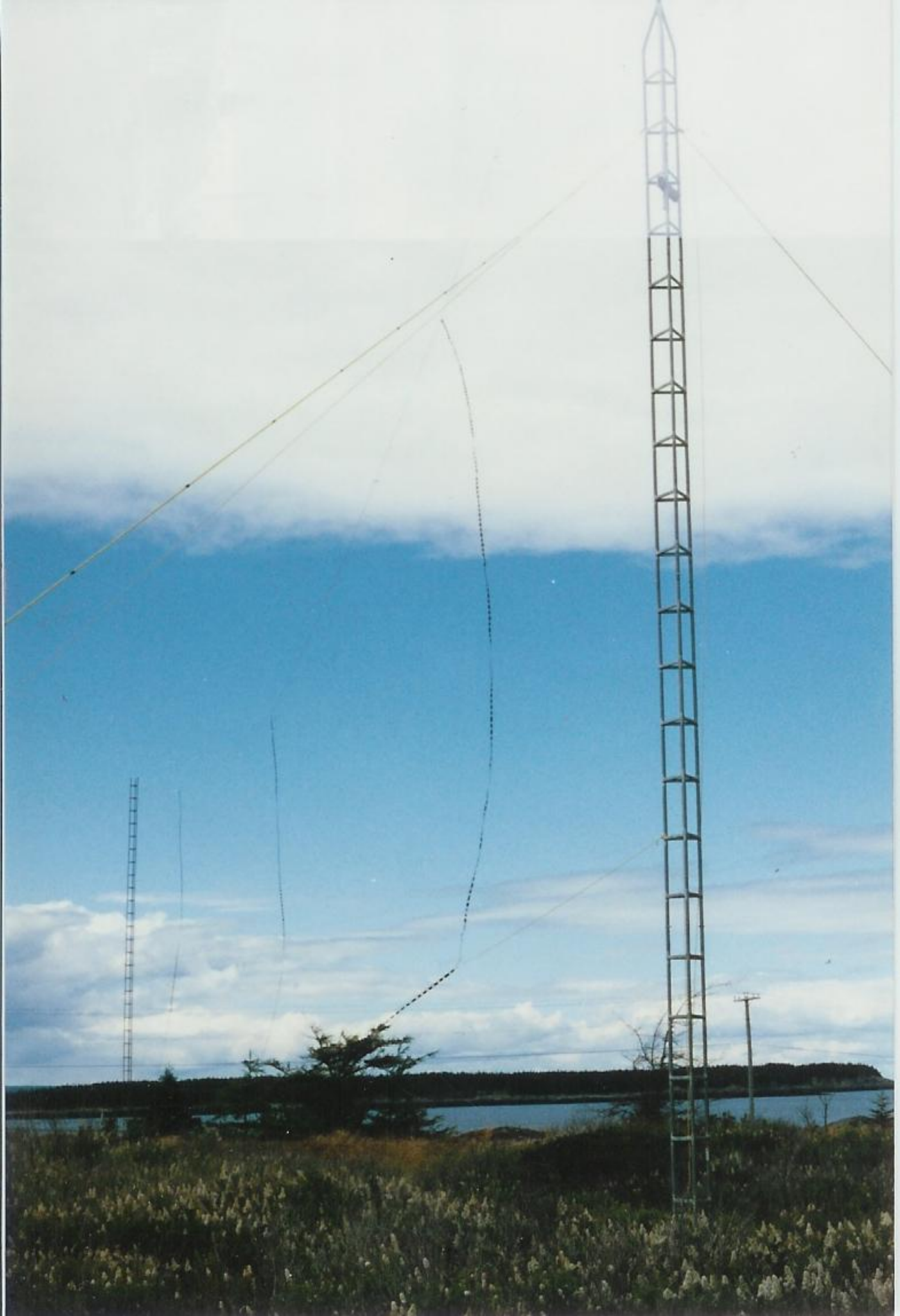

Three-bay Sterba Curtain
for 40m, Whitehead Island,
Bay of Fundy

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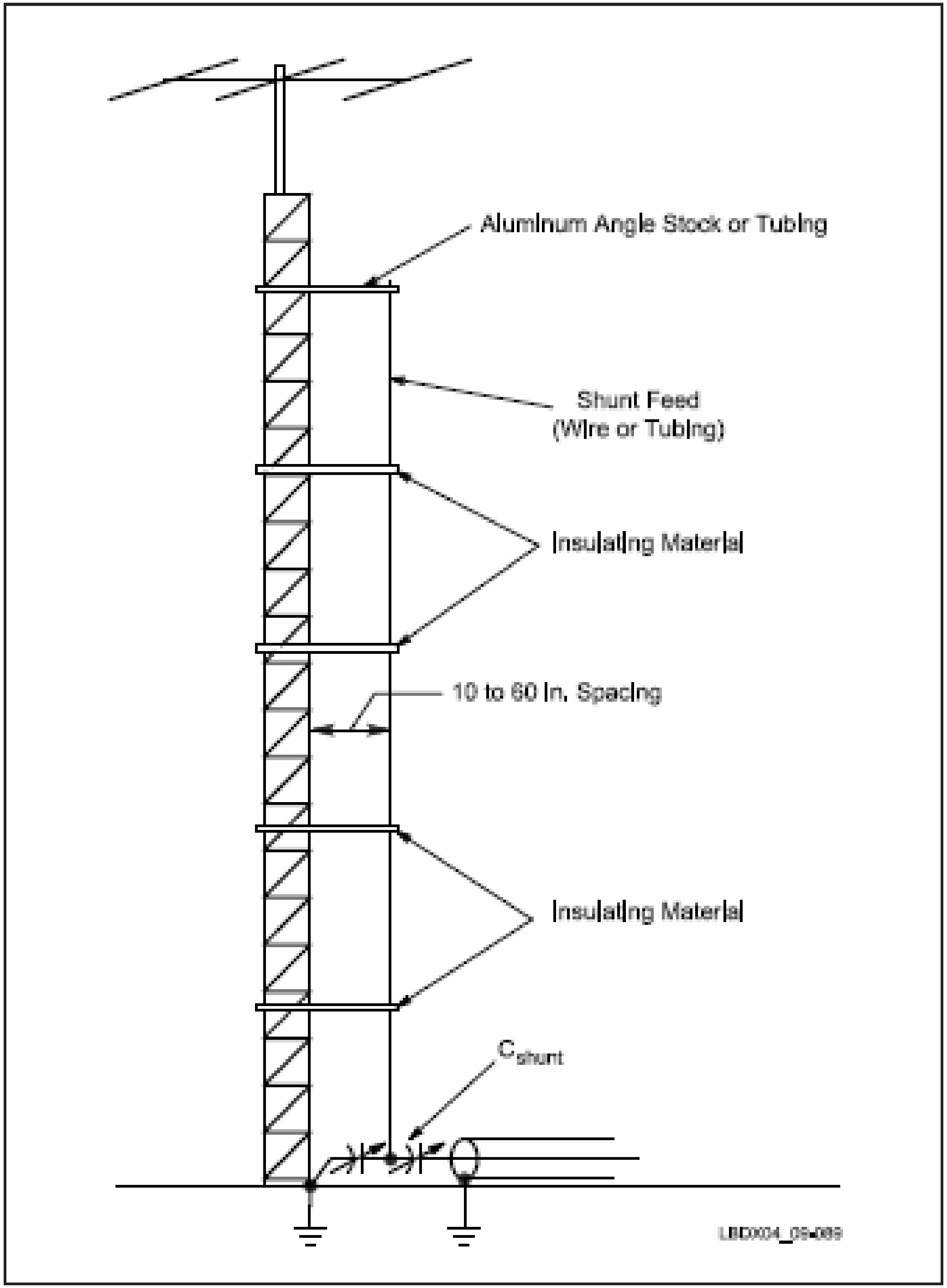
Shunt Fed Vertical



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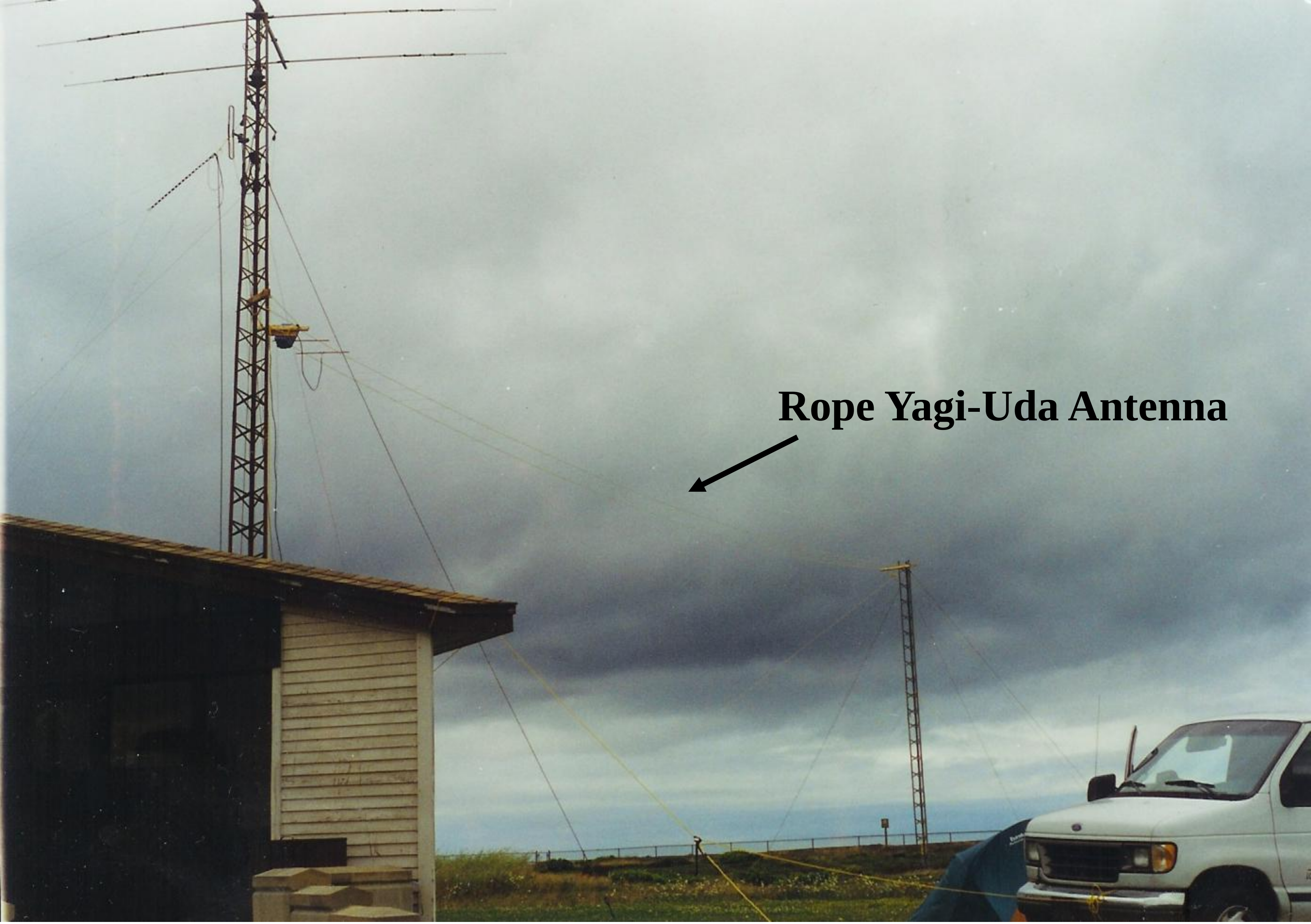
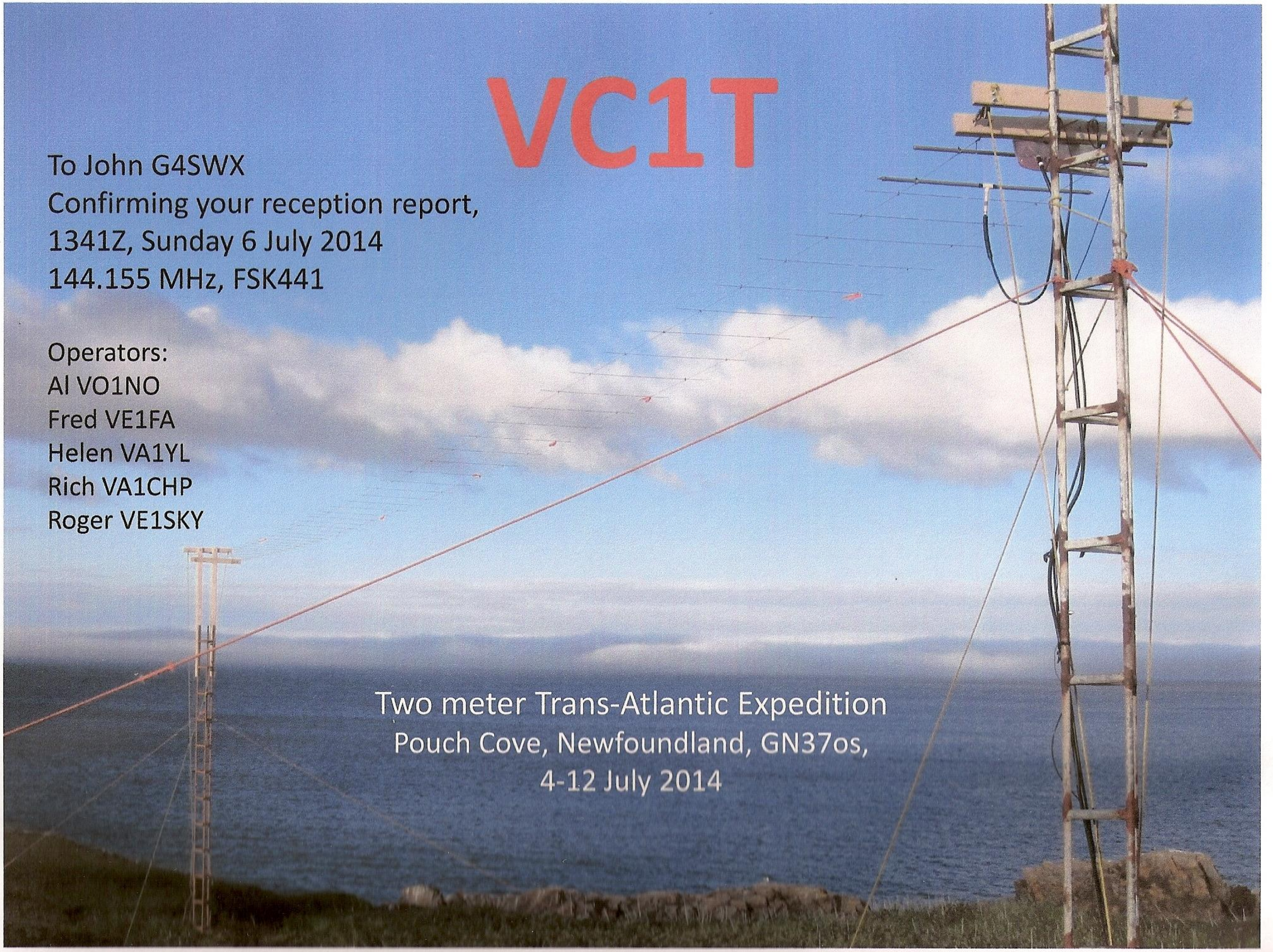
Al Penney
VO1NO

Al Penney
VO1NO



Rope Yagi-Uda Antenna

2m Trans-Atlantic attempt, Marconi National Historic Site, Nova Scotia



VC1T

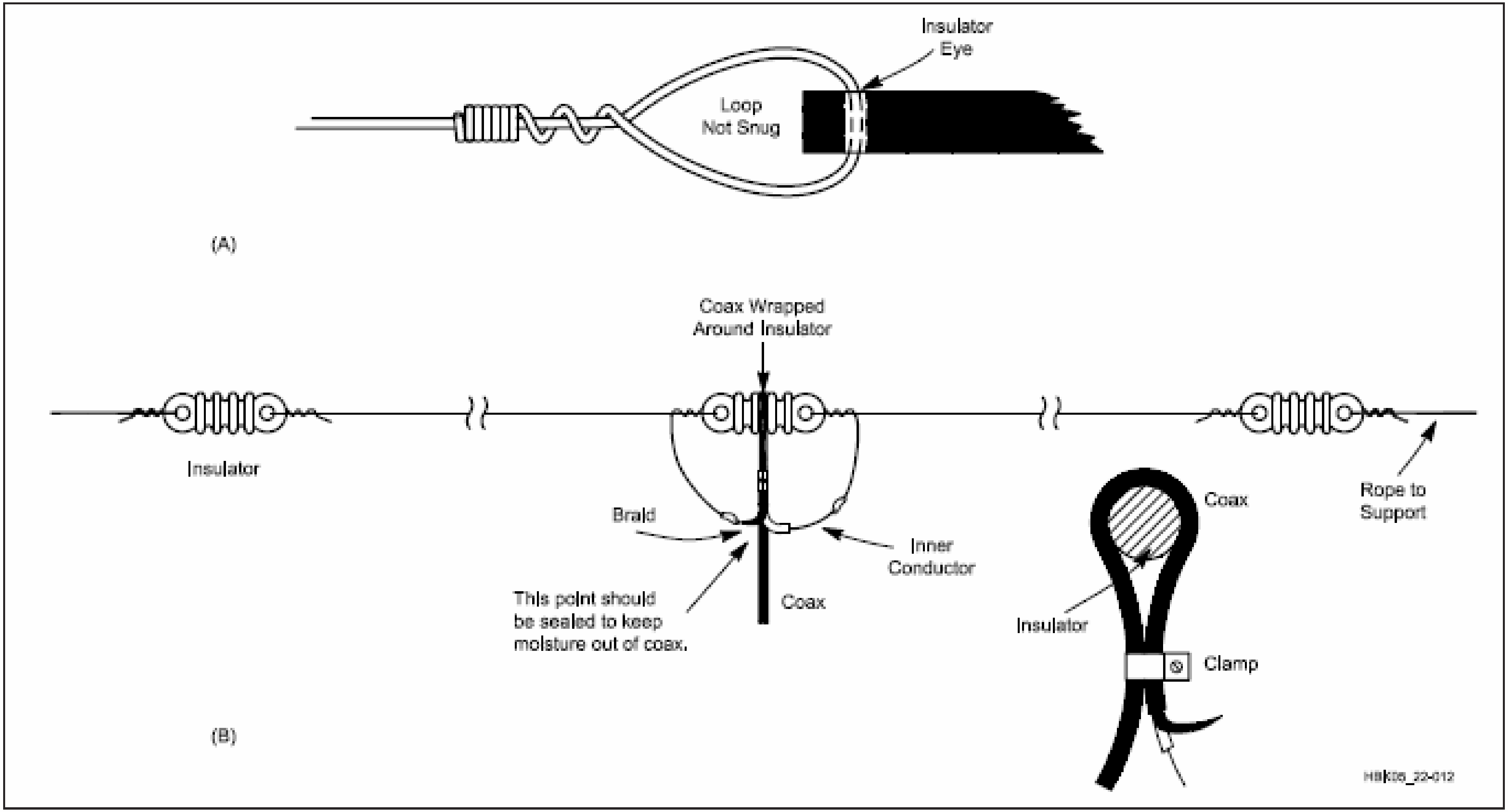
To John G4SWX
Confirming your reception report,
1341Z, Sunday 6 July 2014
144.155 MHz, FSK441

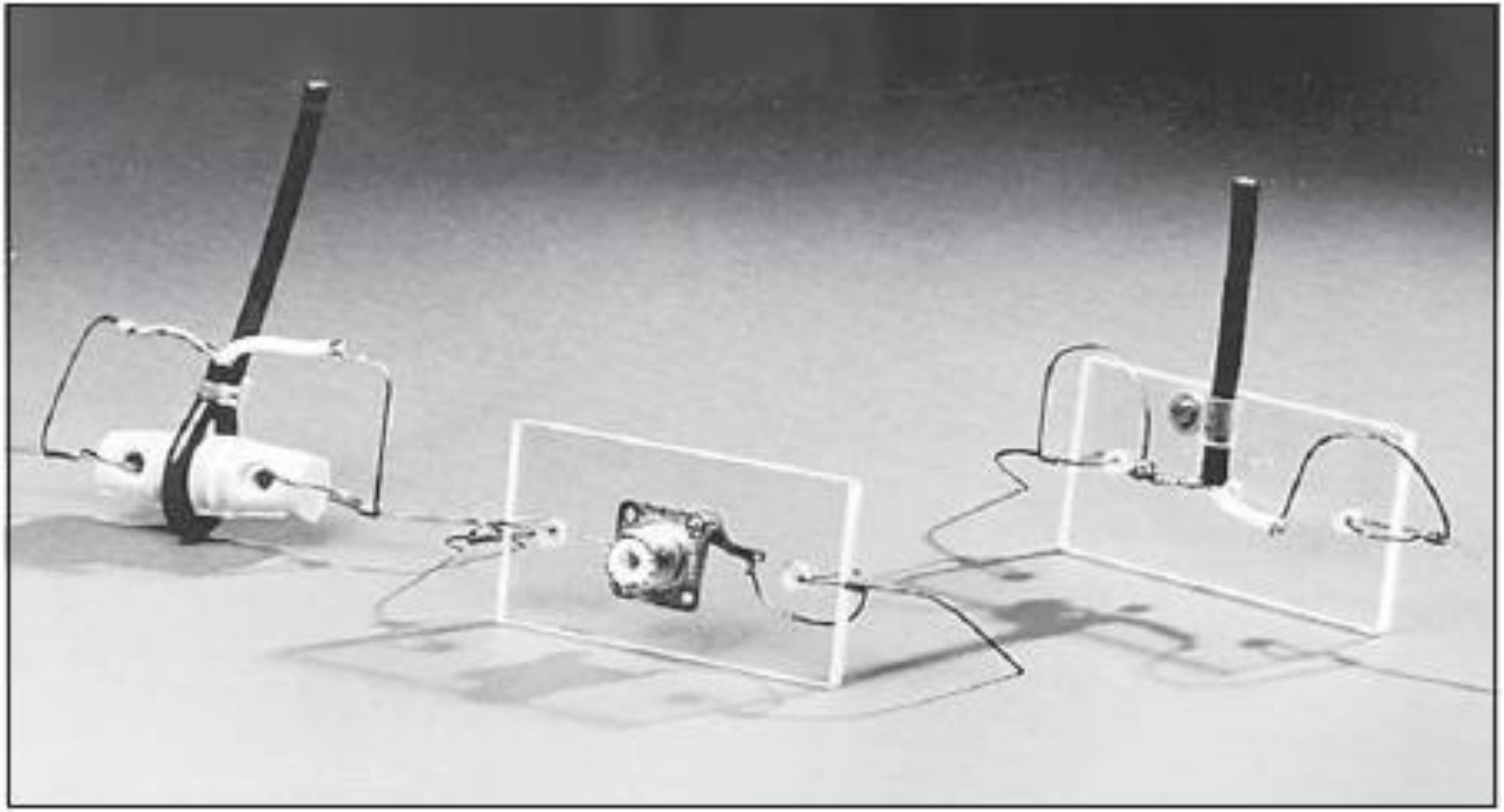
Operators:
Al VO1NO
Fred VE1FA
Helen VA1YL
Rich VA1CHP
Roger VE1SKY

Two meter Trans-Atlantic Expedition
Pouch Cove, Newfoundland, GN37os,
4-12 July 2014

Practical Antenna Construction

Al Penney
VO1NO


Insulator Eye
Loop Not Snug
(A)
Coax Wrapped Around Insulator
Insulator
Braid
Inner Conductor
This point should be sealed to keep moisture out of coax.
Coax
Coax
Rope to Support
Insulator
Clamp
(B)
HBK05_22-012



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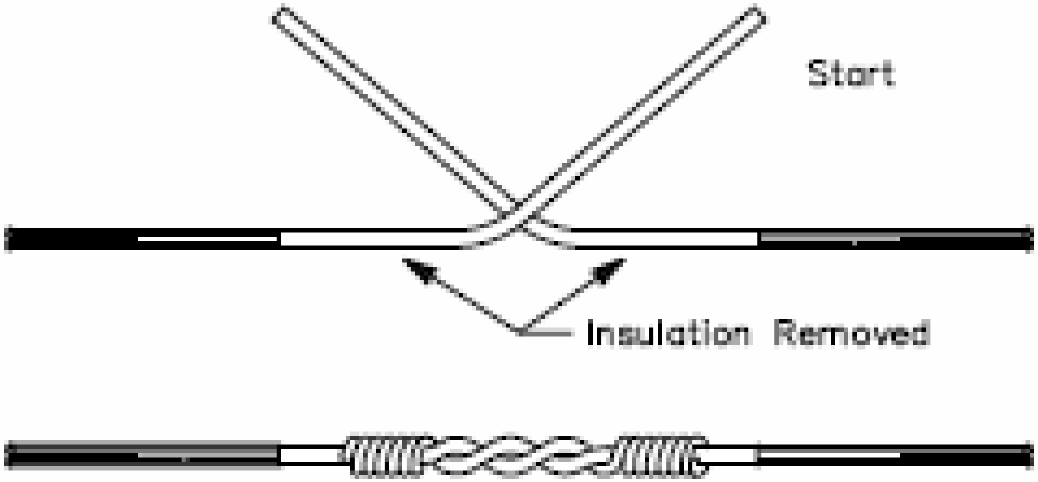

Fig 3—Correct method of splicing antenna wire. Solder should be flowed into the wraps after the connection is completed. After cooling, the joint should be sprayed with acrylic to prevent oxidation and corrosion.

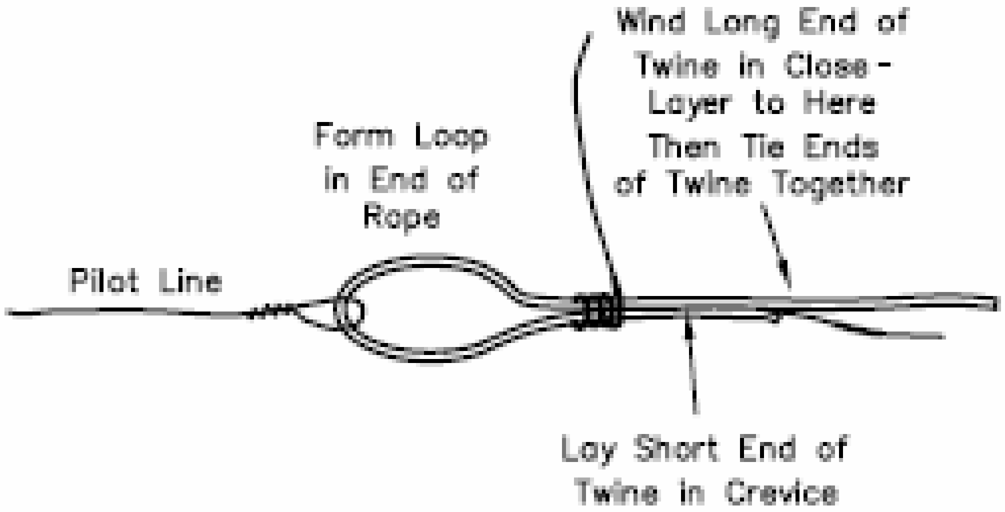

Fig 2—In connecting the halyard to the pilot line, a large knot that might snag in the crotch of a tree should be avoided, as shown.

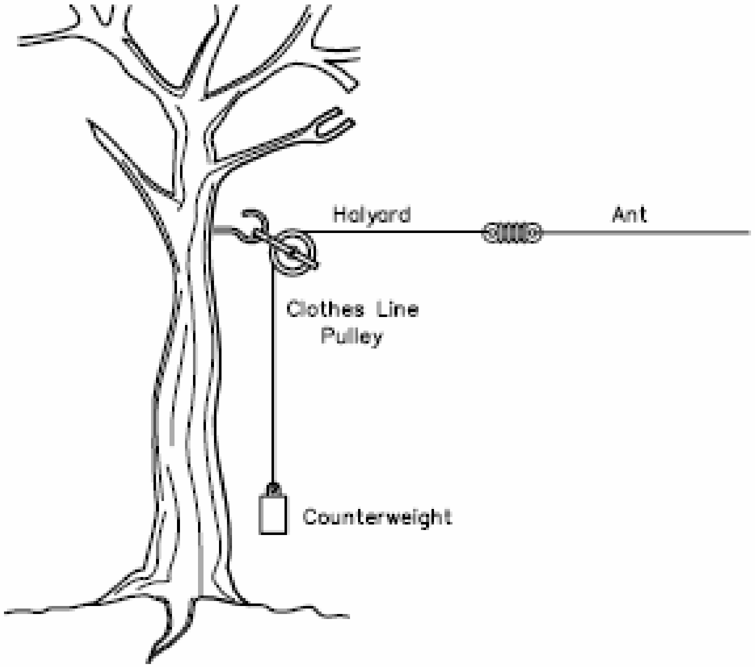

Fig 1—A method of counter weighting to minimize antenna movement and avoid its breaking from tree movement in the wind. The antenna may be lowered without climbing the tree by removing the counterweight and tying additional rope at the bottom end of the halyard. Excess rope may be left at the counterweight for this purpose, as the knot at the lower end of the halyard will not pass through the pulley.

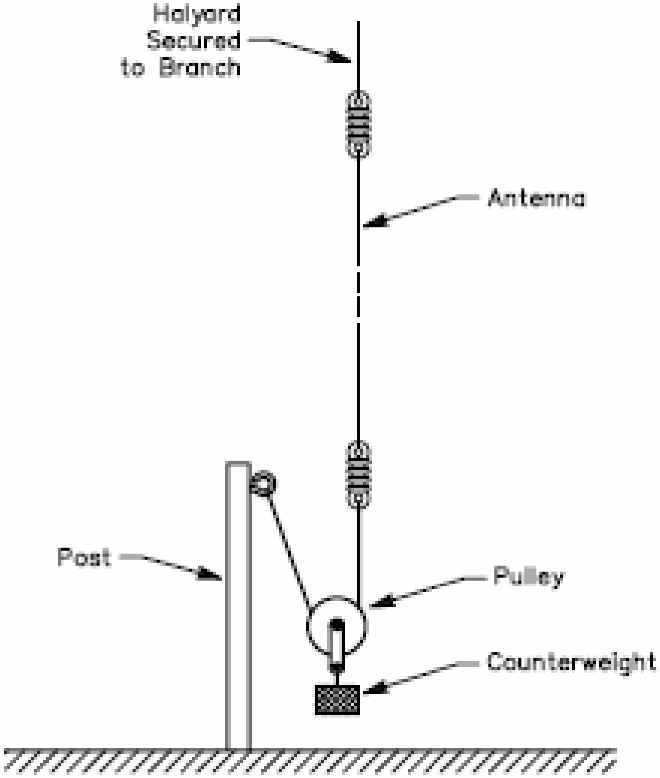

Fig 5—Counterweight for a vertical antenna suspended from an overhanging tree branch.

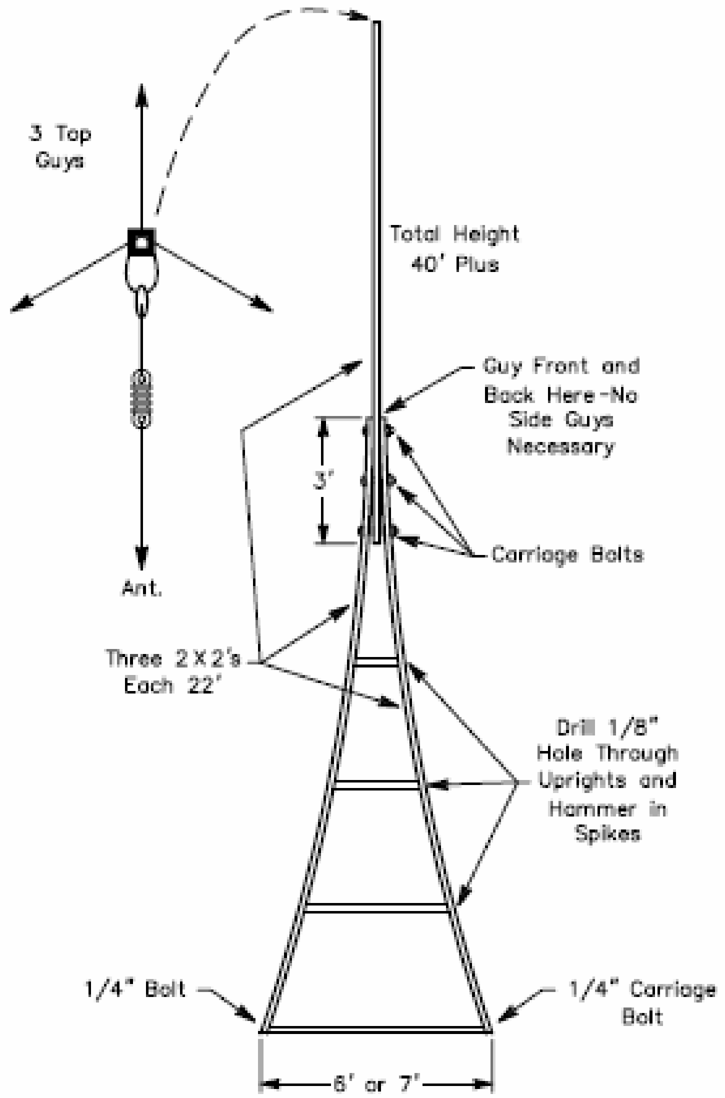

Fig 7—The A-frame mast is lightweight and easily constructed and erected.

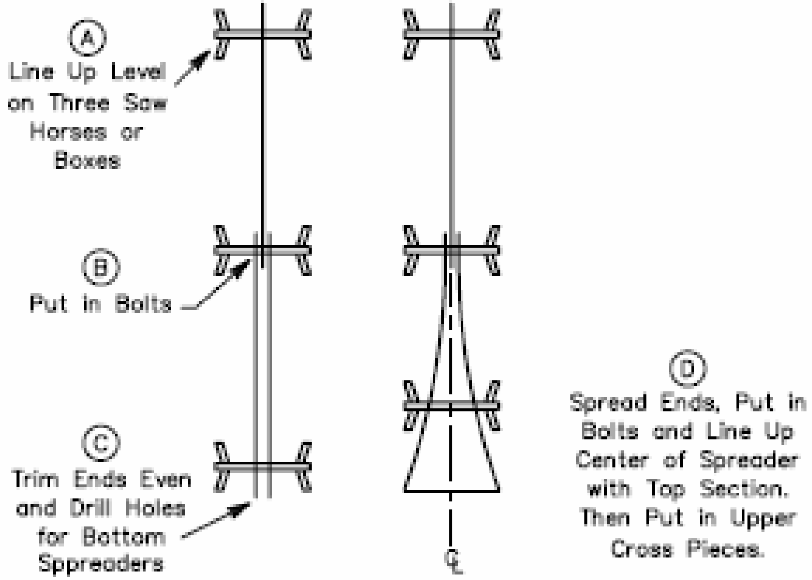

Fig 8—Method of assembling the A-frame mast on sawhorses.

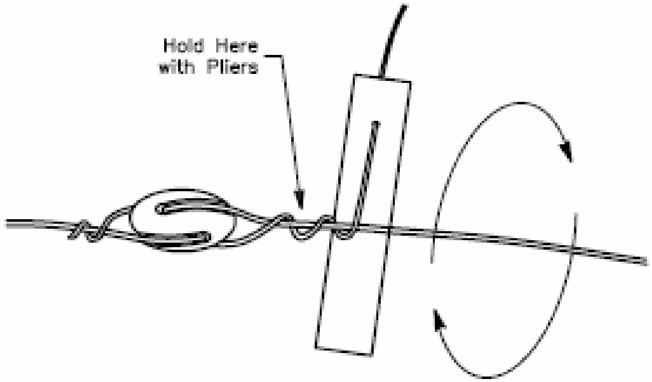

Fig 9—Simple lever for twisting solid guy wires when attaching strain insulators.

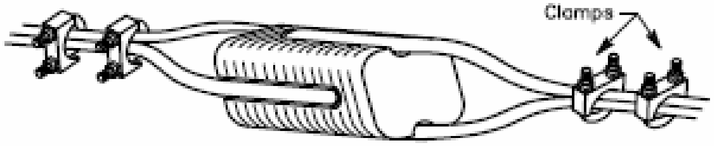

Fig 10—Stranded guy wire should be attached to strain insulators by means of standard cable clamps made to fit the size of wire used.

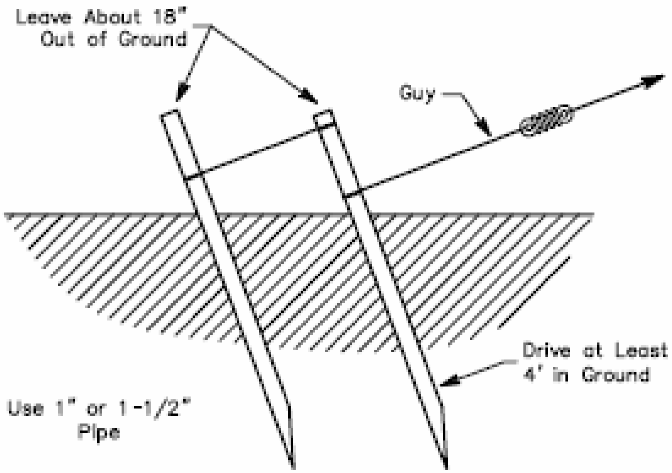

Fig 11—Driven guy anchors. One pipe is usually sufficient for a small mast. For added strength, a second pipe may be added, as shown.

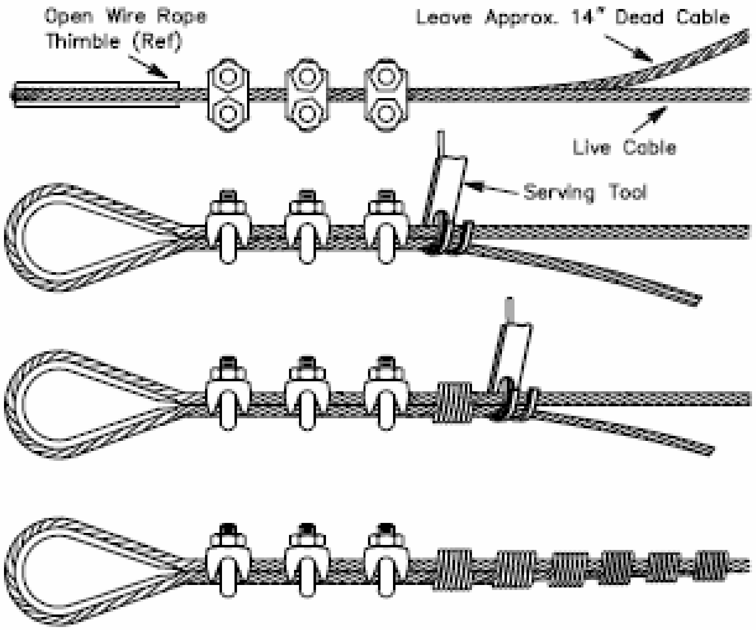

Fig 25—Traditional method for securing the end of a guy wire.

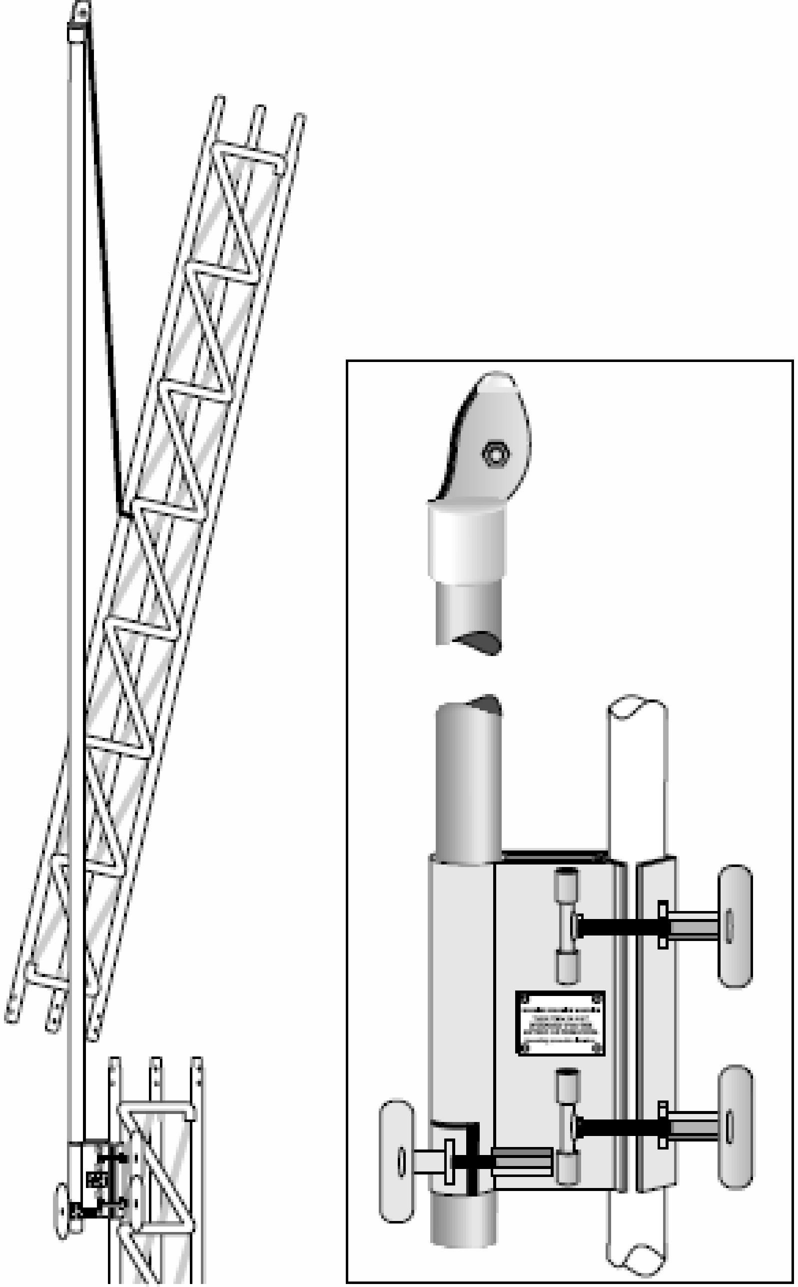

Fig 21—Drawing of Rohn "Erection Fixture" EF2545, also known commonly as a "gin pole."

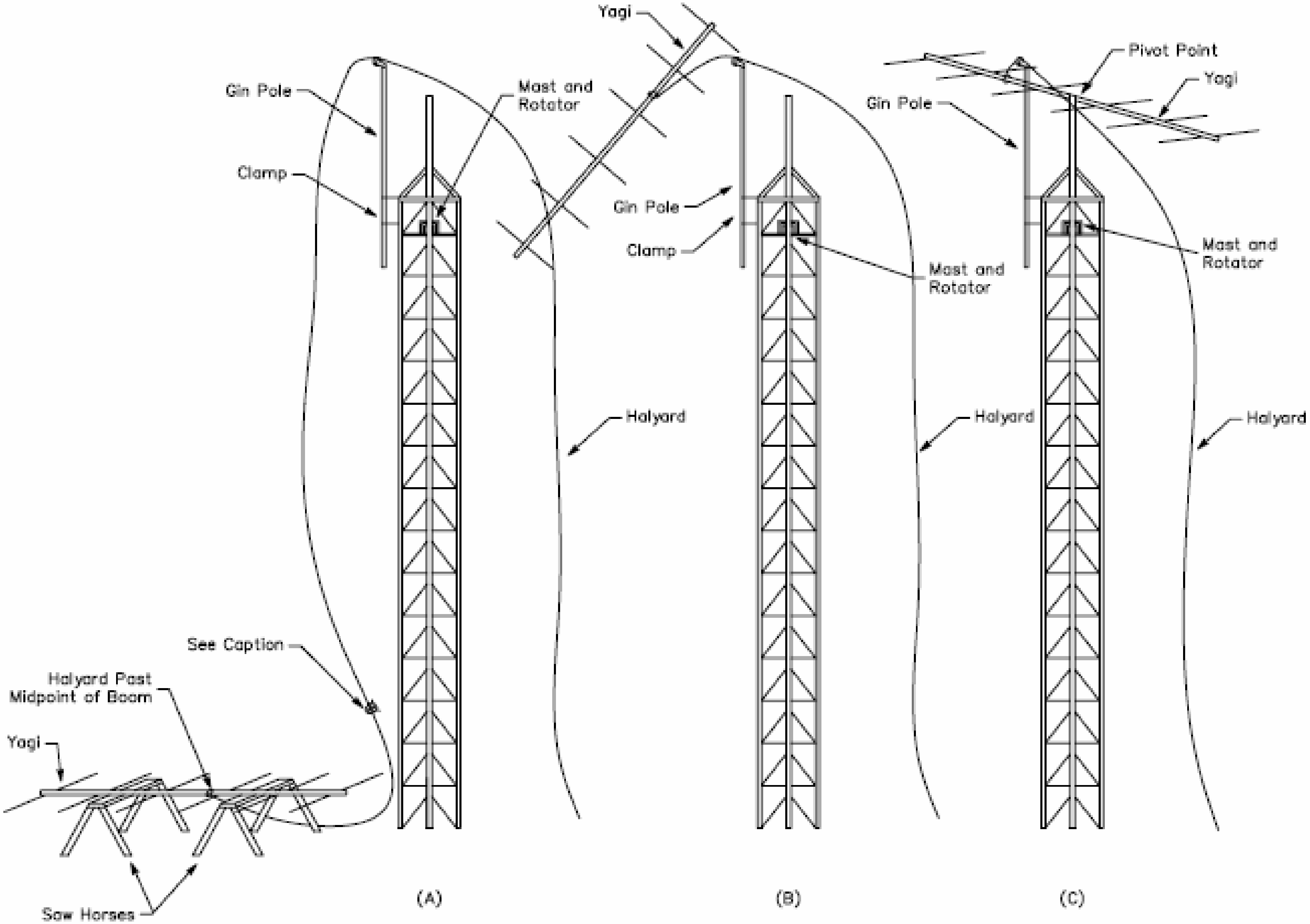

Fig 33—Raising a Yagi antenna alongside the tower. At A the Yagi is placed in a clear area, with the boom pointing toward the tower. The halyard is passed under the elements, then is secured to the boom beyond the midpoint. B shows the antenna approaching the top of the mast. The person on the tower guides it after the lifting rope has been untied from the front of the antenna. At C the antenna is pulled into a horizontal position by the ground crew. The tower worker inserts the pivot bolt and secures it. Note: A short piece of rope is tied around the halyard and the boom at the front of the antenna to stabilize the beam as it is being raised. The tower worker removes it when the boom reaches him at the top of the tower.

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Questions?

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Many types of antennas exhibit a feed-point impedance lower than the 50-Ω characteristic impedance of commonly available coax cable. Both the so-called *T-Match* and the *Gamma-Match* are used extensively on Yagi and quad beam antennas to increase the antenna feed impedance to 50 Ω.

The method of matching shown in **Fig 21.8** is based on the fact that the impedance between any two points equidistant from the center along a resonant antenna is resistive, and has a value that depends on the spacing between the two points. It is therefore possible to choose a pair of points between which the impedance will have the right value to match a transmission line. In practice, the line cannot be connected directly at these points because the distance between them is much greater than the conductor spacing of a practical transmission line. The T arrangement in Fig 21.8A overcomes this difficulty by using a second conductor paralleling the antenna to form a matching section to which the line may be connected.

The T is particularly well suited to use with parallel-conductor feed line. The operation of this system is somewhat complex. Each T conductor (Y in the drawing) forms a short section of transmission line with the antenna conductor opposite it. Each of these transmission-line sections can be considered to be terminated in the impedance that exists at the point of connection to the antenna. Thus, the part of the antenna between the two points carries a transmission-line current in addition to the normal antenna current. The two transmission-line matching sections are in series, as seen by the main transmission line.

If the antenna by itself is resonant at the operating frequency, its impedance will be purely resistive. In this case the matching-section lines are terminated in a resistive load. As transmission-line sections, however, these matching sections are terminated in a short, and are shorter than a quarter wavelength. Thus their input impedance, the impedance seen by the main transmission line looking into the matching-section terminals, will be inductive as well as resistive. The reactive component of the input impedance must be tuned out before a proper match can be obtained.

One way to do this is to detune the antenna just enough, by shortening its length, to cause capacitive reactance to appear at the input terminals of the matching section, thus canceling the reactance introduced. Another method, which is considerably easier to adjust, is to insert a variable capacitor in series with each matching section where it connects to the transmission line, as shown in the chapter on **Antennas**. The capacitors must be protected from the weather.

When the series-capacitor method of reactance compensation is used, the antenna should be the proper length for resonance at the operating frequency. Trial positions of the matching-section taps are then taken, each time adjusting the capacitor for minimum SWR, until the lowest possible SWR has been achieved. The unbalanced (gamma) arrangement in Fig 21.8B is similar in principle to the T, but is adapted for use with single coax line. The method of adjustment is the same.

The Hairpin Match

In beam antennas such as Yagis or quads, which utilize parasitic directors and reflectors to achieve directive gain, the mutual impedance between the parasitic and the driven elements lowers the resistive component of the driven-element impedance, typically to a value between 10 and 30 Ω. If the driven element is purposely cut slightly shorter than its half-wave resonant length, it will exhibit a capacitive reactance at its feed point. A shunt inductor as shown in **Fig 21.9** placed across the feed-point center in-sulator can be used to transform the antenna resistance to match the characteristic impedance of the transmission line, while canceling out the capacitive reactance simultaneously. The antenna's capacitive reactance and the *hairpin*-shaped shunt inductor form an L network.

For mechanical convenience, the shunt inductor is often constructed using heavy- The disadvantage of the hairpin match is that it does require that the driven element be split and insulated at its center. The length of the driven element and the value of shunt inductance can be varied in the hairpin match to bring the SWR down to exactly 1:1 at a desired frequency in the band. This can also be achieved with the T or gamma matches previously described.

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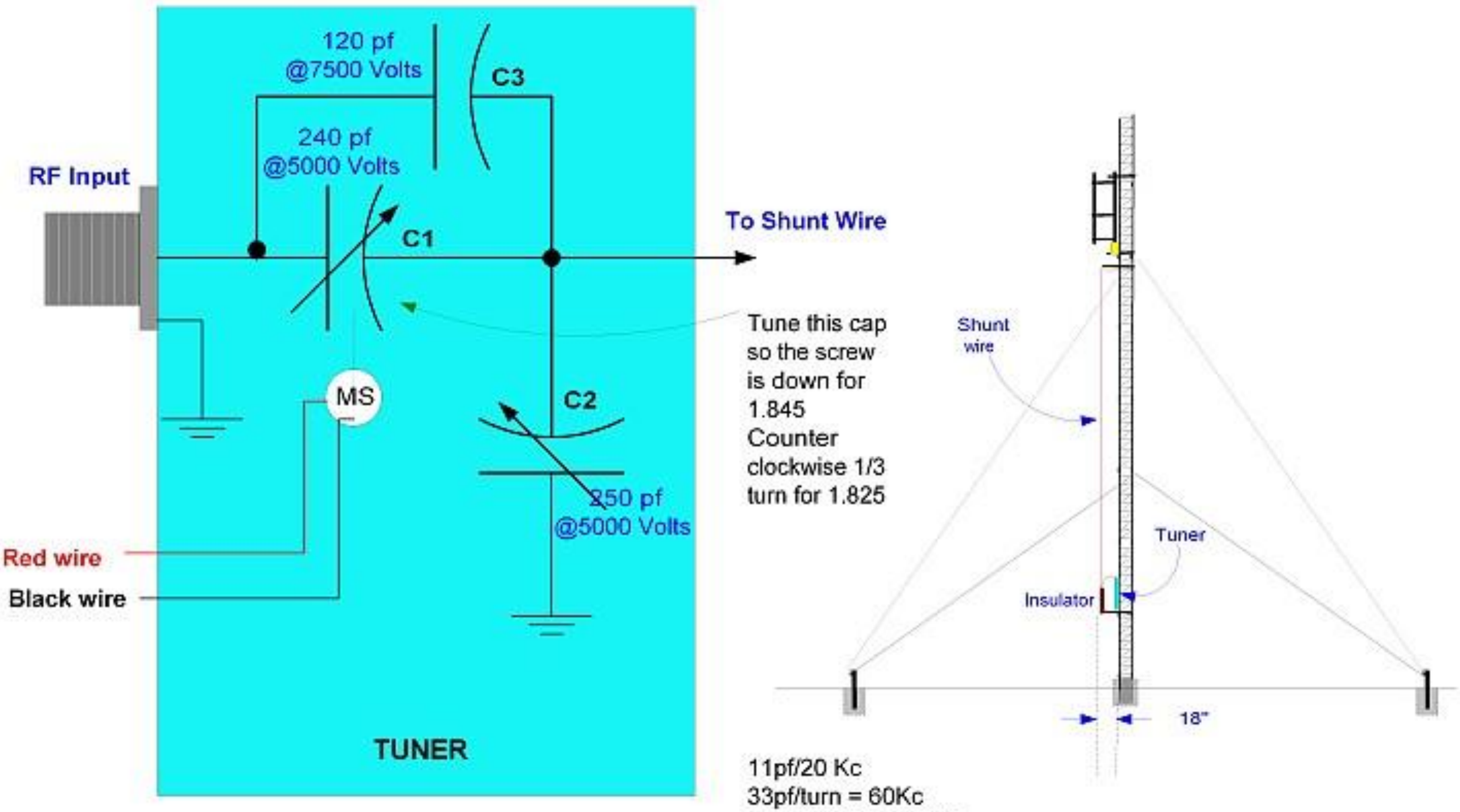
160 Meter Shunt Tuner



Tune this cap so the screw is down for 1.845 Counter clockwise 1/3 turn for 1.825

C1 = 260 pf **C2 =** 108 pf

11pf/20 Kc
33pf/turn = 60Kc
1.910-1.810 = 100Kc
5 x 20kc = 100 K c
5 x11 pf = 55pf
1 2/3 turn

W7EJ: 07/04/2005

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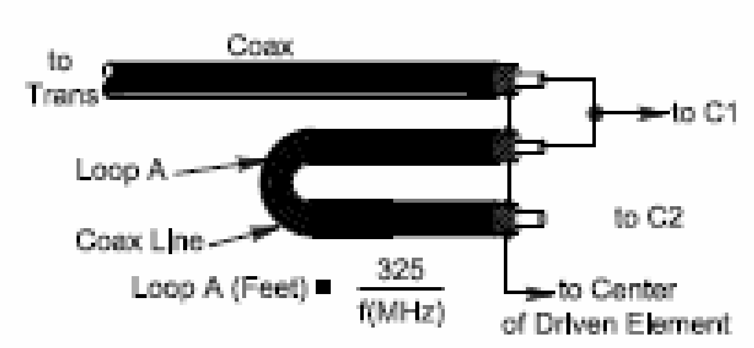

4; 1 Coax Balun

Figure 18 — The W1AB Killer Antenna is an elevated ground plane sized as a 40-meter antenna, but fed with ladder line and an antenna tuner for use on all HF bands and 160 meters. The radials for the elevated counterpoise are 6 to 10 feet above the ground, and are not connected to earth ground. For low-profile use, you can run the 33-foot vertical wire up the side of the tree.