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HF Mobile Set-up and Operation

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HF Mobile

- Easy to put new radios into cars
  - Alinco DX-70T/TH
  - Icom IC-706/MKII/MKIIG
  - Kenwood TS-50S
  - Yaesu FT-100/100D/857ND
- We'll look at:
  - Transceiver mounting
  - Powering
  - Noise reduction
  - Antenna location, theory, and types

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Transceiver Installation

- Mount the radio for accessibility and visibility
  - Don't interfere with car operation and safety equipment!
- Provide SHORT ground connection at the radio.
- Use a CD-player-to-cassette adapter for great sound
- Make a permanent mount, but provide for easy removal of the radio
  - Make thumbscrews (4mm X 20 mm screws)

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Powering

- Power directly from the battery
  - Use #12 wire or larger
- Fuse positive & negative power leads right at the battery
  - Use blade-type fuses and fuse holders
- Use 30-amp PowerPole connectors

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Antenna Connections

- Use a *high-quality* ball-mount on left side of car
  - Less prone to hitting overhead tree branches
- Use Home Depot “appliance” paint on antennas and ball-mount to match car
- Use trunk-lip, mag-mount, hatch-back mounts only as last resort.
  - Measured 15 ohms higher ground loss on hatch-back vs ball mount on Ford Explorer
- Use LMR-200 or LMR-240 (RG-58/8X size) coax.
  - Both are 100% shielded

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Noise Reduction

- Noise problems are normally your greatest challenge!
- Test noise level with & without 20 meter antenna, with & without car engine running.
  - Determines whether noise is radiated or conducted
- Conducted power line noise:
  - Use RS 270-055 20-amp 12-volt in-line filter.

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Radiated Noise Solutions

- Connect tinned copper braid from hood to body
- Connect tinned copper braid from trunk or hatchback to body
- Connect tinned copper braid from engine to body
- Connect tinned copper braid from exhaust pipe to body at engine end, **and tail pipe end**.
  - Tail pipe looks like $\lambda/4$ on 20 meters!
- Put coaxial bypass capacitors on all fan and air conditioning leads
  - RS272-1085

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Short Antennas

- Radiation resistance is proportional to both **height²** and **frequency²**
- As frequency decreases and length decreases, radiation resistance plummets!
- Low radiation resistance can become an insignificant part of the total system resistance
  - Ground loss
  - Coil loss
- This can significantly affect your antenna efficiency

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Short Antennas (Cont.)

- Short antennas look capacitive
  - 3.75 pf/ft
  - 34 pf for a 9-foot antenna
- You can resonate the capacitance with the loading inductor, leaving just the radiation resistance (and other losses)
- $L = 1/[(2\pi f)^2 C]$ (Henries, Hertz, Farads)
  - Base Loading
- $L = 2/[(2\pi f)^2 C]$ (Henries, Hertz, Farads)
  - Center Loading

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40 meter example

- Assume a 40 meter 9-foot base-loaded antenna:
  - $L = 1/[(2\pi 7.2X10^{6})2(34X10^{-12})] = 14.5\ \mu hy$
- For coil Q = 300
  - $R_L = 2\pi fL/Q = 2\pi(7.2)(14.5)/300 = 2.2\ \Omega$
- Radiation resistance (base loading)
  - $R_R = 2.9X10^{-6}(hf)^2$ (h=inches, f=MHz)
  - $R_R = 2.9X10^{-6}(108X7.2)^2 = 1.8\ \Omega$

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40 meter example (Cont.)

- The coil loss is greater than the radiation resistance! Plus we probably have at least 10 Ω of ground loss.
- Radiation resistance for center loading:
  - $R_R = 6.7X10^{-6}(hf)^2$
  - In this example, $R_R = 4\ \Omega$
- However, the center loading coil has twice the inductance of a base coil, and so has twice the loss.

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Antenna Efficiency

- You can find the power loss easily:
  - Power Loss (dB) = 10 LOG [$R_R/(R_R + R_L + R_G)$]

Base vs Center loading comparison

Loading	Reqd L	R_R	R_G	R_L	Loss
Base	14.5 μhy	1.8	10	2.2	8.9 dB
Center	29.0 μhy	4.0	10	4.4	6.6 dB

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Efficiency Summary

- Use center loading
  - About 1/2 S-unit improvement
- Use high-Q coils
  - Large wire (with at least 1-turn wire separation)
  - Air wound
- High-Q means reduced operating bandwidth!
  - But more power is radiated
- Use the highest frequency HF band available
  - Doubling the frequency (7→14 Mhz) ***quadruples*** the radiation resistance.

AD5X Mobile Antenna Comparisons

Type	2:1 SWR BW (40m)
Hamstick	50 kHz
Hustler “Standard”	40-50 kHz
Hustler “Super”	50-80 kHz
Outbacker	50 kHz
Carolina BugKatcher	30 kHz
Big DK3	50 kHz

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Antenna Efficiency

- What type of antenna efficiency differences do we see for the previous antennas? This is relatively easy to determine:
  - Determine the inductive reactance of the base or center loading coil
  - Find the antenna system Q
    - $Q_L = 360F_{MHz}/(2{:}1\ SWR\ BW_{kHz})$
  - Calculate radiation resistance
  - Determine Efficiency

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Q VS Efficiency (30 kHz BW)

- $L = 2/[(2\pi F)^2 C] = 2/(2\pi 7.15 \times 10^6)^2(26 \times 10^{-12})$
  $= 38\ \mu Hy$ (for a 7-foot antenna length)
- $R_L = 2\pi FL/Q_U = 2\pi 7.15 \times 38/300 = 5.7\Omega$
- $R_R = 6.7 \times 10^{-6}(hF)^2 = 2.4\Omega$
- $Q_L = 360F_{MHz}/(2{:}1\ SWR\ BW_{kHz}) = 360 \times 7.15/30$
  $= 85.8$
- $R_{Total} = X_L/Q_L = 1707/85.8 = 20\Omega$
- $R_G = R_{Total} - R_L - R_R = 20\text{-}5.7\text{-}2.4 = 12\ \Omega$
- **Efficiency = 2.4/(2.4+5.7+12) = 12%**

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Q VS Efficiency (50 kHz BW)

- L = 38 μHy
- $R_R = 6.7x10^{-6}(hF)^2 = 2.4\Omega$
- $R_G = 12\ \Omega$
- $Q_L = 360F_{MHz}/(2{:}1\ SWR\ BW_{kHz}) = 360x7.15/50$
  $= 51.5$
- $R_{Total} = X_L/Q_L = 1707/51.5 = 33\Omega$
- $R_L = 33\text{-}12\text{-}2.4 = 18.6\Omega$
  - Inductor Q = 92
- **Efficiency = 2.4/(2.4+18.6+12) = 7.3%**

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Q VS Efficiency (80 kHz BW)

- L = 38 μHy
- $R_R = 6.7x10^{-6}(hF)^2 = 2.4\Omega$
- $R_G = 12\ \Omega$
- $Q_L = 360F_{MHz}/(2{:}1\ SWR\ BW_{kHz}) = 360x7.15/80$
  $= 32$
- $R_{Total} = X_L/Q_L = 1707/32 = 53\Omega$
- $R_L = 53\text{-}12\text{-}2.4 = 38.6\Omega$
  - Inductor Q = 44
- **Efficiency = 2.4/(2.4+38.6+12) = 4.5%**

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Mobile Antenna “Tricks”

- Hamsticks
  - Replace two #6 setscrews with one #6 thumbscrew
  - Use each on two bands with 1/8” shorter brass rod
    - 40/30m, 20/17m, 15/12m
  - Use capacitive base matching
    - 560 pf for 40m, 150 pf for 20 &17m
- Carolina BugKatcher
  - Replace two #6 setscrews with one #6 thumbscrew
  - Use capacitive base matching
    - 680 pf/40m, 220 pf/20m, 150 pf/17m, 52 pf/15m, 24 pf/12m

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Mobile Antenna "Tricks" (cont.)

- Outbacker
  - Screw 7/16" SS nut over normal thumb bushing
    - Makes tightening and adjusting whip easier
- Bug Catchers
  - Capacity hats should be well above loading coil
  - Want to increase capacitance to ground, not capacitance to loading coil!
- All Antennas
  - Keep loading coil ABOVE car roof

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Auto-tuners

- Auto-tuners at base of 8-foot whips
  - Consider “Q” of auto-tuner coils
    - Auto-tuners don’t normally have nice big air-wound inductors
    - Low “Q” series-L increases loss
  - Interconnect to antenna with wire, not coax
    - Wire will radiate inside your car
    - Coax will cost you **<u>at least</u>** 1/2 your power
- It is BEST to resonate/match the antenna!!

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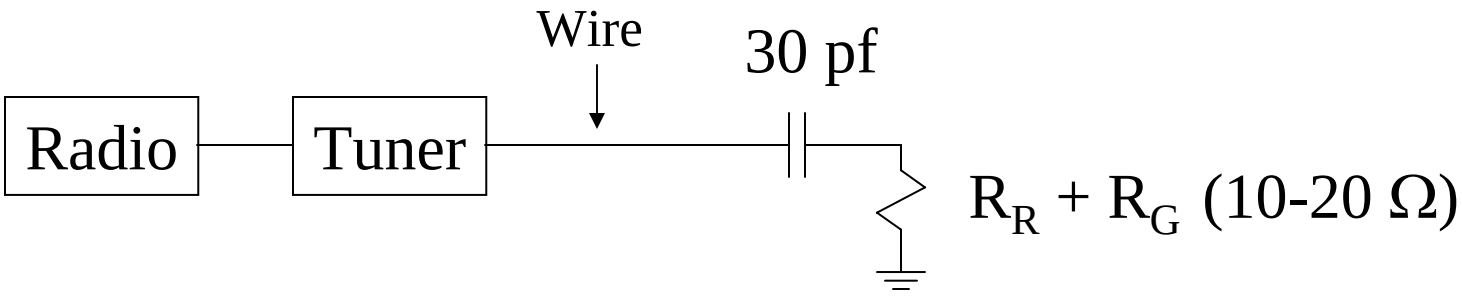
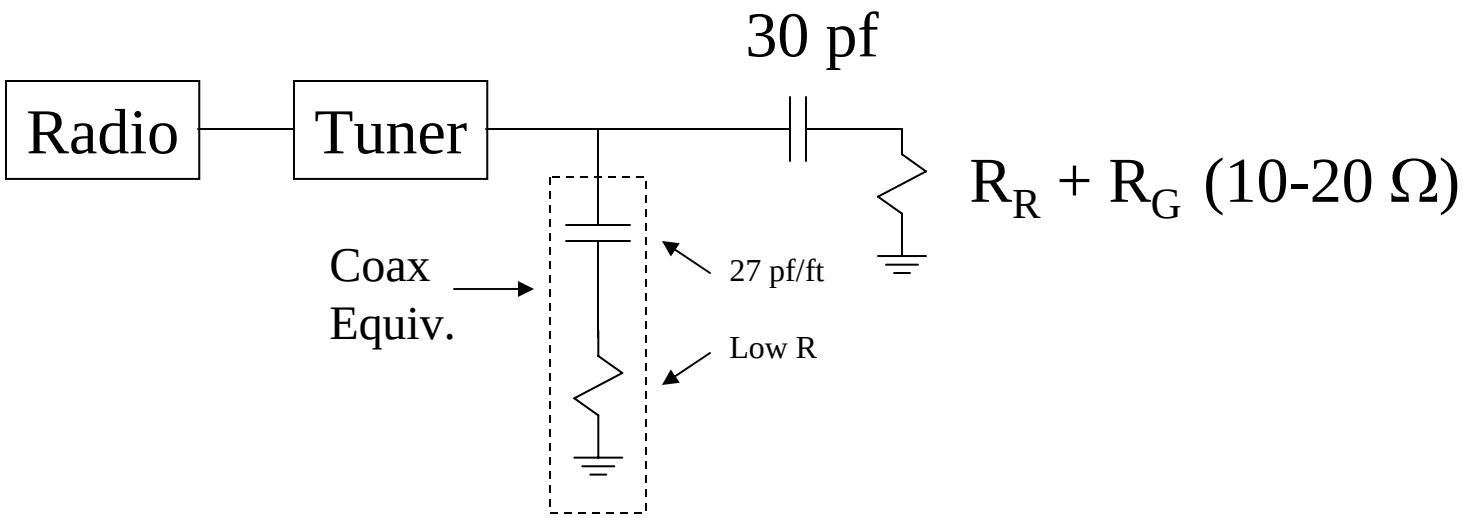
Auto-tuners (Cont.)





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General “Tricks”

- Always use stainless steel hardware
- 1/8 NPT brass plumbing pieces are tapered 3/8X24 threads.
  - Can be chased with 3/8X24 tap.
- You can screw a single-hole SO-239 into a 3/8 NPT brass adapter.

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General “Tricks” (Cont.)

- Use a “UHF-T” with capacitors soldered into PL-259 connectors for base matching
- Build a base capacitive matching box
  - RS275-1385 rotary switch
  - RS270-235 aluminum box
  - Appropriate capacitors
    - 300V minimum
    - Silver Mica preferred
- Consider making your own antenna!

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References

- Don Johnson, "40+5 Years Of HF Mobileering", World Radio.
- Dave Ingram, "The Modern Amateur's Mobile Handbook", MFJ Enterprises, Inc.
- Walt Maxwell, "Reflections", ARRL.
- "The ARRL Antenna Book", 16th Edition, Chapter 16.
- Bruce Brown, "Optimum Design Of Short Coil-Loaded High Frequency Mobile Antennas", The ARRL Antenna Compendium Volume 1.
- J.S. Belrose, "Short Antennas For Mobile Operation", QST September 1953.
- Don Johnson, "Everything you forgot to ask about HF Mobileering", World Radio.

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HF Installation in Geo

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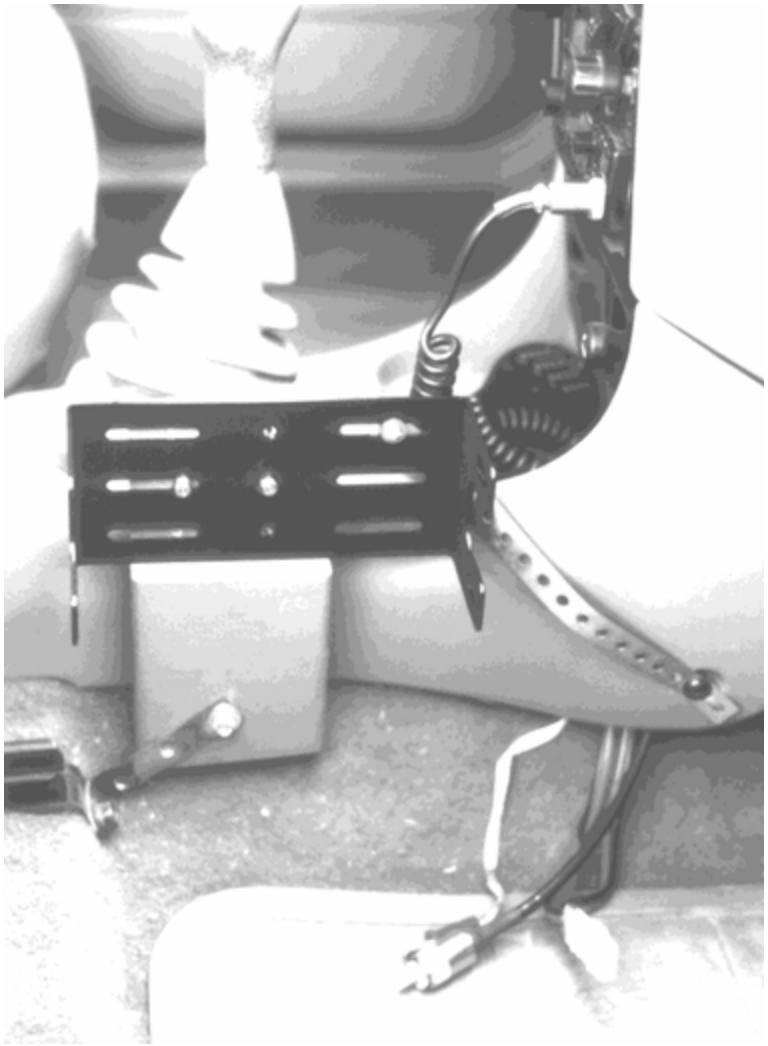

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IC-706 in Geo

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IC-706 & IC-3200 in Explorer

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Close-up

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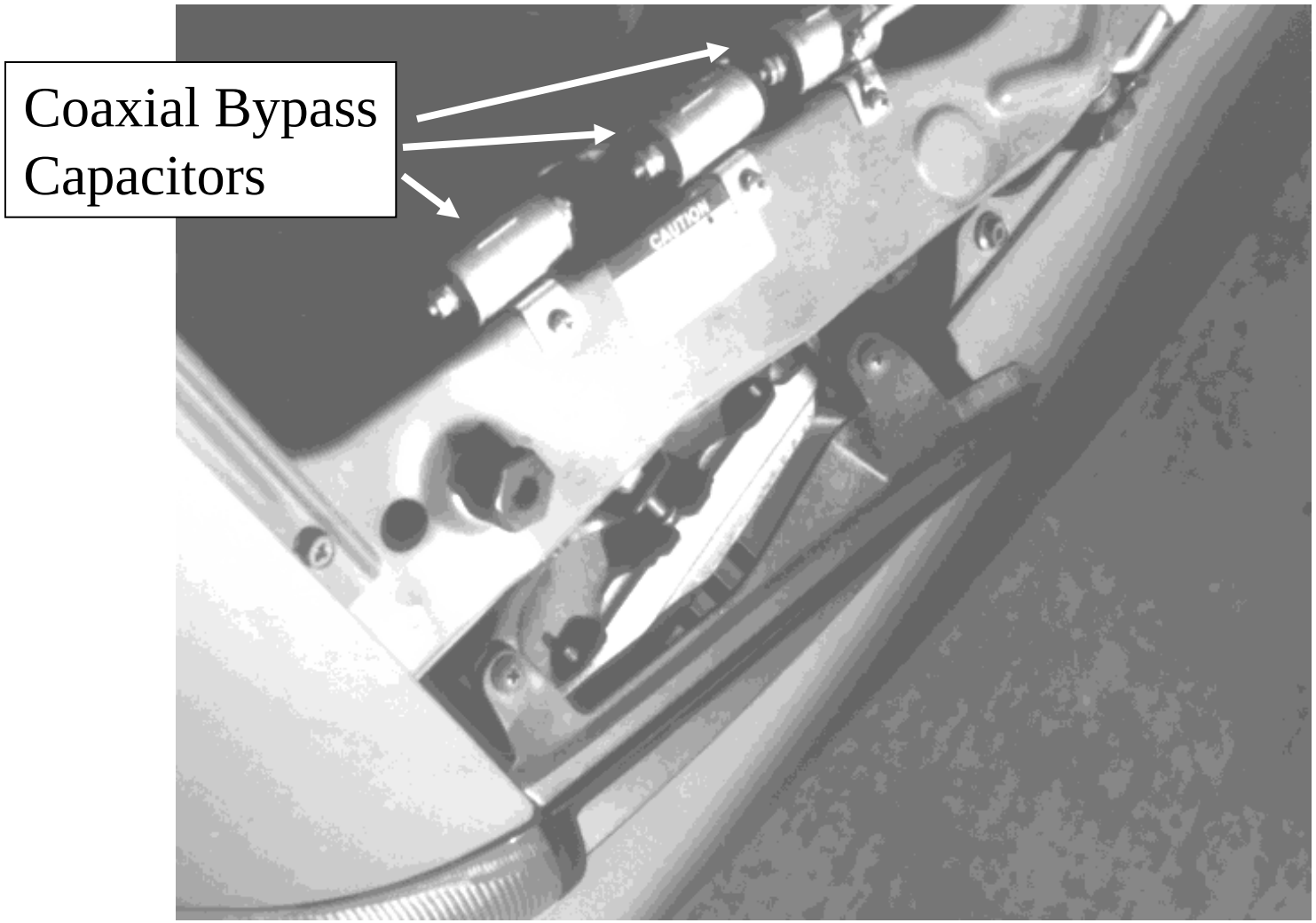
Caps on Geo



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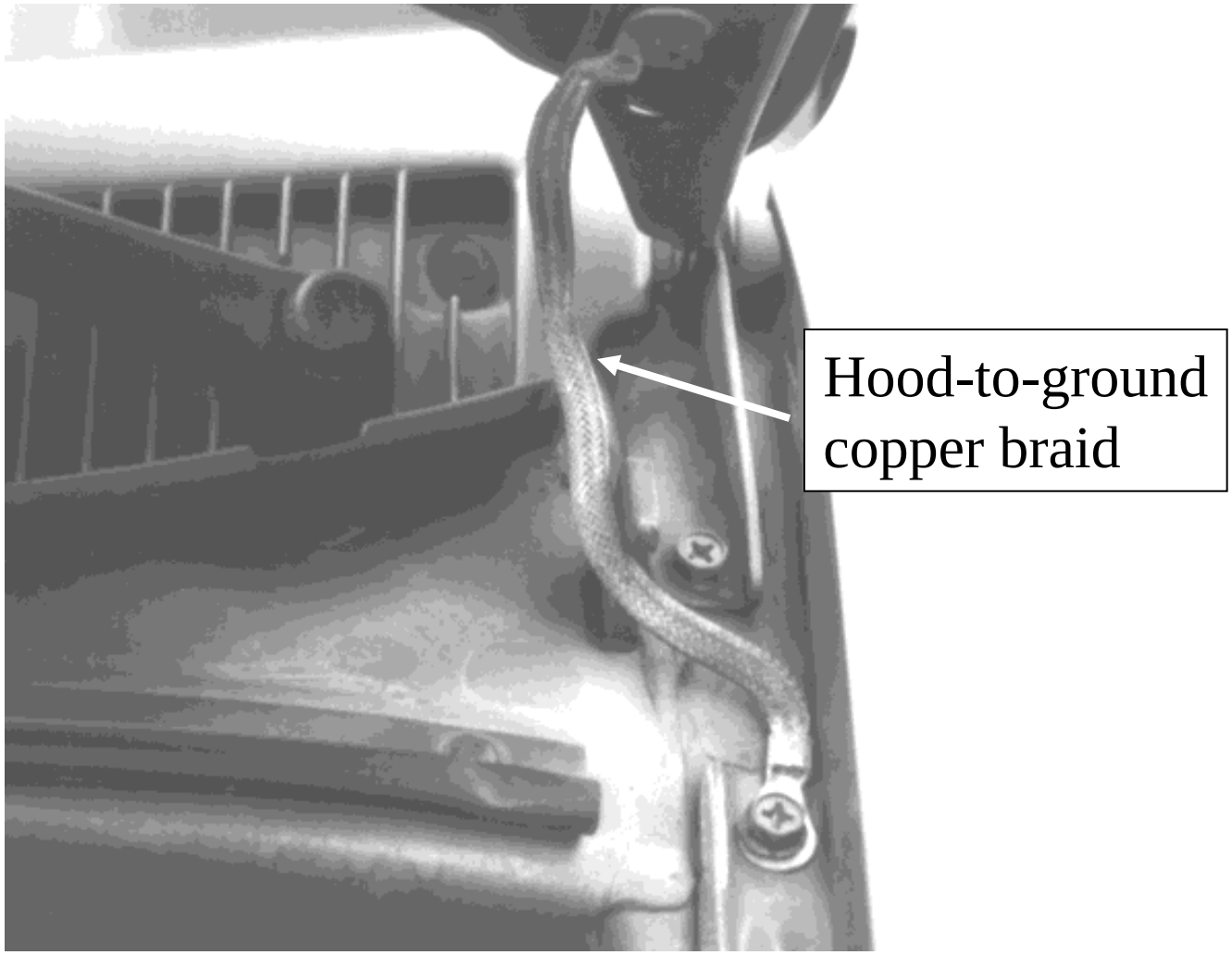
Braid on Hood



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Outbacker on Geo

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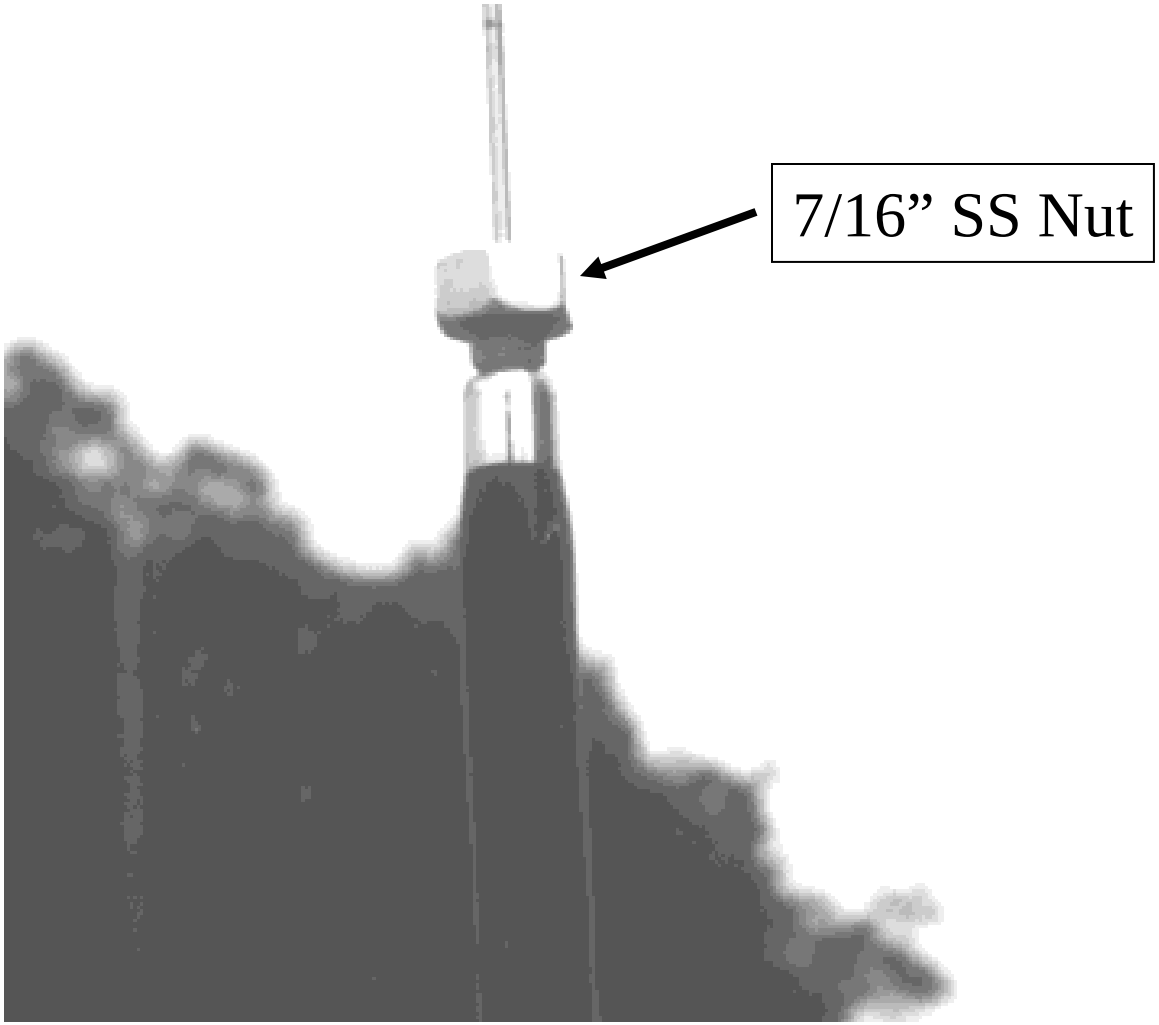
Easy Adjust for Outbacker



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Screwdriver on Geo

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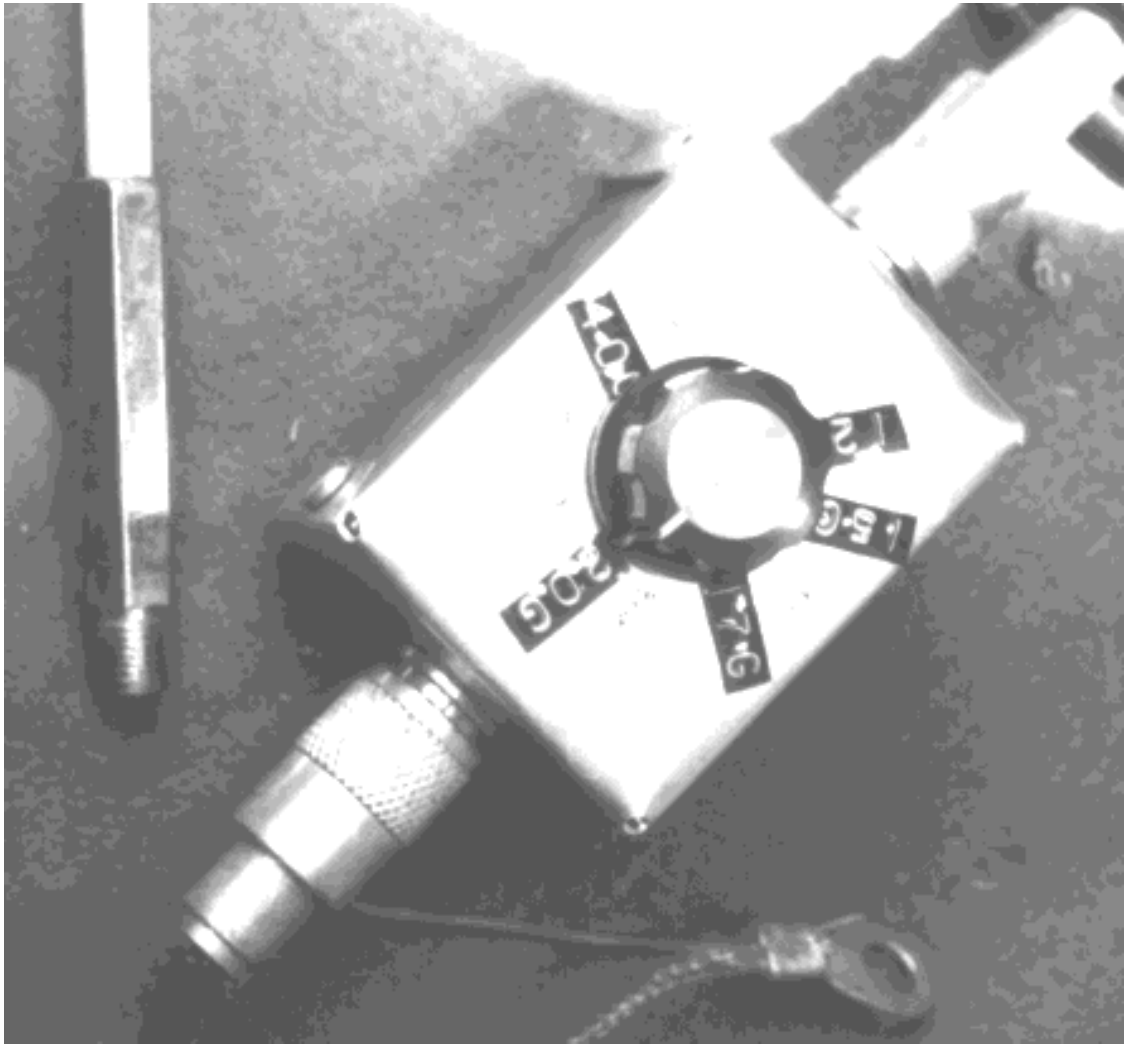
Capacitor Matching Box



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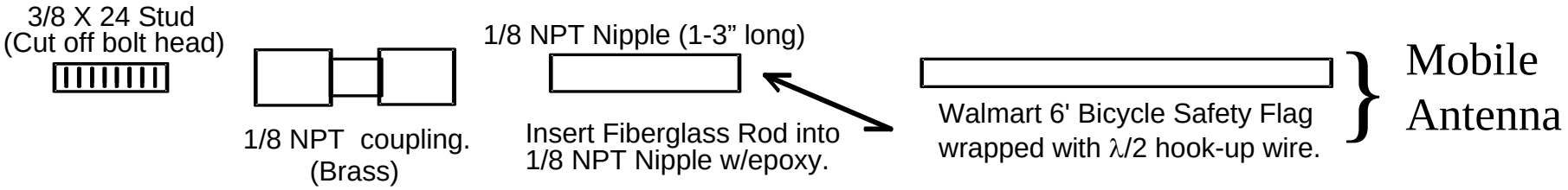
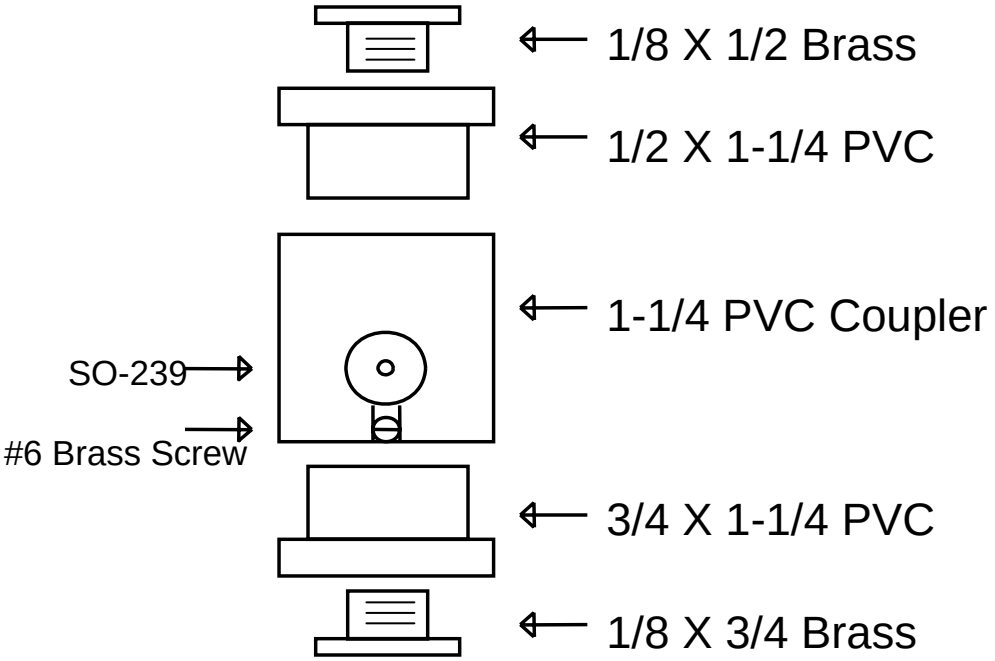
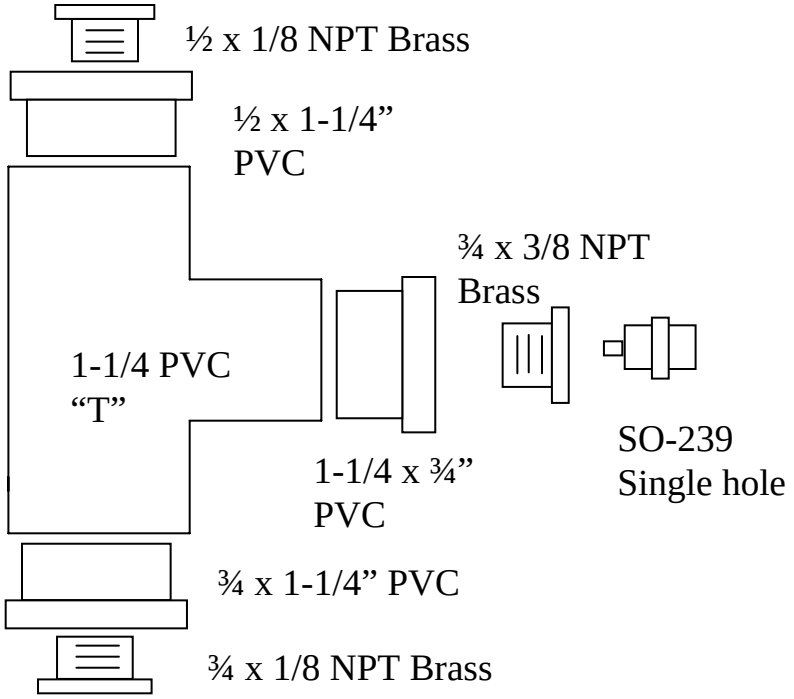
AD5X Homebrew Antenna/Mounts





Simple Mount



Sophisticated Mount

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