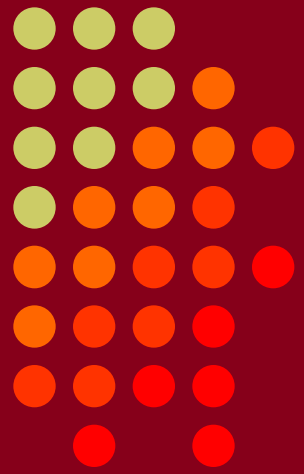
Hardware Tips & Sage Advice For the Average Contester

Hal Kennedy, N4GG



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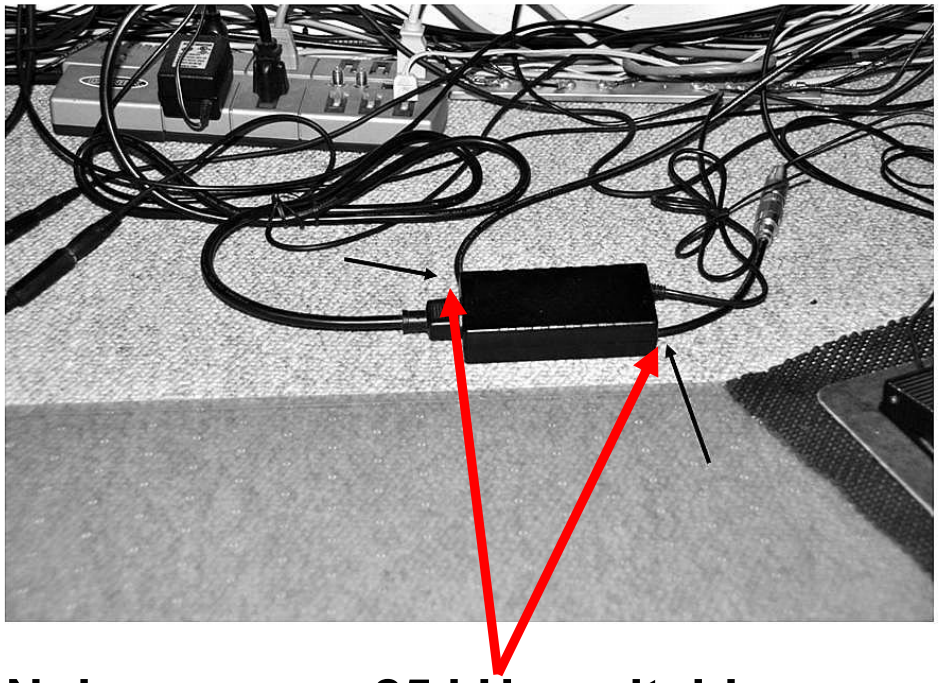
Today's Topics

- Achieving a low receive noise floor
  - Noise from magnetic coupling
  - Noise from conducted emissions
  - RFI from near-field arcs & rectification
  - Testing low-gain receive antennas
- PL-259s & UHF connectors
  - Avoiding the problems of low-quality parts
- Shack Design – Tips & Techniques

Magnetically Coupled Receiver Noise
(Example: S9 Noise on 160 & 80 at N4GG)



Coax provides little shielding of *magnetic* fields

Noise source: 25 kHz switching supply laying on coax

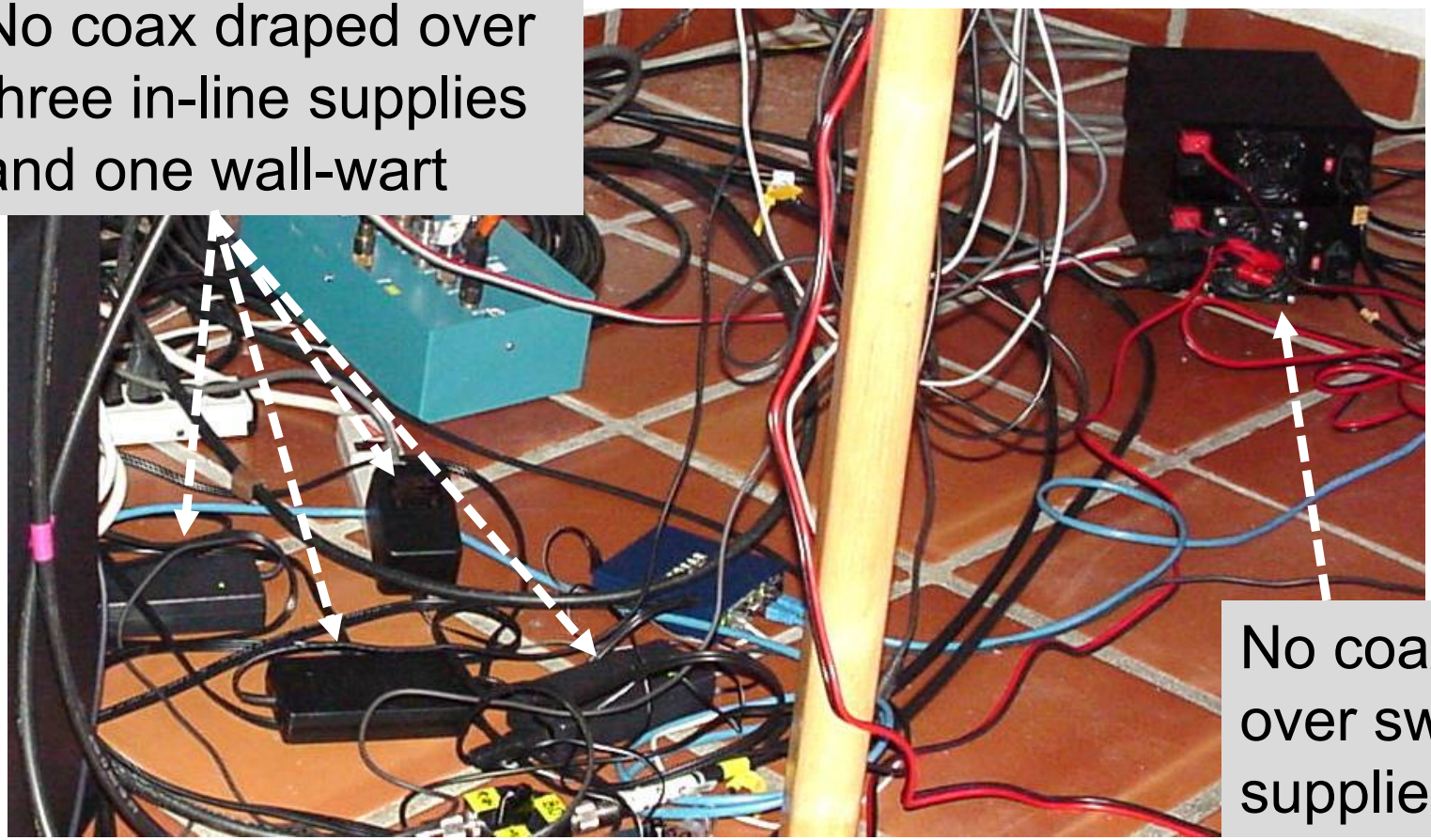
Magnetically Coupled Noise

- The chief culprit: In-line switching supplies
  - LCD Monitors, Laptop Computers, SteppIR Control Boxes, some “Wall-Warts”
  - 60 Hz usually not a problem, 20 - 40 kHz is!
- Particularly susceptible: Low signal-level antenna cables
  - Beverages, K9AY Loops, etc.
- Noise level proportional to power supply current
- Magnetic fields fall off as distance cubed
  - Helpful and better than RFI (distance squared)

Blind luck at PJ4R in 2005

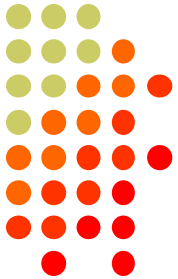
ARRL DX CW World-High M/2

No coax draped over three in-line supplies and one wall-wart



No coax draped over switching supplies

Magnetically Coupled Noise



- Mitigation
  - Keep coax at least 6” from switching power supplies
    - In-line supplies
    - Rig supplies (Typically >20 amps @ 13.8 VDC)
- If you insist on neat cable routing:
  - Separate power and signals into separate bundles!

Conducted Emissions - Noise Paths

RFI – The noise we usually worry about

Conducted Emissions

Common mode & differential noise on every line that breaches the cabinet

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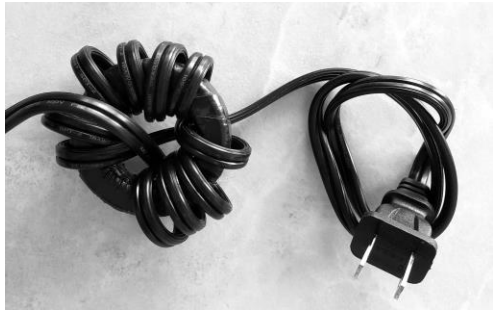
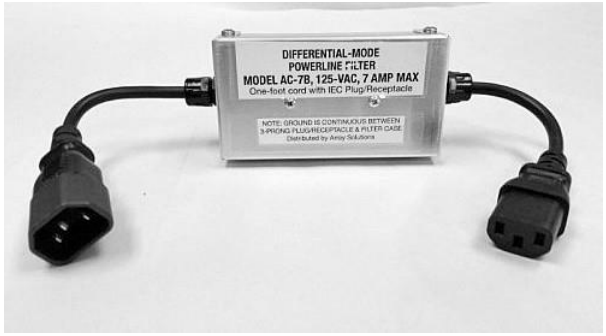
Testing for Conducted Emissions

- Set receiver gain to max, preamp on
- Disconnect *everything* except:
  - 50-ohm load on antenna jack(s)
  - 50-ohm load on Rx antenna jack
  - DC power from battery

- Add connections one-by-one, then measure noise on every band
  - CAT, PTT, Key, Mic., Ethernet. Etc.

Conducted Emissions - Mitigation





AC line filters, Ferrite Chokes

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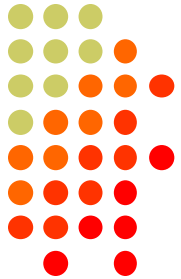
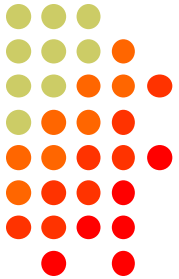
Near-Field Noise - Arcs & Rectification



- Caused by RF current flowing through poor connections, then being re-radiated
  - Arcing
  - Unanticipated diode junctions (rectification)
    - Diodes are non-linear by definition (harmonic rich)
- Possible in any multi-receiver environment
  - Second Receiver, SO2R, 2BSIQ, M/S+, M/2, M/M, Field Day

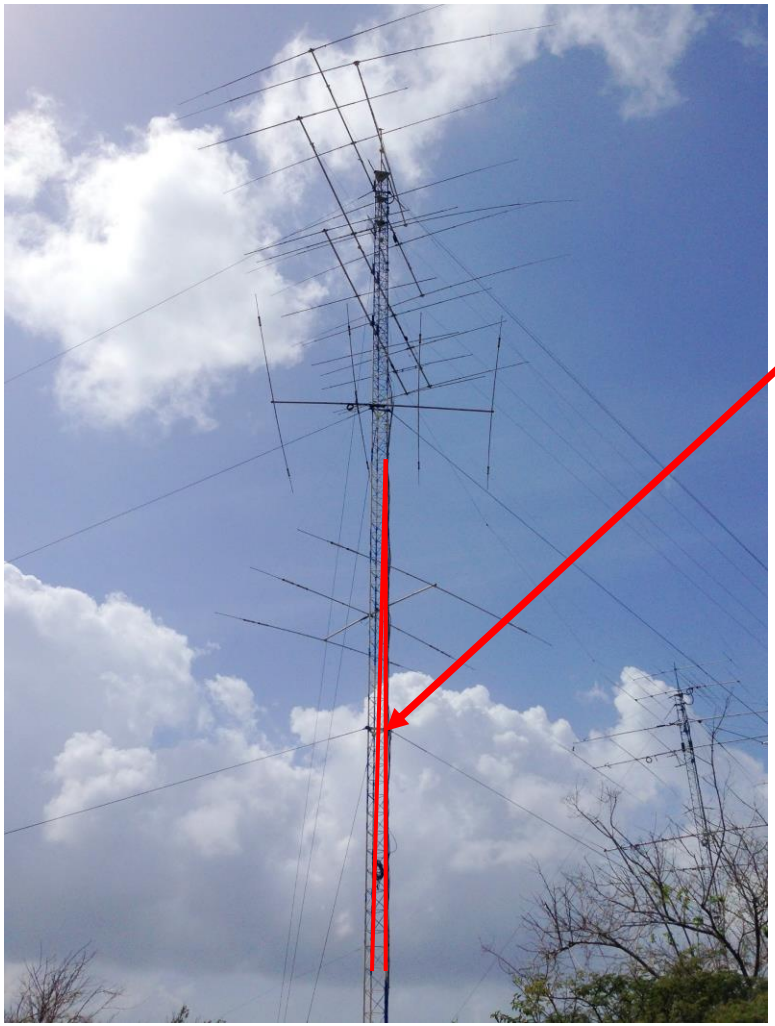
Near-Field Arc & Rectification Noise - Sources



- Loose antenna hardware
- Wires touching wires, touching towers
- Corrosion & bad grounds including radials
- Gutters, plumbing, house wiring, CATV, HVAC
- Front-end overload in secondary receivers
- Your neighbor's yard (oh, nuts!)
- Nearby AM broadcast stations

Near-Field Rectification Noise

Example: Wires Touching Towers

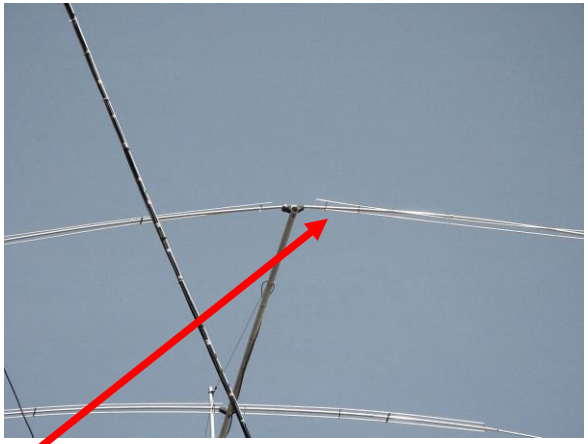


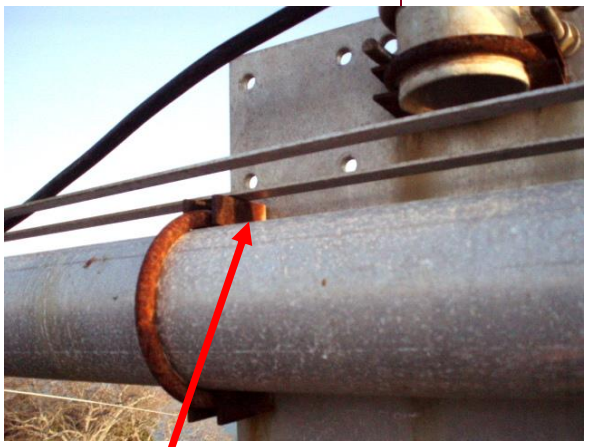
Abandoned 80 meter Inverted-V dangling against the tower

Excited on 40 & 20 meters, Re-radiating on every band, 160 to 10!

Arcing & Rectification Noise

Loose/broken antenna connections





Arcing in broken linear-loading tubes

Rectification at unintended, corroded junctions

KLM 4-element 40M Yagi at HP1XX

Resulted in 2nd place finish – 2007 ARRL DX CW M/2

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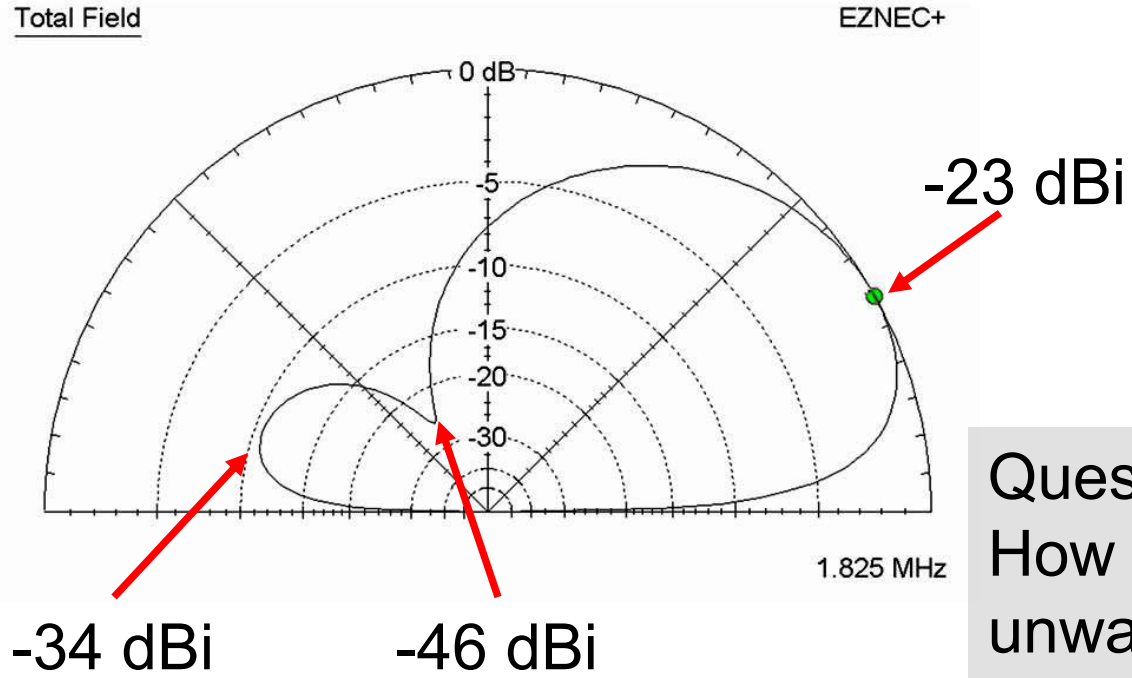
Testing Receive Antennas

Example – K9AY Loop



Question:
How can we verify unwanted signal incursion is 20 dB below -46 dBi?

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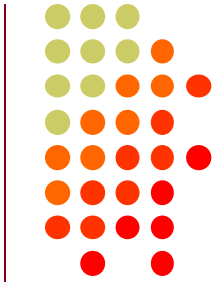
Measuring Receive Antennas - Procedure



- Using a local AM broadcast station, check F/B
  - The signal off the back needs to be 10 dB (20 is better) above the noise, during the daytime
- Disconnect the antenna wire(s) & measure the residual signal (ideally there is no signal)
  - Everything else stays connected and turned on
- Any signal with the wire(s) disconnected should be at least 10 dB below the signal off the back with the wire(s) connected.

Measuring Receive Antennas - Considerations

- Receiving antennas are a system
  - Terminations, grounds, controls boxes, preamps, transmission line(s), bias-Ts
- Measurements should be made at the shack end of the transmission line
- Use a narrow filter (CW) and slow AGC
- Results will vary - try multiple AM stations
- If test station signals are significant with the antenna wires disconnected – you probably have common-mode signal incursion

PL-259 Components
Best-of-class Attributes

Center pin
Silver plated brass
Correct ID: 0.125

Correct back-threads

Reducer
Silver plated brass

Nut, Silver plated brass

Body, Silver plated brass

Insulator
PTFE or PBT
Molded in
> 5KV Hipot

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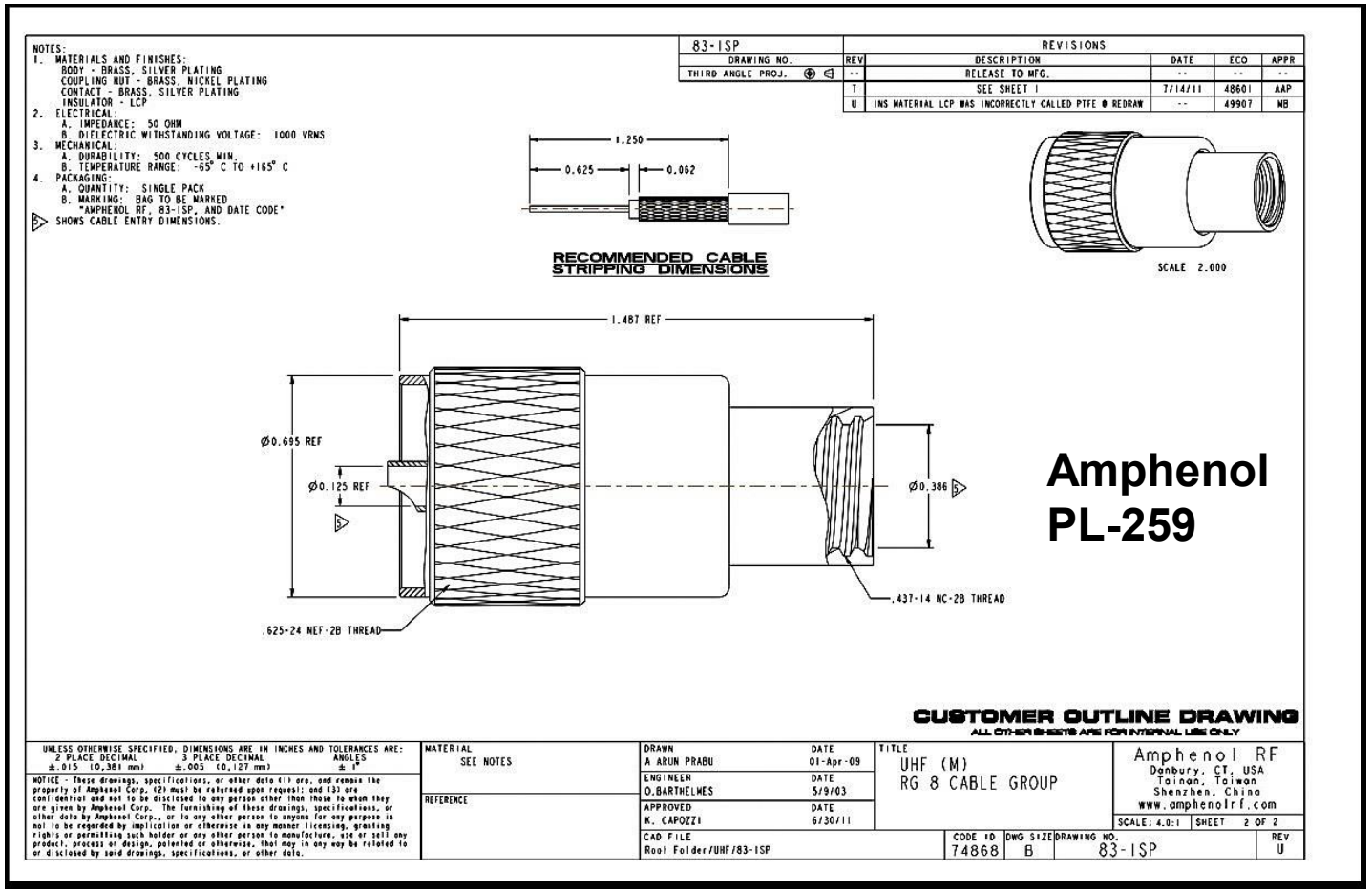
SO-239s & Barrel Connectors

Best-of-class Components

- Flange
  - Silver Plated Brass
  - "16 V" not 4V, not 2V
  - Marked with Part No.
- Insulator
  - PTFE (Teflon) or PBT
- Center Contact
  - Silver Plated Brass
  - Correct ID: ~ 0.137

Good Connectors are Marked & Have Drawings (No Mysteries!)



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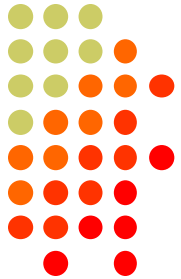
Inferior PL-259s for Sale – Cheap!



- Center pin ID & OD too small
  - Won't accept LMR-400 or 3/8" Heliax
  - Loose fit into SO-239s and barrel connectors
    - Temperature-sensitive intermittents, outdoors
- Poor materials (Body & Nut)
  - Pot metal, chrome plating, poor solderability
- Metric reducer threads
- Polystyrene insulators – melt & drift

Spotting Inferior Connectors

- No markings, no spec's, no drawings
  - Everything is a mystery
- Too shiny (chrome plating)
- Center pin ID is too small
  - Check with a 1/8" drill bit
- Center pin swaged in, not molded in
- Marked with water-soluble ink (fake Amphenol)
- Too inexpensive

UHF Connectors Tips

- Avoid mystery connectors
- Avoid “bargains” If < $2.50, walk away
- Buy from known primary sources
  - Amphenol, DX Eng, Max-Gain Systems
- Always test insertion force before use
- 90-degree Ell and Tee connectors:
  - Only Amphenol or known good sources

90-Degree Ells & Tees

Only use the best

Required:
Center conductor tapped & threaded (Amphenol, MGS)

Inferior approach:
Spring finger internal connection (Dayton flea market)

Always tighten the center pin before use!

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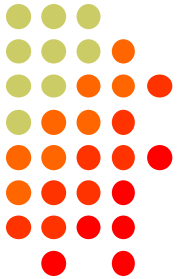
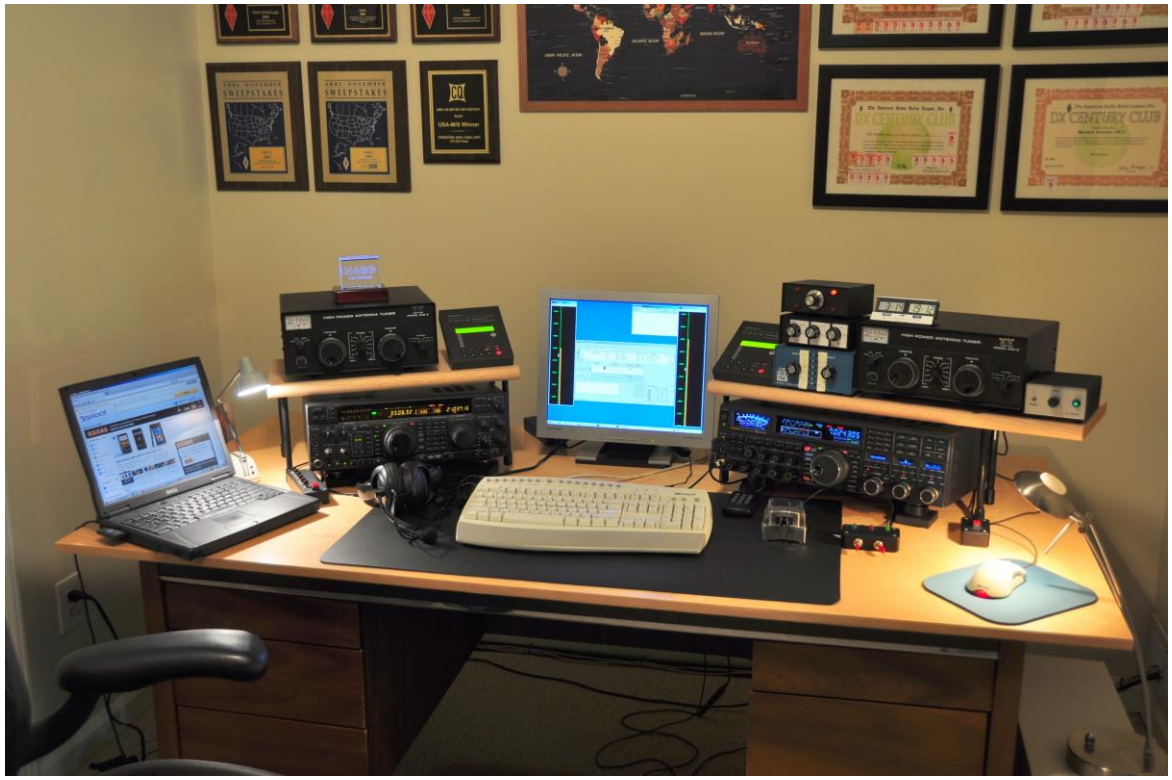
Shack Design
Tips & Techniques



- Fatigue and unreliability are the enemy
- For contesting fun and success
  - A great chair (example: Herman Miller Aeron)
  - Desk space for elbows, arms, coffee
  - Proper, indirect lighting
  - Ergonomic layout
    - No extraneous hardware (example: wattmeters)
    - Power supplies off the operating desk
  - Automation as desired

Shack Design – An Example



Downward Lighting
Aeron Chair
Remote:
  Power Supplies
  Amplifiers
S&P Radio with
  dominant hand
Room for elbows
Room for legs
No extra boxes

Hardware Tips & Sage Advice For the Average Contester

73,

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