Grounding, Bonding, Safety, RFI
By Bill Mader, K8TE

Albuquerque DX Association
Good DX
Good Luck in the Contest!
https://groups.io/g/adxa
Longer Lives for You and Your Radio

- Safety First—Grounding
- Bonding—Keep the Noise Down
- RFI—Radio Frequency Interference
- Buy the Book by N0AX!
Safety First—Grounding

- National Electrical Code—Safety!
  Electrical Safety—Current Kills!
- No Help with RFI
- No Antenna Improvement
- Combine with Bonding for Safety!
- Lightning Protection (not Prevention)
National Electrical Code

- Helps Lessen Likelihood of This
National Electrical Code

- NEC/National Fire Protection Association
- DGYBS (Don’t Get Your Butt Shocked)
- Test Your Outlets
- Lights Dim on Transmit?
  Loose Connections Lead to Fires
  Wiring Size Too Small
- Don’t Cut/Bypass the Green Wire!
  “Here, Hold My Beer. What Could Go Wrong With This?”
NEC on Grounding

- Ground Neutral at Breaker Panel Only
- Tie All Grounds to a Single Point
- Inspect At Least Annually!
- If In Doubt, Get Help
- Local Code Additions Matter
- Avoidance Can Cancel Your Insurance Payout
- Be Careful—120 VAC Can Kill You!
Bonding (NOT Grounding)

- Robust, Low Resistance, Short
- Between All Gear
- The Connection Order Matters
- Lightning is a Pulse, Not Direct Current
- Inductance Matters Fast Rise/Decay Times
- Thanks to Jim Brown, K9YC
What to Bond? Everything!

- Power Service Entry
- Telephone Entry
- Cable TV Entry
- Antenna Entry
- Operating Desk
- All Ground Rods
- Towers near the Building
- Building’s Structural Steel
- Grounded Metallic Plumbing
How to Bond K9YC

- EVERYTHING TOGETHER!
  Separate Bonds are Hazardous!

**Bonding All Building Grounds**

- BREAKER PANEL
- HAM SHACK
- TOWER
- CABLE TV
- TELCO
- GROUND ROD
- COLD WATER
- RADIALS

Grounding is for SAFETY
Lightning protection
Blow a breaker if a power system short
Connections should be big copper and
How to Bond K9YC

- Bigger is Better
  At Least 4 AWG for Towers
  At Least 10 AWG for Shack
  Steel Conduit (Properly Installed) is OK

- Shorter is Better
  Wires are Inductors
  Steep Pulses with High Current = High Voltage
  Resistance (Ohmic) is Futile in Bonding
Why Bond Equipment? K9YC

- Lightning Doesn’t Follow Maps
- Kill Hum, Buzz, RFI
- Shields Carry Leakage Currents
- Shields Act as Antennas (TX & RX)
- Pin One Problems Cause Noise
- Poor Engineering Construction Practices
- Shield Not Bonded to Metal Case
  at Ingress and/or Egress
- Coupling Inside Gear Creates/Allows for RFI
Pin 1 Example

Pin 1 in **Unbalanced** Interfaces

- SHIELDING ENCLOSURE

**SIGNAL CIRCUITRY**

- **WRONG**

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**PSU**
Rigs with Pin 1 Problem

Dayton 2014 Booth Survey

Rigs With Apparent Pin One Problems
- Yaesu (all I could look at)
- Kenwood (all I could look at)
- ICOM (all I could look at)
- Ten Tec (all I could look at)
- Elecraft (KX3)
- Many (most?) other booths
- Flex (most models)
Guidelines For Bonding

- Add bonding in parallel with every unbalanced audio and data path
- Use #10 copper or larger
  - Strip braid from transmitting RG8, RG11
  - Or buy braid if you see it cheap enough
  - #10 THHN stranded is fine, but stiffer
- Bond to chassis of rigs and computers
- Always as short as possible
Equipment Bonding – A Basic QRO Station

Rig

Most Critical

Computer

Amp

Amp Pwr Supply
RFI—Radio Frequency Interference

- Switching Mode Power Supplies
- Cell Phone Chargers
- Laptops/Desktops/Tablets
- USB Hubs
- Our Own 12VDC Power Supplies!
- Station Layout (W8JI.com)

- All the New “Stuff” Your Neighbors Buy
- “If it ain’t heavy, it’s RFI’ing” K8TE
In House Search

- Identify & Document RFI by Band
- Connect Rig to a Battery (Should be “Standard”)
- Turn Off Main Breaker
- Check All Bands Previously Noted
- Some RFI Disappears?
- Enable One Breaker At-a-Time
- Locate and Discard/Replace the Culprits
Neighborhood Search

• Rotate Your Beam
• Document Frequencies/Time/Spectrum
• Use Portable Radio; Short Wave is Best
• Search for Loudest Signals
• Good Luck from Here
• Common Additional Sources
• Grow Lamps (Mary Jane?)
• Solar Systems
• Variable Speed HVAC
• LED Lighting—Research Replacements
RFI Remediation

- Move to the Boondocks
- Buy Spouse an LED TV (K8TE)
- Separate RX Antenna (Magnetic Loop)
- Noise Cancelling System
  DX Engineering NCC2
- Move Beyond the Boondocks in NM
- RX Noise Blanker
- Use CW (Narrow the Bandpass)
- Use JT-65/FT-8 (“Below” Noise Capable)
40m Noise at K8TE on 80m OCF
40m Noise at K8TE on 80m R8
Grounding and Bonding for Us

- Ward Silver, N0AX
- Engineer
- Long Time ARRL Editor
- Fun, Amiable Guy!
- Buy the Book
What Did I Tell You?

- Safety First—Grounding
- Bonding—Keep the Noise Down
- RFI—Radio Frequency Interference
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DCHF Highlights

- Three Days of 50+ Concurrent Technical & Operational Sessions
- 21-23 September Register Now!
- HF University 2.0 All Day Friday
- EmComm College All Day Friday
- AMSAT Academy All Day Friday
- VE License Prep & Testing
- SKYWARN Training Sunday Morning
- QSL-card Checking for ARRL Operating Awards
- Build-a-thon With Rex Harper, W1REX
DCHF Highlights

- Two Breakfast Banquets
- Evening ARRL Awards Banquet
- Friday Evening Mixer and Auction
- All With Separate Door Prizes
- Raffles With Exceptional Prizes
- (2) IC-7300’s and KX2 (probably) & More
- Manufacturers and Commercial Vendors
- STEM-Student High-Altitude Balloon Launch En Route to CubeSat!
DCHF Highlights

- Indoor Flea Market
- Friday/Saturday Outdoor Tailgate Market
- Consider Volunteering—Free Admission/Prize

The Venue:
- Isleta Casino & Resort Convention Center
  10 Minutes South of the Albuquerque Airport
- Food Station for Lunch
- Early Admission Only $12.50! $15.00 at the door
- Sign-up for Monthly E-Mail Updates
- https://www.dukecityhamfest.org/
Questions

- No “Dumb” Questions
- Maybe a Dumb Answer
References

- http://www.nfpa.org/nec
- https://www.dxengineering.com/parts/dxe-rf-pro-1b
- https://www.dxengineering.com/parts/dxe-ncc-2
- http://w8ji.com/house_ground_layouts.htm
Pin 1 Fixes

- Rewire Connector—Shield to Metal Chassis
- Bond Connector to Chassis, NOT PCB
- Use Common Mode Choking Snap-on Ferrites
  Wind Cables around Ferrite Cores
- Bonding Gear Together and to Shack Ground
  Reduces Noise Generated by Gear
  Eliminates Shock Hazards
- Bond Multiple Outlet Boxes Together
- Use Larger (12/10 AGW) to Breaker Panel