

Transmitting Chokes

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What Makes a Balanced Circuit?

- The impedances of each conductor to the reference plane are equal
- Balance is not defined by voltage or current

Ham Antennas and Balance

- Most ham antennas are unbalanced by their surroundings, even when fed by twinlead
 - Unequal capacitances to nearby conductors
 - Unequal inductive coupling to nearby conductors
 - Trees, buildings, towers, terrain
 - Coax simply adds to that imbalance

What's a Balun?

- Most 1:1 “baluns” are common mode chokes
 - A coil of coax at the antenna
 - A stack of ferrite beads around coax
 - Multiple turns of coax through a toroid or stack of toroids

Unbalanced Antennas and Lines

- If the antenna is unbalanced
 - Unequal voltage and current to earth
 - Unequal currents on the feedline
 - The difference is common mode current, and it radiates from the line
- Coax is just another component of the imbalance!

Coax is Special

- All the differential power (and field) is confined inside the coax
- All the common mode power (and field) is outside the coax
- A ferrite core surrounding coax sees only the common mode power

What Does the Choke Do?

- It reduces common mode current by adding a high impedance in series with the common mode circuit
 - Reduces radiation from the coax
 - Reduces reception by the coax

What About Heat?

- Heat (Power) is I^2R
 - Make R large
 - I reduces in proportion to R
 - P reduces as I^2 so power (heat) is dropping twice as fast as R is increasing

What About Heat?

- Heat is not a problem if R (the choking impedance) is large enough
- How large is enough?
 - At maximum ham power, 5,000 Ω allows a comfortable margin of error

See K9YC's Choke Cookbook (Chapter 7 in the RFI Tutorial) for specific recommendations

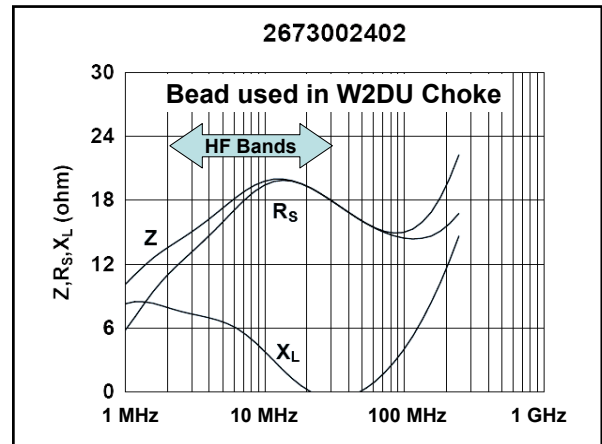
<http://audiosystemsgroup.com/RFI-Ham.pdf>

Why Transmitting Chokes?

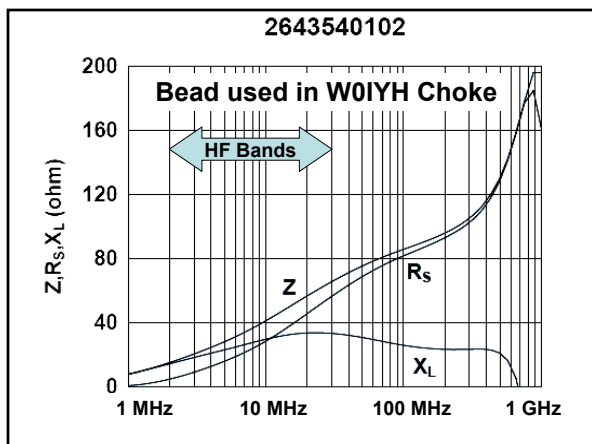
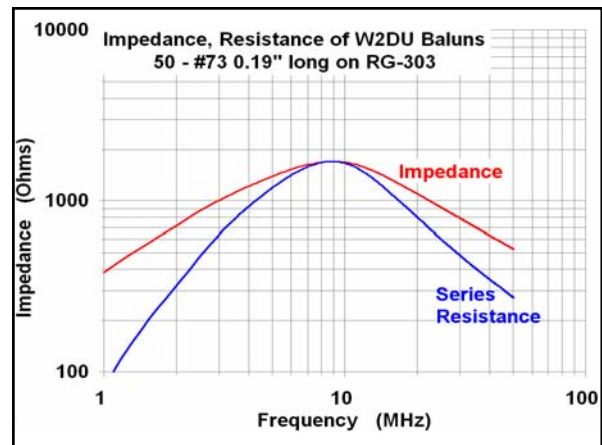
- Isolate antenna from its feedline
- Reduce receive noise
- Keep RF out of the shack
- Minimize antenna interaction
 - SO2R, Multi-multi

Design of Transmitting Chokes

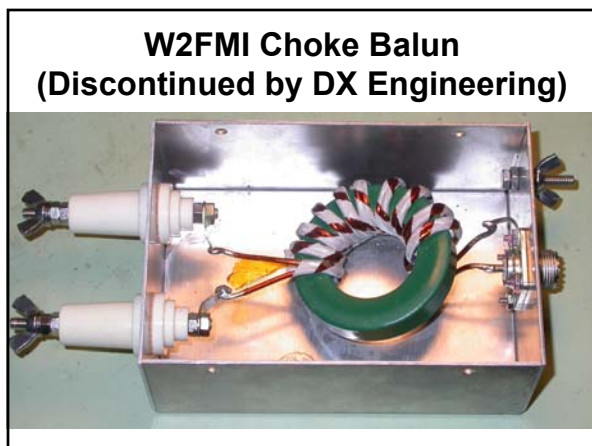
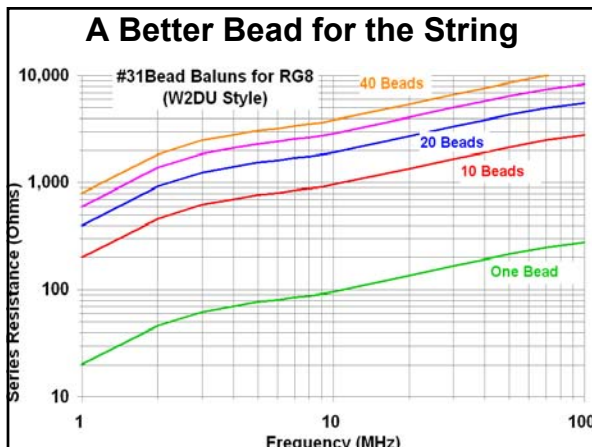
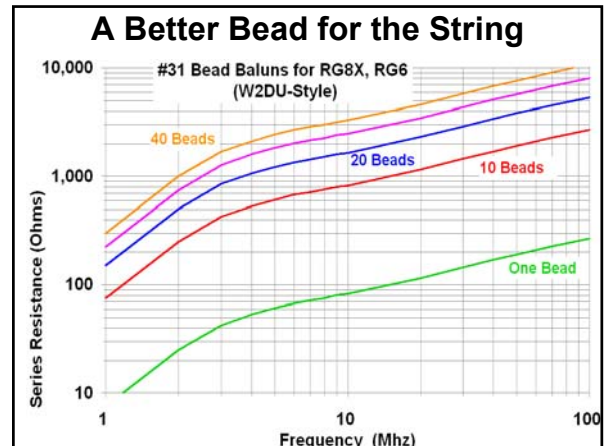
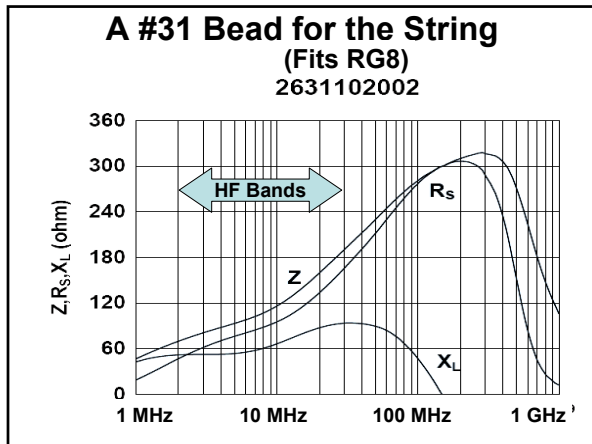
- Higher impedance is better!
 - Reduces common mode current
 - Reduces noise
 - Reduces interaction
 - Reduces RF in the shack
 - Reduces dissipation
- Resistance is better than reactance
 - Not sensitive to feedline length
 - Reactance can resonate with line



- ### W2DU Choke
- A "string of beads" choke
 - Increasingly resistive above 3 MHz
 - Not very sensitive to feedline length
 - Much better than W0IYH choke
 - But many more beads are needed
 - Or use longer beads

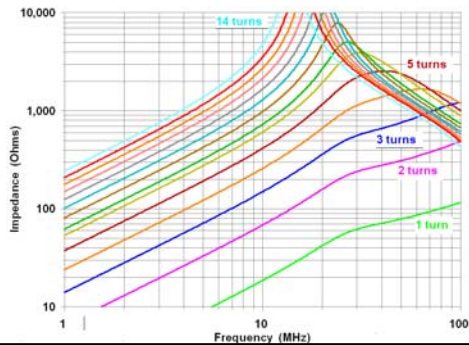


- ### W0IYH Choke
- A "string of beads" choke
 - Predominantly inductive below 25 MHz
 - Very sensitive to feedline length
 - Inductance resonates with a capacitive line
 - Increasingly resistive above 25 MHz
 - Much less sensitive to feedline length
 - Not very effective below 15 meters!



- ### Twin Lead Chokes
- Twin lead has >30% leakage flux
 - Choke sees at least 30% of transmit power plus the common mode voltage
 - Very likely to overheat
 - Very likely to saturate (harmonics, IMD, splatter, choking impedance drops)

W2FMI Choke Balun (Discontinued by DX Engineering)



W2FMI Choke

- Wound on #61 Material
- Predominantly inductive below 25 MHz
 - Very sensitive to feedline length
 - Inductance resonates with a capacitive line
- Twin-lead construction puts 30% of transmit power in ferrite
 - Loss
 - Overheating
 - Distortion (splatter, harmonics)
- Not much choking Z below 14 MHz

K9YC Chokes (Improved W2DU Chokes)



An 80/40 Fan Dipole

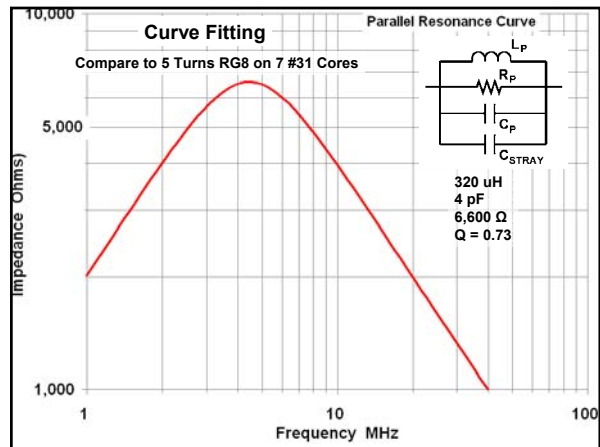
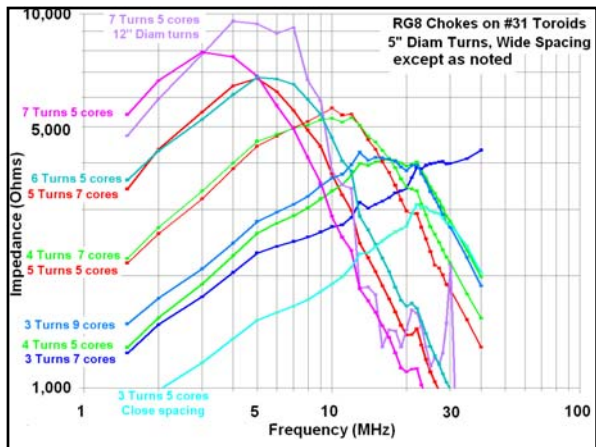
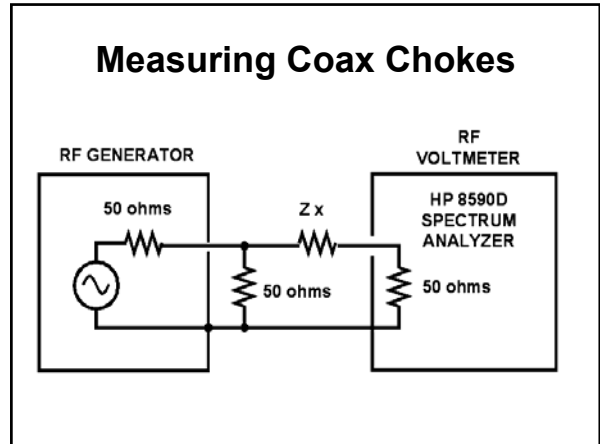


An 80/40 Fan Dipole



Closely Spaced Turns in an 80/40 Fan Dipole



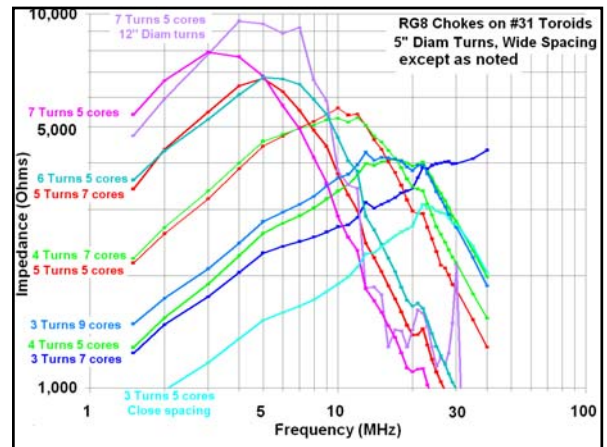
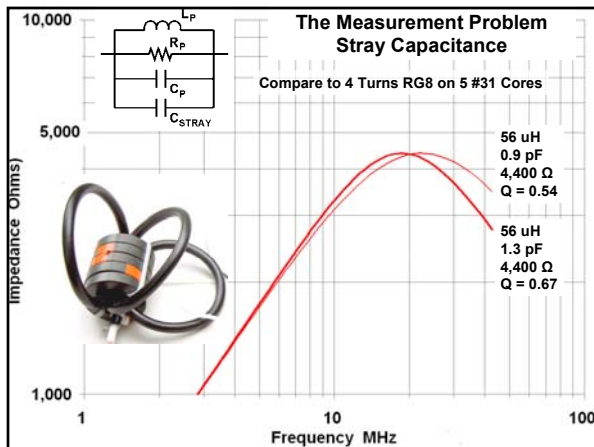
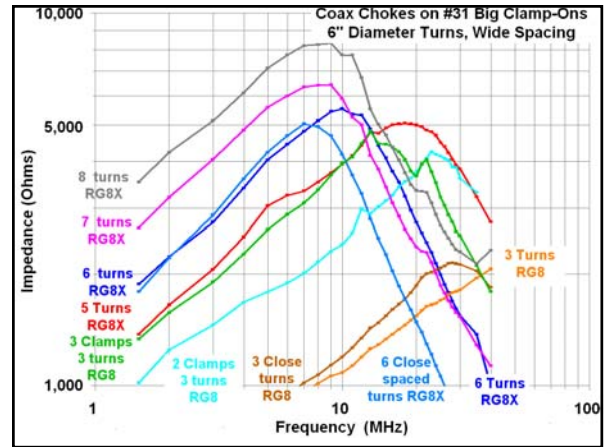
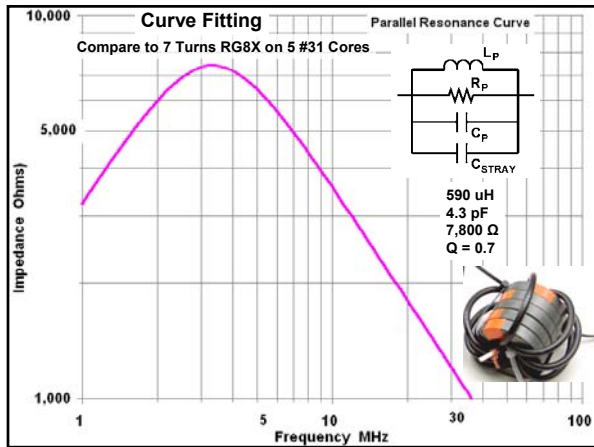


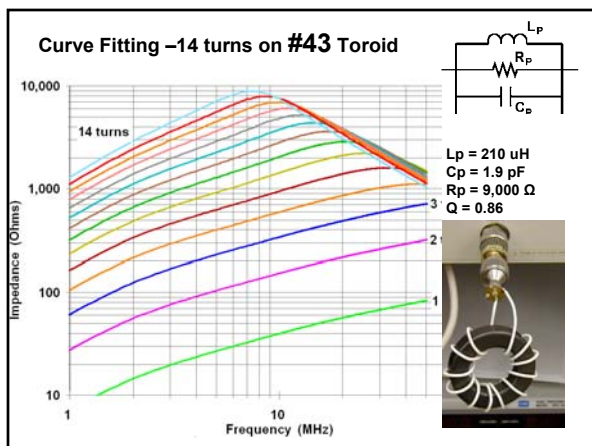
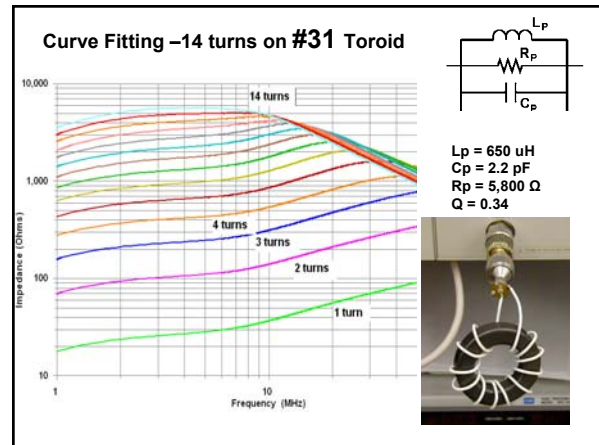
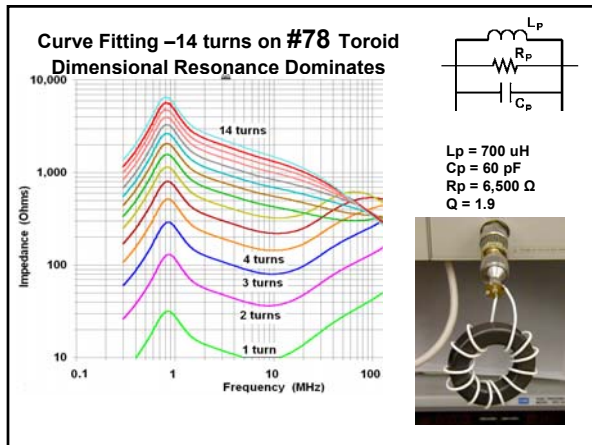
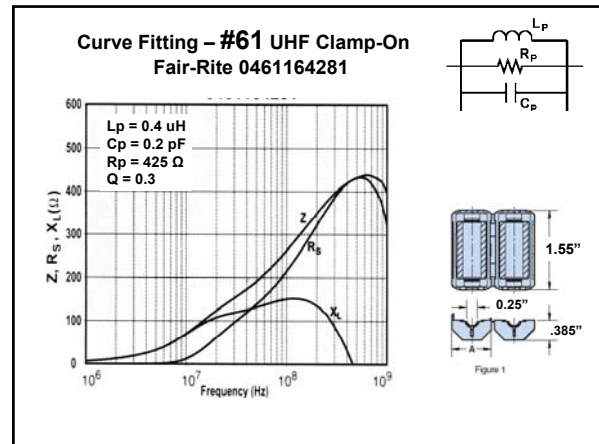
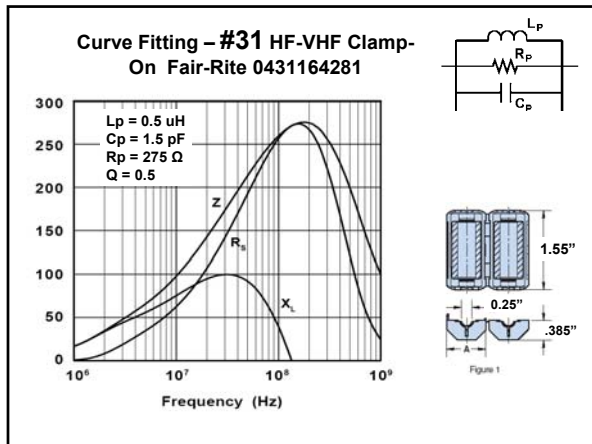
K9YC Chokes (Improved W2DU Chokes)

4 turns
RG8



7 turns
RG8X





- ## References
- Henry Ott, *Noise Reduction Techniques in Electronic Systems*, Wiley Interscience, 1988
 - E. C. Snelling, *Soft Ferrites, Properties and Applications*, CRC Press, 1969
 - E. C. Snelling and A. D. Giles, *Ferrites for Inductors and Transformers*, Research Study Press, 1983
 - *Fair-Rite Products Catalog* This 200-page catalog is a wealth of product data and applications guidance on practical ferrites. <http://www.fair-rite.com>
 - *Ferroxcube Catalog and Applications Notes* More online from another great manufacturer of ferrites. <http://www.ferroxcube.com>

References

- *New Understandings of the Use of Ferrites in the Prevention and Suppression of RF Interference to Audio Systems*, J. Brown (AES Preprint 6564)
- *Understanding How Ferrites Can Prevent and Eliminate RF Interference to Audio Systems*, J. Brown Self-published tutorial (on my website)

Applications notes, tutorials, and my AES papers are on my website for free download

<http://audiosystemsgroup.com/publish>

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