Balun/Unun Construction

Mike, N1IW
Outline

- 1:1 & 4:1 Balun description
- Design Considerations
- Construction Materials
- Construction Steps
- Parts Sources
- Questions?
Balun Description
Baluns for Antennas

• **Purpose**
  - Isolate transmission line from antenna (suppresses “inverted-L mode”)
  - Provide balanced output currents into unequal dipole leg impedances

• **Misconceptions**
  - Will affect antenna bandwidth
  - Inefficient & prone to core saturation
  - Provides lightening protection
Why a Balun?

- $I_1$: Center conductor current
- $I_2$: Current on inside surface of the shield
- $I_3$: RF current at antenna feedpoint
- $I_4$: therefore current traveling down the outside surface of the shield

Inadequate isolation between an antenna and its feedline will cause $I_2$ to divide into $I_3 + I_4$.

RF current from transmitter
The Basic Current Balun
The 4:1 Gaunella Current Balun
Design Considerations

- High choking reactance, $250\Omega$ minimum (limits low frequency response)
- Low stray capacitance (limits high frequency response)
- Short transmission line, $<< \frac{1}{4}$ wave (The shorter, the better)
- High power handling
- Minimize resistive losses
- Correct core selection
- Robust mechanical design
Design Considerations

- **Line Impedance, $Z_0$**
  - For 1:1 make equal to load and line impedance
  - For 4:1, make geometric mean of line and load impedance (e.g., 50Ω to 200Ω requires 100Ω line)

- **Transmission line examples**
  - Parallel line (wrap with Scotch No. 27 glass tape)
    - 50Ω: bifilar wound #14, wrap one wire with 1 layer of Scotch No. 92 tape to control wire spacing
    - 100Ω: bifilar wound #14 + Teflon tubing
  - 50Ω Coax
    - **RG303**, RG142, RG400

- **Enclosure**
  - Lightweight
  - Mechanical integrity
  - Weatherproof
Material Choices...

- Choose magnetics size for power
  - $\leq 0.5”$ OD cores for QRP and receive applications
  - 1.4”-1.5” OD cores for matched loads up to 1 kW
  - 2.4” OD cores for reliable legal limit +
  - Cores can also be stacked

- Choose magnetics material for frequency
  - $\mu = 250$ for 160M (K mix)
  - $\mu = 125$ for 80M and up (Q1, 61)
  - $\mu = 40$ for 20M and up (Q2, 67)
Rods and Donuts
## Ferrite Core Examples (Amidon)

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<th>O.D</th>
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Material Choices…

• Choose wire for power and $Z_0$
  - Thermaleze or Formvar enamel insulated wire
  - #12, #14 for high power; #16, #18 for medium power
  - Use tape, spaghetti or insulation to adjust wire spacing
  - Smaller cores will require smaller wire diameter to get the number of turns needed

• Use Scotch No. 27 glass tape to secure parallel lines

• 50Ω Coax (RG303, RG142, RG400)
1:1 Designs  (50Ω design objective)

- **HP1**: 10 bifilar turns #12 on 2.4” OD core; wrap one wire with 2 layers of Scotch No. 92 tape
  - µ of 250 for 160M/80M
  - µ of 125 for 80M – 10M
  - µ of 40 for 20M - 6M
- **HP2**: 10 bifilar turns #14 on 2.4” OD core; wrap one wire with 1 layer of Scotch 92 tape
- **MP**: 8 bifilar turns of #14 on 1.5” OD core (~45Ω)
- **LP**: 10 bifilar turns of #16 on 1.25” OD core
Coax or Parallel Line, 1:1
1:1 and 4:1 Examples
200Ω:50Ω Designs  (100Ω design objective)

- Inputs (50Ω side) in parallel; outputs (200Ω side) in series
- 2 X 8 bifilar turns #14 on single 2.4” OD core (cover each wire with teflon tubing)
- 14-16 bifilar turns #14 on 2.4” OD core x 2 cores (cover each wire with teflon tubing)
- Can substitute #14 solid house wire but take hit in breakdown voltage
- LP: 14 bifilar turns #20 insulated hook-up wire on each 1.25” OD core; 2 X 7 bifilar turns on single core
Efficiency (Sevick)

- 250 for 160M / 80M
  - 99% at 1.8 MHz, 97% at 30 MHz
- 125 for 80M thru 10M
  - 99% at 3.5 MHz, 98% at 30 MHz
- 40 for 20M thru 10M
  - 99% at 14 MHz and 30 MHz
Construction Steps
Taping the Magnetics
Winding the Torroid
Dressing the Leads
Lining Things Up
Balanced End Connection
Unbalanced End Connections
Getting Close…
A Handy Enclosure
Finished Prototype
Additional Reading…

- Lewallen’s Article
  - www.eznec.com/Amateur/Articles/Baluns.pdf

- 4:1 QRP Balun
  - http://www.n0ss.net/qrp_4-1_guanella-type_balun.pdf

- Putting a Balun and a Tuner Together, W9CF
  - http://fermi.la.asu.edu/w9cf/articles/balun.pdf

- Hybrid Tuner Balun, ZS1AN