BALUNS 101
Learn Just Enough to be Dangerous!

Important Principle:

• Don’t believe anyone who claims to be an expert on baluns.
First - Some Terms

• BALUN comes from “Balanced to Unbalanced”
  This usually means connecting a balanced load such as a dipole antenna to an unbalanced input such as a 50-ohm coaxial cable. The shield side of the cable is usually grounded.

• BALUNS can also change impedance levels. For example, 4:1, or $200\Omega$ to $50\Omega$ or $300\Omega$ to $75\Omega$.

• UNUN means “Unbalanced to Unbalanced”
  This is a device inserted into a coaxial transmission line usually to reduce “common mode” currents - more on that later.
The BALUN is a Transmission Line Transformer (TLT)

- Some BALUNS are “narrow-band” because they depend on a section of transmission line that is a particular fraction of a wavelength.
- However, most BALUNS are made from short sections of transmission lines (compared to $\lambda$) surrounded by magnetic media with their ends connected to show transformer-like properties. These have much greater bandwidths.
- In many cases the transmissions lines are bifilar or multifilar windings but can be coaxial cable or strip-line cable.
Differential vs. Common Mode Current

"Differential" Mode

$I_d$

"Common" Mode

$I_c$
Two Types of BALUNS

1:1 Voltage Balun

1:1 Current Balun

**Dot Convention:** Positively increasing instantaneous current entering the primary winding’s dot end induces positive polarity voltage at the secondary winding’s dot end.

**Note:** When building transformers, dotted ends of the windings enter the core center from the same side.
Two Types of BALUNS

- Some authors claim that if the impedance ratio is greater than 1:1 it must be a Voltage BALUN.
- However, this does not seem to be true, and Current BALUNs can have different impedance ratios.
Common Mode Current in Coax can Radiate and Create RFI in Shack
Current BALUN Opposes Common Mode Currents

\[ I_c \]

1:1 Current Balun

The Current BALUN opposes Common Mode currents. Sometimes called a “Choke BALUN.”
This BALUN forces the voltage to be 2V across the antenna, but does not prevent common mode current from factors which “unbalance” the antenna.
A Broadband 4:1 Voltage BALUN

The Ruthroff 4:1 Voltage Balun with Symmetrical Load
Ruthroff 4:1 Voltage BALUN with Unbalanced Load

Note: Unless the loads are symmetrical (balanced) and $I_2 - I_1 = 0$, some excess current flows through the ground connection as “common mode” current.

The Ruthroff 4:1 Voltage Balun
New Carolina Windom Antenna

The “New Carolina Windom” Antenna for 40, 20, 15, and 10 meters

*The Choke can be made with tubular ferrite cores slipped over a short section of coaxial cable.
Choke UNUNs
Choke UNUNs

DX Engineering FCC050-H05-A
160 to 6 meters, 2kW CW/5kW SSB
“Ugly” Choke UNUNs

Usually 15 to 22 feet of RG-8 coax wound on a form 4 to 6 inches in diameter.
Fig 36—Fixed-balun methods for balancing the termination when a coaxial cable is connected to a balanced antenna. These baluns work at a single frequency. The balun at B is known as a “sleeve balun” and is often found at VHF.
Off Center Fed (OCF) Dipole (80:20)

Note: I have seen ratios reported of 84:16, 80:20, 66:34, and the "traditional" 62:38. W8JI claims this antenna has better than 2:1 SWR on 80, 40, 30, 20, 15, 12, and 10 meters. (http://www.w8ji.com/windom_off_center_fed.htm)
4:1 Guanella Current BALUN

The Guanella 4:1 Current Balun with Floating Load
The Guanella 4:1 Current Balun with Unbalanced Load
4:1 Guanella Current BALUN

Guanella BALUN should be made with two cores.
An Improved 4:1 Current Balun with Symmetrical Load
(http://www.home.earthlink.net/~christrask/Trask4to1Balun.pdf)
An Improved 4:1 Current Balun with Unbalanced Load
(http://www.home.earthlink.net/~christrask/Trask4to1Balun.pdf)

This BALUN can be wound on a single core.
References

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