Brass Tacks

An in-depth look at a radio-related topic

Balun 101

In the ham world you might hear the word ***balun*** (pronounced BAL-en) thrown around once in awhile and wonder what that means. You might even hear somebody claim that he needs one, while another claims he does not, and still others say that baluns are unnecessary. So, what are these mystery devices, and why would you consider using one? I mean, people and even reputable manufacturers make them, so just what are they used for, and should you get one?

What is a balun?

The word **balun** is contrived from the words ***bal***anced and ***un***balanced, referring to two general types of two-conductor transmission lines that feed RF signals to an antenna system. A balanced conductor pair has two parallel conductors that are *identical* in size, shape, and material, while the two conductors in an unbalanced conductor pair *differ* in size, shape, or material. In most ham radio circles, a balanced feedline can be ladder line, twin-lead, or twisted pair, while an unbalanced feedline is usually coaxial cable. A balun, therefore, couples an unbalanced feedline with a balanced feedline in an antenna system.

But if the purpose of a balun was merely to connect two different types of feedlines, there are simpler (and less costly) ways of connecting them, and there would be little else to discuss here, let alone justify an article. In practice a balun is a *transformer* that is one of two designs: a voltage balun and a current balun.

The voltage balun

A voltage balun is an RF transformer that attempts to balance its output voltages (equal and opposite output voltages) regardless of load impedances. In this way, a voltage balun is used to match the impedances of two different feedlines. If your antenna system presents an impedance of, say, 200 ohms, your SWR will be 200 ÷ 50 = 4:1, so you'll need to provide a way to match its impedance to your transmitter, or risk damaging your rig. (This is what a *tuner* does.) To match your 200 ohm antenna system with your 50 ohm coax, therefore, you can use a 4:1 voltage balun to perform the match.

But the match created by a voltage balun comes at a dear price in the way of signal current. Remember that ***your antenna field strength is proportional to the current in its elements***, not the voltage, and you're after as strong an antenna field as you can generate. The greater the difference between the impedances you're trying to match, the greater amount of current is lost to the matching, and the worse the antenna performs because of the balun. *Even though you've matched your antenna system to your transmitter, and have reduced your SWR, the signal loss in the matching will be significant.*

Furthermore, because the voltage balun balances voltages, the currents in the system (antenna, feedline, transceiver, ground) are not balanced, resulting in *common-mode current*, especially if your rig is grounded. This is the main source of feedline radiation, often manifested as

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RFI (radio-frequency interference) into your TV set or heard through your computer speakers. In other words, by grounding your rig you've turned your coax into an antenna that transmits unwanted radiation, and you've made it worse by inserting a voltage balun.

The current balun

A current balun is also a transformer, but it attempts to balance its currents (equal and opposite currents) regardless of load impedances. This allows the maximum amount of current to be sent into the antenna elements, which maximizes your signal strength, but results in a poor ability to match impedances, and is therefore often referred to as a 1:1 balun. So the current balun can actually maximize the signal sent from your transceiver to the sky, one of your primary goals.

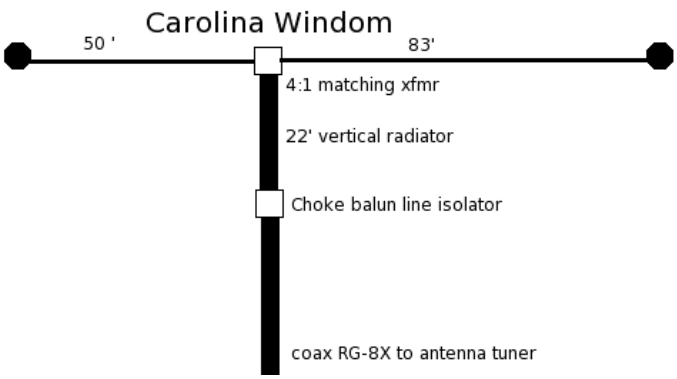
DIY current balun on my HF mast (wires are radials)

Because it suppresses common-mode currents in your antenna system, a current balun minimizes the amount of RFI sent to your household devices. The RF-suppression property makes this balun type a good candidate for *line isolation*, which essentially confines the RFI to a small section of your antenna system, leading some manufacturers to market it as an *RF isolator* or *choke balun*.

These being said, it's possible to design a voltage balun to suppress RFI, and it's possible to design a current balun to match feedline impedances, although far from ideal, usually because of compromises on both qualities. Furthermore, it's possible to create a single balun that is both a voltage and a current type, but that construction can become a little involved, interpreted as *expensive* if purchased from a manufacturer.

The last word

In most cases, it's best to tune your antenna system as closely to your transceiver impedance as possible, then use a current balun to suppress RFI from annoying your family members and neighbors who are watching TV or using the computer. Even if your precisely-measured dipole shows a 1.1:1 SWR in your garage, if your dipole legs are installed at an angle relative to the ground surface (think sloper antenna or inverted-V), the differences in heights of your antenna sections will introduce common-mode currents, which need to be suppressed.



An interesting application that demonstrates the need for both a matching RF transformer and an RF isolator is the *Carolina Windom* antenna, which actually requires both because a portion of its feedline is intended to radiate as part of its antenna.

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