From the Help Desk – March 2026

Note – this is part of an ongoing series of related articles that will each take a look at some facet of radio selection, installation, or operation as suggested by actual questions received from Club members or other amateur operators.

Q: **"**I recently opened up an old balun that I was given, so that I could look at what was inside the housing and see how it was made. What I found confused me, which brings me to the question that I need to have answered. I was told that this was a 9:1 balun, but there are only eight turns wound on the toroid. What is the type and turns ratio of a toroidal transformer wound with three parallel (not twisted) wires making eight turns on the toroid, with each wire labeled as A1 at one end and A2 at the other end, and so forth through B1/B2 and C1/C2, and where A1 goes to the antenna terminal, B1 connects to A2, C1 connects to the transmitter and to B2, and C2 connects to ground? Also, how much power can this balun handle?"

A: To start out, the device is actually *not* a balun at all, but is actually an unun. Refer to the drawing at Figure 1 as you read the response that follows. In a nutshell, what you have described, and what is shown in the drawing, is a 9:1 *unun*, which is an unbalanced device to unbalanced device transformer (or autotransformer) used for antenna impedance matching.

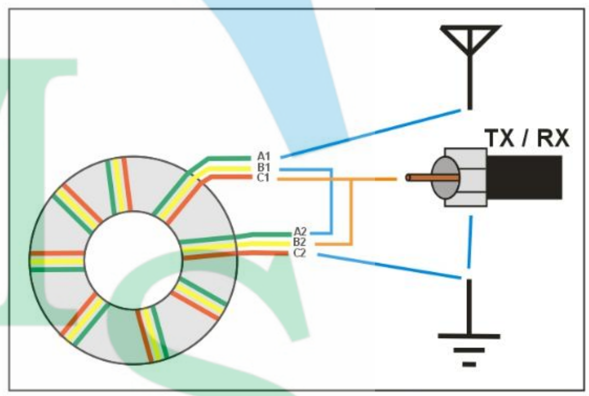

Figure 1 - Drawing of described device

<u>Type and Function</u>

This configuration creates an autotransformer or, more specifically in amateur radio applications, an unun. An unun matches an unbalanced line (coaxial cable from the transmitter) to another unbalanced impedance (like a random wire antenna).

The purpose of this specific wiring is to match a 50-ohm transmitter output to a much higher impedance antenna, typically in the range of 450 ohms (9 x 50 ohms).

<u>Turns Ratio</u>

The turns ratio is determined by the total number of turns used for the primary (input) winding and the secondary (output) winding.

Referring to the wire end designations shown in the Figure 1 drawing, the input (primary winding) is across C1 (connected to the transmitter center pin) and C2 (connected to ground). C1 connects to B2, B1 connects to A2, and A1 goes to the antenna terminal. The input uses the turns of winding C and winding B in series, with C2 grounded. So, the number of turns for the primary is the eight turns of wire C, with B and A windings acting as part of the total coupled system.

The output (secondary winding) is across A1 (antenna terminal) and C2 (ground). The output uses the series combination of windings A, B, and C. So, the number of turns for the secondary is the eight turns of A plus the eight turns of B plus the eight turns of C, totaling twenty-four turns.

As to the turns ratio of the primary to the secondary (primary : secondary) windings, what we have is eight turns of the primary to twenty-four turns of the secondary (8 : 24), which simplifies to a 1 : 3 turns ratio.

Impedance Ratio

The impedance ratio is a bit different. The impedance ratio can be calculated from the turns ratio, as the square of the related turns ratio. Therefore, with a 1:3 primary to secondary turns ratio, we would have $1^2 : 3^2$, or 1 : 9 as the primary to secondary impedance ratio. This results in a 9:1 impedance transformation, which is a common ratio for matching a 50-ohm transmitter to a high-impedance random wire antenna.

This unun would be appropriate for connection of a random-length wire antenna or an end-fed antenna of either band-cut (tuned) length or random length. Ideal antenna impedances would be on the order of 450 ohms, though impedances as low as 200 ohms will operate satisfactorily.

Power Handling

Power handling is primarily a function of the size and material of the transformer core upon which the transformer is wound. To a much lesser extent, it is also a function of the wire gauge and type used in the construction of the transformer. As you did not provide any core or wire data, the power-handling capability of this unun cannot readily be determined. However, some information can be provided, based upon common design practices for this type of device.

It is common practice to wind the transformers of such devices using solid copper enamel-coated magnet wire of a diameter ranging from 14 AWG to, under certain circumstances, 22 AWG. Typically, for medium- to high-power applications, 14 AWG to 16 AWG magnet wire is used. For low- to medium-power applications, 18 AWG to 22 AWG magnet wire is common, and for the highest-power applications, 14 AWG to 10 AWG magnet wire is used.

One common design uses an FT240-43 toroid and 15 AWG wire, with Teflon™ tube sleeving on the wire. Such an arrangement will produce an unun capable of handling 200 to 400 watts in continuous wave operation, and from 500 to 700 watts in single-sideband operations. This design, using the same 15 AWG wire, can be boosted to 1500W full legal power capability by stacking two or three of the FT240-43 toroidal cores. Stacking the cores helps to prevent core saturation and also serves to provide for better heat management.

I hope that this helps you to understand a little bit about this impedance-matching device and how its ratios can be determined. Sometimes, a diagram helps to visualize the circuit a bit better than words alone can do.

See you next month!