7/17/91

Chuck:

Worked with the "Collins Balun" again last night (see attached chart). It didn't make any difference where the coil was... at the radio in the shack, at the base of the tower, or hanging on the tower directly below the T5... the SWR checks showed that there are only very minor variances.

Do you think potential for TVI/RFI (by reducing current flow on the shield) might be better checked by installation at the antenna or would it really make much difference?

One thing I did discover, however, was that I was more than a little off when I supposed my coil of RG213u to be about 100-feet... I stretched it all over the yard last night and measured it. Right at 200-feet! What a balun.

You made a statement that I wouldn't need 100-feet to see these SWR readings and referred me to the article.

The two pages you sent me were interesting but the article was incomplete. I read the parts of the article that you faxed but it said the design and measurement details of the balun construction were in Part Two.

If you have both Parts One and Two of the article, could you fax or send them to me?

How many feet of coax do you figure would be required to assure these present (or better) statistics? Cut in any quarter wavelength, etc segments?

Thanks...

Woody
WR0S

488-6188 office
488-6015 fax
980-0006 home

# C-TECH (TENNADYNE)

1361 kennedy drive
denver, colorado 80234
(303) 451-7100

17 JUL, 1991

WOODY LINWOOD

---

The entire comment on the COLLINS BALUN was contained within the two pages that I FAXed to you yesterday. However, I feel that about 10 turns with a diameter of 1' would be adequate. Let me know.

It seems to me that if you want to eliminate shield currents, you should do so as close to the source as is possible. Put the coil at the antenna feed point!

Chuck

This article shows how to build and design broadband rf transformers and baluns without magnetic cores.

## problems with magnetic cores

Amateurs build or buy highly linear SSB equipment and effective lowpass filters to avoid TVI. We then subject our clean, harmonic-free signals to the uncertainties of ferrite-core transformers or baluns in our antenna systems. The cores in these devices are subject to saturation and, therefore, nonlinearity. High permeability ferrite cores are also susceptible to permanent damage at flux densities of a few hundred gauss.[5] Tune up your linear into the wrong antenna just once and the damage is done.

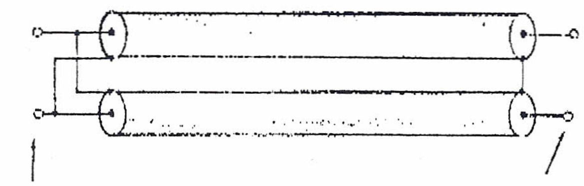


fig. 1. Broadband transmission-line transformers are made of two or more transmission lines connected in parallel at one end and in series at the other. One volt applied to two coax lines in parallel at the input results in 1 volt across *each* of the lines at the output. If these two lines are connected in series at the output as shown, the output will be 2 volts. In this way a 1:4 impedance stepup is achieved. Sufficient impedance must be provided over the length of the outside conductors to prevent the connections at one end from shorting the other end.

Magnetic materials such as ferrite, powdered iron, and specialty steel tapes have added greatly to the performance of components available to circuit designers. However, these materials should not be used in high-power circuits or antenna systems unless they are adequately characterized regarding power-handling capability and saturation effects. This is necessary so that interaction of the material with your system can be thoroughly understood. Put another way, sufficient core material must be used to keep the flux density well below the saturation level. Data on harmonic distortion measurements, taken at high power on a popular commercial ferrite core balun, are presented in part 2 of this article.

Ferrite baluns and transformers are usually wound with copper wire coated with thin enamel insulation. Pairs of wires are placed close together or twisted to make transmission lines, which are wound tightly onto the core. The conductors must be close, because the surge impedance of the wire pairs must be correctly related to the impedances to be matched.

WOODY LINWOOD
FAX: 488-6015

What you have done is to decouple the antenna to a greater degree than the 'natural' balun of the antenna itself. It's called the COLLINS BALUN, see the following. RG213/8 at 30 MHz has a loss of 1.13 Db.
As you will wee from the following, you don't need 100'.

chuck

put end of each of the two lines. If the output ends are connected in series so that the two voltages add, the output is 2 volts, thus creating a 1:2 voltage increase (1:4 impedance transformation). Fig. 1 also can be used to describe a 4:1 impedance reduction; for example, from 50 ohms to 12.5 ohms.

Sufficient rf impedance must be provided between the input and output ends of the transformer of fig. 1 to prevent the connections at one end of the lines from shorting the other end of the lines. The impedance is usually provided by wrapping the transmission lines around magnetic cores.

## the Collins balun

By far the best balun I've ever used is the Collins balun which, to my knowledge, was first described in a book published by the Collins Radio Company entitled *Fundamentals of Single Sideband*.[6] The Collins balun derives its name from this reference. I believe the earliest reference to an Amateur application was in an article by K2HLT in *G.E. Ham Notes* in 1960.[7] The Collins balun is rarely mentioned in Amateur literature, which is surprising in view of its superb performance. However, Bill Orr, W6SAI, describes one in his *Radio Handbook*.[8]

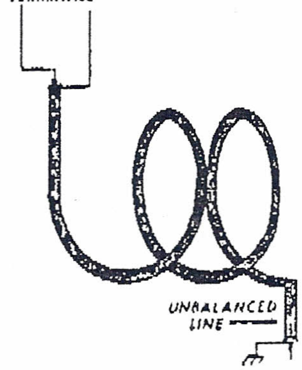


fig. 2. Simple coiled length of coaxial line isolates output terminals from ground.

Perhaps the reason the Collins balun hasn't gained popularity with Amateurs is that it's quite bulky when made with RG-8/U. The balun is extremely simple. No exotic materials are used in its construction; only coaxial cable and insulated wire. I've used these baluns for years with various antennas and never had a failure. One has been on my three-element 10-15 meter quad for eight years with no sign of deterioration. There are only two disadvantages to the Collins design: 1) when made with RG-8/U, the balun is bulky — too large for installation on a clean-design antenna system; and 2) the balun is useful only at 50 ohms. This article shows how to eliminate these disadvantages.

## balun theory

Baluns convert energy from unbalanced coaxial line to balanced two-wire line by isolating the two balanced terminals from ground. As in the transmission-line transformer, this is often accomplished by coiling transmission lines around magnetic material so the impedance to ground from both output terminals is high compared with the characteristic impedance of the input coaxial line. By using this technique, shown in **fig. 2**, the two balanced terminals are "floated" with respect to ground by the isolation provided by the coiled-line impedance. However, a simple coiled length of transmission line is often not adequate because it doesn't contribute to the balance of the system.[9] For a balun to make this contribution, the impedance ground from both terminals must be nearly matched.

Accordingly, in the Collins balun, a dummy length of coax is wound as a continuation of the isolating winding, so that the coil consists of the original length of coiled coax of **fig. 2** plus an equivalent length of dummy line, as shown in **fig. 3**.

The dummy-line center conductor is unused and is left floating, or both ends may be shorted to the outer conductor if desired. The dummy length of line causes the impedance to ground, from each of the two output terminals, to be nearly equal. The isolation impedance (common-mode impedance) is held higher than the coax-line characteristic impedance over a wide frequency range by the distributed capacitance and inductance of the combined coil. The coil must have sufficient inductance so the impedance, at the lowest operating frequency, is higher than the line surge impedance. As the frequency is increased, the impedance increases through parallel self-resonance, then decreases as the frequency is further increased.

Because the self-resonant circuit consisting of the distributed capacitance and inductance of the combined coil is loaded by the low characteristic impedance of the line, the impedance versus frequency curve is broad. Balun performance therefore is not critical with respect to frequency. Data taken on measurements of the common-mode impedance on a typical Collins balun are presented in Part 2.

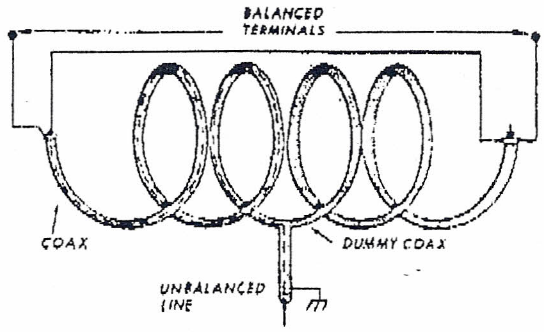


fig. 3. Broadband coil balun is evolved from the coiled coaxial line of fig. 1.

The symmetry provided by the dummy line makes balun performance less dependent on common-mode impedance and is therefore often essential in baluns and balanced systems.[9] The isolation, balance, and impedance match of this class of balun are superb over the hf Amateur bands. Specific designs, performance data, and a systematic design procedure are presented in Part 2.

## new class of transformers

Faced with the need to match a very low-impedance antenna system, I decided to try to develop a 4:1 transmission-line transformer based on the principles of the well-proven Collins balun. The transformer was successfully developed; in fact, a new class of wideband transformers evolved from this work.

One of the nice things about an avocation — as compared with a vocation — is that you're not on a time schedule. I found that the performance of the 4:1 transformer was so good that the idea of other transformer designs based on the same principles looked interesting. I shelved the phased-array project long enough to enjoy the freedom to explore the possibilities of these transformers. The result was a series of broadband balanced and unbalanced transformer designs that are extremely simple, made entirely of coax, and, most important, don't depend on ferrite or powdered-iron materials.

## design concept

Because the Collins balun so successfully isolates the balanced output terminals from the unbalanced coaxial line input, it seemed reasonable that a similar broadly resonant configuration would provide the isolation necessary to the series and parallel lines of **fig. 1**. From previous experience I'd found that it's unnecessary to wind the Collins balun on a cylindrical