Making Baluns

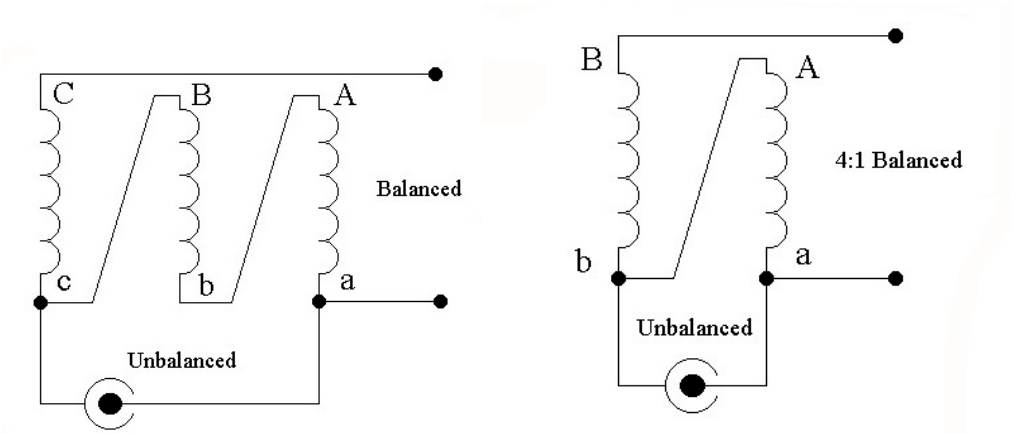
I'm sure many of you have heard of the balun, but how many people have had ago at making one? Sure you can buy them from most radio emporiums, but once you learn how to make them yourself you will save around 80% of the cost.
If you do not understand when and where a balun should be used, then check out the many antenna books and the Internet. I tend to use baluns in all my dipoles to stop current on the outer sheath of the coax - this could lead to RF getting in to the shack, TVI problems etc.

There are two types of balun: a voltage type and a current type I have not found a use as yet for a voltage type so I stick to the current type balun. Most amateurs know that impedances higher or lower than 50 ohms at the antenna port of a rig can spell disaster for its PA on transmit. Why radios with built in ATU's do not have a balanced input in today's fast moving electronics industry is beyond me.

So how do you construct a current type balun? The first thing to consider is the power you wish to push through the balun - this will dictate the type of ferrite core you use and the size of the winding conductor.
Below is a list of the types of ferrite cores and the maximum power that can be safety used with them. Personally I would use a safety margin of about two thirds of the maximum rating, as to avoid heating of the ferrite core. All the cores listed below should be red in colour. Basically the colour refers to the make up of the core, which I will not go into detail here, and the listed cores are suitable for 1 MHz to 30MHz only.

Core type	Power
T-80-2	60 watt
T-106-2	100 watts
T-130-2	150 watts
T-157-2	250 watts
T-200-2	400 watts
T-200A-2	400 watts
T400-2	1000 watts

Once you have chosen the core, the next thing to consider is the size of the windings. I personally prefer enamelled copper wire for this, as it's easily obtained from places like Maplin. For 1:1 baluns on a T-130-2 core I use 0.90mm (20swg). For a 4:1 on the same core I use 1.25mm(18swg), because you have one fewer winding on the core, as can be seen from the electrical drawings below. I should mention here the higher the number of the core the larger its diameter will be, that gives you more room for larger diameter windings.



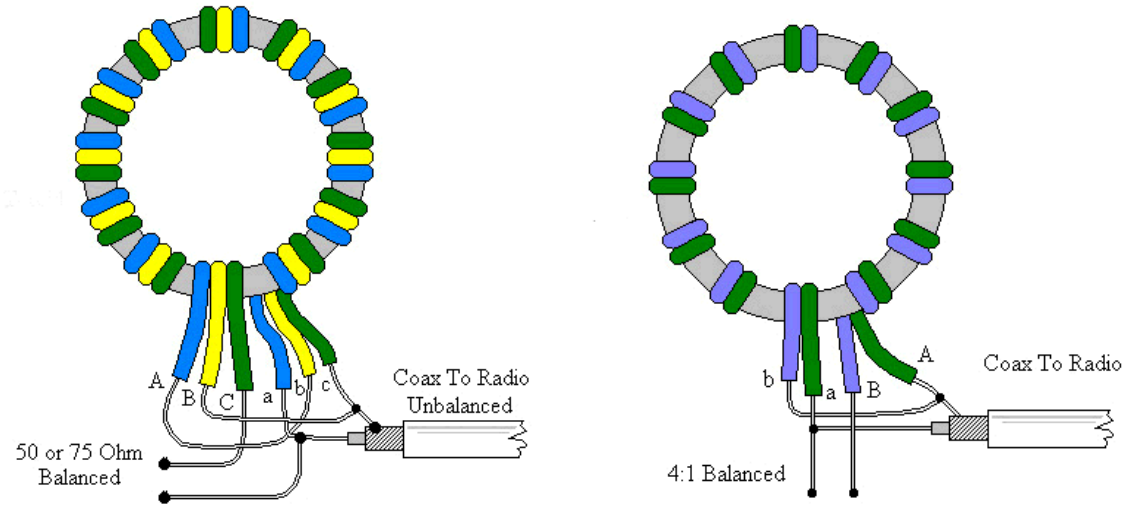
Electrical drawings for a 1:1 balun (left) 4:1balun (right)

The next very important step is of course how many windings are required to make the balun. To help you here I have made a list of all which have worked well for me in the past. You can of course optimise the windings if you have a need to by adding or subtracting a winding accordingly.

Core type	Number of turns
T-80-2	25
T-106-2	16
T-130-2	18
T-157-2	16
T-200-2	17
T-200A-2	13
T400-2	14

As can be seen from the electrical drawings above a 4:1 balun only has two windings wound onto the core together side by side. This is called 'bifilar', and the 1:1 has three windings together which is called 'trifilar' wound.
It makes no difference if you are making a 1:1 or 4:1 balun - the number of turns are the same, but you'll obviously need more space for trifilar winding.

For a 1:1 balun start by cutting three equal lengths of your winding conductor and mark the ends A-a B-b C-c. This will avoid any confusion when it comes to soldering the connections once the balun has been wound. It's always better to cut the winding conductors too long as it's easy to trim off waste but impossible to add to the length! 1.2 metres each for a T130-2 should be about right. You can attach the start of the winding to the core by using a small cable tie to keep it in place – you need to keep a firm tension on the wire as you're threading through to keep nice tight windings.
Simply wind all three conductors together around the core, keeping them tight and evenly spaced (see below picture). The windings must not cross over.



Winding and connection detail.

Finally it's time to connect the balun up! It's far easier to look at the above pictures rather than try and verbally explain. Check all your pairs with an Ohm meter before connecting/soldering. If you've got one with a buzzer that'll make life easier. The balun will need some form of housing, and I have used plastic boxes, tubes etc, but if you are worried about stray RF then a metal enclosure could be used, or simply line a plastic box with metallic tape or tin foil.

There are many myths surrounding baluns: some people swear by them, others just swear at them! High SWR will only be caused by the balun if you've wound it incorrectly or burnt it out by overpowering it; they also do not generate harmonics! A 1:1 balun at the centre of a balanced dipole can only de-couple the current from the outer sheath of the coax and it's impossible for it to change the impedance of the antenna giving a high SWR. That's the theory anyway.

I'm fully in favour of baluns and their usage. Some other interesting things I have found – the bandwidth of your antenna increases, prior to installing a balun into my loaded 80m dipole my bandwith was around 100 khz, after installing a balun the bandwidth increased by around 50%

again to 150khz with no effect on SWR. Another important use of baluns is that some TVI problems tend to disappear.

Hope you have fun making your own baluns and using them!

Clive, 2E0KGV

Further reading: Any of the books by Jerry Sevick