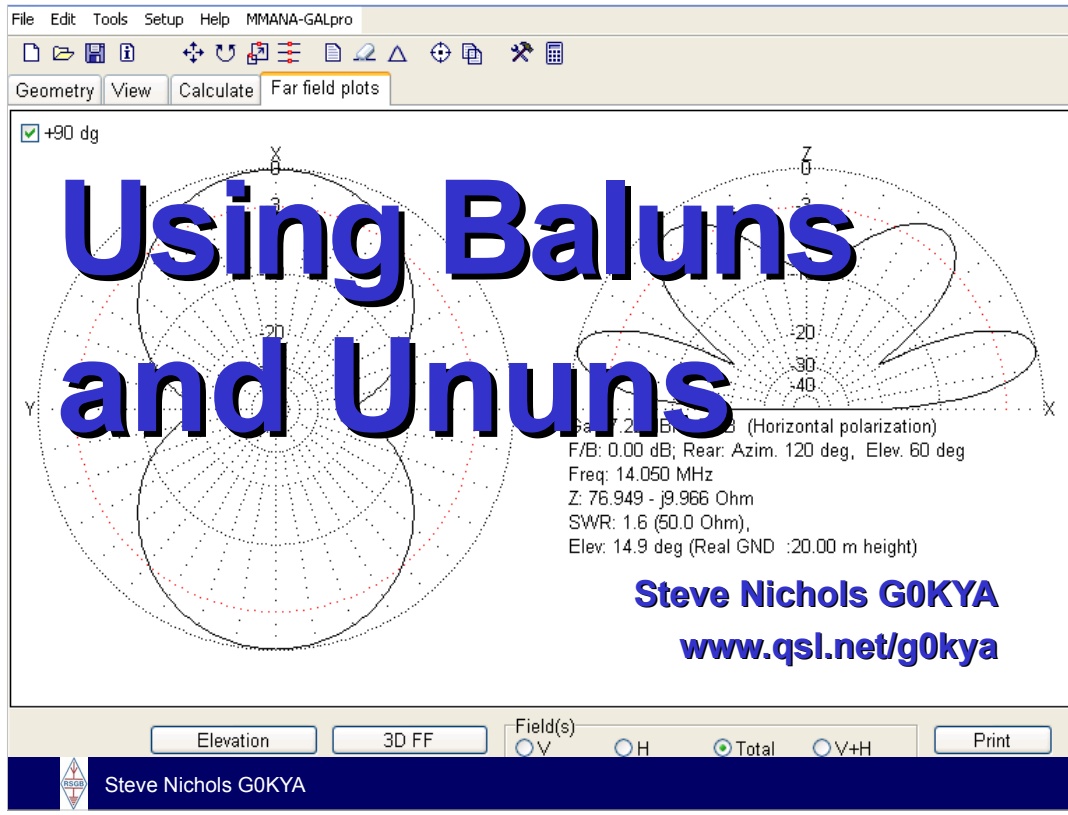
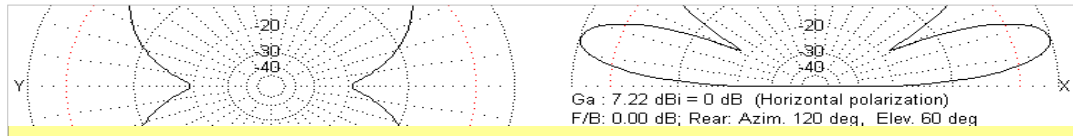
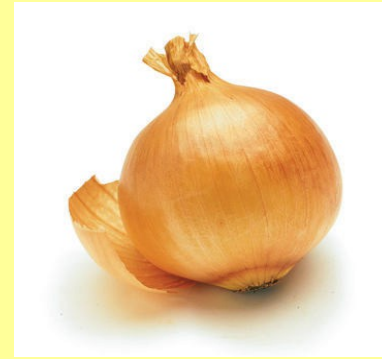


This is a presentation I gave at Norfolk Amateur Radio Club on Baluns and Ununs



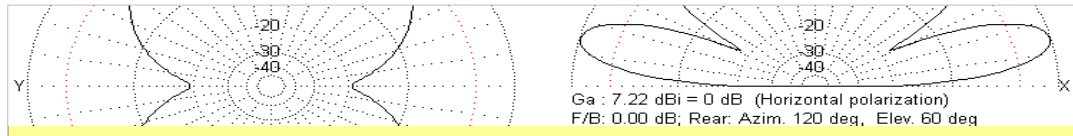
Balums and onions!



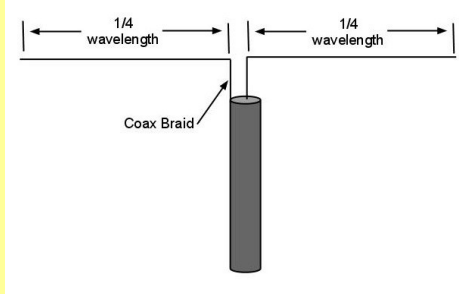
Note they are not pronounced “Balums” or “Onions” or even U-nuns – it is baluns and ununs!

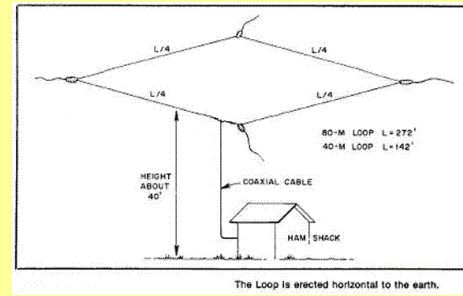
Steve Nichols G0KYA

Note they are not pronounced “Balums” or “Onions” or even U-nuns – it is baluns and ununs!



What is a balanced antenna?



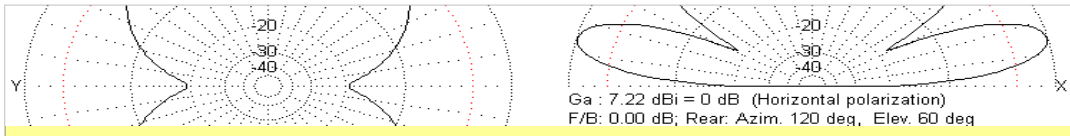


A balanced antenna is one:

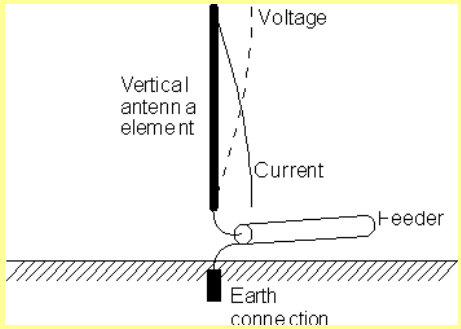
- That is symmetrical
- That doesn't rely on the earth as part of the antenna

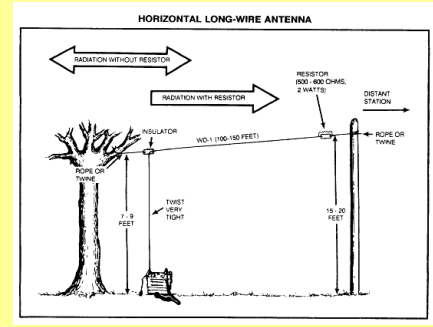
Steve Nichols G0KYA

Tricky one this as ask five people for their definition and you'll get five slightly different answers. We can say that it is bilaterally symmetrical, but that doesn't cover the off centre fed dipole (OCFD), which does needs a balun to work and is not symmetrical. Most commonly, balanced antennas don't use the earth as part of the antenna system.



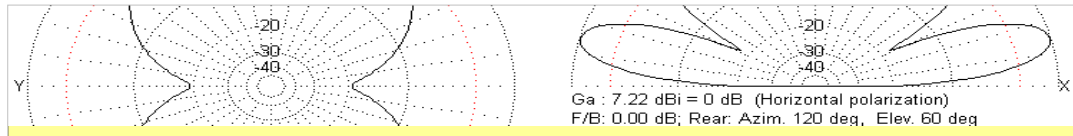
What is an unbalanced antenna?



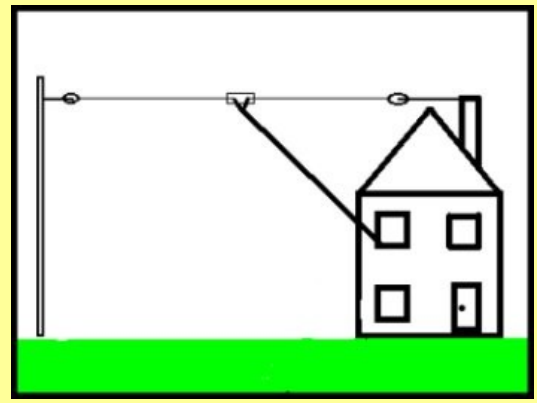


Uses the earth as part of the “system”

If they rely on the earth for the current return they are not balanced antennas



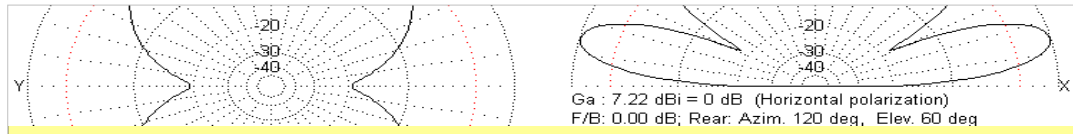
Can a balanced antenna system become unbalanced?



Yes it can!

Steve Nichols G0KYA

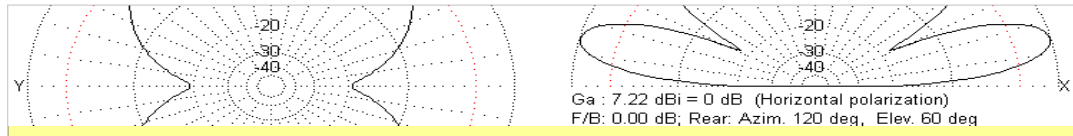
A balanced antenna can become unbalanced if the feed is not symmetrical – this will induce common mode currents, causing the SWR to change and promote RFI problems.



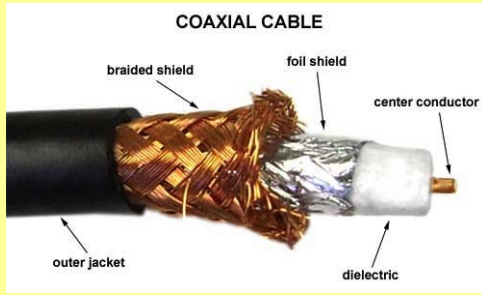
All radios have an unbalanced output

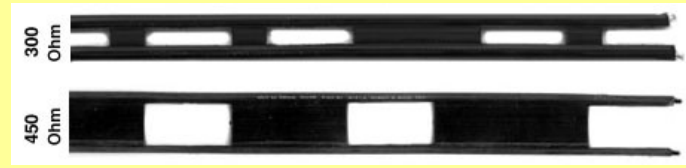
Steve Nichols G0KYA

All commercial radio transceivers have a 50 Ohm unbalanced output.



Coax is unbalanced …..

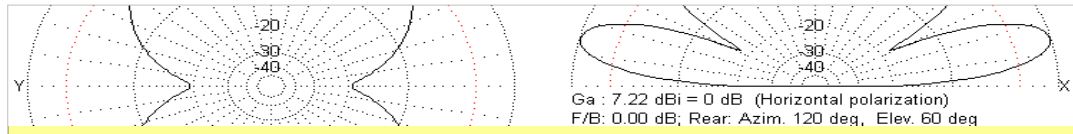




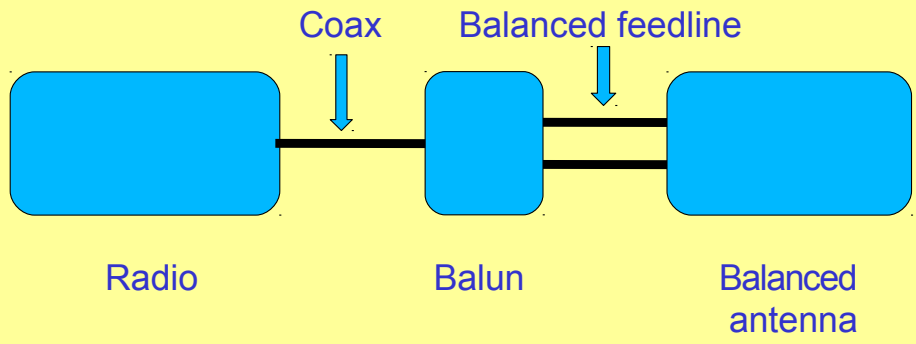
… Ladder line is balanced

Steve Nichols G0KYA

Coax is unbalanced, while ladder line and open wire feeder is balanced, as long as it is used properly and is kept away from metal and "earthy" materials

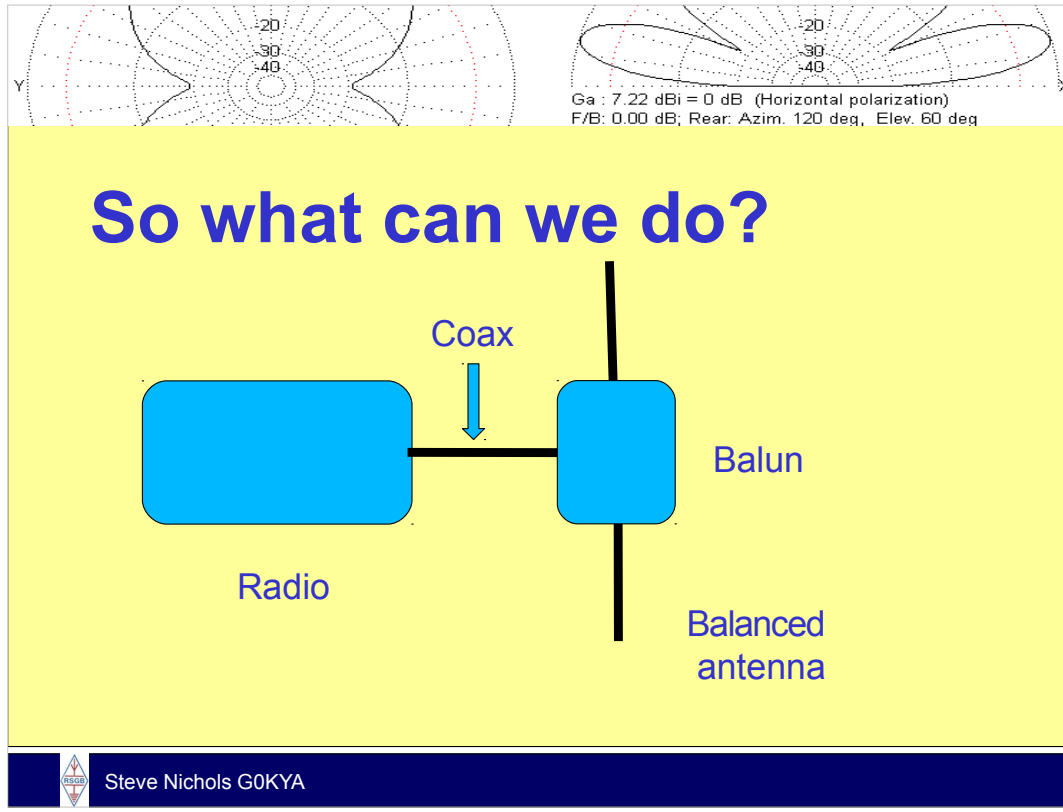


So what can we do?

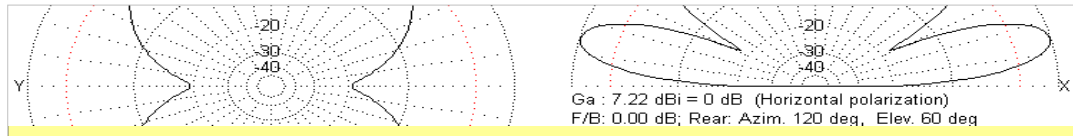


Steve Nichols G0KYA

So we can use a balun – a balanced to unbalanced device - to one to another. This prevents common mode currents and may help prevent noise pickup too.



The balun can be placed at the feedpoint too.



Advantages of balanced feeder

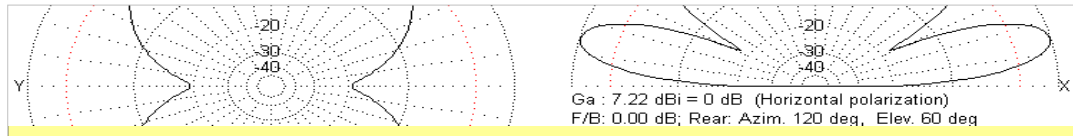
Lower loss than coax, especially with high SWR and over long distances. These are from www.saarsham.net/coax.html

28 MHz	**28 MHz**
SWR 10:1	SWR 10:1
10m	100m
RG58 coax losses: 3.1 dB	RG58 coax losses: 13.4 dB
RG8 coax losses: 1 dB	RG8 coax losses: 5.72 dB
Ladderline losses: 0.24 dB	Ladderline losses: 1.99 dB

* 450 Ohm ladderline

Steve Nichols G0KYA

Balanced feeder offers much lower loss than coax, especially where a high SWR exists. This makes it ideal for multiband doublets These are from the coax loss calculator at http://www.saarsham.net/coax.html



Advantages of baluns

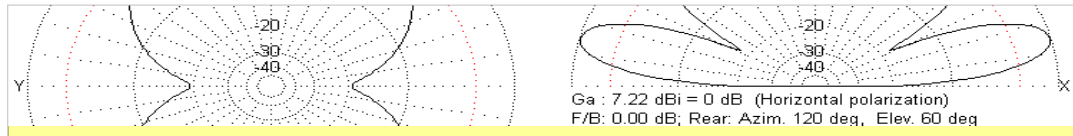
1. Help prevent feed line radiation
2. This can cause RFI problems or distort radiation patterns
3. May reduce noise pick-up

Disadvantages of baluns

1. Can introduce losses
2. Can saturate and cause problems
3. Poor low frequency suitability eg iron powder toroids
4. Might not offer 4:1 or 6:1, despite what they say!

Steve Nichols G0KYA

Iron powder toroids, such as the T200-2 don't provide sufficient choking reactance at low frequencies. Ferrite is better

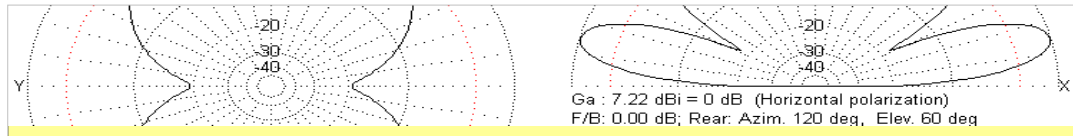


Balun construction is a black art!

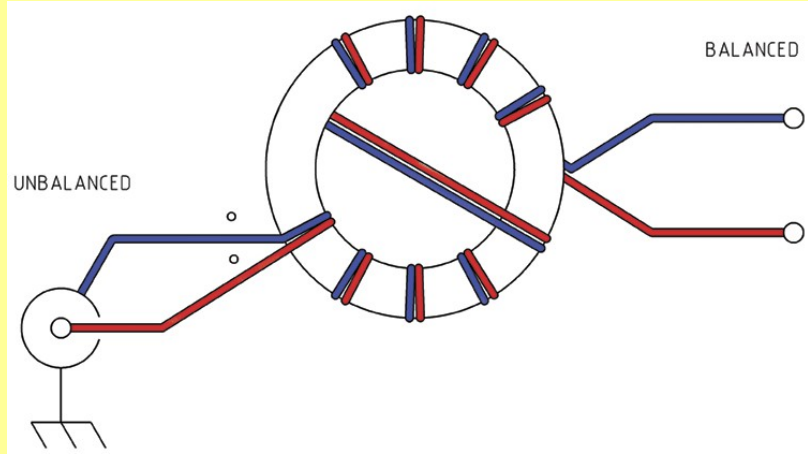
- "High impedance baluns exhibit a poor bandwidth because of increased reactance caused by parasitics within their core."
- "As we move higher in frequency this added inductance begins to "ring" or display parasitics, which causes the balun efficiency (and band-width) to degrade rapidly, in effect, causing its maximum usable frequency to suffer."
- "The type 2 Iron powder core has a very low value of permeability. It needs a large number of turns to achieve a high enough value of primary shunt impedance. Unfortunately the self capacitance associated with a large number of turns also results in unwanted resonances occurring."

Steve Nichols G0KYA

These are the types of comments you will come across. There is plenty of room for error.



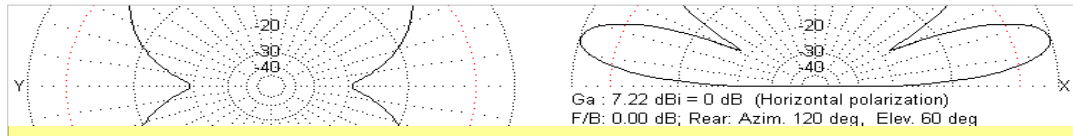
1:1 Guanella current balun



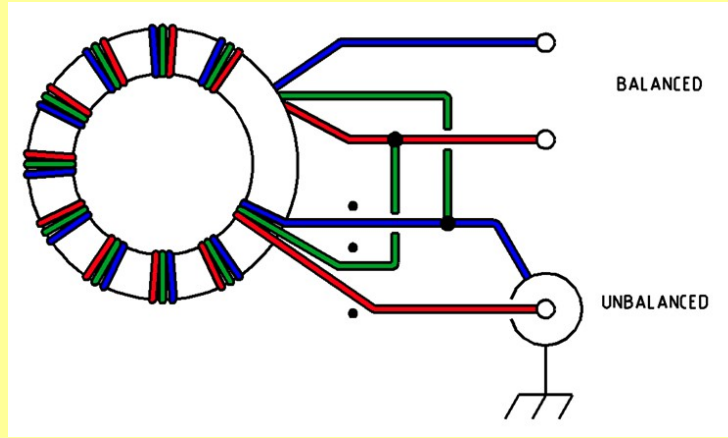
* 450 Ohm ladderline

Steve Nichols G0KYA

A Guanella or current balun is very common. Current baluns stop RF from coming back down the outside of the coax shield, and are so called that because they "force equal currents in each side of a dipole"



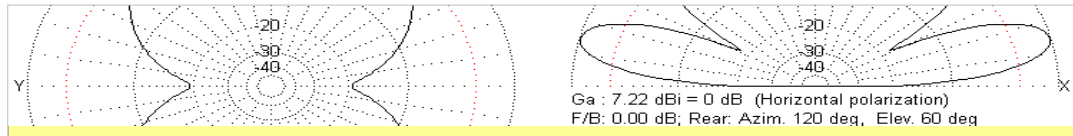
1:1 Ruthroff Voltage Balun



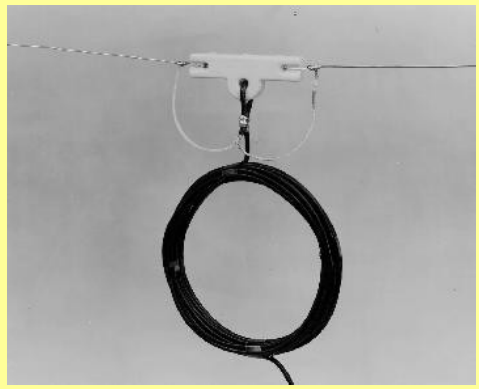
* 450 Ohm ladderline

Steve Nichols G0KYA

The Ruthroff or voltage balun is another type. Voltage baluns balance the voltages. Current balance is considered to be superior to voltage balance. Voltage baluns should not be used in lines with high SWR. They have the narrowest impedance and frequency range of any balun type. Properly designed voltage baluns have low common mode impedance. Properly designed current baluns have high common mode impedance, and provide better balance. If you want to stop common mode currents flowing on your coax a current balun is a better choice. But in the Carolina Windom, which uses the vertical coax as a radiator you WANT common mode currents, so a Ruthroff voltage balun is better.



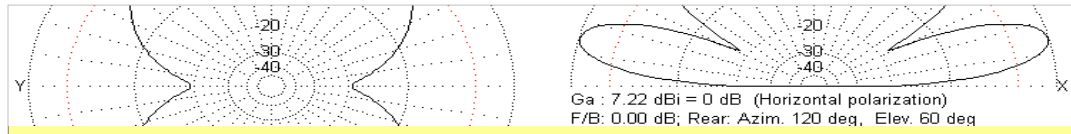
What other types of baluns are there?

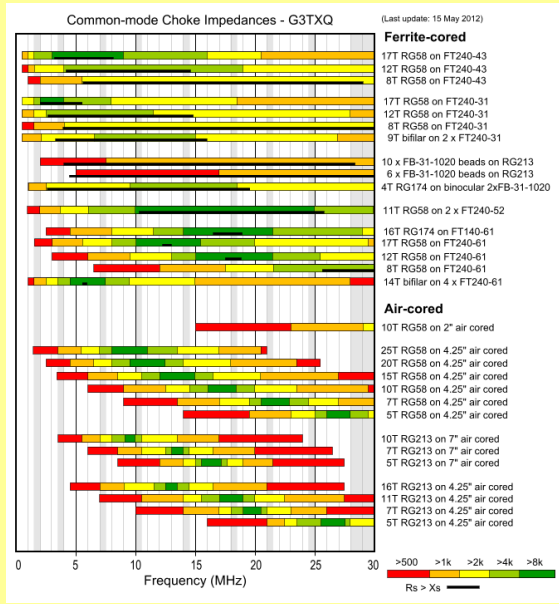


The air-wound choke or “ugly balun” – see G3TXQ website www.karinya.net/g3txq/chokes/

Steve Nichols G0KYA

There are also air-cored chokes, most commonly used with Yagis. You can also use them at the feed point of verticals. But the diameter and number of turns affects the choking impedance – see Steve G3TXQ’s website http://www.karinya.net/g3txq/chokes/

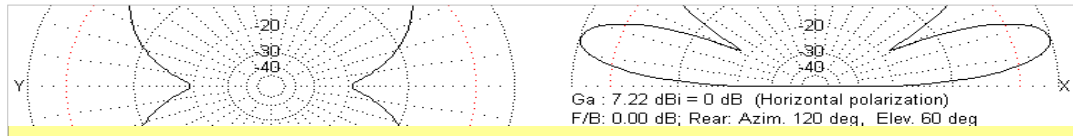




Steve G3TXQ's work on chokes and their effective impedances.

Steve Nichols G0KYA

http://www.karinya.net/g3txq/chokes/ - an excellent resource if making a choke.



Jerry Sevick, W2FMI, says

"In summary ……. 1:1 baluns are really only needed for:

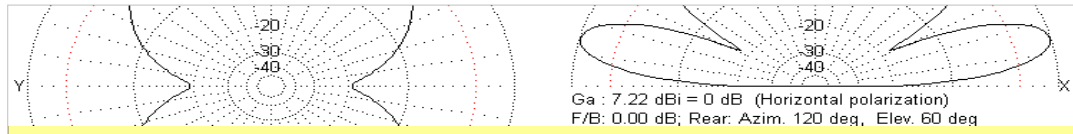
a) Yagi beam antennas where severe pattern distortion can take place without one, and

b) Dipoles and inverted Vs that have the coaxial cable feed lines out of the ground plane that bisects the antennas, or are unbalanced by their proximity to manmade or natural structures."

Understanding, Building and Using Baluns and Ununs

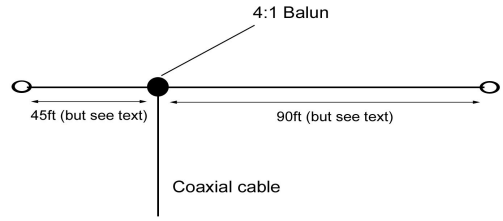
Steve Nichols G0KYA

If feeding a dipole you don't always need to use a balun.



But what if your antenna isn't 50 Ohms?

OCFD

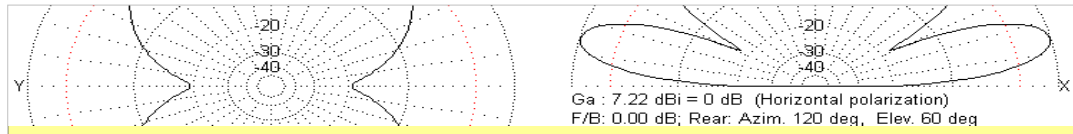


Take a half-wave dipole cut for 80m, break it at the one third/two thirds point and feed with a balun.

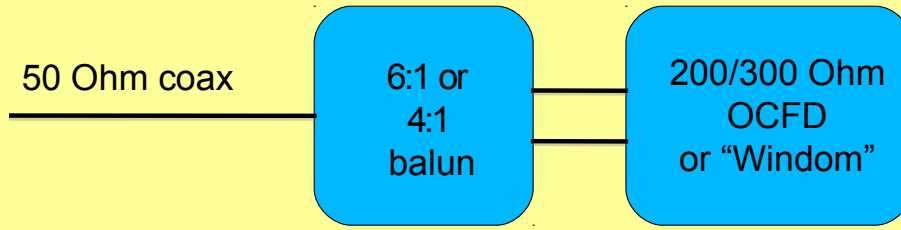
Steve Nichols G0KYA

You can also use a balun for impedance transformation, such as from 50 Ohms to the 200/300 Ohms of an off centre fed dipole.

.



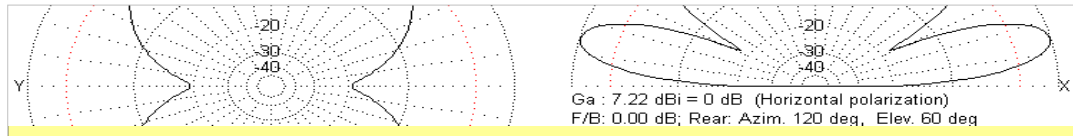
But what if your antenna isn't 50 Ohms?



* 300/450 Ohm ladderline

Steve Nichols G0KYA

You can also use a balun for impedance transformation, such as from 50 Ohms to the 200/300 Ohms of an off centre fed dipole. At normal heights a 4:1 balun is fine. You only need a 6:1 if the OCFD is mounted very high in the air.



What type of toroid/rod material do I use?

Good question!!!!!

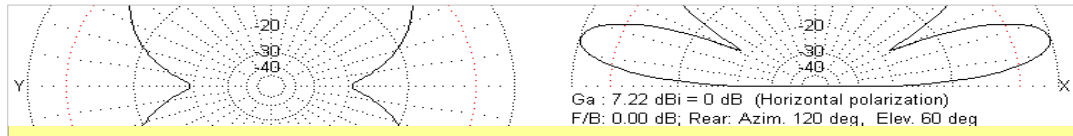
- Two basic types – iron power and ferrite

- Types called FT-XXX-YY are ferrite
- Types called T-XXX-YY are iron powder

- The XX is the diameter in inches eg T200 is 2”
- The YY is the ferrite material eg type 43, 61, 2 etc

Steve Nichols G0KYA

Toroids starting with “FT” are ferrite and iron powder if “T”. The next part describes the diameter in inches, so T200 is an iron powder toroid 2 inches in diameter. The final part tells you the material, so an FT240-31 is a ferrite toroid 2.4 inches in diameter made from type 31 material.

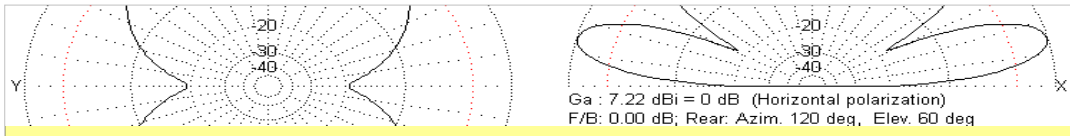


What type of material do I use?

Get it wrong and problems that occur include:

- Limited bandwidth
- Poor impedance transformation ratios
- High throughput loss
- And large impedance swings due to self resonance, especially when connected to reactive loads such as antennas.

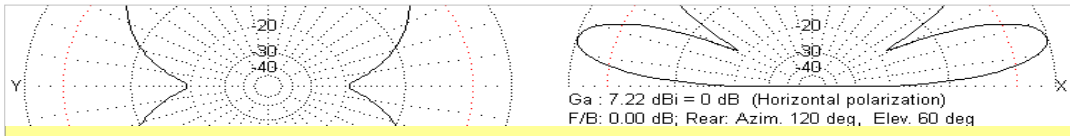
Choosing the right toroid material, size and balun/unun type is very important.



What type of material do I use?

The "current" thinking:

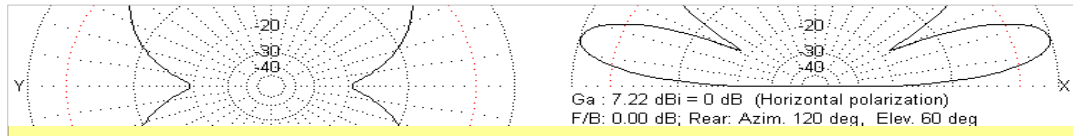
- The balun has to be "man" enough for the power level you are running
- Iron powder toroids don't offer sufficient choking reactance at low frequencies eg 3.5 MHz
- Therefore, a suitable toroid material for a 3.5-30 MHz 4:1 Guanella balun might be ferrite eg FT140-61 up to 200 W. FT240-61 up to 400W



What type of material do I use?

The "current" thinking:

- Ferrite Type 61 for the top end of the HF range; Type 43 for the bottom end; or Type 31 for the best compromise across the range.
- To build an effective 4:1 Guanella balun you need two 1:1 balun cores. You then wire one end in parallel and the other end in series.



The best 4:1 balun?

Built two 1:1 balun cores. You then wire one end in parallel and the other end in series. The characteristic impedance of the twin wire is about 100 Ohms.

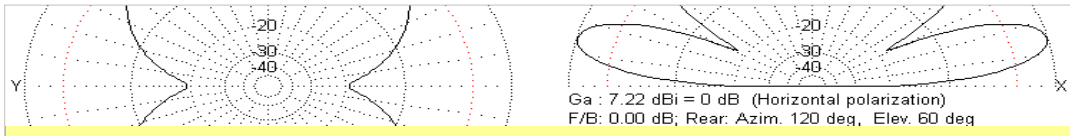
2 x 100 Ohms in series = 200 Ohms

2 x 100 Ohms in parallel = 50 Ohms

200/50 = 4:1 impedance transformation

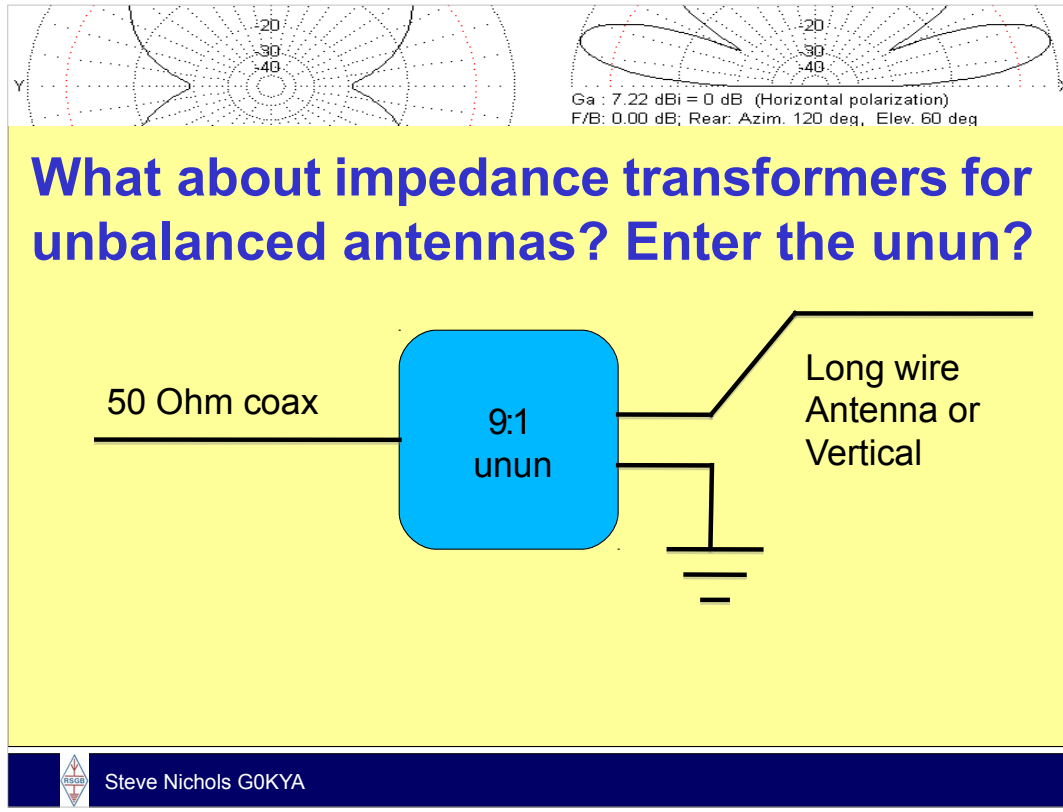
Steve Nichols G0KYA

G3TXQ says the only way to make an effective 4:1 balun is to use two cores,. Build two 1:1 baluns and wire them up in parallel and series. Check it works by putting a 200 Ohm resistor on the output and test for a 1:1 SWR at the input across the frequency range you wish to use the balun.

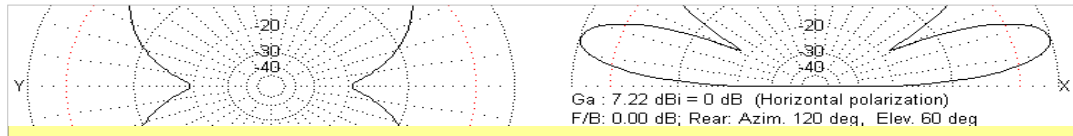


What type of material do I use?

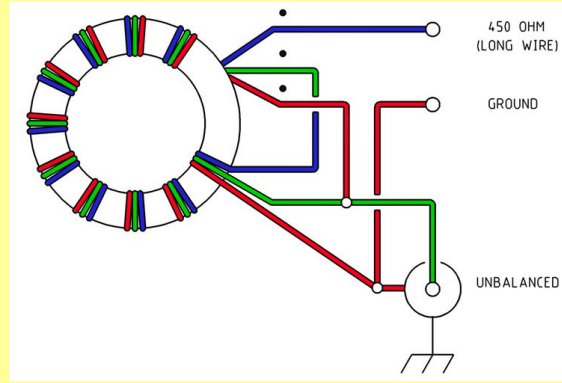
- If matching a balanced antenna, such as a folded dipole, you can use a Ruthroff design
- If matching an “unbalanced” design, such as an off centre fed dipole (OCFD or “Windom”) use a Guanella design – unless you actually want feedline radiation (Carolina Windom). Many commercial manufacturers get this wrong!
- Powdered iron and Ruthroff designs *can* be used in ATUs, although Martin G8JNJ disagrees.



An unun can help reduce the apparent SWR seen at the feeder when using non resonant random length wires. Eg a 7.6 or 8.m vertical wire and a 4:1 unun can make an effective HF antenna (Rybakov design).



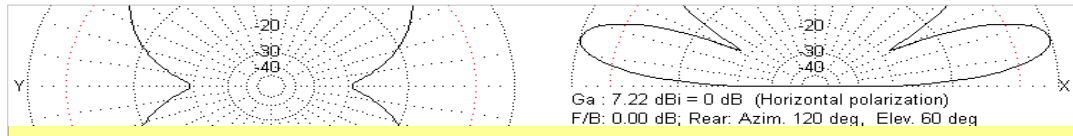
What about impedance transformers for unbalanced antennas? Enter the unun?



9:1 Ruthroff voltage balun

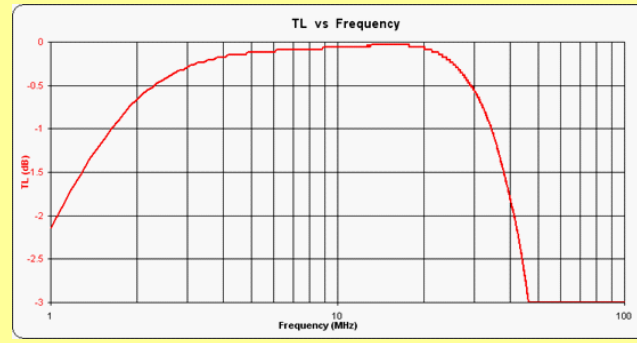
Steve Nichols G0KYA

A 9:1 Ruthroff Unun can help you tune a 65ft long wire from 80m-10m with lower SWRs.



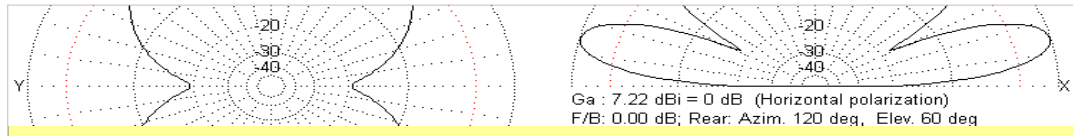
Martin G8JNJ has done a lot of work on ununs

"If you wish to feed a random length of wire, vertical antenna or some other form of unbalanced antenna then I suggest you use a 4:1 voltage (Ruthroff) unun."



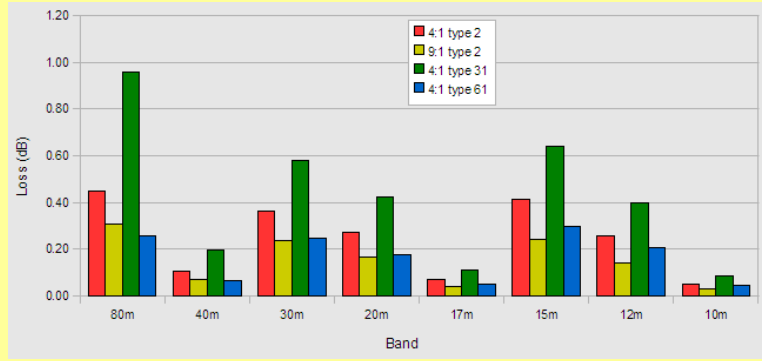
Steve Nichols G0KYA

Read Martin's web site for lots of info on the different ununs, toroid materials and their effectiveness. See http://g8jnj.webs.com/



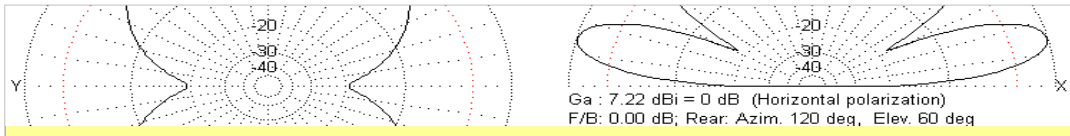
Steve Hunt G3TXQ on ununs

"With a 40ft vertical, the 9:1 unun wound on Type 2 iron dust material (T200-2) gave the best overall results."



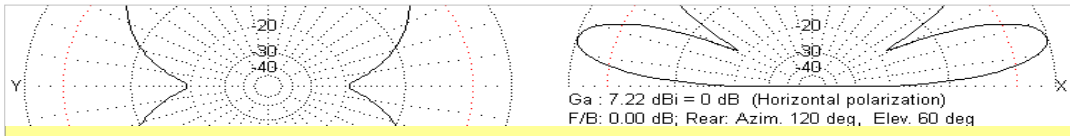
Steve Nichols G0KYA

Steve G3TXQ found that a T200-2 9:1 unun gave good results. See http://www.karinya.net/g3txq/unun/



In conclusion:

- Balun and unun construction can be a “black art”
- An air core “balun” can be sufficient for a Yagi
- Don’t get hung up on baluns for dipoles, unless the feed is asymmetric
- OCFDs really need Guanella 4:1 baluns, built with ferrite materials, unless you really want feedline radiation.
- A 9:1 or 4:1 Ruthroff unun can allow a long wire to be matched more easily
- If interested read more on the subject



Sources

- *"Understanding, Building and Using Baluns and Ununs"* by Jerry Sevick, W2FMI
- Martin Ehrenfried G8JNJ's website at www.g8jnj.net
- Steve G3TXQ's website at www.karinya.net/g3txq/