BALUN BS

Are the Balun Venders Selling us Snake Oil?

by Rick Westerman, DJ0IP

Contents: Part-1 BALUN Basics

ABOUT

The Purpose of this Presentation is:

- To raise awareness of some of the myths and nonsense about Baluns that is widespread in ham radio.
- To point out that some of the 'BALUN OEMS' are selling products "as BALUN", that are not really BALUNs! (Snake Oil)
- To show what a BALUN is Supposed to Do.
- To point out the consequences of choosing the wrong BALUN for your antenna project.
- This presentation is not a One-Stop Course in BALUN Technology!
  - See Slide #39 "Recommended Resources" for links to excellent papers and web sites about BALUNs

(Simplified) Definitions

- **BALUN:** See “What is a BALUN?” page 11.
- **BS:** Brown smelly stuff that falls out the backside of a Bull: 
- **CMC:** **C**ommon **M**ode **C**urrent; RF [return] Current flowing to ground on the **outer surface** of the braid of the coax.
- **CMI:** **C**ommon **M**ode **I**mpedance; a measurement of an RF choke’s ability to impede the flow of CMC, stated in Ohms.
- **Curie Point:** The temperature at which certain magnetic materials undergo a sharp change in their magnetic properties.
- **Differential Current:** The RF Current flowing **inside** of a coax, specifically in the center conductor and along the **inner** surface of the braid.
- **OEM:** **O**riginal **E**quipment **M**anufacturer. This is an acronym used to refer to manufacturers of various types of equipment.
- **Snake Oil:** A product which is sold by using false or exaggerated advertising. (i.e., a so-called “BALUN” that is just a Transformer – not a BALUN)

RF Current Flow in and on Coax

- THE Primary Job of the BALUN is to prevent CMC from flowing on the **outside surface** of the coax shield . . .
- by presenting a high impedance path to CMC along the outer surface of the coax braid.
- This forces return current to flow **inside** of the coax,
- **thus maintaining the *Balance in Differential Current.****
- **The BALUN does not affect the Differential Current flowing inside of the coax.**

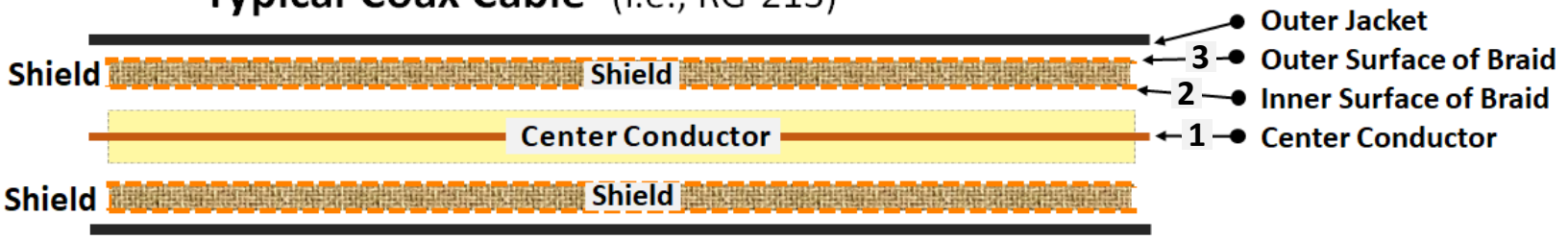
***This is the "Balance" that the BALUN is tasked with maintaining.
It is not attempting to balance the antenna!!!**

RF Current Flow in and on Coax

The drawing below has exaggerated spacing
to enable better viewing of its insides.

Cut-Away View of Coax Cable

Typical Coax Cable (i.e., RG-213)



Note: in this drawing, the spacing between the shield (braid) and the insulation around the center conductor is exaggerated; in real life the inner surface of the braid is touching the insulation around the center conductor. The outer jacket and the outer surface for the shield are also touching.

Drawing: DJ0IP

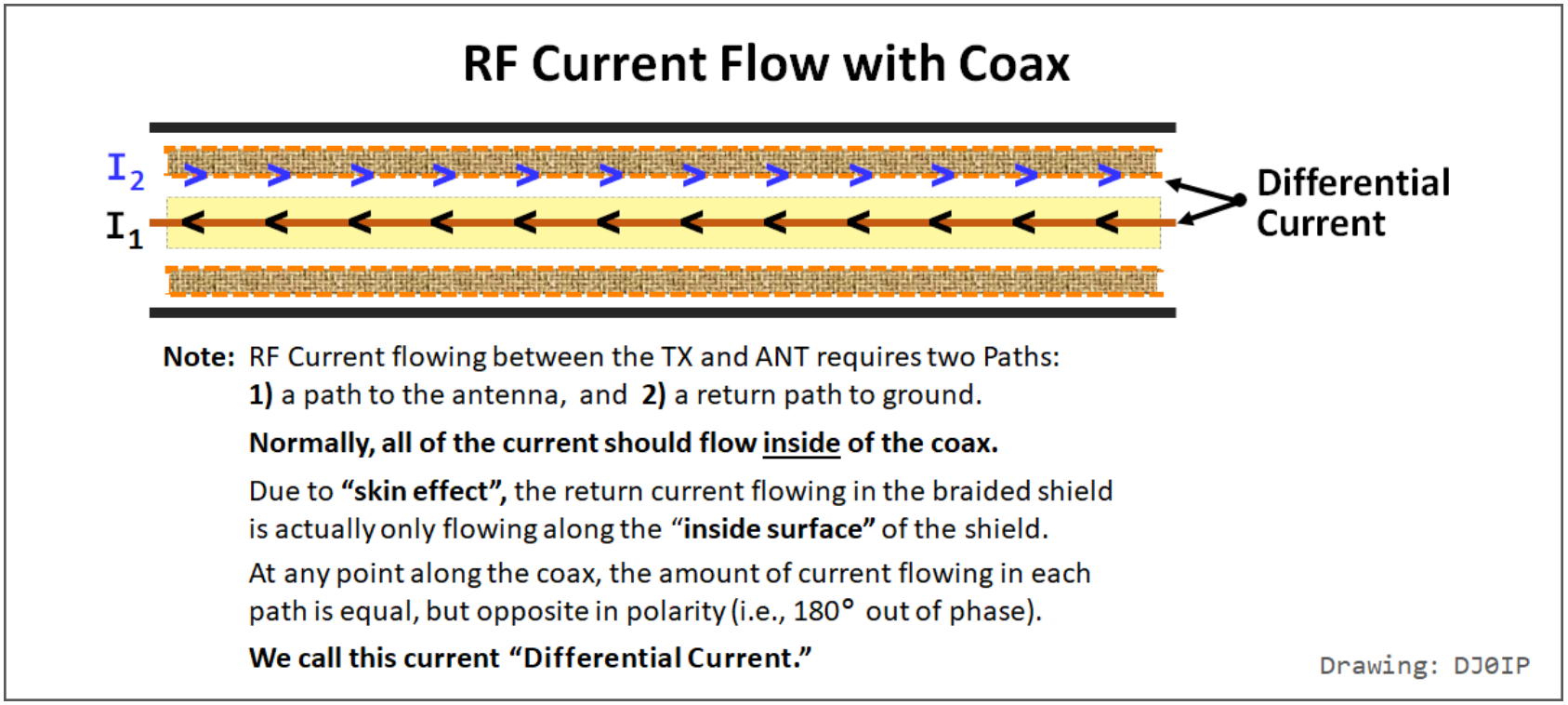
Although there are only 2 wires, *the Center Conductor and the Shield*, due to **Skin-Effect**, RF-Current sees the shield (braid) as 2 wires:

- the inner surface of the braid
- the outer surface of the braid

(Total: 3 Wires)

RF Current Flow in and on Coax

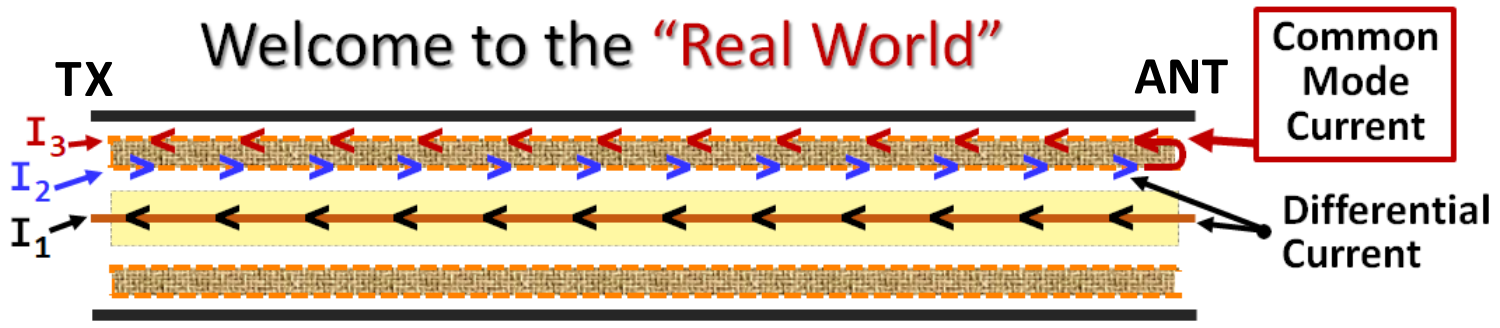
Again with exaggerated spacing:



In a "Perfect World", ALL RF current flows inside of the coax as "Differential Current", and no current is flowing on the outer surface of the coax shield. ***Unfortunately, it isn't always perfect.***

RF Current Flow in and on Coax

Remember, although the inner and outer surfaces of the shield are seen as two wires, they connect together at the antenna and at the transmitter - *where they are commonly grounded.*



Note: Due to skin effect, the inner surface and outer surface of the shield behave like two separate wires, both connected to one side of the antenna. Current returning to ground sees two return paths and attempts to split and take both paths.

The path along the outer surface of the coax shield is undesirable; when current flows there, many bad side-effects may occur.

Drawing: DJ0IP

As seen in drawing, part of the return current is attempting to use the outer surface of the coax shield as its return path. When this happens, $\mathbf{I_2}$ no longer equals $\mathbf{I_1}$, thus the Differential Current inside of the coax is no longer *in balance*.

If we do not find a way to block (impede) the flow of CMC along the outer surface of the coax, bad things will happen. See slides #15 & #16.

A Dipole Without A BALUN

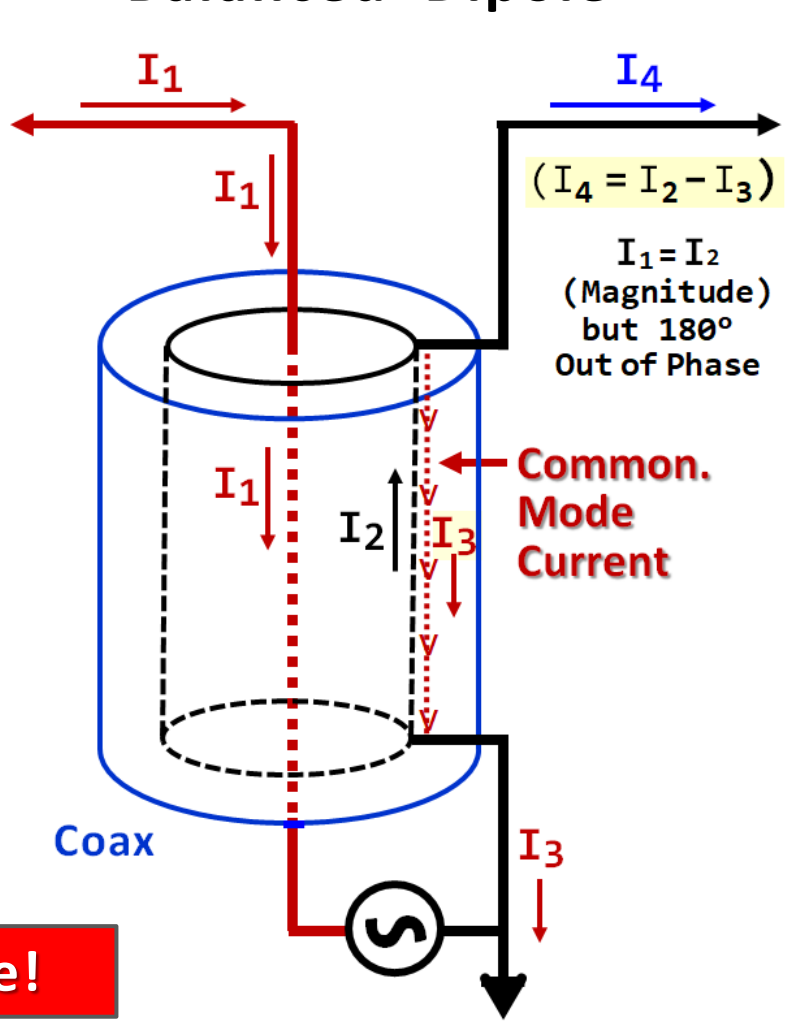
The TX generates RF Current and transfers it to the antenna as "Differential Current", **inside** of the unbalanced coax.

The inner and outer surfaces of the coax shield/braid are connected at both ends; the TX end is grounded.

Without a BALUN, when the RF reaches the antenna, part of I_2 flows into the dipole half, and part flows onto the outer surface of the shield, returning to ground.

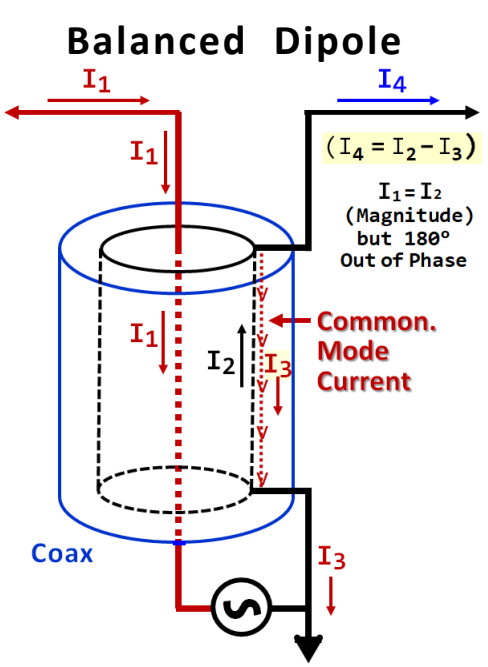
As a result, the outer surface of the coax becomes part of the antenna and radiates RF energy.

Worst Case: All Hell Breaks Loose!

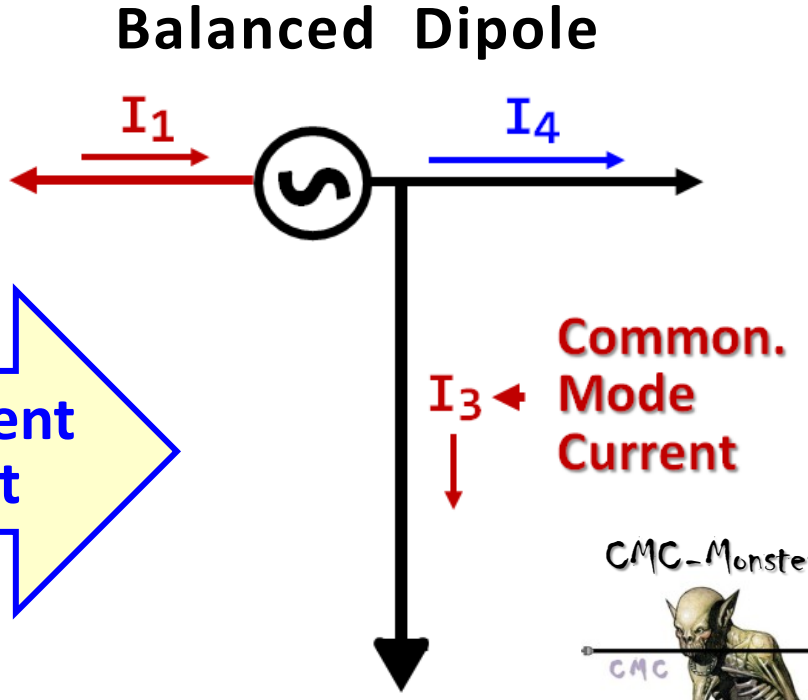


A Dipole Without A BALUN

. . . is actually a Tri-pole!



Equivalent Circuit



And the coax radiates all the way to the shack!

Other evil side-effects of CMC are listed on slides #15 & #16.

Now let's add a BALUN.

What a BALUN "is":

Although a BALUN is used between an Antenna and the Transmission Line, it is:

A "Transmission Line Accessory",

NOT an Antenna Accessory!

If you look up BALUNs in "THE ARRL HANDBOOK", You will find BALUNs listed in the chapter on "Transmission Lines", not in the Antenna chapter.

What a BALUN "Must Do"

(Repeat of Slide #5)

- THE Primary Job of the BALUN is to prevent CMC from flowing on the outside surface of the coax shield. . .
- by forcing return current to flow inside of the coax,
- ***thus maintaining the balance in Differential Current.***
- The BALUN accomplishes this by presenting a high impedance into the common mode path along the outer surface of the coax shield.
- This is usually achieved by using a coiled transmission line, wrapped around a Ferrite Toroid.
- A good BALUN also prevents distortion to the antenna's radiation pattern… but this is not a "must."

BALUN Facts

- A “good” [Choke] BALUN presents a high enough impedance to the outer surface of the shield of the coax to prevent the flow of Common Mode Current (CMC). Unfortunately, not all BALUNs are good.
- The amount of **C**ommon **M**ode **I**mpedance (CMI) of the BALUN depends of the number of turns of transmission line wrapped around the ferrite toroid, and the permeability of the ferrite mix used in the Toroid. It can vary from a few hundred to several thousand Ohms.
- The CMI increases with the amount of permeability of the ferrite mix, as well as with the number of turns of transmission line wrapped around the Toroid. (CMI increases with the square of the number of turns.)
- The amount of CMI required depends on the **C**ommon **M**ode **C**urrent (CMC) characteristics of the antenna, as well as the power level applied to the antenna. These differ significantly from antenna to antenna.
- Reflections from objects near the antenna can also increase CMC.

Importance of the Curie Point

- CMC flowing on the outer surface of the coax, as well as high SWR **will warm the Toroid.**
- As the Toroid's temperature increases, its magnetic characteristics begin to change, and **Losses Increase**.
- This also causes the SWR to slowly creep upwards.
- As the Curie Point is approached, the SWR creep increases rapidly and suddenly spikes upwards. **Losses Increase Rapidly.**
- Worst case, if the temperature remains above the Curie Point for a longer period of time, it can even crack the Ferrite in the Toroid.

- In General, Toroids with high permeability have a much lower Curie points than Toroids with low permeability.

Ferrite	Perm.	Curie
#31	1500	>130°
#43	800	>130°
#52	250	>250°
#61	125	>300°

That Evil Common Mode Current

Negative Effects of Common Mode Current:

- **The entire coax radiates RF power**, which may cause all sorts of problems with the consumer products in your house or the neighbor's house.
- RF burns to the lips from the mic and to the fingers from the Morse code key.
- CMC on the coax may **increase the noise level** on the receiver.
- You get **bogus readings** on an antenna analyzer.
- **The frequency of SWRmin skews *up the band*** (on the fundamental band).
  - Normally it only skews on the fundamental band, not on the higher harmonic bands. This is because the level of CMC is a magnitude greater on the fundamental band than on the harmonic bands.
    - (Source: **DJ0IP's 2013 CMC Test**)

That Evil Common Mode Current

Negative Effects of Common Mode Current (Continued)

- **The shape of the SWR curve** across the band **begins to flatten** with CMC, and its dip broadens out when the CMC increases.
  - This is one reason why many people believe the bandwidth of the OCFD is much broader than that of a common dipole!
- When measuring the SWR and other parameters, **if you touch the coax connector with your hand, the reading on the analyzer changes.**
- The **level of SWR** and other characteristics change noticeably with small changes in the length of coax between the transmitter and the antenna.
  - This is why some OCFD Antenna manufacturers specify certain lengths of coax to use, or lengths to avoid.
- **The radiation pattern of the antenna is distorted**
- **Power Loss in the BALUN !**

Part-1: Summary & Conclusion

- A BALUN is a “Transmission Line Accessory”, not an “Antenna Accessory”.
- Its Primary Task is to ***Maintain the ‘BALANCE’*** in Differential Current flowing **inside** of the Coax.
- It accomplishes this by presenting high enough **C**ommon **M**ode **I**mpedance to prevent RF (Return) Current from flowing along the **Outer Surface** of the Shield/Braid, back to ground.
- **Baluns with Insufficient CMI cause Problems:**
  - CMC flows on the outer surface of the coax.
  - This can reek havoc in the shack and neighborhood.
  - This warms the BALUN and **creates LOSS.**
  - It “can” cause the BALUN to burn up.
- The amount of CMI required depends on the Common Mode Current (CMC) characteristics of the antenna, the power level applied to the antenna, as well as the surrounding environment.

[END OF PART-1]

Contents: Part-2 Wrong/Bad Balun

- BAD BALUNs
- WRONG BALUNs
- Consequences of using Wrong Baluns
- RIGHT BALUNs
- About Balun OEMs
- BUYER BEWARE
- Buying instead of Building
- Part-2 Summary and Conclusions
- Recommended Resources

'Joe Ham'

BAD BALUNs

- BAD BALUNs are BALUNs which do not fulfil the **two primary tasks** of a BALUN:
  1. **Prevent CMC** from flowing on the outer surface of the coax braid/shield
  2. **Maintain a balance** in the Differential Current flowing inside of the coax.
- Good BALUNs used in the Wrong Application behave like BAD BALUNs.
- Most BALUN OEMs continue to sell Bad BALUNs along with their Good BALUNs. Shame on THEM!

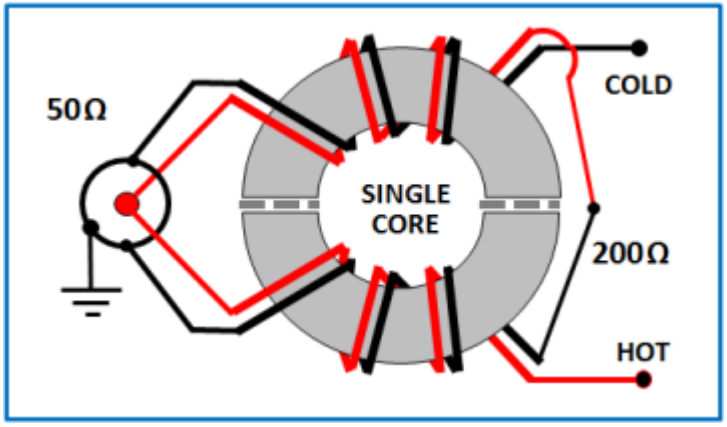
BAD BALUNs

- BALUNs wrapped with Enamel-Insulated Copper Wire.
  - Use of enamel-insulated wire is one of the most common causes of failure.
  - The insulation can quickly burn through in the presence of high voltage – which is caused by high SWR.

Any BALUN using Enamel Insulated Wire:

- 'Single-Core' 4:1 "Guanella (current) BALUN"
  - This has ZERO CMI!*
  - It actually *generates* CMC!
  - Yet is sold by many/most of the commercial BALUN OEMs.

Snake Oil:



This is 'just a transformer', not a BALUN!

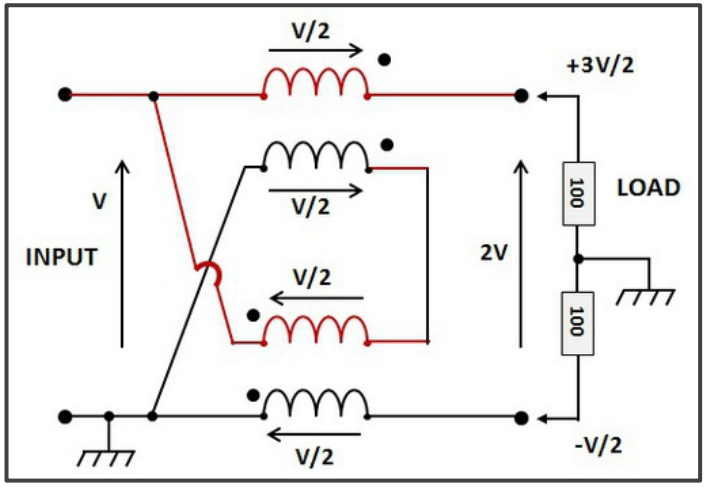
***Source: G3TXQ "Basic_baluns"**
http://www.karinya.net/g3txq/baluns/

BAD BALUNs

The Single-Core 4:1 Guanella (Current) BALUN:

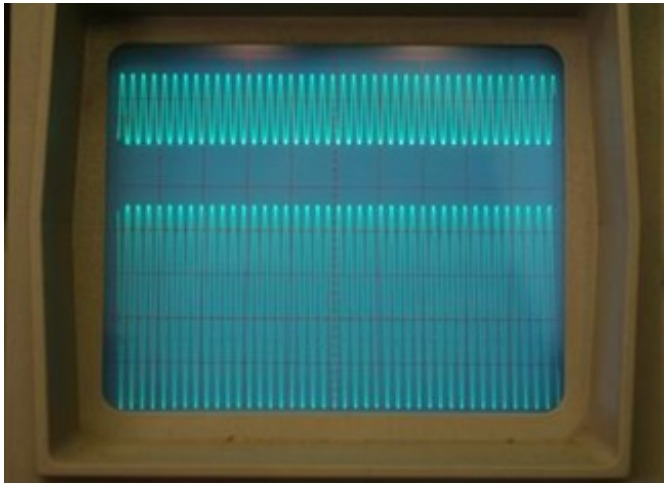
Steve Hunt, G3TXQ (SK): ***I like to refer to it as a "Voltage UnBalun".***

Mathematical Proof:



Source: G3TXQ

Lab Measurements:



The voltage on the top output terminal is 3x as great as the voltage on the lower output terminal. This is not balanced. Indeed it represents a 3:1 imbalance.

This screen shot shows the signals on the two output terminals. The lower is 3x as great as the upper. This NOT balanced; in fact it represents a 3:1 imbalance.

The Single-Core 4:1 Guanella (Current) Balun:

Steve Hunt, G3TXQ (SK) worked closely with me during my 2013 CMC Field Tests and gave me written permission to publish this data on my web. Here are his further comments:

According to Steve, G3TXQ:

*Because of Sevick's pre-occupation with differential-mode performance, he never spotted that effect. In fact he made lots of DM measurements - DM impedance, phase delays etc - but with a *floating* load; and as we all know, if you have a floating load you don't need a balun to maintain current balance :)*

*The simple fact is that a 4:1 Guanella balun wound as two 1:1 chokes on a common core will force voltage and current *imbalance* with any non-floating load; I don't call that "working" !*

For a 4:1 Guanella balun to "work" properly and drive equal currents into any load, the CM voltages of the two chokes must be able to take up different values; they can't do that if they share the same magnetic circuit.

BAD BALUNs

eham Forum QSO between Steve, G3TXQ and Tom, W8JI

RE: Baluns, antenna's, and W8JI DX Engineerings Articles
« **Reply #11 on:** July 31, 2011, 09:40:21 AM »

Quote from: G3TXQ on July 30, 2011, 03:14:16 PM

I paid the $20 dollar price - it's probably worth that, but it's by no means the "Holy Grail". There are some serious misunderstandings in the book - particularly the section on what drives common-mode current at the feedpoint of a dipole.

Steve G3TXQ

Note: The topic here is Sevick's book on BALUNs and UNUNs

Thank you Steve for pointing that out. That book has been accepted as the Holy Grail without question, even though it has some very serious errors.

W8JI
Member
Posts: 9748

One of the balun designs does not even work as a balun. It actually forces unbalance into the system!!!!

Logged

Source: https://www.eham.net/forum/view?id=topic=76625.0

Single-Core 4:1 Guanella

BAD BALUNs

Single Core 4:1 Current BALUN:

“This balun, that is not even a balun at all and forces unbalance into the system, **is actually sold by people.** The design even made it into a PalStar tuner I repaired for a friend of mine.

One thing that clearly shows [is that] Sevick did not understand common mode and the need for a balun is early in the book, where he talks about not needing a balun on a 20 meter dipole because the coax is small diameter compared to the wavelength. I think this is what led him to the flawed single core 4:1 current balun.

There are also errors about core flux levels and transmission line transformers, and that may have also contributed to the 4:1 non-balun balun.”

Tom, W8JI

https://www.eham.net/forum/view?id=topic=76625.0

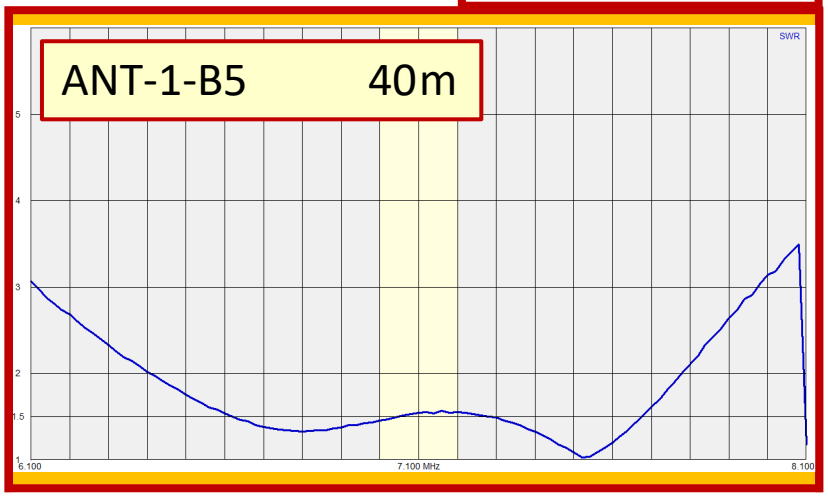
BAD BALUNS

Single-Core vs. Dual-Core 4:1 Guanella (Current) BALUN

DJ0IP's Field Test* of Common Mode Current (2013):

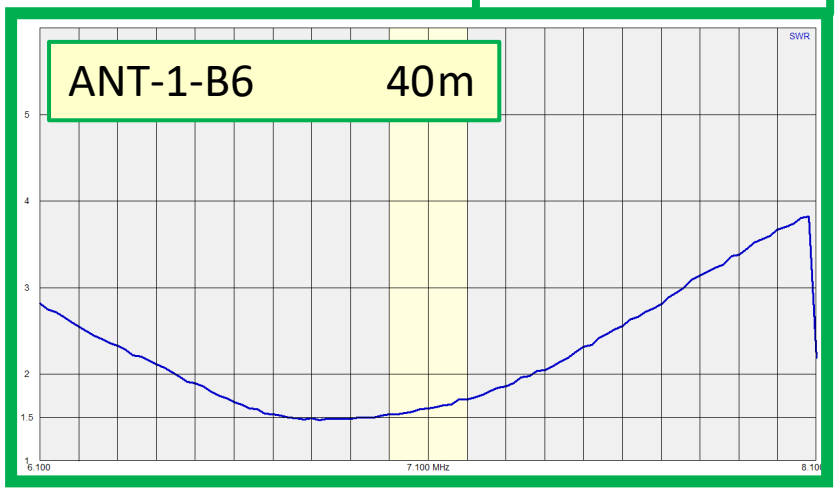
For this test I created a "worst case" scenario, forcing CMC into a 40m OCFD Antenna. I applied 100 Watts of power and measured the CMC at different points along the coax:

SINGLE - CORE **(CMC = 340mA)**



With the common (pervasive) single-core BALUN, the SWR curve was highly distorted.

DUAL - CORE **(CMC = 105mA)**



With the dual-core 4:1 Guanella BALUN, the SWR curve was just barely distorted.

*** Full Details:** https://www.dj0ip.de/cmc-test/

BAD BALUNs: (Single-Core 4:1 Guanella)

- Tom Rauch (W8JI) has flagged this on his web site **about 15 years ago.**
- Steve Hunt (G3TXQ) has shown proof that it does not work on his web site for about **10 years** now.
- I have personally confirmed this in my 2013 CMC Test on OCFD antennas.
- Unfortunately, most BALUN OEMs, even the ones with a good reputation, **are still selling this** Snake Oil!

By continuing to sell these "non-BALUN" transformer devices as BALUNs, and by promoting them as "OCFD BALUNs", these OEMs are doing Ham Radio a **DISSERVICE!**

Indeed, these OEMs are major contributors to the bad reputation the OCFD has gained over the years!

WRONG BALUNs

Which BALUN? The Choices are Many:

- Voltage
- Current
- Guanella
- Ruthroff
- Maxwell
- Hybrid

- 1:1
- 2:1
- 4:1
- 6:1
- 9:1
- XY:1

- Coax ?
- Bifilar ?
- Twisted Pair ?

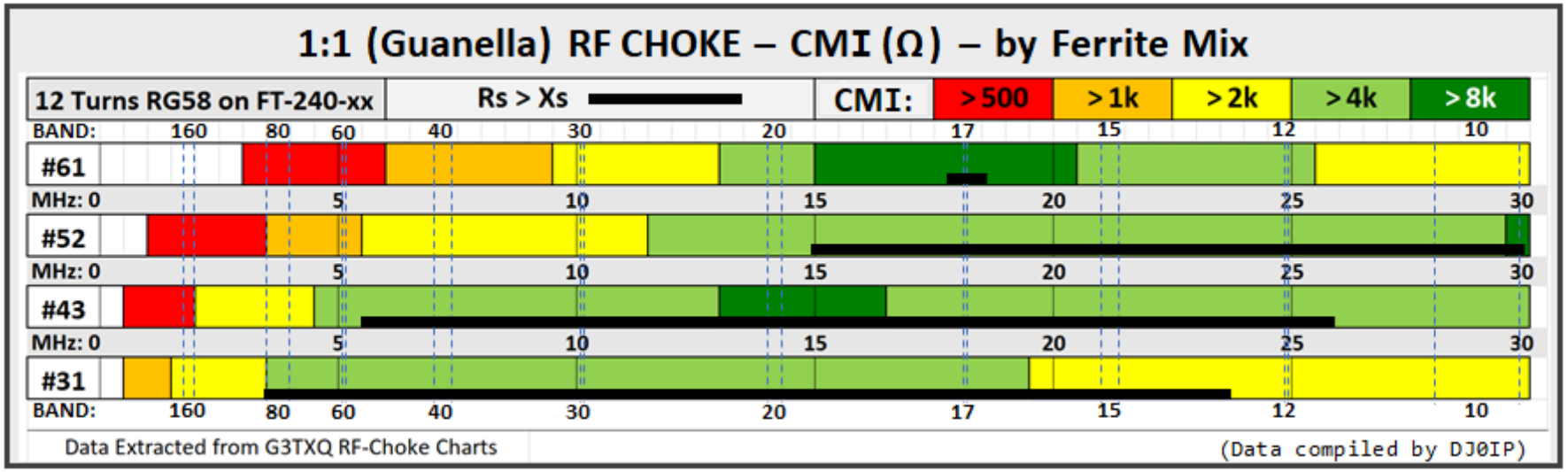
And that's not even all there is!

(I'll bet 'YOU' choose the wrong one!)

WRONG BALUNs

EXAMPLE: 1:1 Guanella Choke-BALUN:

- Which Toroid? What Size? Which Mix? Turns-Count?
- Should it use Coax, Bifilar, or Twisted-Pair?
- *How in the H€LL shall anyone know?**



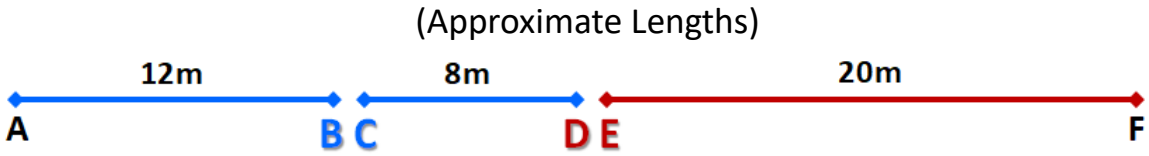
Choice of Ferrite Mix and Turns-Count make a HUGE Difference!

Unfortunately, BALUN OEMs do not usually disclose this information.

*One thing is for sure: the BALUN OEMs DO NOT KNOW EITHER!

Consequence of using the Wrong BALUN

80m λ/2 Dipole, AGL: 12m,
λ/2 RG-58, Fed at 29.7%



Balun →	B1	B3	B4	B5	B10	B12
Description	**DJ0IP d-i-y 1:1 Guanella** FT-240-43	**4:1 Guanella** Dual-Core 2x FT-240-52 Model 4115	**DJ0IP HP-Hybrid** 4:1 Ruthroff #61 1:1 Guanella #43 FT-**240**-## Cores	**DJ0IP d-i-y 4:1 Guanella** Dual-Core 2x FT-240-43	**DJ0IP LP-Hybrid** 4:1 Ruthroff #61 1:1 Guanella #43 FT-**114**-## Cores	**DJ0IP MP-Hybrid** 4:1 Ruthroff #61 1:1 Guanella #43 FT-**140**-## Cores
Approximate CMI (80m)	**8k Ω**	**500 Ω**	**8k Ω**	**1k Ω**	**8k Ω**	**8k Ω**
Configuration 1: B-C shorted; Balun at D-E (Standard Dipole)						
SWRmin at:	3.460 MHz	Before testing in the OCFD configuration, the antenna was tested as a standard dipole and the wire lengths were adjusted for the frequency at which minimum SWR occurs (SWRmin) to be 3.460 MHz- "ideal" for an 80m OCFD antenna.				
SWR:	1.44:1					
Resonance (jØ)	N/T					
Configuration 2: D-E shorted; Balun at B-C (OCFD)						
SWRmin at:	3.460 MHz	3.750 MHz	3.460 MHz	3.560 MHz	3.460 MHz	3.450 MHz
SWR:	1.94:1	1.47:1	1.50:1	1.20:1	1.52:1	1.48:1
Resonance (jØ)	N/T	3.670 MHz	3.430 MHz	3.535 MHz	3.450 MHz	3.425 MHz
	GOOD	TERRIBLE	EXCELLENT	BAD	EXCELLENT	EXCELLENT

N/T = Not Tested

Source: DJ0IP Battle of Baluns Field Test (2015/16)

Consequence of using the Wrong BALUN

- **B1** was inserted at the center of the dipole and also at the 29.7% offset feedpoint. In both cases the frequency at which minimum SWR occurred was the same: 3.460 MHz.
- **B4, B10, & B12** all incurred SWRmin at about 3.460 MHz, and exhibited none of the evil side effects listed in slides #15 & #16.
- **B5** is inadequate for this antenna. It is allowing CMC to flow, thus creating a "Tri-pole" with radiating coax; and the frequency of SWRmin has skewed up the band by 100 kHz.
- **B3 is terrible for this antenna; much worse than B5.** It has caused SWRmin to skew 300 kHz up the band.
- In addition, both B3 and B5 were plagued by several of the evil side-effects caused by CMC (as listed on pages #15 & #16).
- The poor performance of B5 and especially B3 caused me to abandon the 4:1 Guanella design and develop a BALUN with significantly more Common Mode Impedance.
  - The "DJ0IP Hybrid BALUN" is completely different than the Hybrid BALUN by ZS1AN, as described by G3TXQ in his paper "Basic_baluns".

Consequences of Using the Wrong Baluns

- A "good" BALUN in some applications (i.e, Folded Dipole), may be a "bad" BALUN in other applications (i.e., OCFD).
  - **Thus, it is the Wrong BALUN.**
- A Wrong BALUN can be just as bad as using a Bad BALUN.
  - Thus, it can lead to all of the negatives pointed out in Part-1 of this presentation. (Slides #15 & #16)
  - **B3** is a good quality dual-core 4:1 BALUN, adequate for antennas with light CMC issues (i.e., Loops or Folded Dipoles), **but very poor in OCFD's.**

Unfortunately, the Balun OEMs, even those with an excellent reputation, *are clueless* about BALUNs for OCFD antennas.

- with one "possible" exception (in California)

They continue to sell inferior OCFD BALUNs to their customers. ☹

2 Ways to wind a 1:1 Guanella BALUN

17-turn Toriod Winding

13-turn (cross-wound) "W1JR"

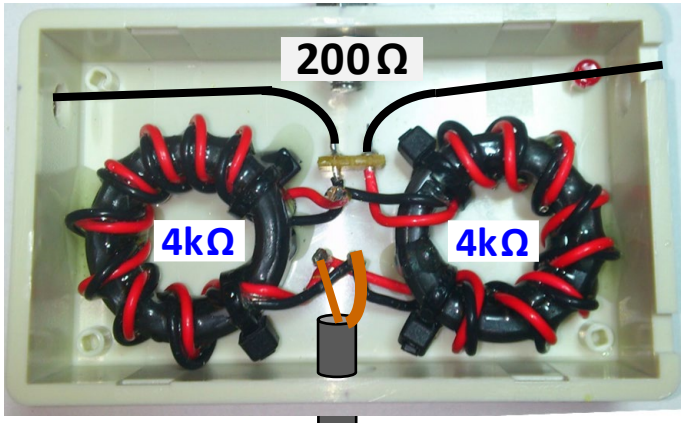
Except for the turns-count, these are electrically about the same. Which one you choose depends on whether you want both ends of the coax to exit on the same or opposite sides.

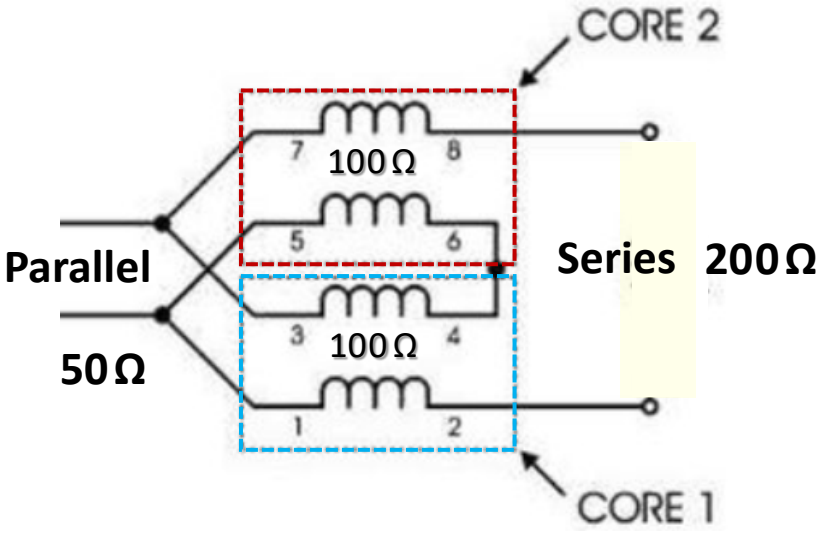
'Anyone' (even 'YOU') can wind a 1:1 Guanella Choke/BALUN

As long as you choose the right 'Ferrite Mix' and 'Turns-Count'.

RIGHT BALUNs

What about 4:1 Guanella BALUNs? "Dual-Core" of Course!





- Built from 2x 1:1 Guanella
- Twisted Pair = 100Ω
- Inputs are in Parallel = 50Ω
- Outputs are in Series = 200Ω
- 4:1 Transformer Balun

Good general purpose 4:1 BALUN for use in antennas with only light CMC issues (i.e., Loops, Folded Dipoles).

- Effectively, their inductors are in parallel.
- Thus, the impedance is only ½ as much as the impedance of each individual coil.
- **Thus, the CMI is only ½ as much as the CMI of a 1:1 Guanella !!!**

This BALUN is insufficient for use in OCFD antennas with feed points far removed from the center. You must use an additional 1:1 Guanella Choke with it.

About BALUN OEM's

- Most BALUN OEM's:
  - Have a broad portfolio of different models of BALUNs,
  - Build good quality BALUNs (in general),
  - But, unfortunately they do not understand the unique CMC issues plaguing the OCFD antenna.
    - Thus, the BALUNs they offer for OCFD antennas are insufficient for the job and require an additional Choke.
- Unfortunately, many of these "good" OEMs are still offering Single-Core 4:1 Guanella "devices".
  - This makes me wonder if they even understand BALUN technology at all?
    - And if they even know what a BALUN **must do**?

BUYER BEWARE!

- As we have seen in Part-2, BALUN Technology is very complex.
- The challenge is matching the CMC characteristics of the antenna to the CMI characteristics of the BALUN.
- Do not rely on the BALUN OEM, nor the local Ham Shop salesman to always give correct advice.
  - When you telephone with a reputable Ham Shop, you don't know if the salesman on the telephone is knowledgeable, or a new-hire, just a few weeks on the job.
- When a salesman recommends a specific BALUN, **ask him why**.
  - If his answer is "that's what most people buy", **hang up the phone.** Most people know nothing about Baluns, and obviously, he doesn't either.

BUYER BEWARE! (continued)

- BALUN OEMs like to advertise their products, (example) as "Good for 160m thru 6m @3 kW"
  - The only way to obtain this bandwidth and power rating is to use low permeability cores and low turn-counts, which results in very low CMI.
  - Rarely does an antenna project cover 160m thru 6m.
    - Broad bandwidth may not even be a requirement.
    - High CMI might be.
  - OCFD antennas for 80m or 160m have heavy CMC issues and require high CMI, especially on their fundamental frequency.
    - This is where these broadband BALUNs have their worst CMI!
    - **BUYER BEWARE!**
- If a Balun OEM is selling 4:1 Guanella BALUNs **built on a single core** (or 2 cores stacked, as if they are one thick Toroid), this is a clear sign that this OEM does not understand BALUN technology! **BUYER BEWARE!**

Buying Instead of Building

- It is understandable that not every OM/YL is comfortable with building his/her own BALUN.
- It is perfectly OK to buy many types of Baluns from most any BALUN OEM.
- But, you MUST watch out for three BALUNs to avoid:
  1. BALUNs using enamel-insulated wire (BAD)
  2. Single-Core 4:1 Guanella BALUNs (VERY BAD!)
     - Snake Oil! . . . but OEMs sell them!

     And if it is for an OCFD Antenna:
  3. Broadband Baluns from 160m thru 6m
     - These cannot possibly have enough CMI for an 80m or 160m OCFD! Might *possibly* work for a 40m OCFD.

Part-2 Summary and Conclusions

- The market is full of Bad BALUNs and Wrong BALUNs.
- 'YOU' must understand the specific CMI needs of the antenna you intend to buy/build.
- Do your own due diligence before you buy or build.
  - See next slide.
- Never ask advice from someone trying to sell you something!
- Old rules of thumb (*the BALUN must have 10x the CMI as the impedance of the antenna*) are just that: **Old (and Outdated).**
  - The world has changed since that rule was created.
  - And, that rule applied to antennas with low inherent CMC issues, such as the simple dipole or loop antenna.
  - Other antennas (i.e., OCFD) require much higher CMI depending on their fundamental band, feedpoint offset, height above ground, and objects in the near vicinity.

Recommended Resources

Reading:

- W7EL - Roy LeWallen's article: Baluns: What they Do And How They Do It
- G3TXQ - Steve Hunt's article: Basic_baluns
- K9YC - Jim Brown's article: A New Choke Cookbook for the 160–10M Bands

VK1OD's Web Site:

Theme Page Baluns: https://owenduffy.net/balun/index.htm

For OCFD Antennas:

Join the OCFD Group in Groups.io: https://groups.io/g/ocfd


P0RKY
"That's all Folks!"