Practical Applications of Camouflage Antennas

Agent Q's answer to HOAs also know as S.P.E.C.T.R.E.

(Special Product Engineering for Covert Transmit Receive Electromagnetics)

Antenna Project Goals

- VHF/UHF Dual Band
- Maximum gain on each band for increased ERP
- Slimline design that can easily be routed up through tree branches without getting hung up
- Durable antenna, all weather, mechanically strong
- Antenna to be hung from a high tree branch
- Coax cable would be supported by the hanging rope and not the antenna body
- Antenna would NOT be visible from the front of the house

CAMOFLAGE

Starting Antenna

- Diamond X300
- Dual Band
- 2 meters
- 70 cm
- White fiberglass
- Counterpoise (optional)
  - VSWR was the same with or without

Here is the tree…

120 foot tall Tulip Poplar

Original Peak Location

Too close to the tree trunk

Original White Color

Base of antenna is 75 feet above ground

Type N vs UHF PL-259 - Mechanical

- Type N Pros
  - Watertight connector
  - 50 Ohm for minimal loss

Type N Cons

- Center conductor pin slides in Teflon insulator – not captured
- Cable is held by shield wires via clamp – medium pull strength
- Avoid crimp connector types when good mechanical strength is needed
- Higher connector cost

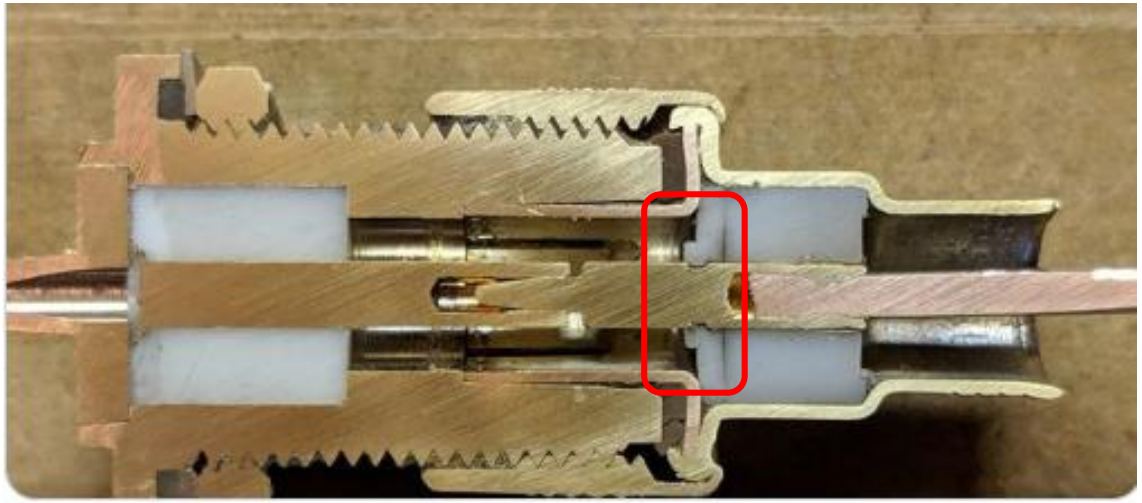
- PL-259 Pros
  - Center pin is molded into the connector insulator
  - Center conductor is soldered into center pin for good mechanical strength
  - Outer conductor threads into the coax jacket for very good linear strength
  - Low cost connector

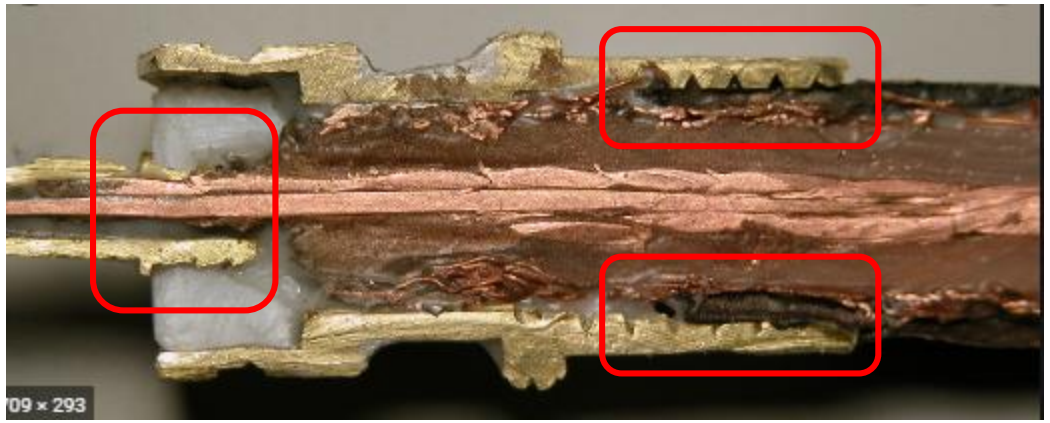
PL-259 Cons

- Requires additional waterproofing
- Not a 50 Ohm connector
- Avoid crimp connector types when good mechanical strength is needed

This is what happens when 75 feet of LMR400 is suspended from a Type N Male connector

Cross section of Type N and PL 259 connectors

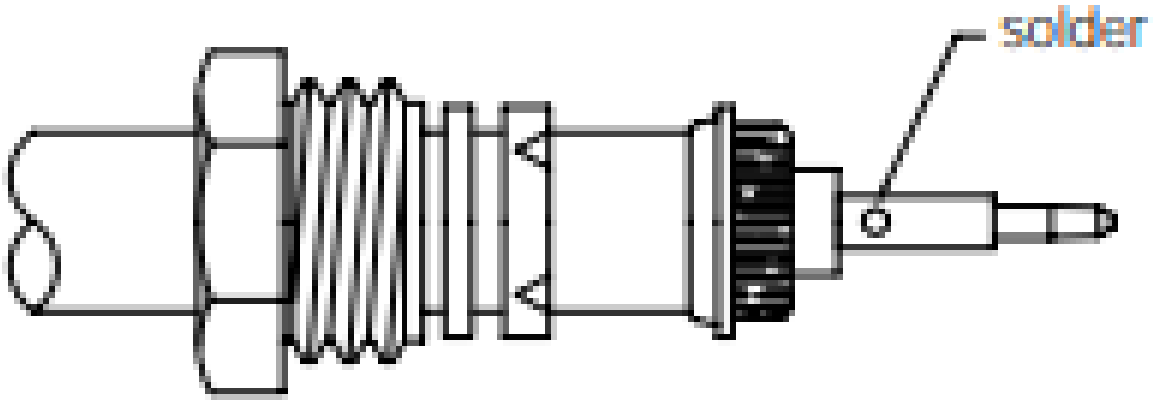




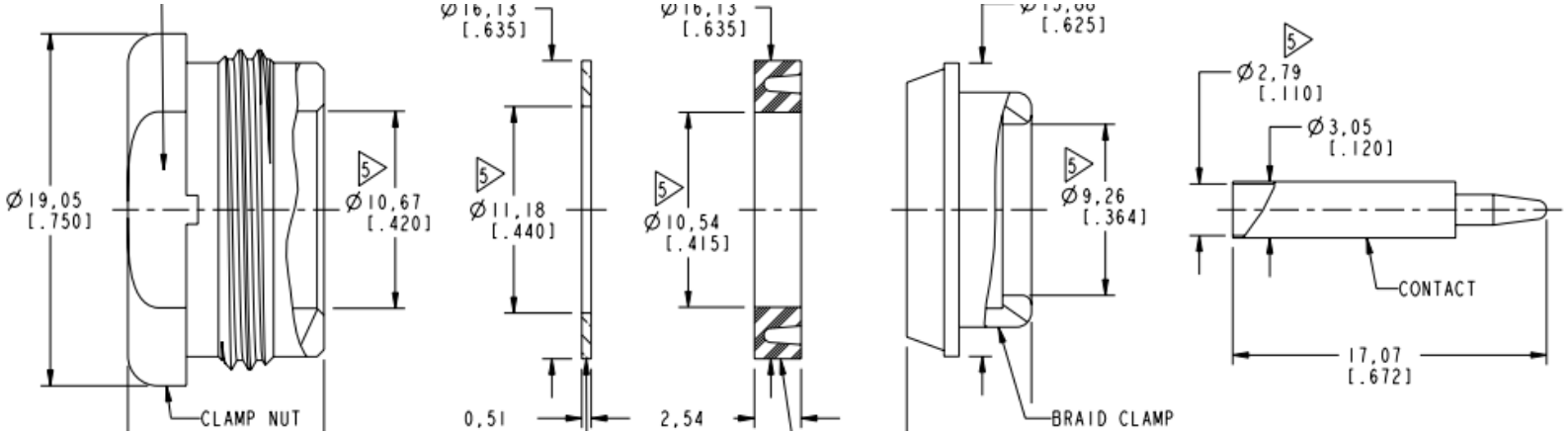
Note the areas highlighted in red.

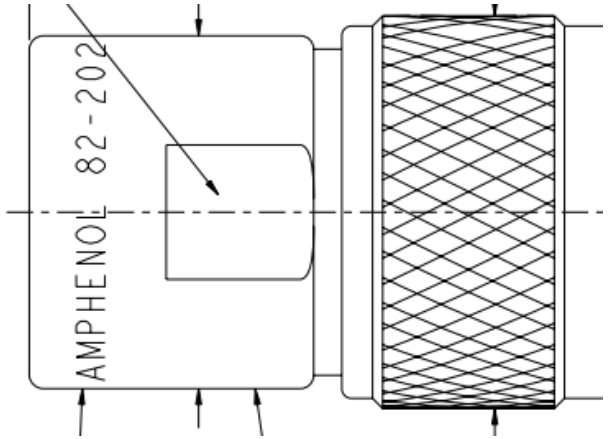
- For Type N – this is mainly for centering the pin at the correct depth
- For PL-259 – note that there are several barbs and threads that grab the coaxial cable conductor and jacket

Amphenol Type N Male Connector



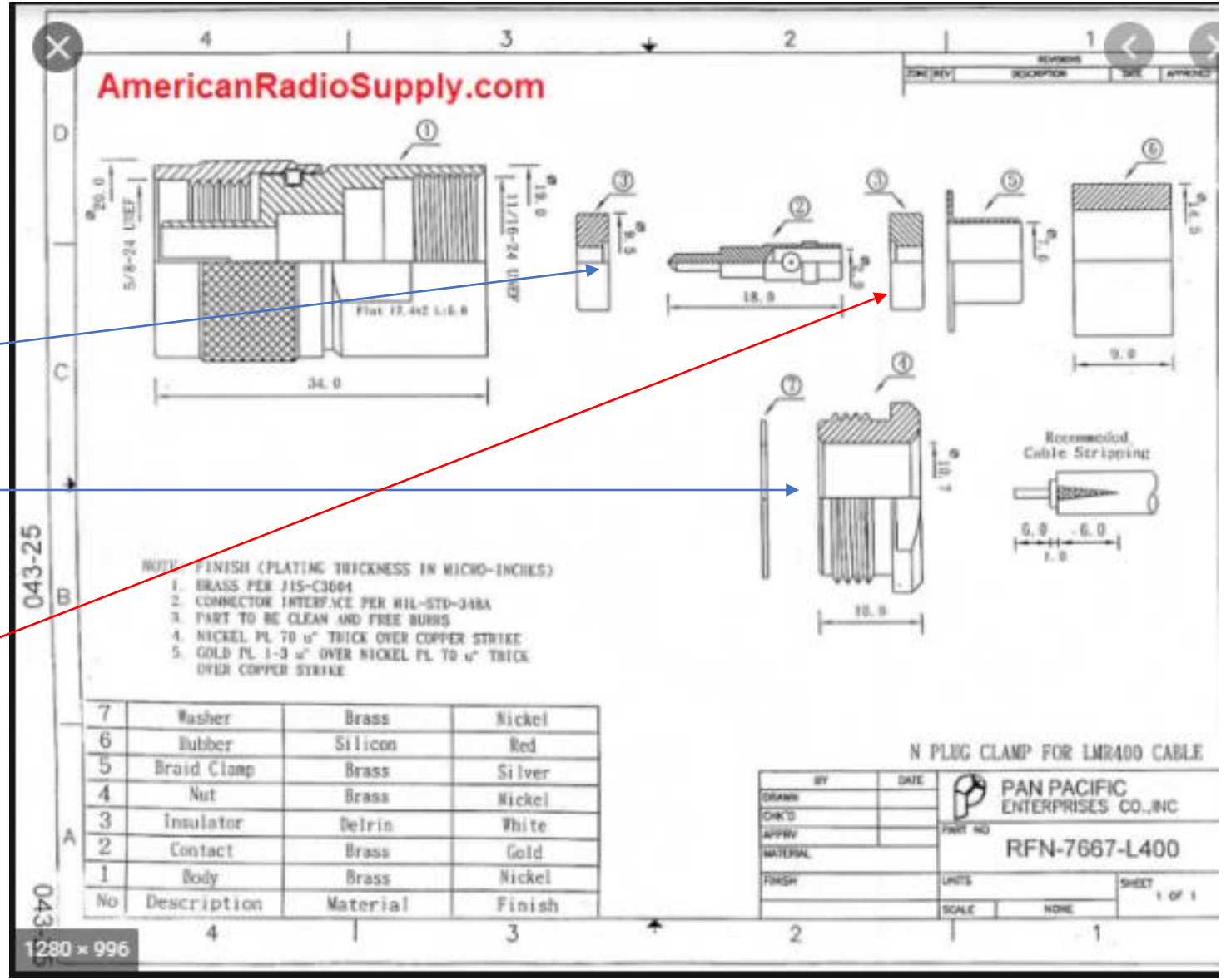
- Exploded View
  - The male center conductor pin has a smooth surface that does not “grab” the interior of the center insulator. Therefore it is easy to pull out





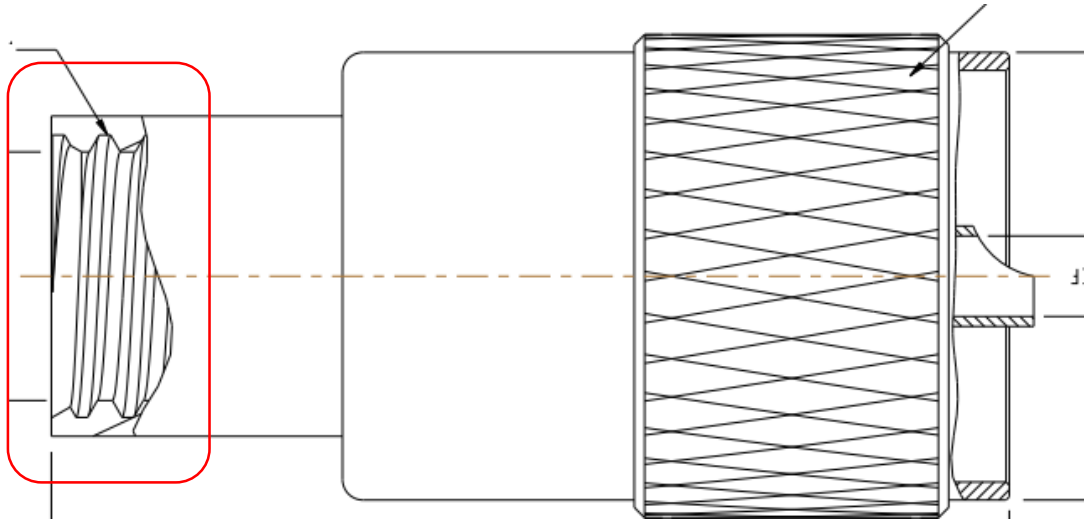
Type N with Clamp

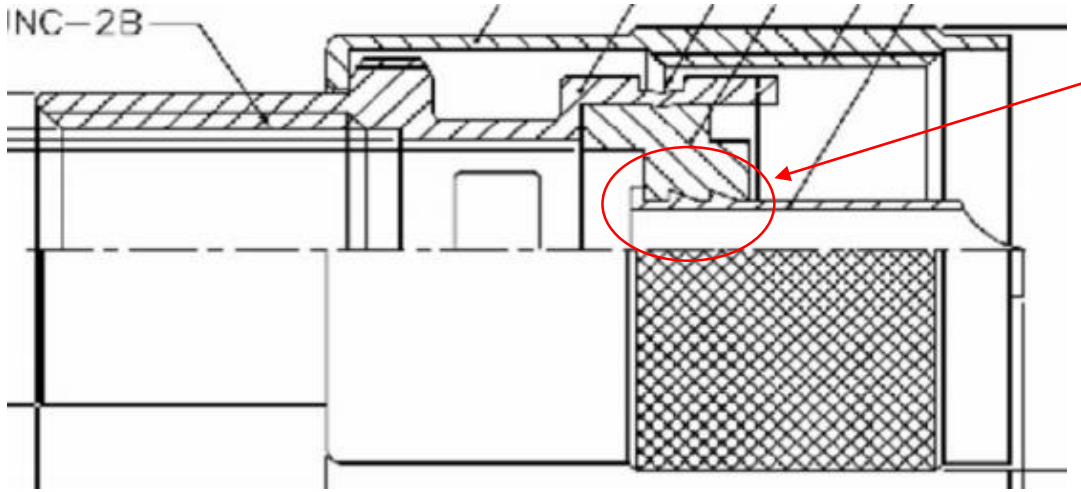
- Center pin can pull out of insulator
- Clamp Nut compresses the braid against the inside of the connector body but what is to prevent the braid from slipping out?
- With this design, there is an extra insulator which should provide additional pull strength but this is not included in most Type N connector models



PL-259 Connector Cross-Section

Inside of outer conductor is threaded and grips into the coaxial cable jacket for additional pull strength as well as limited weather sealing

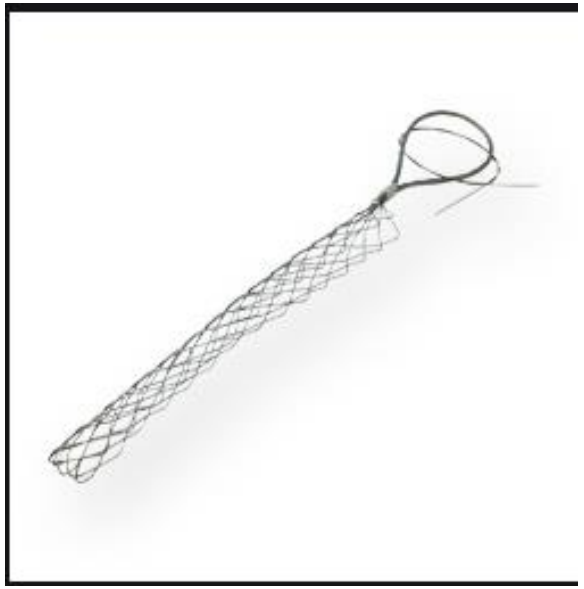




Note the barbs of the center conductor as they grab the center insulator

Support features

- Antenna supported throughout the antenna length by a separate rope
  - One rope at the top, two ropes going down to separate supports; antenna and coax
- Coax supported by a hose clamp
- Better approach is to use this special coaxial cable clamp (Chinese finger trap design)



Standalone Antenna Support

Top | Bottom | Middle

Camoflage Paints

- Krylon and Rust-Oleum
- Ultra Flat spray paint
- Other helpful colors
  - Rust-Oleum Flat Brown
    - 338947 enamel
  - Krylon Matte Deep Gray
    - 5550
- Color match the tree bark
  - Bark is not one color but several shades

Let the Painting Begin!

- Hanging the antenna horizontally above the ground so it can be easily rotated throughout the painting process
- Once the paint is dried, then the rope is moved to finish painting the last white sections

Rotate, Then Paint Some More

Almost Done. Starting to Blend In

Finished Horizontal Painting

Transition and Touch Up

- From left to right the first view after horizontal painting
- Then some touch-up with dark gray
- Followed by touch-up with flat brown enamel

Final touch-up to match the tree

- Pulled up the top end and looked edge-wise on the antenna with the tree in the background
- Added some more color in the right areas

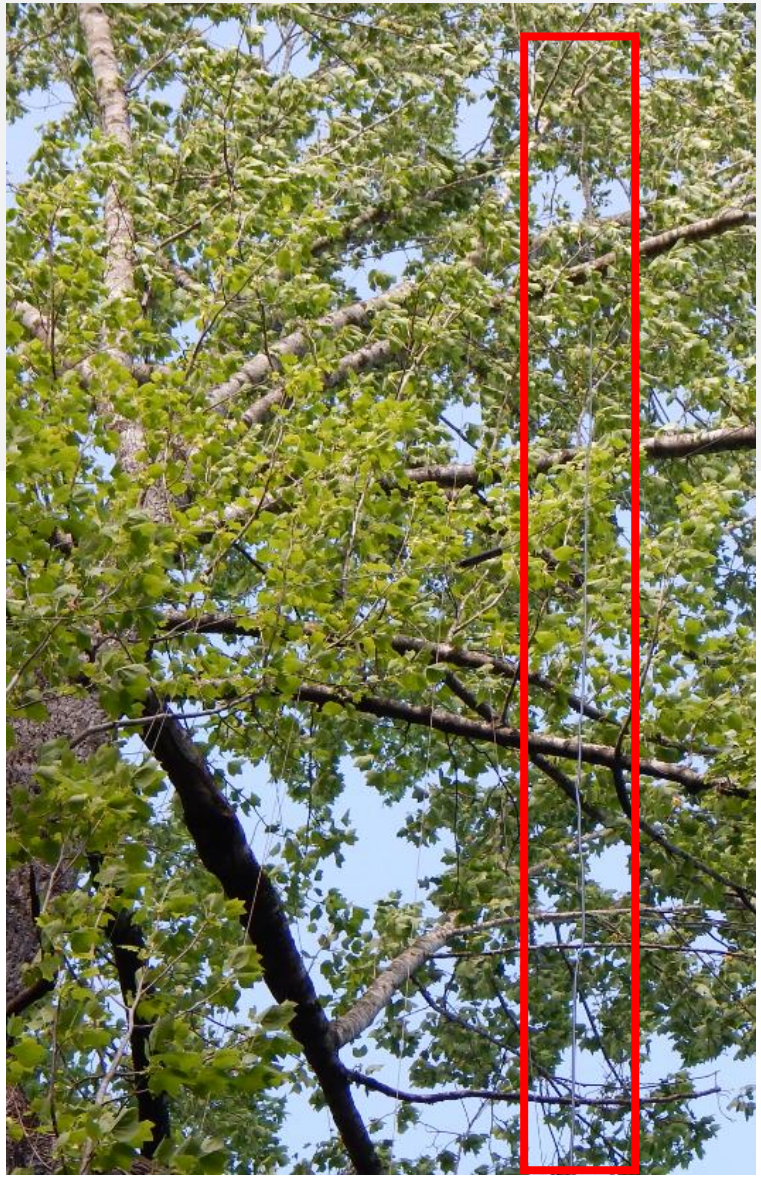
Finished product against the tree trunk

New Location is farther away from the main tree shaft

- Another rope is hanging over a 90 foot high branch away from the center of the tree (green oval)
- Less shadowing of the antenna pattern by the main tree shaft compared to the previous location (red box)

Close Up Shots New Location

- Coax is somewhat visible in the left picture
- Antenna is clearly away from the main tree shaft
- Camo antenna disappears in the tree!!!



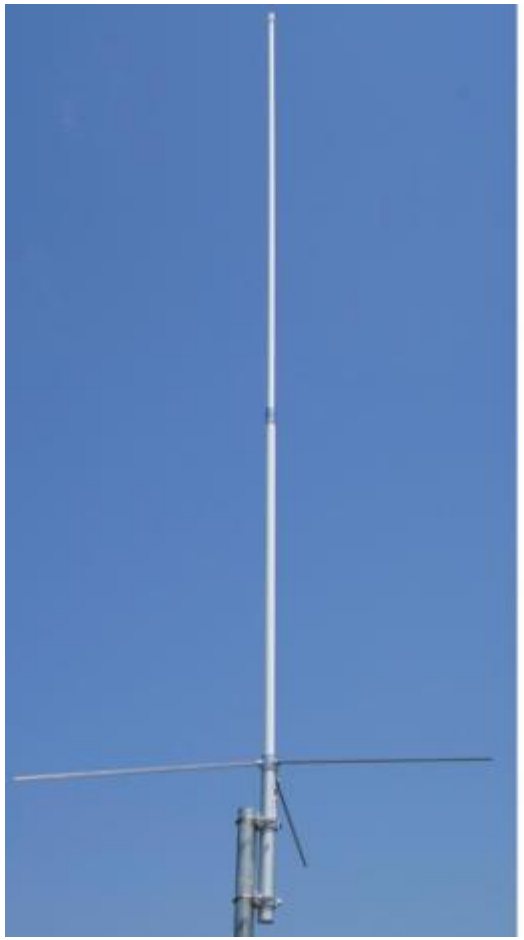
Close-Up

Antenna blends in

Close-Up Views

Other Antenna Ideas

- Diamond 7900A
  - Base mates with UHF Female
- Tram Model 1480 ($50 from Home Depot)
  - Design is similar to the Diamond X300
  - Radials may just be a counterpoise for de-coupling the antenna from the coax and could be removed to fit up in a tree



Know Your Coax

Know Your Coax – Not all RG8 is the same

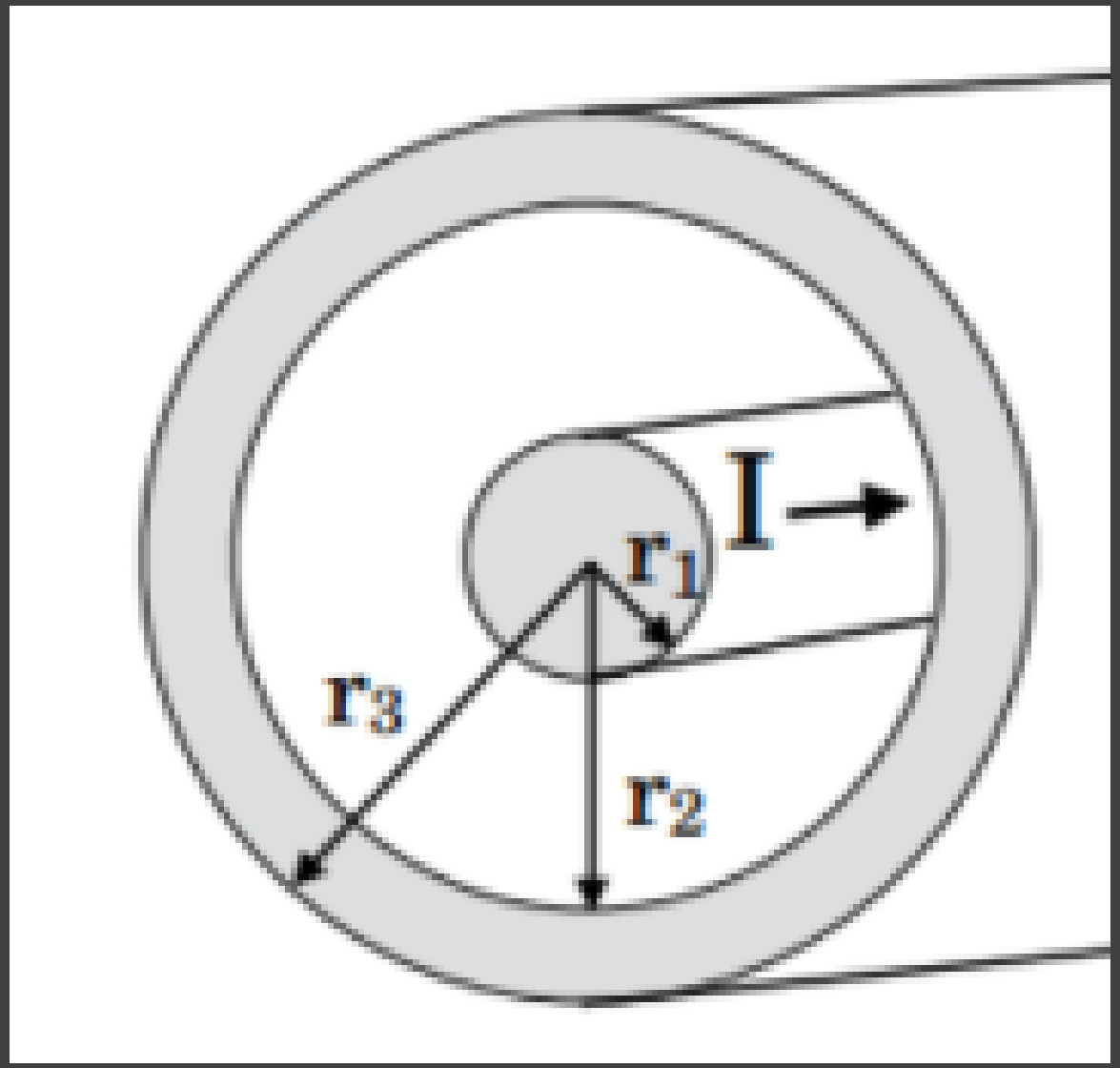
- The same is true for other coax “types”; RG8X, LMR400…
- Some key attributes that affect the RF/electrical performance:
  - Dielectric type – some have more loss than others
    - Air, Teflon, Foam, Polyethylene
  - Shield type and percentage of coverage for flexible types
    - Low grade coax has a coverage from 60 to 80% braid shield
    - Better grade coax have 95% braided coverage
    - The best coax have multiple shields providing 100% coverage
      - Some use 100% aluminum foil wrapped by tinned-copper braid
  - Center Conductor
    - Single conductor vs multi-stranded center conductor
  - RF performance vs Frequency

Mechanical and Environment Differences

- Water is the main enemy of coaxial cable
- Jacket types
  - Some are direct burial, others are not
  - Some can handle UV light, others degrade quickly, get brittle and crack
  - Some are submersible in water
- Center conductors
  - Solid (more stiff) vs Stranded (more flexible)
- Bend radius
  - This is the minimum radius required to maintain the advertised impedance. Sharp bends can change the impedance at that point and cause system loss due to reflections

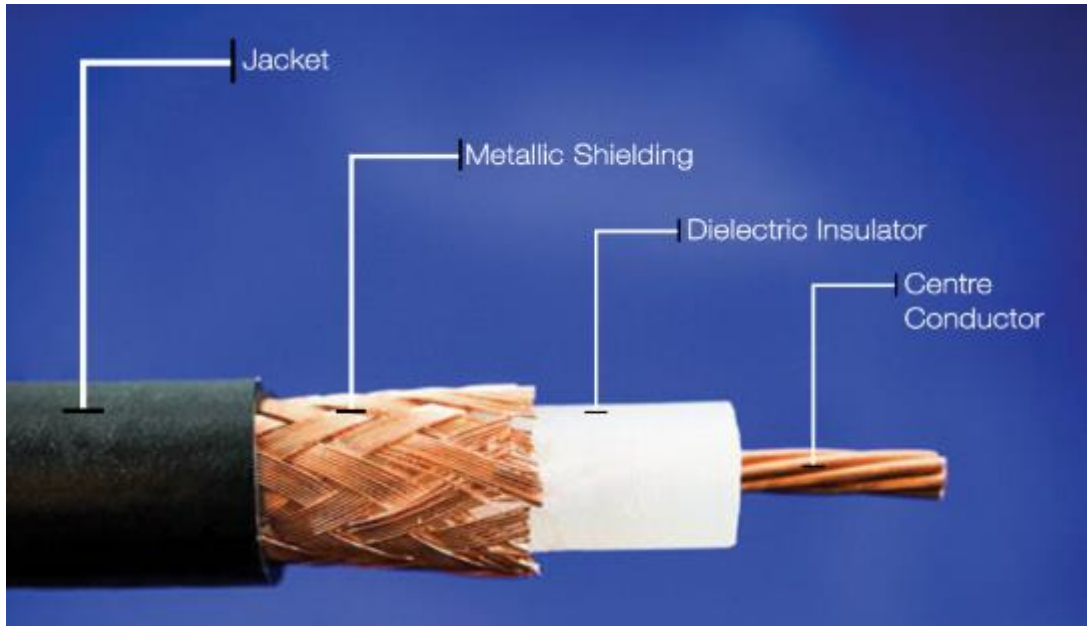
RF Performance vs Frequency

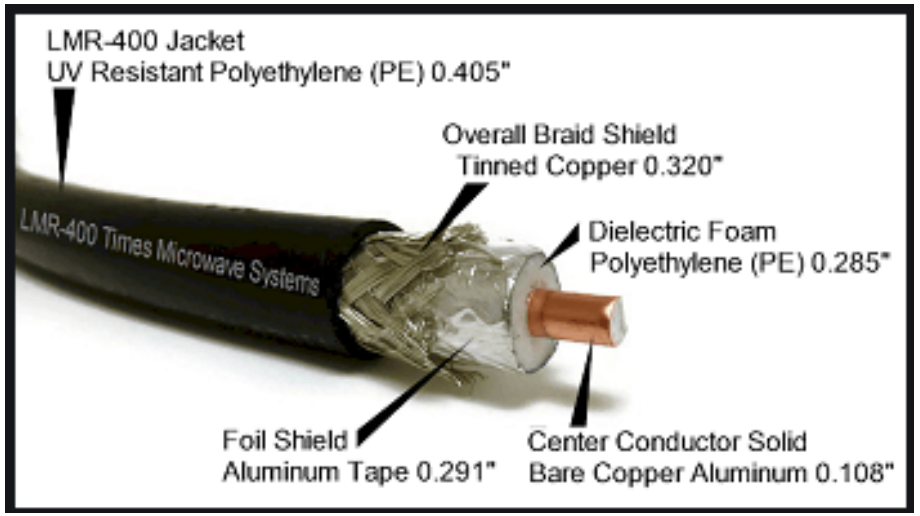
- Most RG8 and some RG8X cables are fine for HF frequencies (30 MHz and below) but bad for VHF and HORRIBLE for UHF and higher
- For LMR type cables, solid center conductors have less loss than stranded because the inner conductor/outer conductor ratio is more consistent



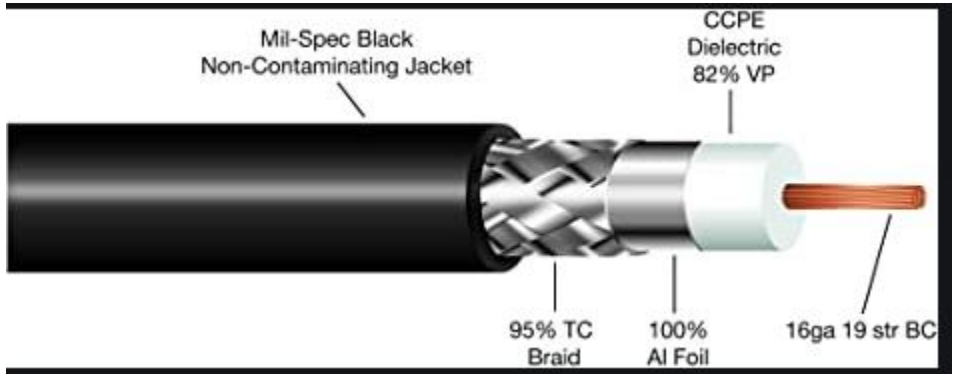
Various Dielectrics and Jacket Coverage

Typical RG8





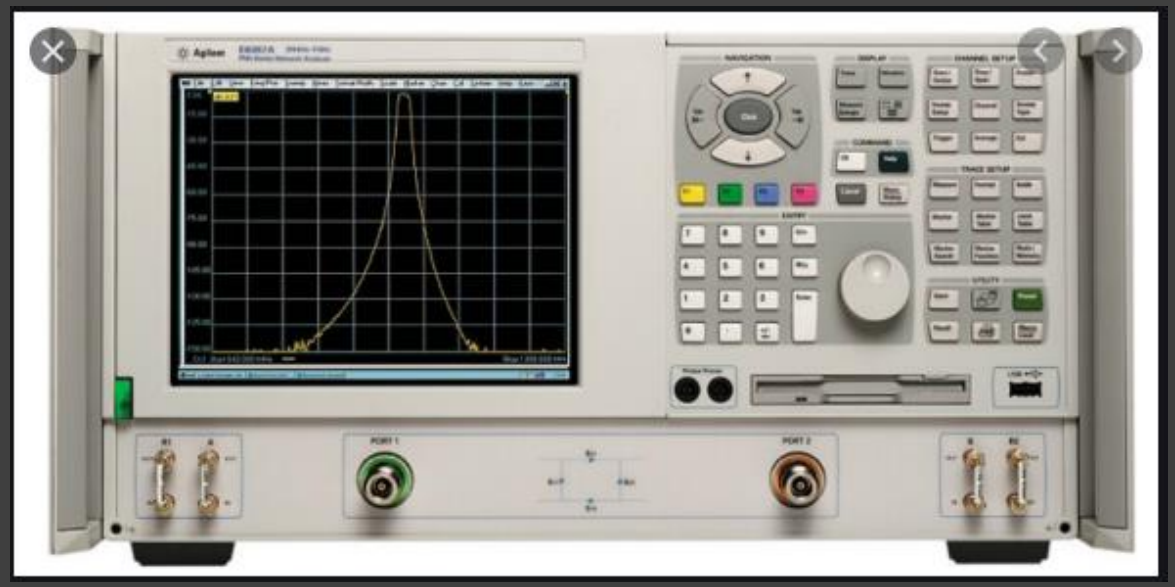
ABR Industries RG8X



Similar dielectric to 9913

S Parameters

- Maybe you have seen references to “S Parameters”? What do they mean?
- Refer to the Vector Network Analyzer shown
  - Port 1
  - Port 2
  - Each port can be configured to either be an RF source (TX) or a Receiver (RX)
- S Parameters – the numbers refer to the port of the VNA and the path of the Source-to-Receiver
  - S11 (VSWR or Return Loss to/from Port 1)
  - S12 (Path Loss from Port 1 to Port 2)
  - S21 (Path Loss from Port 2 to Port 1)
  - S22 (VSWR or Return Loss to/from Port 2)

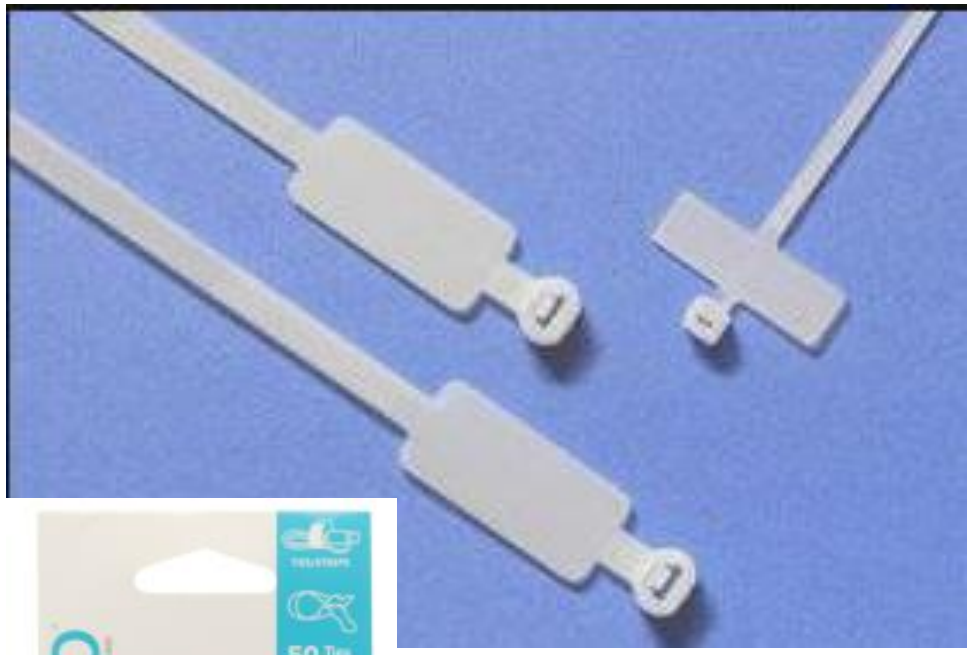


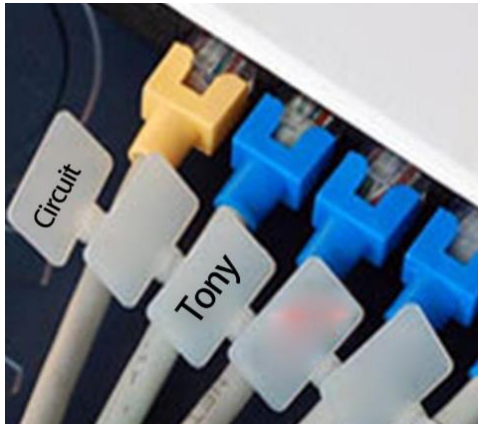
Cataloging Your Coax Jumpers

- Test the following:
  - Continuity from center conductor to center conductor on each end
  - Short circuit from center conductor to the shield
    - Static (not moving)
    - Dynamic (while moving the coax behind the connector)
  - VSWR (Return loss or S11/S22)
    - Must have a good 50 non-reactive dummy load on the opposite end of the coax
    - Static
    - Dynamic
  - Cable Loss (from end to end)

Labeling and Harnessing Methods

- Need to use method that does not wash off or peel off
- Zip ties with marker space
- Wire marker labels; self adhesive
- Velcro Thin Ties
- There are many other methods





Measuring Cable Loss

Step 1

Input Power to Coax

Step 2

Output Power to Load

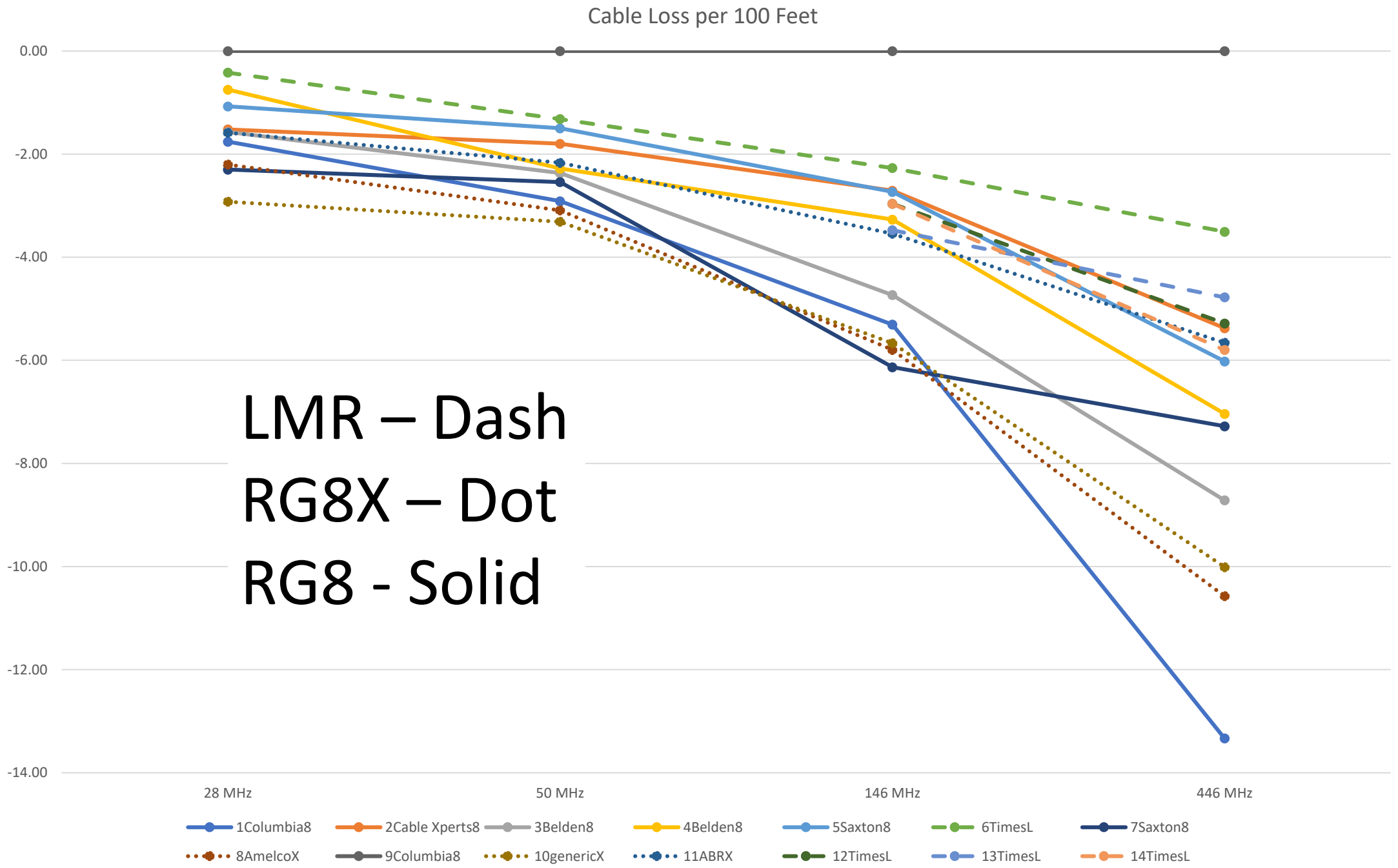
Jumper Cable Inventory – Raw Data

H4 =10*LOG(G4/F4)

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q
1	Coaxial Cable Inventory and Measurements																
2						28 MHz			50 MHz			146 MHz			446 MHz		
3	Cable #	Type	Vendor	Type Abbr	Length (ft)	Input	Output	Loss	Input	Output	Loss	Input	Output	Loss	Input	Output	Loss
4	1	RG8	Columbia	8	75	84	62	-1.32	86	52	-2.18	10	4	-3.98	10	1	-10.00
5	2	RG8	Cable Xperts	8	44	84	72	-0.67	84	70	-0.79	10	7.6	-1.19	10	5.8	-2.37
6	3	8237 RG8	Belden	8	60	82	66	-0.94	86	62	-1.42	10	5.2	-2.84	10	3	-5.23
7	4	8237 RG8	Belden	8	29	82	78	-0.22	85	73	-0.66	10.2	8.2	-0.95	9.6	6	-2.04
8	5	RG8	Saxton	8	50	86	76	-0.54	82	69	-0.75	10	7.3	-1.37	10	5	-3.01
9	6	LMR400	Times	L	25	84	82	-0.10	82	76	-0.33	9.8	8.6	-0.57	9.3	7.6	-0.88
10	7	RG8	Saxton	8	18	88	80	-0.41	80	72	-0.46	9.8	7.6	-1.10	9.6	7.1	-1.31
11	8	RG8X	Amelco	X	64	83	60	-1.41	82	52	-1.98	9.4	4	-3.71	9.5	2	-6.77
12	9	RG8	Columbia	8	70			#DIV/0!			#DIV/0!			#DIV/0!			#DIV/0!
13	10	RG8X	generic	X	50	84	60	-1.46	82	56	-1.66	9.6	5	-2.83	9.5	3	-5.01
14	11	RG8X	ABR	X	100	85	59	-1.59	84	51	-2.17	9.5	4.2	-3.54	9.2	2.5	-5.66
15	12	LMR400	Times	L	10			#DIV/0!			#DIV/0!	9.1	8.5	-0.30	9.6	8.5	-0.53
16	13	LMR400	Times	L	10			#DIV/0!			#DIV/0!	9.1	8.4	-0.35	9.6	8.6	-0.48
17	14	LMR400	Times	L	10			#DIV/0!			#DIV/0!	9.1	8.5	-0.30	9.6	8.4	-0.58
18	15	LMR400	Times	L	10			#DIV/0!			#DIV/0!	7.4	7	-0.24	6.6	5.75	-0.60
19	16	LMR400	Times	L	10			#DIV/0!			#DIV/0!	8.1	7.8	-0.16	6.6	6	-0.41
20								#DIV/0!			#DIV/0!			#DIV/0!			#DIV/0!
21																	

Scaled to 100 Feet to Compare Advertised Specs

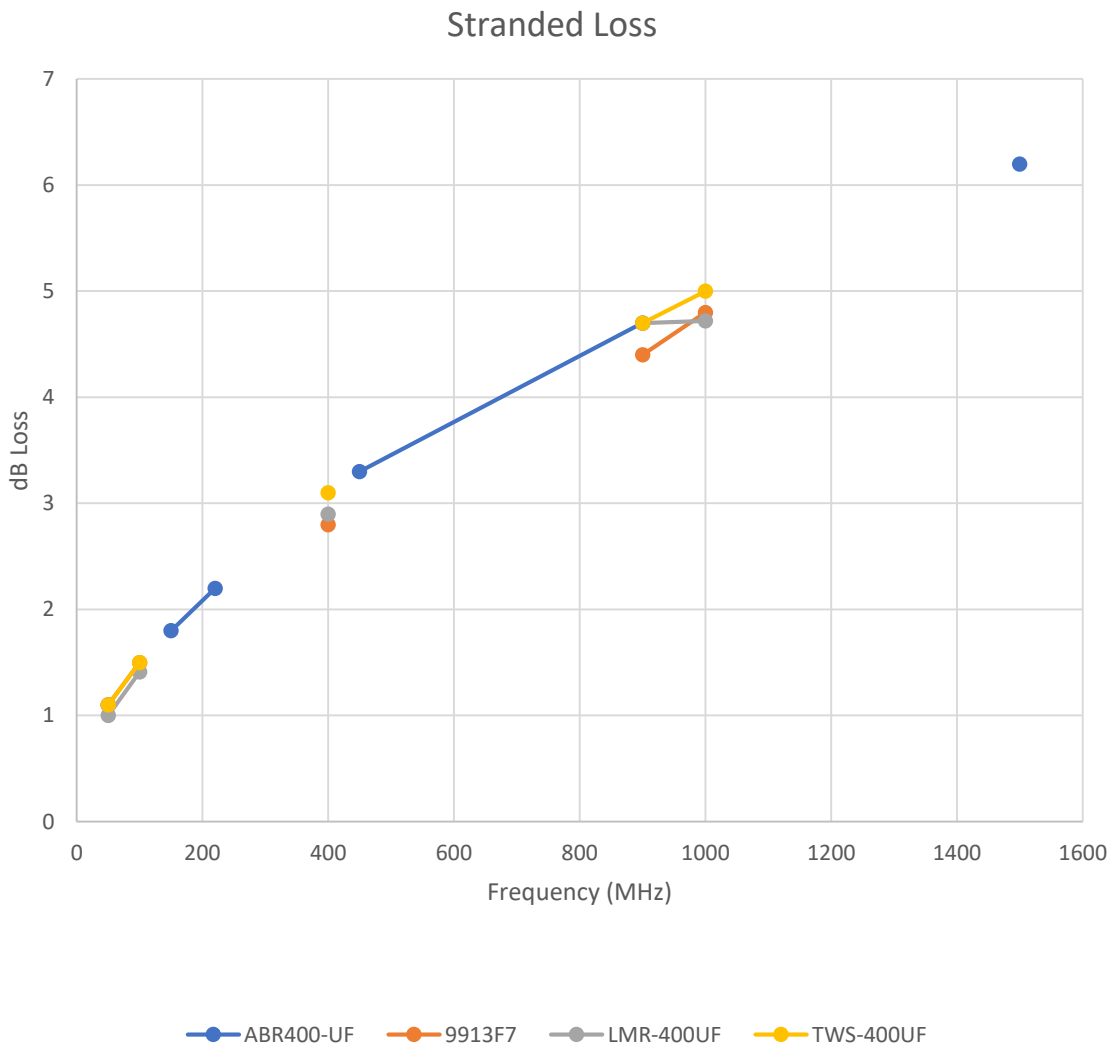
					28 MHz			50 MHz			146 MHz			446 MHz		
Cable #	Type	Vendor		Length (ft)	Input	Output	Loss	Input	Output	Loss	Input	Output	Loss	Input	Output	Loss
1	RG8	Columbia		75	84	62	-1.76	86	52	-2.91	10	4	-5.31	10	1	-13.33
2	RG8	Cable Xperts		44	84	72	-1.52	84	70	-1.80	10	7.6	-2.71	10	5.8	-5.38
3	8237 RG8	Belden		60	82	66	-1.57	86	62	-2.37	10	5.2	-4.73	10	3	-8.71
4	8237 RG8	Belden		29	82	78	-0.75	85	73	-2.28	10.2	8.2	-3.27	9.6	6	-7.04
5	RG8	Saxton		50	86	76	-1.07	82	69	-1.50	10	7.3	-2.73	10	5	-6.02
6	LMR400	Times		25	84	82	-0.42	82	76	-1.32	9.8	8.6	-2.27	9.3	7.6	-3.51
7	RG8	Saxton		18	88	80	-2.30	80	72	-2.54	9.8	7.6	-6.13	9.6	7.1	-7.28
8	RG8X	Amelco		64	83	60	-2.20	82	52	-3.09079	9.4	4	-5.79794	9.5	2	-10.5733
9	RG8	Columbia		70	0	0	#DIV/0!	0	0	#DIV/0!	0	0	#DIV/0!	0	0	#DIV/0!
10	RG8X	generic		50	84	60	-2.92256	82	56	-3.31252	9.6	5	-5.66602	9.5	3	-10.012
11	RG8X	ABR		100	85	59	-1.58567	84	51	-2.16709	9.5	4.2	-3.54474	9.2	2.5	-5.65848
12	LMR400	Times		10	0	0	#DIV/0!	0	0	#DIV/0!	9.1	8.5	-2.96225	9.6	8.5	-5.28523
13	LMR400	Times		10	0	0	#DIV/0!	0	0	#DIV/0!	9.1	8.4	-3.47621	9.6	8.6	-4.77728
14	LMR400	Times		10	0	0	#DIV/0!	0	0	#DIV/0!	9.1	8.5	-2.96225	9.6	8.4	-5.79919
15	LMR400	Times		10	0	0	#DIV/0!	0	0	#DIV/0!	7.4	7	-2.41337	6.6	5.75	-5.98761
16	LMR400	Times		10	0	0	#DIV/0!	0	0	#DIV/0!	8.1	7.8	-1.63904	6.6	6	-4.13927
0	0	0		0	0	0	#DIV/0!	0	0	#DIV/0!	0	0	#DIV/0!	0	0	#DIV/0!

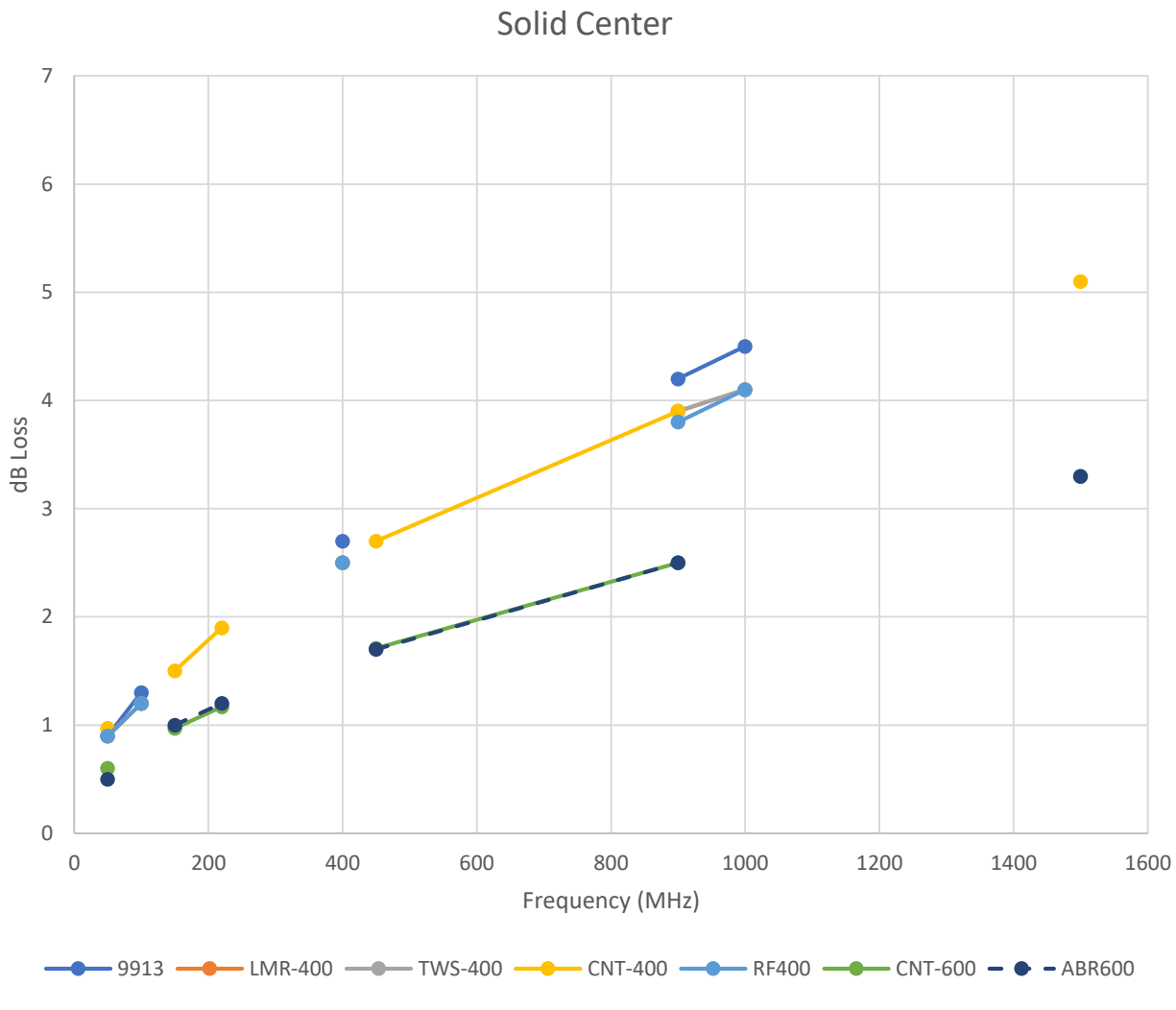

Cable Loss per 100 Feet
0.00
-2.00
-4.00
-6.00
-8.00
-10.00
-12.00
-14.00
LMR – Dash
RG8X – Dot
RG8 - Solid
28 MHz
50 MHz
146 MHz
446 MHz
1Columbia8
2Cable Xperts8
3Belden8
4Belden8
5Saxton8
6TimesL
7Saxton8
8AmelcoX
9Columbia8
10genericX
11ABRX
12TimesL
13TimesL
14TimesL

Comparing LMR Type Cables

Coax Comparison	Attenuation per 100 feet (-dB)											
Cost per foot	$ 1.09	$ 1.09	$ 1.49	$ 0.99		$ 0.99	$ 0.99	$ 0.79	$ 1.29	$ 0.99	$ 2.00	
	Stranded Center Conductor					Solid Center Conductor						
Freq (MHz)	ABR400-UF	9913F7	LMR-400UF	TWS-400UF		9913	LMR-400	TWS-400	CNT-400	RF400	CNT-600	ABR600
50	1.1	1.1	1	1.1	50	0.9	0.9	0.9	0.97	0.9	0.6	0.5
100		1.5	1.41	1.5	100	1.3	1.2	1.2		1.2		
150	1.8				150				1.5		0.97	1
220	2.2				220				1.9		1.17	1.2
400		2.8	2.9	3.1	400	2.7	2.5	2.5		2.5		
450	3.3				450				2.7		1.71	1.7
900	4.7	4.4	4.7	4.7	900	4.2	3.9	3.9	3.9	3.8	2.5	2.5
1000		4.8	4.72	5	1000	4.5	4.1	4.1		4.1		
1500	6.2				1500				5.1		3.3	3.3

LMR400 Stranded vs Solid Center Conductor





Cool Websites

- Gain/Loss calculator
  - http://www.sengpielaudio.com/calculator-amplification.htm
- Cable Specs
  - http://rfelektronik.se/manuals/Datasheets/Coaxial_Cable_Attenuation_Chart.pdf
- KE5EE monster antenna farm
  - https://www.qrz.com/db/KE5EE?fbclid=IwAR3rvbwi05g6NB00hTk5npldvGUbb80Vec6hvNpK5tpRrX6kjS2Rm-mjpMU

Google Maps