Antennas for Small Spaces

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CCARC General meeting

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Topics

- Introduction
- SWR
- Antenna Tuners
- Antenna Analyzers
- Sample antennas

Introduction

- Talking about apartment and condo antennas elicited comments and articles on things such as:
  - HOAs and antenna restrictions.
  - Stealth antennas – how I got away with it on 20 meters!
  - Why everyone needs a flagpole to hide it.
  - How to build small antennas for your deck.
  - ETC……

Introduction

- Contrary to the doom and gloom stories HAM radio in small spaces is alive and well.
- Earlier this year we talked about radio's – full size rigs – in a tool box.
- There are a plethora of commercial, well made, antennas for small spaces.
- Requires better operating skills:
  - Better understanding of radio physics.
  - Greater awareness of the operating environment.
  - Ability to physically configure antennas to meet your needs.

Small Antenna Characteristics

- Physically they are smaller than other antennas.
- Engineers have found solutions to deal with physical limitations:
  - Adjustable antenna elements.
  - Loading coils.
- Narrow bandwidths.
- Tuning requires lots of manual manipulation.

SWR

- SWR is a measure of power transferred to the antenna.
  - Best transfer at a resonant and harmonic frequencies the “DIP” on the SWR meter.
  - Higher SWR the more “Loss”.
  - Modern transmitters automatically reduce power when SWR is too high to avoid excessive collector current on back end transistors.
    - You may not notice it because the transmitter will still transmit – at a much reduced power.
    - Check the amp meter on your power supply against the transmitter’s output power level.
    - If the transmitter dumps power there is something wrong.

SWR

- A low SWR does not indicate the antenna is radiating power nor is it necessarily where the antenna is resonant.
- Small antennas may often not have low SWRs where resonant. That can be fixed with impedance matching.

Objects in the Environment

- Anything within the wavelength of the antenna, for example: A ¼ Wave, 10 meter antenna is affected by everything within a diameter of 17 feet.
- Stuff moving around in the environment may change tuning and/or SWR . Different days may require retuning antenna.
- Moving the antenna's location.
- Very different from a dipole out in the yard and up in the air.
- Weather conditions.

SWR Countered by Impedance Matchers

(Antenna Tuners)

- Actually:
  - Don't tune an antenna.
  - Don't change the electrical or physical properties of an antenna.
  - Simply match the impedance of the antenna to something resembling the radios impedance of 50 ohms allowing efficient power transfer at a given frequency.
- Impedance is expressed as:

  Ohms of resistance '+' j of capacitance or ' –' j of inductance. For example 50+17Ω of impedance means 50 ohms resistance added to 17 ohms of inductive reactance.

- Antenna tuners add or subtract inductance and/or capacitance to ameliorate reactance over a small set of frequencies widening usable frequencies.
- Matching impedance at a frequency means more power to the antenna and less stress on the transmitter's backend components.
- Matches antenna to tuner and tuner to transceiver.

Loss

- Caused by impedance – Inductive and/or Capacitive.
- Is expressed as heat and current on the transmitter's backend components.
- An SWR at a frequency says that you can apply X% of your output power to the antenna at that frequency with Y% loss.

Adding or subtracting reactance components "pushes" back the reactance wall allowing a wider set of frequencies to efficiently transfer power to the antenna.

- Tuners widen the frequencies where power can be **efficiently** transferred to the antenna.
- Outside that envelope the antenna's physical properties must be changed to accommodate a different set of frequencies.

POWER LOSS AT VARIOUS SWR READINGS AND RESIDUAL POWER

SWR READING	% OF LOSS	ERP*	WATTS AVAILABLE	SWR READING	% OF LOSS	ERP*	WATTS AVAILABLE
1.0:1	0.00%	100.00%	4	2.4:1	17.00%	83.00%	3.32
1.1:1	0.20%	99.80%	3.99	2.5:1	18.40%	81.60%	3.27
1.2:1	0.80%	99.20%	3.97	2.6:1	19.80%	80.20%	3.21
1.3:1	1.70%	98.30%	3.93	2.7:1	21.10%	78.90%	3.16
1.4:1	2.80%	97.20%	3.89	2.8:1	22.40%	77.60%	3.1
1.5:1	4.00%	96.00%	3.84	2.9:1	23.70%	76.30%	3.05
1.6:1	5.30%	94.70%	3.79	3.0:1	25.00%	75.00%	3
1.7:1	6.70%	93.30%	3.73	4.0:1	36.00%	64.00%	2.56
1.8:1	8.20%	91.80%	3.67	5.0:1	44.40%	55.60%	2.22
1.9:1	9.60%	90.40%	3.61	6.0:1	51.00%	49.00%	1.96
2.0:1	11.10%	88.90%	3.56	7.0:1	56.30%	43.80%	1.75
2.1:1	112.60%	87.40%	3.5	8.0:1	60.50%	39.50%	1.58
2.2:1	14.10%	85.90%	3.44	9.0:1	64.00%	36.00%	1.44
2.3:1	15.50%	84.50%	3.38	10.0:1	66.90%	33.10%	1.32

The formula: Power in Watts x ((SWR-1) x (SWR-1)) ÷ ((SWR+1) x (SWR+1)) = Loss of Power in Watts

* ERP = Percentage of Effective Radiated Power

Antenna analyzers

- Describe the bandwidth of an antenna at a specific frequency and configuration.
- Not necessary, but very useful!
- Need to adjust 3 or 4 variables to tune:
  - Element length.
  - Loading coil.
  - Radials, if it required them.
  - Accounting for objects in the environment.

Tuning

Adjusting three variables:

- Element(s) length.
- Coil winding.
- Radial length.

The Circle of Radio

•Radio's are great today. Along way s from soldering kits together.

•Operator skills are what we are all working on.

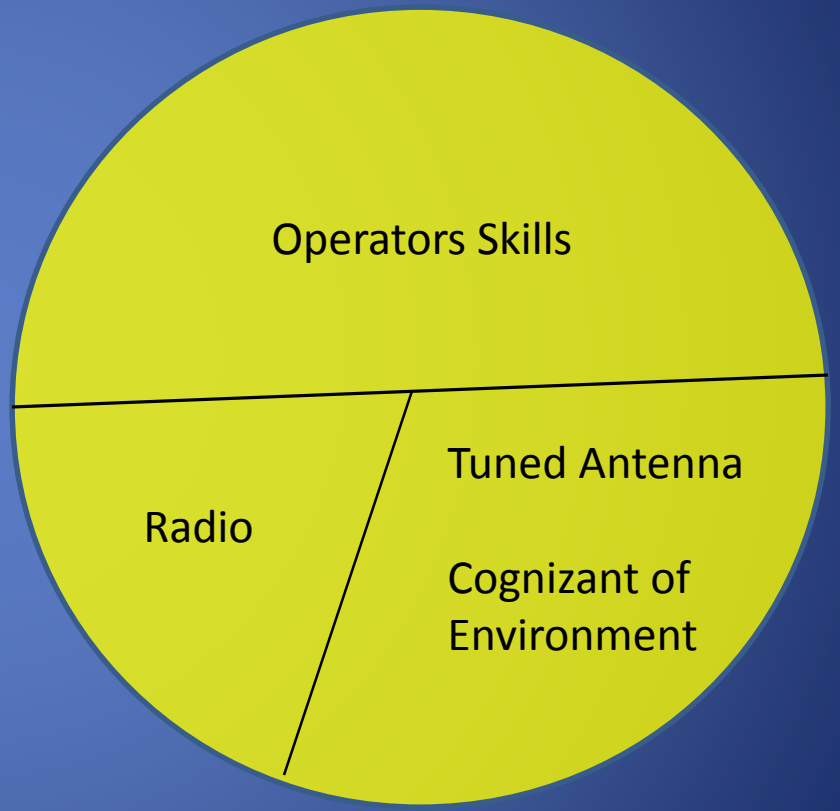
•Difficulties:

•Physically manipulating the antenna to tune at a desired frequency.

•Need to adjust coils, elements, and radials.

•The interaction of the antenna with the environment.

- ➢Low power tuning.
- ➢High power operation.



Finicky

- Example the MFJ 1622 Apartment Antenna.
- Covers 40m, 30m, 20m,17m,15m, 12m, 10m, 6m, 2m
- It has a coil, adjustable element, and a radial.
- It can be frustrating as seen in this review. Remember engineers designed and built it so does work – but not for this guy:

A eham.net Review…..

- A complete waste of time and money. Complete crap. I could never get SWR below 18:1. I can't believe MFJ sells this junk.
- I

  Earlier 0-star review posted by WU6R on 2017-09-03

  I bought this antenna 9 months ago to attach to my 3rd floor balcony rail -- SWR was off the charts ~18::1 on all bands. I checked all connections, rechecked by moving the tap clip from the top "1" coil position to the middle and to the bottom and I still could not get a good SWR. I followed the instructions for counterpoise lengths and tapped coil position, still to no avail. I moved a few months ago and today I got it out of the box and tried it in my backyard on a tripod. Using a RigExpert AA-600 in multi band mode from 40m-2m, SWR ranged from 18.1 :: 1 at 7.00 MHz to 8.1::1 at 50.100 MHz, regardless of telescopic length or coil tap position. This thing simply does not work.
- Not a happy camper to say the least.
- Maybe The antenna is installed incorrectly – happened to me. *Not until I got my analyzer could this be diagnosed and repaired*.

How it's tuned

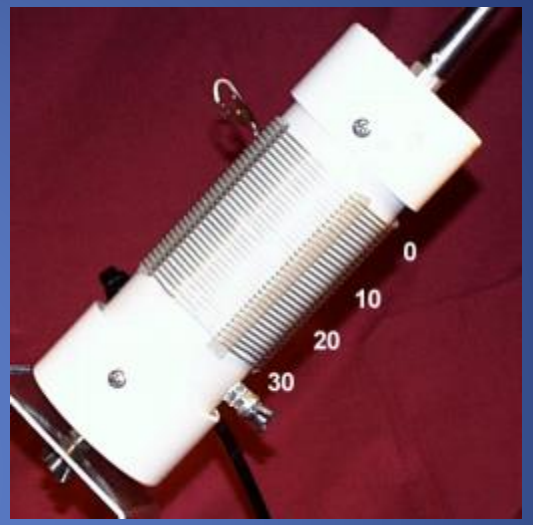
- Instructions are engineering heuristics not definitive statements.
  - The counterpoise wire should be less than 1/4 wavelength of the desired frequency [468 / frequency (MHz)]. This length may need to be increased or decreased according to height above ground level.
  - Excess counterpoise should be wrapped in a small coil 3-4 inches in diameter.
  - With the tap on turn 0 and the counterpoise just under 8 feet, the resonance point should be approximately 30 MHz. If this is not true lower the tap on the coil to lower the frequency or shorten the whip to raise the frequency. Table 1 gives approximate tap points for each of the HF bands with the counterpoise at ground level.

How it's tuned - continued

  - Each installation may require different lengths of counterpoise wire and tap positions. The greatest factor in determining the counterpoise length will be the height above ground level. The higher the installation, the closer the counterpoise length will need to be to a wavelength = 468 / frequency (MHz).
  - Operation on the 6 and 2 meter bands requires that the top section of the whip be retracted completely. This may vary with some installations. The counterpoise length should be less than 5 feet.
- Hunting and pecking your way to a three variable solution can be long and frustrating.
- Analyzers make it quick and easy.

Tuning 14.225 MHz

- The instructions:
  - Closest in the chart is 14.00 MHz
  - Coil winding 9.
    - Where on the 9th winding?
    - Marking and counting takes time and good eye sight!
    - Not that accurate.
  - Radial 18 feet.



Counterpoise Length at Ground Level

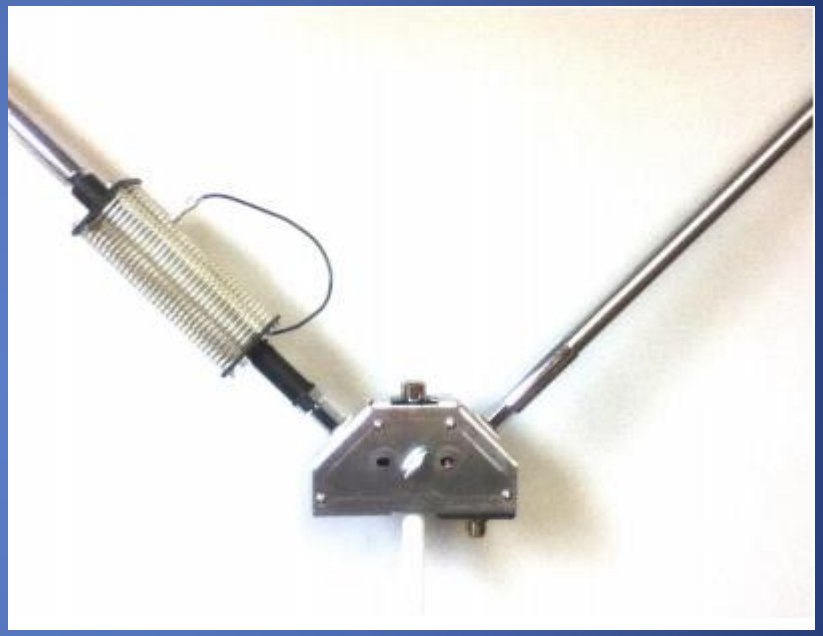
MHz	Coil #	Counterpoise Length (Ft)
144.0	0	5’
50.1	0	5’
28.00	1.75	7’ 9”
24.89	1.5	8’ 5”
21.00	5.5	10’ 6”
18.068	5	11’
14.00	9	18’
10.1	14	19’ 5”
7.00	25	33’

MFJ-1622 Example

- Took 10 minutes.
- Had to move the clip back and forth on the coil.
- Takes patience and practice.
- Antenna analyzer made it possible for me to tune the antenna.

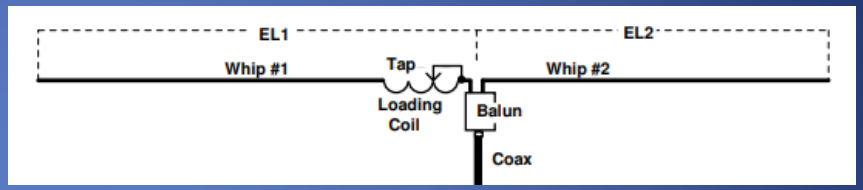
MFJ-2289 – Big Ears

- It is a large antenna.
  - Element lengths are up to 13 feet long .
  - Inverted V dipole.
  - May be too large for your deck, even when leaned-out.
- Covers 40m, 30m requires coil, 20m,17m,15m, 12m, 10m, 6m
- Bigger components make it less finicky, but it still needs lots of manual configuring.



MFJ-2289 – Big Ears

- Need the coil below 20 meters. Same tuning issues as the other antennas.
- Need to adjust the elements, and they are long.
- Antenna analyzer make quick work of tuning it for a specific frequency.



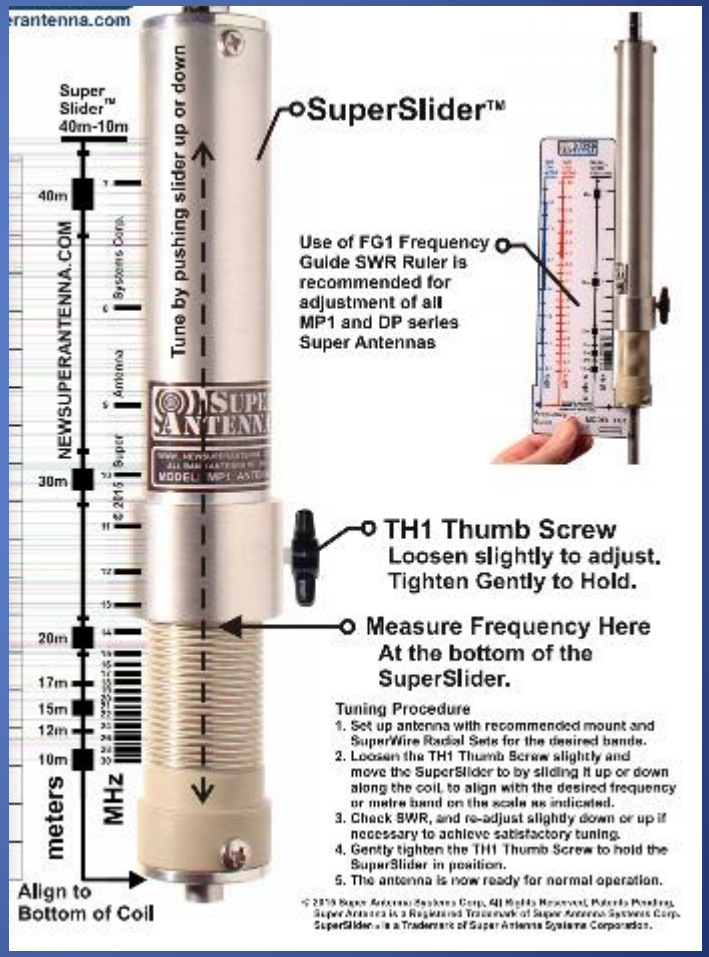
Frequency	E1	E2	L1
7.15	Full Length	Full Length	26-t
10.11	Full Length	9' 9"	16-t
14.15	Full Length	Full length	Shorted
18.11	13'	13'	Shorted
21.20	11'	11'	Shorted
24.93	9' 3"	9' 3"	Shorted
28.50	8' 2"	8' 2"	Shorted
50.10	4' 3"	4' 3"	Shorted

Super Antenna - MP1

- Manual screwdriver.
- Covers 80m, 75m, 40m, 30m, 20m, 17m, 15m, 12m, 11m, 10m meters (3.5MHz to 4.8MHz and 7MHz-30MHz) HF, plus VHF 6m (30MHz- 54MHz)
- Fits into a Tupperware container.

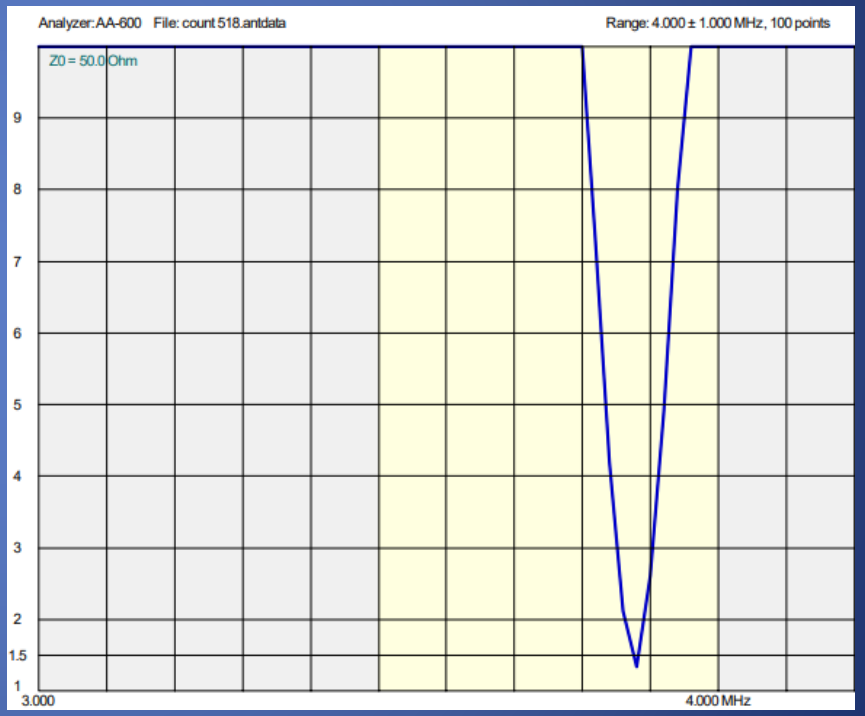
MP1

- Three elements to tune:
  - Radials.
  - Coil length. Comes with a template to direct you and/or your marking s on the coil.
  - Adjustable element.
- Tuning:
  - The person who owns it tunes it by hearing .
  - Antenna analyzer simplifies the process.
- Lots of tuning across the bands.
- Narrow bandwidth.



Screwdriver Bandwidth Example

- Very narrow.
- Tuner can widen the curve a little.
- Auto tuner makes the antenna appear as a mono-band device.



Testing

- Test out your antenna configuration:
  - Try a CQ.
  - FT8 and PSK reporter.
    - Even if you don't contact anyone monitoring stations might pick you up.
    - PSK Reporter to view results.
  - Try listening to yourself on an internet SDR. Look for an empty frequency in it's waterfall and transmit.
    - Open browser to http://69.27.184.62:8901/
    - Look for **KFS WebSDR** HF at websdr.org

Conclusion

- These three antennas illustrate:
  - A range of solutions to the problem.
  - Similar operating issues.
  - Need for good radio skills.
- Small apartment/condo decks provide more than enough space for a ham antenna.
- Many of these antennas are made to literally stick out of a window!
- Need both a tuner and analyzer, or lots of time and patience.
- Radials can be a problem. There are papers on how to fold them.