

Antenna Tuning Presentation

Although some radio amateur's build their antennas, most purchase their antennas from a manufacturer, then install and adjust the antenna in accordance with the instructions. The tuning instructions usually require you to install a SWR meter in the feed line and adjust some part of the antenna for the best SWR reading at your operating frequency.

Antennas have many electrical characteristics that can be measured; the list below is a sample:

- Power Rating – (Watts)
- Frequency Range - (MHz)
- Gain - (dBd/dBi)
- Bandwidth – (3 dB Frequency Points)
- VSWR – (Voltage Ratio)
- Return Loss - (dB)
- Nominal Input Impedance – (Reference to 50 ohms)
- Polarization – (Horizontal/Vertical)
- Resonant Frequency – (X_C and X_L are equal)
- Series Resistance – (ohms)
- Phase Characteristic's – (degrees)
- Match Efficiency – (%)
- Reflective Coefficient – (Ratio of Complex Amplitude)

From the list of specifications above, most manufacturers only specify Power Rating, Frequency, Gain, VSWR and Nominal Impedance. Most amateurs have an instrument that will measure SWR and power, but nothing to measure an antenna's gain or impedance. The relationship between SWR and other antenna specifications are illustrated by the SWR Chart on the next page. One of the things that a SWR meter **cannot** tell you, is the impedance (Z) value. The chart shows that a SWR of 2.0:1 can result in an impedance value between 25 to 100 ohms. Your radio transmitter was designed for an impedance value of 50 ohms.

Antenna Testing and Tuning: Testing and tuning an antenna can be a challenge because how the environment around the antenna affects its characteristics. RF energy radiated by the antenna is reflected by any object (trees, buildings, ground etc.) back to the test antenna. This reflected RF energy can be in-phase or out-of-phase with the antenna's RF radiated RF energy. Objects can absorb and/or distort the antenna's radiation pattern. Most amateurs do not have an antenna test chamber (Anechoic) or an open-field test area. Manufacturers seldom say how they tested their product, although the manufacturer (Alpha Delta) of my 40/80 meter dipole states that this antenna was tested in the clear (no surrounding objects) at a height of 35' with the ends at 10'.

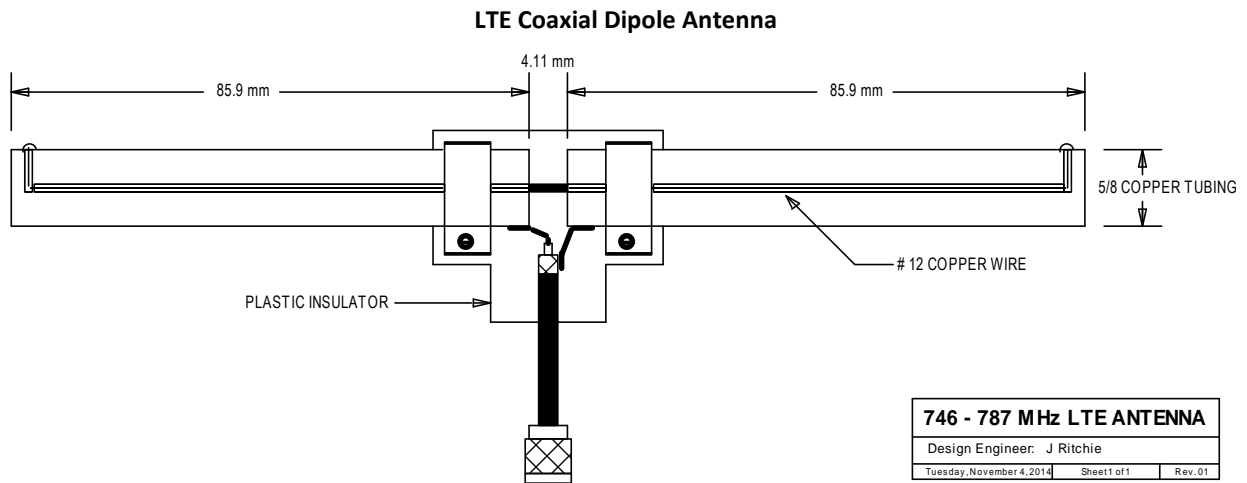
Don't be surprised if your newly purchased antenna isn't performing as advertised and don't park your car in the drive way next to your house while trying to tune a mobile antenna.

Demo: Using a Spectrum Analyzer, Return Loss Bridge, MJF-259B and Bird 43 meter, I will demonstrate antenna tuning and the characteristics of the four (4) antennas.

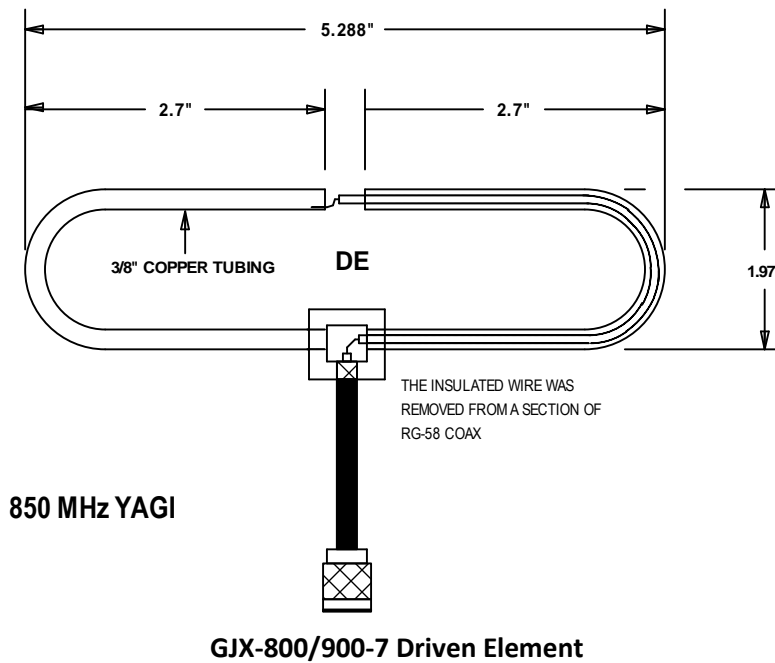
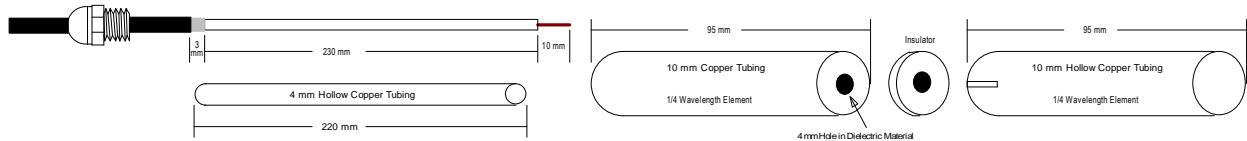
SWR CHART

SWR	RETURN LOSS (dB)	IMPEDANCE Ohms Max/Min	REFLECTED PWR (%)	MATCH EFFICIENCY (%)	Rho (ρ)
1.0:1		50	0	100	0
1.1:1	26.44	55/45.5	0.2	98.8	.048
1.2:1	20.82	60/41.7	0.8	99.2	.090
1.3:1	17.69	65/38.5	1.7	98.3	.130
1.4:1	15.56	70/35.7	2.8	97.2	.167
1.5:1	13.98	75/33.3	4.0	96.0	.200
1.6:1	12.74	80/31.3	5.3	94.7	.231
1.7:1	11.73	85/29.4	6.7	93.3	.259
1.8:1	10.88	90/27.7	8.2	91.8	.286
1.9:1	10.16	95/26.3	9.7	90.3	.310
2.0:1	9.54	100/25	11.1	88.9	.333
2.1:1	8.99	105/23.8	12.6	87.4	.355
2.2:1	8.51	110/22.7	14.1	85.9	.375
2.3:1	8.09	115/21.7	15.6	84.4	.394
2.4:1	7.70	120/20.8	17.0	83.0	.412
2.5:1	7.36	125/20.0	18.4	81.6	.429
2.6:1	7.04	130/19.2	19.8	80.2	.444
2.7:1	6.75	135/18.5	21.2	78.8	.459
2.8:1	6.49	140/17.8	22.5	77.5	.474
2.9:1	6.24	145/17.2	23.7	76.3	.487
3.0:1	6.02	150/16.6	25.0	75.0	.500

Demo Antenna Designs:



PTE-A-700F Vertical Antenna



Summary: At HF frequencies, a well-designed SWR meter can provide all of information you need to adjust an antenna. At VHF & UHF frequencies, the SWR meter and cable added in-line must equal to $\frac{1}{2} \lambda$ for accurate measurements. There's a lot of "Antenna Analyzer's" on the market today, and they are a better choice for making antenna adjustments. These analyzers connect directly to the feed line connector that attaches to your radio, so they measure the SWR and impedance that your transmitter will see.

Jerry WA5OKO