Broken Arrow Amateur Radio Club

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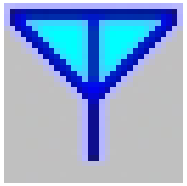
UNDERSTANDING SWR

From A Practical Viewpoint

Don Cochran WAØJOW

21826 Gardner Rd.
Spring Hill, KS 66083

913 856-4075



What Is SWR

- SWR is short for Standing Wave Ratio
- A ratio of Forward and Reflected signals
- Typically used in reference to transmission lines and antennas
- This includes coaxial cable, ladder line, micro-strip, strip line and other types of transmission lines
- Also includes baluns, connectors, matching between amplifier stages and more
- Amateurs usually use the term in reference to their antennas and transmission line

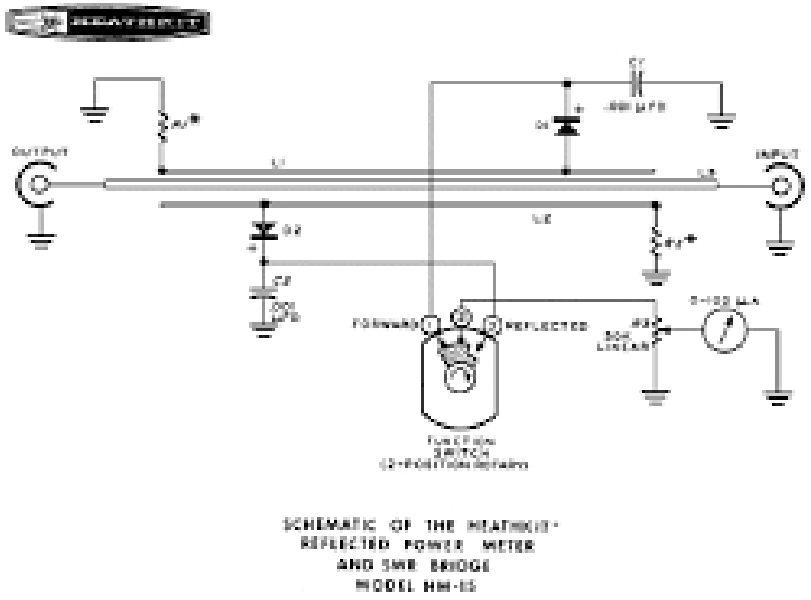
What Causes SWR

- The simple answer is: A mis-match between two things carrying a signal
- Not all of the signal passes from one thing to the other thing
- Some of the signal gets reflected due to a mismatch of impedances
- This can happen at a:
  - Coaxial cable to antenna
  - Transmitter to coaxial cable
  - Coaxial cable to a balun
  - Connection to another connector anywhere
- Every mismatch has an accumulative effect on reflected signal amplitude

How Do We Measure SWR

- First, lets define the terminology to express SWR
  - Voltage - VSWR
  - Current - ISWR
  - Power - Comparing forward and reflected power
  - S Parameters - Typically used in matching between amplifier stages
  - Return Loss - The difference between forward and reflected power measured in dB
- All of these can be used to calculate SWR. Hams typically use SWR in a universal sense and do not really care how it is measured.
- The SWR Analyzer is one of the easiest methods of measuring SWR
- There are several types of other instruments that can be used to measure SWR

SWR Measurement



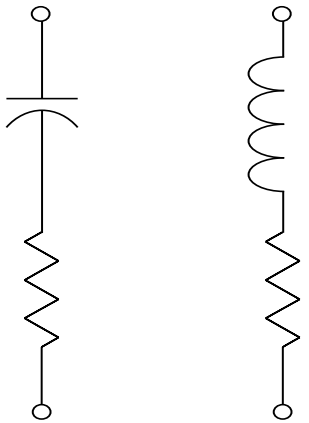
SCHEMATIC OF THE HEATHKIT REFLECTED POWER METER AND SWR BRIDGE MODEL HM-15

- ***Good Things***
- Signal Generator
- 50 Ohm Wheatstone Bridge
- Micro Controller
- Digital Display
- Dual Analog Meters
- Excellent Accuracy With 50 Ohm Loads

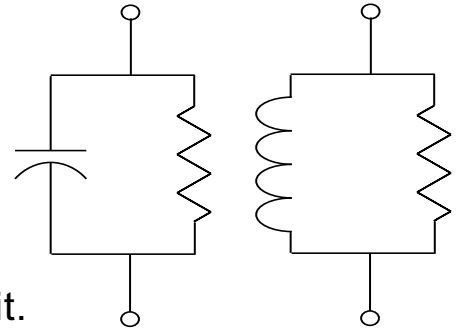
- ***Bad Things***
- Large Measurement Errors Below About 10 to 15 Ohms
- Large Measurement Errors Above About 150 to 200 Ohms
- Internal Alignment Is Critical And Difficult To Perform
- Battery Life

A Look at Impedance

- Series Resistance and Capacitive Reactance.
- Series Resistance and Inductive Reactance.



- Parallel Resistance and Capacitive Reactance.
- Parallel Resistance and Inductive Reactance.



- You can convert a Series circuit to it's equivalent Parallel circuit.
- You can convert a Parallel circuit to it's equivalent Series circuit.

Ranges of Resistance and Reactance

SWR	Percent Reflected Power	Return Loss in dB	Range of Resistance for 50 Ohm Line	Range of Reactance for 50 Ohm Line
1.0 : 1	0.0	Infinite	50.0 Ohms	0.0 Ohms
1.1 : 1	0.2	26.4	45.5 to 55.0 Ohms	-j 4.8 to +j 4.8 Ohms
1.2 : 1	0.8	20.8	41.7 to 60.0 Ohms	-j 9.2 to +j 9.2 Ohms
1.3 : 1	1.7	17.7	38.5 to 65.0 Ohms	-j 13.3 to +j 13.3 Ohms
1.4 : 1	2.8	15.6	35.7 to 70.0 Ohms	-j 17.1 to +j 17.1 Ohms
1.5 : 1	4.0	14.0	33.3 to 75.0 Ohms	-j 20.8 to +j 20.8 Ohms
1.6 : 1	5.3	12.7	31.3 to 80.0 Ohms	-j 24.4 to +j 24.4 Ohms
1.7 : 1	6.7	11.7	29.4 to 85.0 Ohms	-j 27.8 to +j 27.8 Ohms
1.8 : 1	8.2	10.9	27.8 to 90.0 Ohms	-j 31.1 to +j 31.1 Ohms
1.9 : 1	9.6	10.2	26.3 to 95.0 Ohms	-j 34.3 to +j 34.3 Ohms
2.0 : 1	11.1	9.5	25.0 to 100.0 Ohms	-j 37.5 to +j 37.5 Ohms
2.5 : 1	18.4	7.4	20.0 to 125.0 Ohms	-j 52.5 to +j 52.5 Ohms
3.0 : 1	25.0	6.0	16.7 to 150.0 Ohms	-j 66.7 to +j 66.7 Ohms

Where Does the Power Go?