

Introduction to SWR (VSWR).

---UNDERSTAND THIS IS NOT AN EXHAUSTIVE IN DEPTH DISCUSSION, THERE ARE SOME SIMPLIFICATIONS TO MAKE IT EASIER TO GRASP---

S21, S11, and Return loss at a later date.

<https://www.arrl.org/files/file/Technology/tis/info/pdf/q1106037.pdf>

My point is to invoke thought and if you are inclined to investigate it further then knock yourself out. (Don't get wrapped up in the math)

What is SWR?

Simply put how well the load (antenna) is consuming power. Matched in impedance.

SWR has nothing to do with radiation efficiency (how well the antenna works)

SWR is technically VSWR, Voltage Standing Wave Ratio.

1:1 is perfect match

That is to say the transmitter (50 ohm (R or Z)) output voltage is going to a 50 ohm line (coax) to an antenna that is resonant to the frequency of the transmitter at 50 ohms then the SWR is 1:1, no voltage is reflected voltage. $SWR = Z_{source} \div Z_{load}$

If the 50 ohm transmitter is sending voltage to a 50 ohm line, and the antenna is not a resonant load (something other than 50 ohms) the antenna won't consume all of the voltage and will send (reflect) it back to where it came from.

For an antenna there will be at least two points of reflected voltage one above where the antenna would be matched (+ or capacitive) and (- or inductive). (*simplification, there may be resonant points at different frequencies on the same antenna, subject for later discussion*)

So if we are putting some voltage in at 50 ohms and the antenna is 25 ohms, $SWR = 50 (Z_{src}) \div 25 (Z_{load}) = 2:1$ so the antenna is radiating 67% and reflecting 33% of the voltage.

SWR vs Reflected Voltage or Power

VSWR	Voltage Reflected (%)	Power Reflected (%)
1.0:1	0	0
1.1:1	5	0.2
1.2:1	9	0.8
1.3:1	13	1.7
1.4:1	17	2.8
1.5:1	20	4
1.6:1	23	5.3
1.7:1	26	6.7
1.8:1	29	8.2
1.9:1	31	9.6
2.0:1	33	11
2.5:1	43	18.4
3.0:1	50	25
4.0:1	56	36
5.0:1	67	44.4
10.0:1	82	67

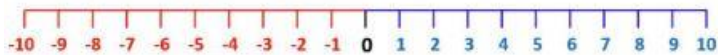
(QST, November 2006, K5DVW)

These ratios work for voltage (V or E), power (W), and impedance (Z) they just give a different perspective. *(discussion for a later date)*

How does the SWR meter know what the voltage going out (forward) and voltage coming back (reflected) is?

There is a component inside (transmission line section) that can develop a voltage going one direction and a voltage going the other direction. By comparing these two voltages we come up with a ratio. $SWR = V_{max} \div V_{min}$ *(simplification, standing wave phase addition and cancelation and reflection coefficient)*

Phase addition or cancelation is basically when two peaks of voltage come together, they add, when they are opposite, they cancel. *(remember number lines and positive and negative numbers?)* A positive and a positive equal a bigger positive or a negative and a negative equal a bigger negative. An equal value positive and negative equal ZERO. If the positive and negative values are different then the sum will be somewhere between them.



i.e. -4 plus $+4 =$ zero, -4 plus $-4 = -8$ $+3$ plus $-2 = +1$