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SOMETHING ABOUT VSWR:

A great deal has been written about VSWR and what it means; however little has been written as to the practical meaning of VSWR . Unfortunately many do not relate power loss in relation to VSWR properly. The following table illustrates the amount of power transfered to the load or antenna for a given VSWR:

VSWR:	EFFECIENCY IN %:
1.00	100.00
1.50	96.00
2.00	88.89
2.50	81.63
3.00	75.00
3.50	69.14
4.00	64.00
4.50	59.50
5.83	50.00

It can be clearly seen that one loses 50% of the power when the VSWR is approximately 6.00 to 1.00. Inasmuch as the field intensity varies as the square root of the power radiated, if we assumed that an antenna was mismatched from a perfect match to a VSWR of 5.83 to 1.00 we would have a power loss of 50% and a field loss of 41.41%. In other words doubling the power only raises the field by 41.41%. It therefore follows that for VSWR's on the order of 2.50 to 1.00 the field loss is small.

A transmission line should be matched to it's load where practical to protect it from voltage flash-overs or current hot spots. The VSWR directly effects the voltage and current on a transmission line. The following formulas show the method of determining the maximum voltage and current on a line:

$$E_{max} = \sqrt{P \times Z_o \ VSWR}$$

$$I_{max} = \sqrt{\frac{P \times VSWR}{Z_o}}$$

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The VSWR is determined by the value of resistance and reactance of the load vs the characteristic impedance of the transmission line. The VSWR is determined as follows:

$$VSWR = \frac{1 + |\Gamma|}{1 - |\Gamma|}$$

Where:

$|\Gamma|$ = reflection coefficient

$|\Gamma|$ is determined as follows:

$$|\Gamma| = \sqrt{\frac{(R - R_o)^2 + X^2}{(R + R_o)^2 + X^2}}$$

Where:

R_o = resistance of line(most cases 50 ohms).

R = resistance of load or antenna.

X = reactance of load or antenna.

Figure 2 is a tabulation of the resistance and reactance pairs that represent a VSWR of 2.00 to 1.00. Any one of these combinations that is any pair represents a VSWR = 2.00.

Figure 4 is a Smith Chart centered on 50 ohms which among other things illustrates the VSWR of 1.5, 2.0 and 5.83.

Figures 2 and 3 are tabulations of the resistance and reactance pairs for VSWR's of 2.0 and 5.83 respectively.

The tabulations of the resistance and reactance pairs for the different VSWR's are tabulated in 5 degree increments around the Smith Chart.

The next time your VSWR meter reads say 2.00, look at Figure 2 and note the many combinations your load or antenna could be.

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FIGURE 1:

RESISTANCE-REACTANCE PAIRS FOR CONSTANT VSWR
INCREMENTING ANGLE (DEGREES) IN R-X PLANE = 5
VSWR = 1.5
EFFICIENCY IN % = 96.0000
CHARACTERISTIC IMPEDANCE = 50

REACTANCE	RESISTANCE
.00	75.0000
1.8157	74.9207
3.6176	74.6834
5.3920	74.2901
7.1254	73.7436
8.8045	73.0480
10.4166	72.2088
11.9495	71.2323
13.3914	70.1259
14.7313	68.8980
15.9592	67.5580
17.0656	66.1161
18.0422	64.5833
18.8814	62.9712
19.5769	61.2920
20.1234	59.5587
20.5168	57.7843
20.7540	55.9824
20.8333	54.1666
20.7540	52.3509
20.5168	50.5489
20.1234	48.7745
19.5769	47.0412
18.8814	45.3621
18.0422	43.7499
17.0656	42.2171
15.9592	40.7752
14.7314	39.4352
13.3914	38.2073
11.9495	37.1009
10.4166	36.1244
8.8045	35.2852
7.1254	34.5897
5.3920	34.0431
3.6176	33.6498
1.8157	33.4125
.0000	33.3333

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FIGURE 2:

RESISTANCE-REACTANCE PAIRS FOR CONSTANT VSWR
INCREMENTING ANGLE (DEGREES) IN R-X PLANE = 5
VSWR = 2.0
EFFICIENCY IN % = 88.8888
CHARACTERISTIC IMPEDANCE = 50

REACTANCE	RESISTANCE
.00	100.0000
3.2683	99.8573
6.5118	99.4302
9.7057	98.7222
12.8257	97.7384
15.8481	96.4865
18.7500	94.9759
21.5091	93.2182
24.1045	91.2266
26.5165	89.0165
28.7266	86.6045
30.7182	84.0091
32.4759	81.2500
33.9865	78.3481
35.2384	75.3257
36.2222	72.2057
36.9303	69.0118
37.3573	65.7683
37.5000	62.5000
37.3573	59.2316
36.9303	55.9881
36.2222	52.7942
35.2385	49.6742
33.9865	46.6518
32.4759	43.7499
30.7182	40.9908
28.7266	38.3954
26.5165	35.9834
24.1045	33.7733
21.5091	31.7817
18.7500	30.0240
15.8482	28.5134
12.8257	27.2614
9.7057	26.2777
6.5118	25.5696
3.2683	25.1426
.0000	24.9999

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FIGURE 3:

RESISTANCE-REACTANCE PAIRS FOR CONSTANT VSWR
INCREMENTING ANGLE (DEGREES) IN R-X PLANE = ! 5
VSWR = 5.83
EFFICIENCY IN % = 49.9904
CHARACTERISTIC IMPEDANCE = 50

REACTANCE	RESISTANCE
.00	291.5000
12.3292	290.9617
24.5645	289.3508
36.6130	286.6798
48.3828	282.9688
59.7843	278.2461
70.7309	272.5477
81.1391	265.9169
90.9299	258.4042
100.0286	250.0668
108.3660	240.9681
115.8788	231.1773
122.5096	220.7691
128.2080	209.8225
132.9307	198.4209
136.6417	186.6512
139.3128	174.6027
140.9236	162.3673
141.4619	150.0381
140.9236	137.7089
139.3128	125.4735
136.6417	113.4251
132.9307	101.6553
128.2080	90.2537
122.5096	79.3071
115.8788	68.8989
108.3661	59.1081
100.0287	50.0094
90.9300	41.6719
81.1392	34.1592
70.7310	27.5284
59.7844	21.8300
48.3828	17.1073
36.6130	13.3963
24.5646	10.7252
12.3292	9.1144
.0000	8.5761

FIGURE 4:

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IMPEDANCE COORDINATES—50-OHM CHARACTERISTIC IMPEDANCE