## **Relationship of VSWR to Return Loss:**

VSWR and return loss are related quantities. Note that the reflection coefficient can be written in terms of the VWSR as:

$$= \frac{\text{VSWR} - 1}{\text{VSWR} + 1}$$

This expression can be derived as follows:

From the given relationship,

$$VSWR = rac{V_{ ext{max}}}{V_{ ext{min}}} = rac{1+
ho}{1-
ho}.$$

We can show that is given by:

$$= | |,$$

thus.

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

Which provides the relationship we started with. The return loss can then be cast in terms of VSWR as.

$$RL(DB) = -20log_{10} \left[ \frac{VSWR - 1}{VSWR + 1} \right]$$

Conversely.

sely,  

$$VSWR = \frac{\left[\frac{RL(dB)}{20.0}\right] + 1.0}{\left[\frac{RL(dB)}{20.0}\right] - 1.0}$$

So if either of the two quantities is known the other can be calculated from it. A table showing conversions is shown below for convenience

Signal Processing Group Inc., technical memorandum. Signal Processing Group Inc, designs, develops and manufactures, Analog and RF/Wireless ASICs and RF/Wireless modules using state of the art semiconductor, PCB and assembly technologies. Please contact us from our website at http://www.signalpro.biz, or email us directly at spg@signalpro.biz.

Return loss ( db)	VSWR	Reflection coefficient
0	Infinite	1.0
1	17.39	0.891
2	8.724	0.794
3	5.848	0.707
4	4.419	0.630
5	3.569	0.562
6	3.009	0.501
7	2.614	0.446
8	2.322	0.398
9	2.099	0.354
10	1.924	0.316
11	1.784	0.281
12	1.670	0.251
13	1.576	0.223
14	1.498	0.199
15	1.432	0.177
16	1.376	0.158
17	1.328	0.141
18	1.288	0.125
19	1.252	0.112
20	1.222	0.100
20.8	1.195	0.089
21.7	1.179	0.082
22.6	1.16	0.074
23.1	1.15	0.069
23.7	1.139	0.065
24.3	1.129	0.060
24.9	1.120	0.056
25.7	1.109	0.051
26.4	1.100	0.047
27.3	1.109	0.043

Signal Processing Group Inc., technical memorandum. Signal Processing Group Inc, designs, develops and manufactures, Analog and RF/Wireless ASICs and RF/Wireless modules using state of the art semiconductor, PCB and assembly technologies. Please contact us from our website at <u>http://www.signalpro.biz</u>, or email us directly at spg@signalpro.biz.

28.3	1.079	0.038
29.4	1.07	0.033
30.7	1.06	0.029
32.3	1.049	0.024
34.1	1.04	0.019
36.6	1.03	0.014
40.1	1.019	0.009
46.1	1.009	0.004

It is instructive to examine a graphical view of the relationship between VSWR and the return loss presented below.



Note the slow variation of the return loss as the VSWR reaches between 1.0 to 2.0. Conversely for a VSWR of 7 or 8 the return loss is large. If the return loss is greater than 10dB the VSWR is less than 2.0.

Signal Processing Group Inc., technical memorandum. Signal Processing Group Inc, designs, develops and manufactures, Analog and RF/Wireless ASICs and RF/Wireless modules using state of the art semiconductor, PCB and assembly technologies. Please contact us from our website at <u>http://www.signalpro.biz</u>, or email us directly at spg@signalpro.biz.