How is SWR Calculated

From Forward and Reflected Power?

Books, such as Radio Communication Handbook, state that SWR, the Standing Wave Ratio, is the ratio of the maximum to the minimum values of the standing wave which exists on a line, and that the Reflection Coefficient (r) is the ratio of the reflected current vector to the incident current vector and thus, the maximum value of the standing wave will be (1 + r) and the minimum value will be (1 – r). SWR, or more correctly VSWR, and they are related by the expression:

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

However, it is not easy to see from this how to calculate the SWR from measured values of forward and reflected power. It must be remembered that the forward power, W_F and reflected power, W_R, are, of course, measured in Watts but SWR is dependent on voltage. Therefore since power, W, is proportional to V^2, the square root of W must be used to calculate r. E.g. for a forward power of 100W and a reflected power of 25W:

$$r = \frac{\sqrt{W_R}}{\sqrt{W_F}} \qquad r = \frac{\sqrt{25}}{\sqrt{100}} \qquad r = \frac{5}{10} \qquad r = 0.5$$

Thus $\text{SWR} = \frac{1+0.5}{1-0.5}$ $\text{SWR} = \frac{1.5}{0.5}$ SWR = 3.00

It may be seen from the above that $r = \frac{5}{10}$ and that SWR may be calculated from:

$$\text{SWR} = \frac{1+\frac{5}{10}}{1-\frac{5}{10}} = \frac{\frac{10+5}{10}}{\frac{10-5}{10}} = \frac{10+5}{10-5} \qquad \text{SWR} = 3.00$$

Thus if the % reflected power is used in the calculation e.g. if W_F = 50W and W_R = 2W the % reflected power = 4, then SWR may be calculated from:

SWR = $\frac{10+\sqrt{4}}{10-\sqrt{4}}$ = $\frac{10+2}{10-2}$ = $\frac{12}{8}$ Thus SWR = 1.50

It is, of course, possible to ”reverse” this calculation and calculate the % reflected power from the SWR. By rearranging the equations above it may be shown that:

$$\sqrt{\%W_R} = \frac{10(SWR-1)}{(SWR+1)}$$

Thus for an SWR of 3.00 $\sqrt{\%W_R} = \frac{10(3-1)}{(3+1)} = \frac{10\times2}{4} = 5$

Thus, if $\sqrt{\%W_R} = 5$ then $\%W_R = 25$

Hence if Forward Power = 100W then Reflected Power = 25W or

if Forward Power = 20W then Reflected Power = 5W, both situations would have an SWR of 3.00