

APPENDIX 3 – DETERMINING SWR FROM R + jX, METHOD 2

I derived this method for calculating the exact value of SWR from R + jX from Eq 3-1 after a suggestion from the late Ken Miller, W2KF.

1) Normalize the load impedance by dividing by the characteristic impedance Z_c of the transmission line.

$$\frac{R + jX}{Z_c} = r + jx$$

2) Find the b term of the quadratic formula

$$\frac{b \pm \sqrt{b^2 - 4ac}}{2a}$$

using values of r and x in the equation

$$b = \left(\frac{x^2 + 1}{r} \right) + r$$

3) Calculate the SWR from the simplified quadratic equation

$$SWR = \frac{b + \sqrt{b^2 - 4}}{2}$$

The a and c terms of the complete quadratic equation reduce to 1 from normalizing the R and X terms of the load impedance. The negative root of the discriminant is ignored.

Let's now try an example by calculating the SWR on a 50-ohm line produced by a load impedance of $40 + j30$ ohms.

$$\text{Normalizing: } r + jx = \frac{40 + j30}{50} = 0.8 + j0.6$$

Find the b term: $b = \left(\frac{0.6^2 + 1}{0.8} + 0.8 = 2.5 \right)$

Calculate the SWR: $SWR = \frac{2.5 + \sqrt{2.5^2 - 4}}{2} = 2$

This is an excellent example because the answer is exactly 2:1 with no fractional remainder. To test your arithmetic, other examples to try which also give exact answers when $Z_c = 50$ ohms are $30 + j40$, $SWR = 3:1$; and $80 + j90$, $SWR = 4:1$. It is also remarkable to note that the following different load impedances all produce an SWR of 2.618031 on 50-ohm lines: $25 + j25$, $50 + j50$, $100 + j50$, and $130 + j10$. See Appendix 4 for a hand calculator program to compute SWR from the above equation.