“Additional Loss due to SWR”

Definitions:

Zload	complex load impedance
Zin	complex line input impedance
Zo	complex line characteristic impedance
l	line length
γ	complex line attenuation constant
ρ*load*	complex reflection coefficient looking into the load
ρ*in*	complex reflection coefficient looking into the line
I*in*	complex current flowing into the line
I*load*	complex current flowing into the load

From Kumar “Microwave techniques - Transmission Lines” page 86; dividing equation (5.69) by equation (5.68) we get:

$$\frac{Iload}{Iin}=\left[\frac{1-\rho\, load}{1-\rho\, in}\right].e^{(-\gamma l)}$$

The term $e^{(-\gamma l)}$ represents the current attenuation into a matched load, so $\left[\frac{1-\rho\, load}{1-\rho\, in}\right]$ represents the additional multiplying factor attributable to the mismatched condition.
This additional current multiplying factor - call it X - can be expanded and simplified as follows:

$$X=\frac{1-\rho\, load}{1-\rho\, in}$$

$$X=\frac{1-\frac{Zload-Zo}{Zload+Zo}}{1-\frac{Zin-Zo}{Zin+Zo}}$$

$$X=\frac{\frac{2.\mathrm{Zo}}{Zload+Zo}}{\frac{2.\mathrm{Zo}}{Zin+Zo}}$$

$$X=\frac{Zin+Zo}{Zload+Zo}$$

To find the additional <u>power</u> multiplication factor, we must square X and also take account of the fact that *Iin* and *Iload* are flowing into different values of resistance. We then get the additional <u>power</u> multiplying factor as:

$\frac{Rload}{Rin}.\left|\frac{Zin+Zo}{Zload+Zo}\right|^2$ or, expressed as additional loss (dB): $-10.\mathrm{Log}\left(\frac{Rload}{Rin}.\left|\frac{Zin+Zo}{Zload+Zo}\right|^2\right)$

where $Rin=\Re(Zin)$ and $Rload=\Re(Zload)$

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