Consider again the voltage along a terminated transmission line, as a function of position $z$:

$$V(z) = V_0^+ [e^{-j\beta z} + \Gamma e^{+j\beta z}]$$

Recall this is a complex function, the magnitude of which expresses the magnitude of the sinusoidal signal at position $z$, while the phase of the complex value represents the relative phase of the sinusoidal signal.

Let's look at the magnitude only:

$$|V(z)| = |V_0^+||e^{-j\beta z} + \Gamma e^{+j\beta z}|$$

$$= |V_0^+||e^{-j\beta z}||1 + \Gamma e^{+j\beta z}|$$

$$= |V_0^+||1 + \Gamma e^{+j\beta z}|$$

ICBST the largest value of $|V(z)|$ occurs at the location $z$ where:

$$\Gamma e^{+j\beta z} = |\Gamma| + j0$$

while the smallest value of $|V(z)|$ occurs at the location $z$ where:

$$\Gamma e^{+j\beta z} = -|\Gamma| + j0$$
As a result we can conclude that:

\[ |V(z)|_{\text{max}} = |V_0^+| (1 + |\Gamma|) \]

\[ |V(z)|_{\text{min}} = |V_0^+| (1 - |\Gamma|) \]

The ratio of \( |V(z)|_{\text{max}} \) to \( |V(z)|_{\text{min}} \) is known as the \textbf{Voltage Standing Wave Ratio (VSWR)}:

\[ \text{VSWR} = \frac{|V(z)|_{\text{max}}}{|V(z)|_{\text{min}}} = \frac{1 + |\Gamma|}{1 - |\Gamma|} \quad \therefore \quad 1 \leq \text{VSWR} \leq \infty \]

Note if \( |\Gamma| = 0 \) (i.e., \( Z_L = Z_0 \)), then \( \text{VSWR} = 1 \). We find for this case:

\[ |V(z)|_{\text{max}} = |V(z)|_{\text{min}} = |V_0^+| \]

In other words, the voltage magnitude is a \textbf{constant} with respect to position \( z \).

Conversely, if \( |\Gamma| = 1 \) (i.e., \( Z_L = jX \)), then \( \text{VSWR} = \infty \). We find for this case:

\[ |V(z)|_{\text{min}} = 0 \quad \text{and} \quad |V(z)|_{\text{max}} = 2|V_0^+| \]

In other words, the voltage magnitude varies \textbf{greatly} with respect to position \( z \).
As with return loss, VSWR is dependent on the magnitude of $\Gamma$ (i.e., $|\Gamma|$) only!