

How do I specify the performance characteristics of a cable assembly?

There are two performance characteristics of cable assemblies that are of interest: VSWR (or Return Loss) and Insertion Loss.

For all but the shortest cable assemblies (less than 6 inches) using extremely low loss cable, the Insertion Loss will be overwhelmingly due to the attenuation of the cable itself and can generally be determined from the manufacturers data sheets.

On the other hand, the VSWR will normally be overwhelmingly due to the connectors. Remembering that VSWR is a vector quantity, as the frequency is swept, the VSWR of each connector will add and then subtract in and out of phase giving a swept VSWR plot that goes up and down. Where these maximums and minimums occur will depend on the length of the cable and its dielectric constant. As a general rule, the maximum can be calculated by determining the Reflection Coefficient of the connectors on each end. Worst case will be the addition of the 2 reflection coefficients. Although small, some amount should be added for the cable. In addition, the attenuation of the cable, if significant, will reduce the VSWR. For this example, we will ignore the attenuation of the cable as a factor in the calculation. As an example, let's say we have one connector with a VSWR of 1.2 at the frequency of interest and the other connector is a 1.25. The cable VSWR is 1.05. Converting the VSWR to reflection coefficient gives .091, .111 and .024 respectively. The maximum Reflection Coefficient = .226. This converts back to a VSWR of 1.584 maximum. A quick way of getting the result is to multiply the 3 VSWR values. In this case it would be $1.2 * 1.25 * 1.05 = 1.575$. This is very close to the previously calculated result. For Return Loss, VSWR can be converted to dB. For Return Loss, if the connectors have the same Return Loss value and the cable Return Loss is at least 6 dB better, then the cable assembly Return Loss can be determined by subtracting 6 dB from the connector Return Loss. For example, if the Return Loss of each connector is 23 dB, then the cable assembly can be expected to have a maximum Return Loss of 17 dB. If the Return Loss of each connector is different or if the cable Return Loss is not insignificant, then each of the Return Losses would have to be converted to Reflection Coefficient, added and then converted back to Return Loss. It is very important to realize that the VSWR of the connectors and cable add vectorially and the resultant VSWR of the cable assembly will be considerably higher than each individual component's VSWR.