Properly Terminating Video Op Amps

Application Note | September 24, 2004 | AN9756.2

When a transmission path is improperly terminated the energy is reflected and re-reflected from these discontinuities until it eventually shows up as linear distortion in the signal. This application note describes how to properly terminate a video amplifier such that distortion is minimized while maintaining the ability to measure the input/output impedance, and forward gain of the amplifier.

Output Termination

When terminating the low impedance output of a video amplifier there are basically three choices. The first choice, shown in Figure 1, is to connect the transmission line directly to the output of the amplifier. This configuration is ideal for measuring the devices output impedance since a network analyzer can be connected directly to the output of the device. The downside to this topology is that the device must be capable of driving a low impedance (50Ω or 75Ω) since Z_L must equal Z_O to avoid reflections at the load. Forward gain can also be measured in this configuration but it would be nice to have more control over the load impedance seen by the device.

The second choice, shown in Figure 2, is to back terminate with Z_1. This configuration doubles the devices effective load impedance (100Ω or 150Ω) and it minimizes distortion since any reflected energy from Z_L mismatches will be absorbed by Z_1 (assuming Z_1 equals Z_o and $Z_{OUT} << Z_1$). One should remember, however, that the overall forward gain will be reduced by two since Z_1 and Z_o form a divider network.

The third choice, shown in Figure 3, is to back to terminate with the resistive network Z_1, and Z_2. This configuration gives control over the amplifiers load impedance while maintaining a good match to the transmission line. Assuming $Z_L = Z_o$, the load impedance seen by the video amplifier is $Z_1+Z_2||Z_o$. The source impedance seen by the cable is $Z_1||Z_2$. For example, if $Z_1 = 900\Omega$ and $Z_2 = Z_o = Z_L = 50\Omega$, then the load impedance seen by the amplifier is 925Ω. The impedance seen by the cable is approximately 50Ω (50Ω||900Ω) which is almost a perfect match. The downside to this topology is the attenuation factor, $(Z_2||Z_0)/(Z_1+Z_2||Z_o)$, on the overall forward gain of the amplifier. For the example shown above, the attenuation factor would be 25/925.

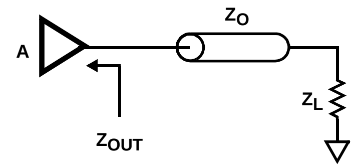

FIGURE 1.

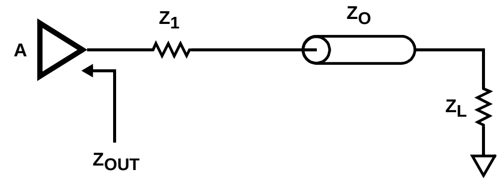

FIGURE 2.

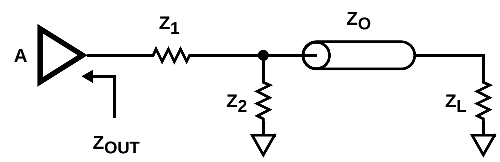

FIGURE 3.

Input Termination

When terminating the high impedance input of a video amplifier there is a choice between terminating the line with Z_1 to ground (see Figure 4) or the input can be left unterminated as shown in Figure 5. Assuming we choose $Z_1 = Z_0$ in Figure 4 there will only be a slight mismatch between $Z_1||Z_A$ and Z_o since Z_A is usually very large. If Z_A is capacitive, the match may degrade with frequency, but any reflected energy will be completely absorbed by R_G as long as $R_G = Z_o$. If there is a mismatch between R_G and Z_o, then some of the reflected energy will be re-reflected from the source and proceed back towards the amplifier and show up as distortion. The amount of distortion at the amplifiers input can also be minimized by keeping the transmission line short compared to the wavelength of the signal propagating down the transmission line. In other words, the less the phase shift between the re-reflected energy and the incident energy, then the less the signals will add and subtract from one another.

When measuring the input impedance of the amplifier, it is a good idea not to terminate (see Figure 5) because Z_A will be very hard to measure since it is in parallel with a much smaller impedance, Z_1.

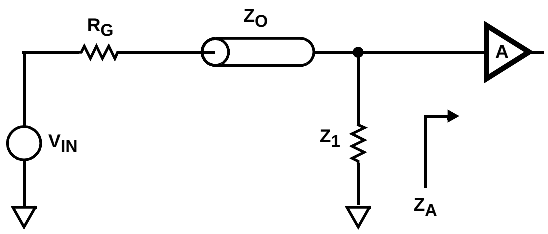

FIGURE 4.

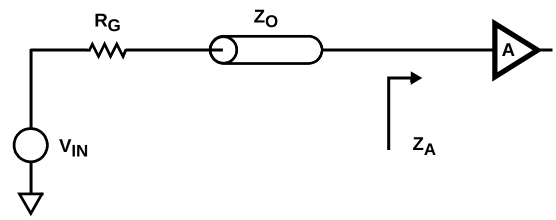

FIGURE 5.