A Unique Coax Cable Driver Circuit with Common Mode Noise Cancellation

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A coaxial cable carries signal through a central wire covered by a dielectric and an outer ground shield. Sometimes with long cables, the actual value of ground is not 0.000V at both ends of the cable. This common mode voltage (CMV) between the source and the load causes interference with the video signal. The CMV is typically compensated or cancelled at the receive end of the cable; however, sometimes the receive end is inaccessible. Figure 1 shows a unique cable driver circuit that rejects CMV at the source end of the cable.

The coax cable in Figure 1 is driven by a source amplifier (Amp 2) configured with a gain of two (by R_F and R_G). To minimize reflections and provide matching, a back termination resistor (R_B) is placed between the source and the coaxial cable. The cable's load end is also terminated with a resistor R_L equal to the impedance of the cable. This termination resistor is located between the output of the cable and the local ground (here called "point A"). The ground reference at point A differs in potential from the ground reference at the source. This difference is represented by the voltage source, CMV.

The rest of the components in Figure 1 perform the common-mode feedback compensation. First, R_S is placed between the source ("point B") side of the coaxial cable and the ground on that side—here assumed to be the true ground reference. As long as the impedance of the ground shield of the cable is low, the common-mode voltage difference between the source and load grounds now appears across R_S. Amp 1 with a gain (A_V = -1) then inverts the common-mode signal and feeds it back as a reference to the source amplifier.

This feedback effectively adds the common-mode voltage difference onto the signal at the source. Then, the output signal will be:

$$V_{OUT+} = V_{SIGNAL} + V_{CM}$$

$$V_{OUT-} = V_{CM}$$

$$V_{OUT\_DIFF} = V_{SIGNAL} \qquad \text{(EQ. 1)}$$

Hence, only the signal is seen on the coax cable output.

While the termination resistance applies voltage division to the signal, it does not divide the common-mode voltage. Therefore, the accuracy of this method is determined by the quality of the gain resistors. Resistors with 1% tolerance are recommended. An example of the improvement provided by this circuit is shown comparing Figure 2 and Figure 3. Figure 2 is an example signal with a sinusoidal common-mode voltage. Figure 3 shows that same signal with the use of the common-mode feedback in Figure 1.

Longer cables are more susceptible to common-mode issues. Cables of 1000 feet will have a typical shield resistance of 0.5Ω to 1.5Ω. With a cable to source ground resistor of 75Ω, the CMV error will be about 16mV per volt of CMV. The load termination will divide this error in two so the CMV error at the load is approximately 8mV per one volt of CMV. The maximum CMV that can be rejected is $2.4V_{PEAK}$ with ±5V amps for AC-coupled video and $2V_{PEAK}$ for DC-coupled video. The value of R_S sets the trade-offs of the system. A lower value for R_S will allow for a greater range of common-mode compensation through voltage division at the cable input. Conversely, R_S must be large enough to provide an adequate voltage to Amp 1. For additional CMV range, ±12V amps, like ISL55002, provide approximately $9V_{PEAK}$ CMV rejection.

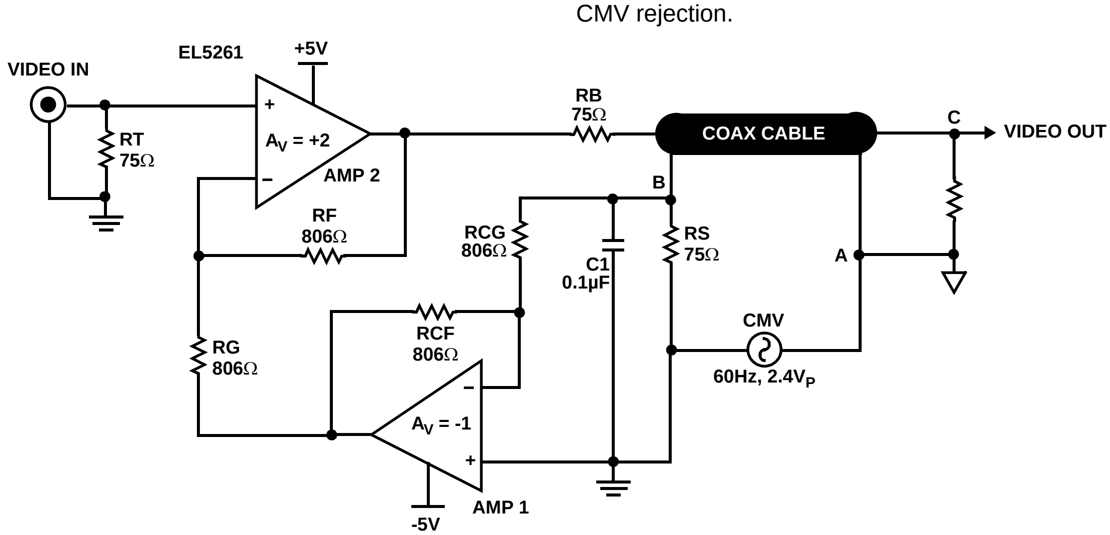

FIGURE 1. CIRCUIT TO REDUCE COMMON-MODE VOLTAGE AT THE SOURCE END OF A COAX CABLE

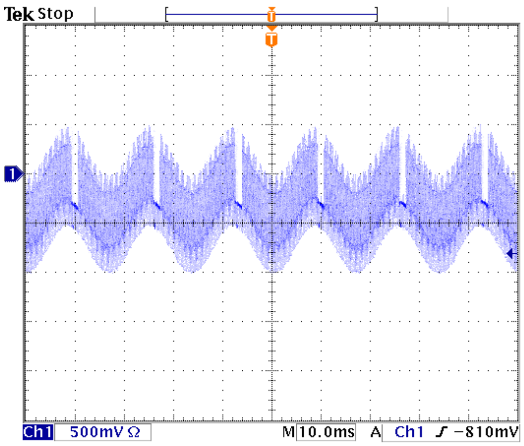

FIGURE 2. WITHOUT CMV REJECTION

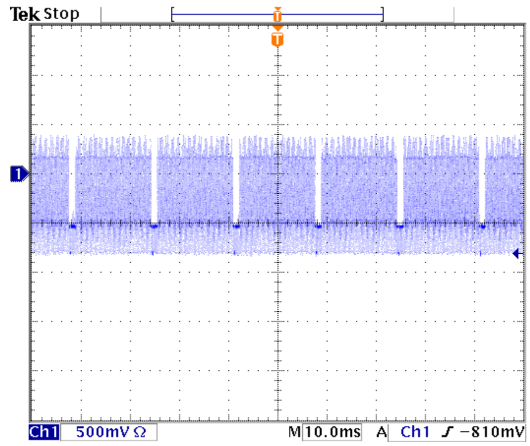

FIGURE 3. WITH CMV REJECTION