Low-Cost Video Multiplexing Using High-Speed Amplifiers

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Over the past few years, the number of video sources connected to a single display has increased steadily, making video signal switching a necessity in most video systems. In a typical home entertainment system, for example, a set-top box (STB) or digital video recorder (DVR) for cable or satellite TV, a VCR, a DVD player, a video game console, and a PC all feed a single display. The ability to switch multiple video sources to a single display extends to cars as well, where video sources include the vehicle entertainment system (VES), rearview camera, DVD player, navigation system, and auxiliary video input.

Traditional CMOS multiplexers and switches suffer several disadvantages at video frequencies— their *on* resistance introduces distortion, degrades differential gain and phase performance, and interacts with the termination resistor to attenuate the incoming video signal and affect the luminance. System designers solve this issue by adding external buffers to add gain and increase drive capability.

Video multiplexing can be simplified by using high-speed video amplifiers with a disable mode. When the amplifier is disabled, its output stage goes into a high-impedance state. This differs from the power-down mode, which significantly lowers the power consumption but leaves the state of the output stage undefined.

High-speed video amplifiers[1] have all the key features required to make them ideal for this function. Their high input impedance does not affect the characteristic impedance of the transmission line, thus allowing back termination. Because they are video amplifiers, they have inherently good video specifications, including differential gain and phase, slew rate, bandwidth, and 0.1-dB flatness.

In a mux configuration, the disabled channels present a high-impedance load to the single active channel. The gain setting and feedback resistors load the active amplifier, but their values are large compared to the 150-Ω video load, so their effect is negligible. Some high-speed video amplifiers that possess these key features are the AD8013, AD8029, and AD8063. Table 1 shows a representative list of muxable video amplifiers.

3:1 Video Multiplexer

The ADA4853-3 has independent disable controls, making it suitable for use as a low-cost 3:1 buffered-output video mux. Its output impedance is greater than 2-kΩ at 10 MHz, so the amplifier outputs can be connected to form a 3:1 mux with excellent switching behavior and great isolation characteristics. Operating on a single 5-V supply, the configuration shown in Figure 1 provides 14-MHz bandwidth (0.1-dB), gain of +2, and 58-dB *off*-channel isolation at 10 MHz. Its 10-μs channel-to-channel switching time supports CVBS analog video applications.
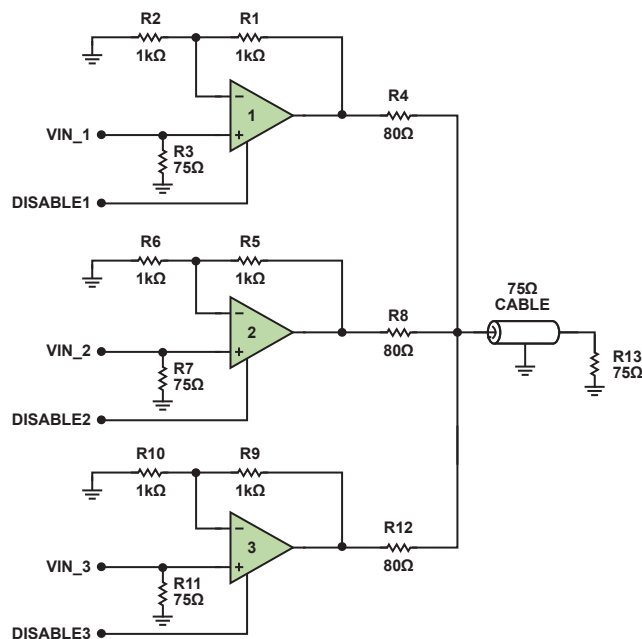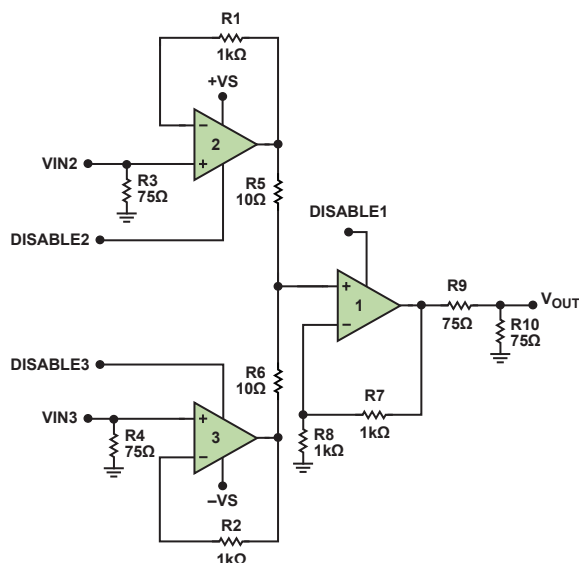

Figure 1. 3:1 video mux.

Figure 2. 2:1 video mux.

High-Performance 2:1 Video Multiplexer

Figure 2 shows a high-performance 2:1 mux. The two input amplifiers are configured as unity gain followers, while the output amplifier is set for a gain of +2. The ability to shut down both stages allows this mux to achieve the excellent input-to-output *off*-isolation shown in Figure 3. Switching time in this configuration is 45 μs.
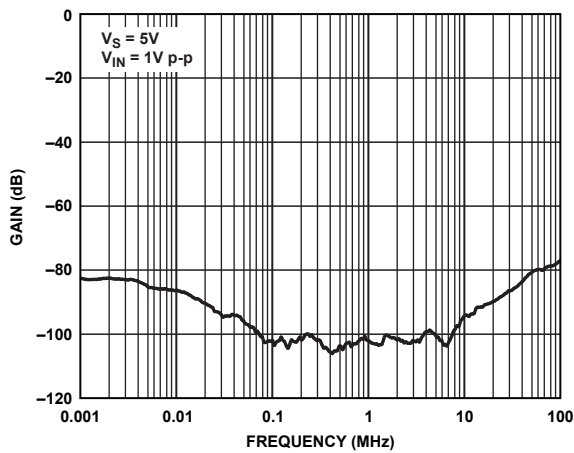
Figure 3. *Off*-isolation of 2:1 mux using the ADA4853-3.

Figure 4. 2:1 video mux.

2:1 Video Multiplexer with SAG Correction

Signal amplitude gain (SAG) correction is used to provide low-frequency compensation for the high-pass filter formed by the 150-Ω video load of a back-terminated cable and the output coupling capacitor. Traditional ac-coupling uses a large, expensive coupling capacitor, making it costly and wasting valuable PCB space. SAG correction allows two small, low-cost capacitors to replace the one large ac-coupling capacitor. Figure 4 shows a high-performance 2:1 multiplexer with SAG correction. The compensation network includes C1, C2, R11, and R12. *Field tilt* is a measure of the voltage droop (tilt) that occurs on the ac-coupling capacitor when a constant luma signal is applied. This droop is caused by the small discharge current created by the 75-Ω load resistor. The capacitor values shown are optimized to achieve the equivalent field tilt of a 220-µF ac-coupling capacitor. A typical 220-µF tantalum ac-coupling capacitor occupies 28 mm² and costs $0.50 in high volume. The typical 47-µF and 22-µF capacitors used for SAG correction occupy about 0.72 mm² and 0.4 mm² and cost as little as $0.10 each in high volumes.

Conclusion

High-speed video amplifiers with individual disable pins are excellent for constructing simple, low-cost video multiplexers and switches for composite and high-resolution video. They are ideal for replacing CMOS switches, and are more cost effective than video multiplexers. Be sure to consider using high-speed video amplifiers if your system requires video switching capability.
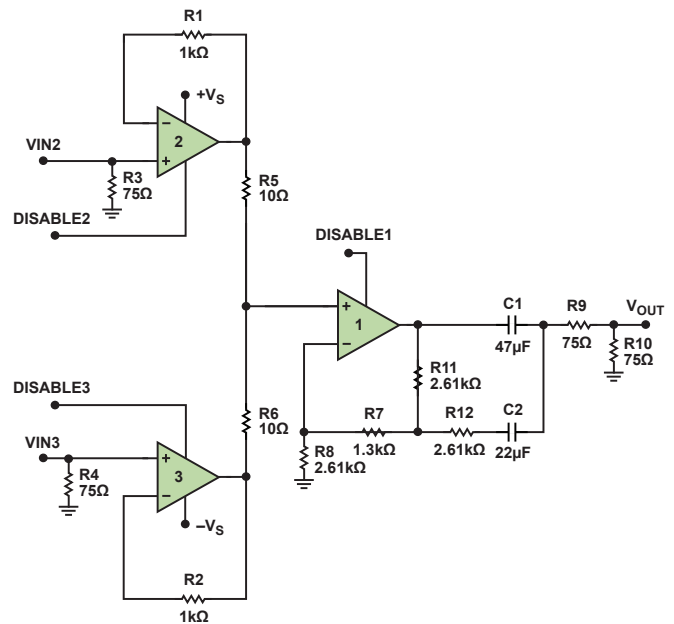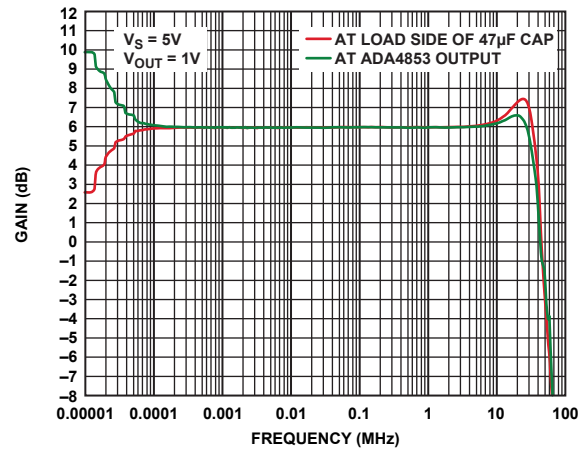

Figure 5. Frequency response of 2:1 mux with SAG correction.

References

[1] www.analog.com/en/amplifiers-and-comparators/video-ampsbuffersfilters/products/index.html#Video_Op-Amps

Table 1. Muxable high-speed amplifiers

Part Number	Number of Amps	−3 dB Bandwidth (MHz)	0.1 dB Flatness (MHz)	Slew Rate (V/µs)	Output Impedance @ 10 MHz (kΩ)	Package
AD8021	Single	490	13	110	2	SOIC, MSOP
AD8027	Single	190	12	100	5	SOIC, SOT-23
AD8029	Single	120	6	55	2	SOT-23, SOIC
AD8063	Single	320	30	650	3.2	SOT-23
AD8099	Single	440	33	715	1.5	SOIC, LFCSP
ADA4853-1	Single	100	22	120	40	SC70
ADA4899-1	Single	535	25	185	1.7	SOIC, LFCSP
ADA4853-2	Dual	100	22	120	40	LFCSP
AD813	Triple	50	20	100	1.5	SOIC
AD8003	Triple	1050	83	2860	1	LFCSP
AD8013	Triple	125	50	400	2	SOIC
AD8023	Triple	125	7	1200	0.6	SOIC, SC70
ADA4853-3	Triple	100	22	120	2	LFCSP, TSSOP