A Robust Video Receiver with Input Short-to-Battery Protection

CIRCUIT FUNCTION AND BENEFITS

The circuit shown in Figure 1 provides a very robust solution, with integrated overvoltage (short-to-battery [STB]) protection, for receiving CBVS video signals in harsh environments. It uses the ADA4830-1 low cost, low power, unipolar, differential receiver to convert a fully differential or pseudo differential (ground referenced single-ended) video signal to a single-ended signal before being digitized by the ADV7180.

The ADA4830-1 is used to eliminate the common-mode noise and phase noise caused by the ground potential differences between an incoming video signal source and the receive circuit. More importantly, the ADA4830-1 and ADV7180 combination provides a very robust input that operates in the harsh automotive environment, and this combination provides protection from and detection of short-to-battery events and meets the strict requirements of automotive manufacturers.

This robust receiver circuit using the ADA4830-1 and ADV7180 follows the traditional, proven architecture of isolating/separating a low voltage integrated circuit like the ADV7180 from the outside world and using an amplifier circuit for signal conditioning and protection.

The ADA4830-1 (single) is a monolithic, high speed difference amplifier that integrates input overvoltage (short-to-battery) protection of up to 18 V with a wide input common-mode voltage range and excellent ESD robustness. It is intended for use as a receiver for differential or pseudo differential CVBS and other high speed video signals in harsh, noisy environments, such as automotive infotainment and vision systems. The ADA4830-1 combines high speed and precision, which allows for accurate reproduction of CVBS video signals, yet rejects unwanted common-mode error voltages.

The combination of STB protection/detection, robust ESD tolerance, and wide input common-mode voltage range allows the ADA4830-1 to be used as an automotive analog video receiver in systems such as rear-view cameras and rear seat entertainment.

The ADV7180 and ADA4830-1 are fully automotive qualified, which makes both products ideal for infotainment and vision-based safety systems for automotive applications. The ADV7180 and the ADA4830-1 are available in a very small LFCSP package which is ideal for space critical applications.

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REVISION HISTORY

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7/2012—Revision 0: Initial Version

CIRCUIT DESCRIPTION

The ADA4830-1 is a monolithic high speed difference amplifier that is specifically designed for automotive applications. Its design is based on the traditional, four resistor difference amplifier, which is then optimized to eliminate the pitfalls while enhancing the benefits of this standard amplifier application circuit.

The short-to-battery protection that is integrated into the ADA4830-1 employs fast switching circuitry to clamp and hold internal voltage nodes at a safe level when an input overvoltage condition is detected. This protection allows the inputs of the ADA4830-1 to be directly connected to a remote video source, such as a rear-view camera, without the need for large expensive series capacitors.

Most video decoders, such as the ADV7180, are built on very low voltage processes and thus have a limited input voltage range. The ADA4830-1 has a signal gain of 0.5 V/V and is designed to keep the video signal within the allowed input range of the video decoder, which is typically 1 V p-p or less.

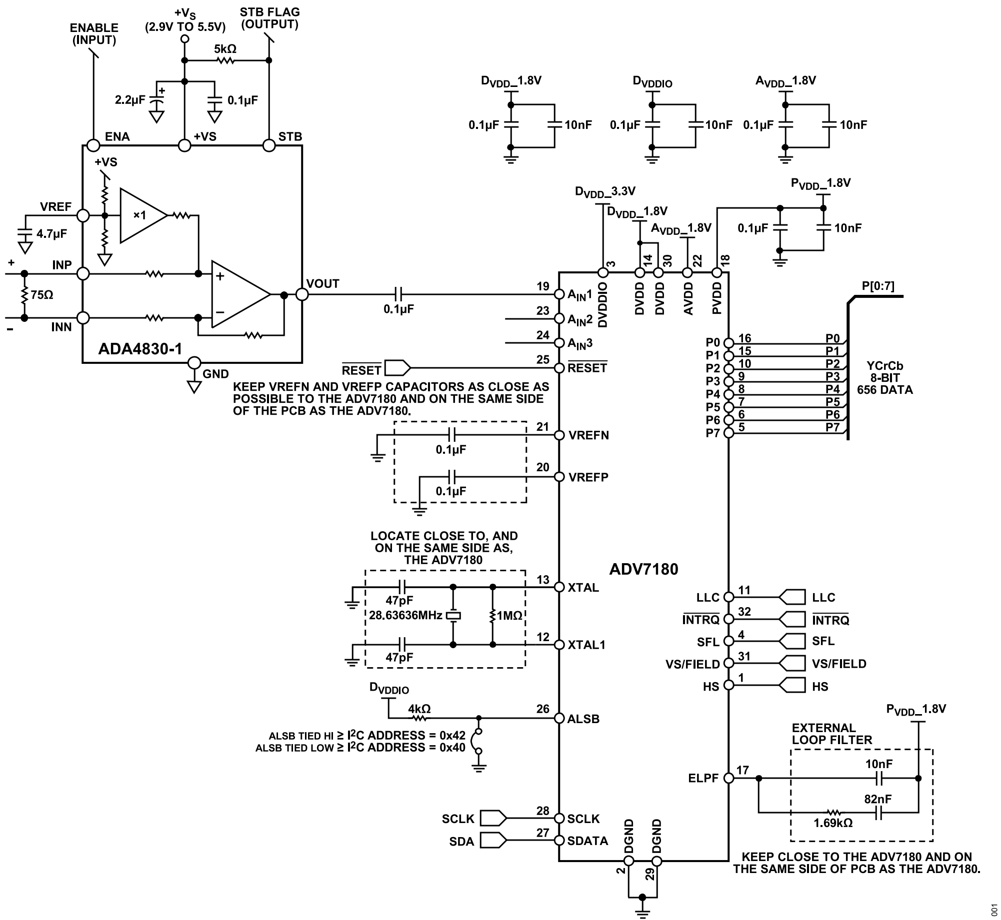

Figure 1. Robust Differential Video Receiver with the ADA4830-1 and the ADV7180 (All Connections and Decoupling Not Shown)

INPUT COMMON-MODE VOLTAGE RANGE

In a standard, four resistor difference amplifier with 0.5 V/V gain, the input common-mode (CM) range is three times the CM range of the core amplifier. The input common-mode of the ADA4830-1 has been extended to more than ±8.5 V around ground (with a 5 V supply). This very wide common-mode range allows the ADA4830-1 and the ADV7180 to operate in the presence of very large common-mode offsets and noise without any adverse effects on image quality.

WIRE DIAGNOSTIC

The ADA4830-1/ADV7180 combination shown in Figure 1 offers a short-to-battery wire diagnostic by connecting the STB output on the ADA4830-1 to one of the GPIO ports of the ADV7180. During a short-to-battery event, the STB output is a logic low signal. The ADV7180 reads this low and generates an interrupt that can be read by a microcontroller in the system. The short-to-battery output flag (STB pin) is functionally independent of the short-to-battery protection. Its purpose is to indicate an overvoltage condition on either input. Because protection is provided passively, it is always available; the flag merely indicates the presence or absence of a fault condition.

INPUT ESD PROTECTION

The protection architecture at the inputs of the ADA4830-1 uses a new technology for bidirectional asymmetrical blocking voltage. It is immune to short-to-battery conditions and able to provide ESD robustness above the 8 kV HBM level. For added ESD protection up to 15 kV, external transient suppressors are recommended.

COMMON-MODE NOISE REJECTION

The on-chip resistors integrated into the ADA4830-1 are inherently well matched, improving its common-mode rejection (CMR) performance over a wide frequency range. The CMR vs. frequency of the ADA4830-1 is shown in Figure 2 and is typically 65 dB at low frequencies, which enables the recovery of video signals in the presence of large levels of common-mode noise.

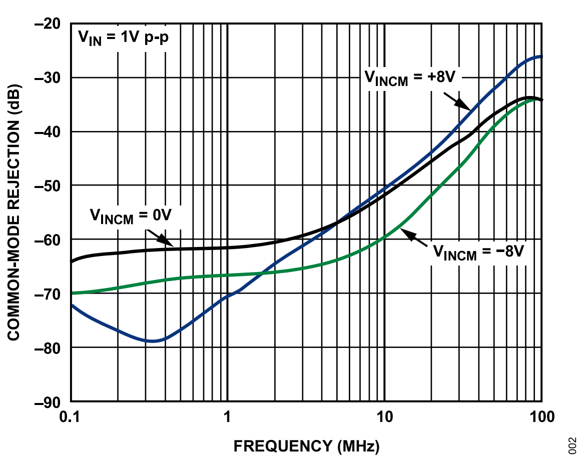

Figure 2. CMR vs. Frequency Response for Various Input Common-Mode Voltages

Common-mode errors, whether dc offsets or ac signals, degrade video image quality. Figure 3 and Figure 4 display a single large black stripe with a white background. Figure 3 shows the effects that a 500 kHz, 1 V p-p common-mode noise signal has on video image quality. Figure 4 shows the improved video image quality by adding the ADA4830-1 input stage to remove common-mode noise.

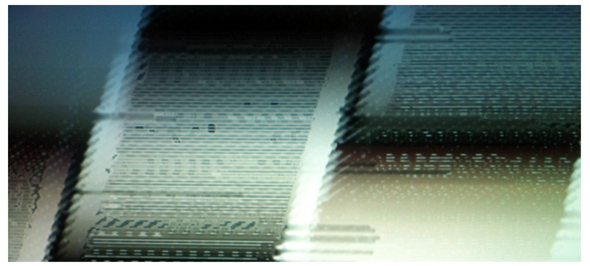

Figure 3. Video Display of a Black Stripe with 1 V p-p, 500 kHz Common-Mode Noise Inserted and ADA4830-1 Bypassed

Figure 4. Video Display of Black Stripe Showing 1 V p-p, 500 kHz Common-Mode Noise Rejected by the ADA4830-1

The ADV7180 automatically detects and converts standard analog baseband television signals compatible with worldwide NSTC, PAL, and SECAM standards into 4:2:2 component video data compatible with the 8-bit ITU-R.656 interface standards. The accurate 10-bit analog-to-digital conversion provides professional quality video performance for consumer applications with true 8-bit data resolution. Three analog video input channels accept standard composite, S-Video, or component video signals, supporting a wide range of consumer video sources. Automatic gain control (AGC) and clamp restore circuitry allow an input video signal peak-to-peak range of up to 1.0 V.

PRINTED CIRCUIT BOARD (PCB) LAYOUT CONSIDERATIONS

In any circuit where accuracy is crucial, it is important to consider the power supply and ground return layout on the board. The PCB should isolate the digital and analog sections as much as possible. The PCB was constructed in a 4-layer stack up with large area ground plane layers and power plane polygons. See the MT-031 Tutorial for more discussion on layout and grounding and the MT-101 Tutorial for information on decoupling techniques.

Decouple the power supply to the ADV7180 with 10 μF and 0.1 μF capacitors. In addition, decouple the ADA4830-1 with 0.1 μF and 22 μF capacitors to properly suppress noise and reduce ripple. Place the capacitors as close to the device as possible to ensure that the 0.1 μF capacitor has a low ESR value. Ceramic capacitors are recommended for all high frequency decoupling.

Ensure that power supply lines have as large a trace width as possible to provide low impedance paths and reduce glitch effects on the supply line. Shield clocks and other fast switching digital signals from other parts of the board by digital ground.