Application Brief

Lower System Cost Solution for Transmitting Video

Application Brief 116

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There are many types of video systems that require the source of a video signal to be located several hundred feet from a video display. A good example of this is a video surveillance system where the camera and display are located at opposite ends of a building. Traditionally, this type of closed-circuit video system would use coaxial cable to transmit the camera's video signal to the display. However, in many cases it would be better to transmit this signal on twisted-pair wire, which is smaller, lighter, and costs 80% less than coaxial cable.

Figure 1 is the block diagram of a system that transmits NTSC video on twisted-pair wire. This system was designed and tested to transmit video on 1,000 feet of inexpensive 24-gauge wire (CAT-3). Even though the signal is transmitted on 1,000 feet of wire, this system provides good quality color video at the display. Both the video driver and receiver use the LMH6643 dual op amp, which has the necessary high-speed AC characteristics for this application.

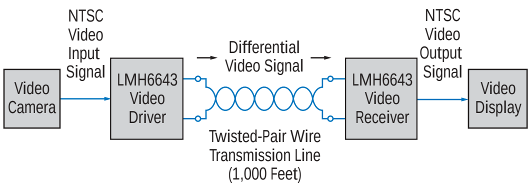

Figure 1: Block Diagram of Twisted-Pair Video System

A detailed schematic of the video driver is shown in *Figure 2*. It is a simple, low cost circuit that converts the single-ended input signal from a camera into a differential signal that drives the twisted-pair line. The input receives an NTSC composite video signal with 1 V_{pp} amplitude, and the output drives the twisted-pair with a 2 V_{pp} differential signal. A 50Ω source resistor is in series with the outputs of both op amps, matching the video driver output resistance to the twisted-pair characteristic impedance. The LMH6643 has a typical gain-bandwidth of 130 MHz, slew rate of 130 V/µs, differential gain of 0.01%, and differential phase of 0.01 degrees. These specifications are more than adequate for transmitting consumer grade video. In addition, the LMH6643 can supply a maximum output current of ±75 mA, so it can easily drive the 100Ω impedance of the twisted-pair line.

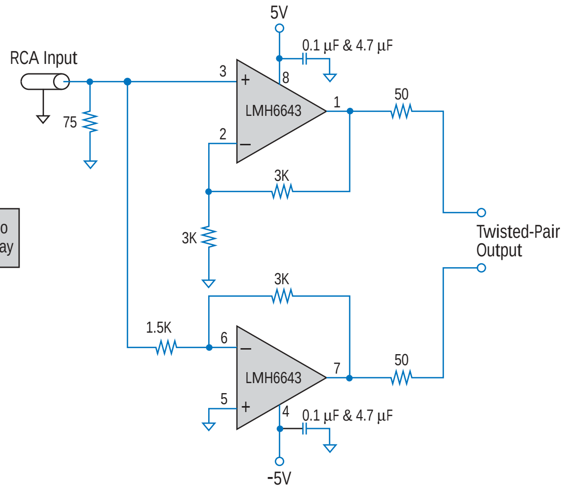

Figure 2: Twisted-Pair Video Driver

In the video receiver circuit of *Figure 3*, the differential input signal from the twisted-pair is converted into a 1 V_{pp} single-ended output signal. Op amp 1 performs the differential to single-ended conversion, and op amp 2 compensates for attenuation of the video signal due to the 1,000 feet of twisted-pair wire. In the circuit of op amp 2, R2 is adjusted so that the overall gain of the system is unity (gain of the last op amp is greater than one in order to compensate for signal loss in the twisted-pair). C1 and R1 provide a zero-pole function that compensates for attenuation of higher frequency signals in the twisted-pair. The proper values for R1, C1, and R2 can be set by transmitting a 1 V_{pp} square wave with a frequency of about 300 kHz, and adjusting these components for an optimized square wave at the output. This can be done with the following procedure: first, adjust R2 so that the square wave at the receiver output has an amplitude of 1 V_{pp} (with the output driving a 75Ω load). Next, set C1 and R1 to optimize the risetime/falltime and damping of this square wave. In the demonstration circuit that transmits video on 1,000 feet of wire, R1 = 3.9K, C1 = 68 pF, and R2 = 3.6K.

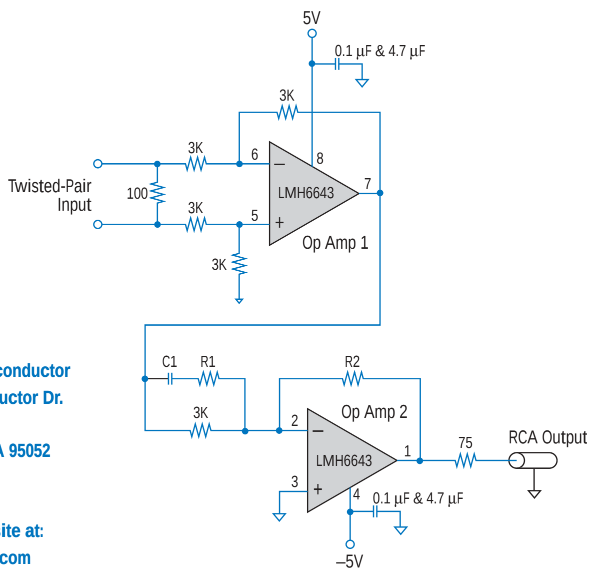

Figure 3: Twisted-Pair Video Receiver

Like the video driver, the receiver also consists of a simple and low-cost circuit. As a result, overall system cost of the twisted-pair wire, video driver and receiver is probably one of the lowest cost solutions for transmitting video on a closed-circuit system.

Figure 4 shows the response of this system when transmitting a square wave. Trace 1 is the input signal and trace 2 is the output. The transitions of the output signal have rise and fall times of 160 ns with about 5% of overshoot. Note that 1,000 feet of twisted-pair wire delays the input signal by 1.4 µs. Differential gain and phase of the system was measured with an HP3577A Network Analyzer. A 0.55 V_{pp} sine wave test signal was applied to the input, and the gain and phase were measured at 3.58 MHz (NTSC reference frequency). When the DC offset of the test signal changed from 0 to 1V, the gain changed –0.028 dB (differential gain), and phase changed 0.23 degrees (differential phase).

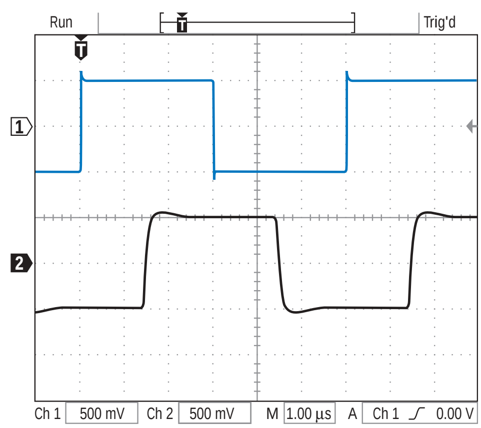

Figure 4: System Square Wave Response
Ch1: Input, Ch2: Output

Additional Information

www.national.com/pf/LM/LMH6643.html
amplifiers.national.com

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