

# DESIGN NOTES

## Send Color Video 1000 Feet Over Low Cost Twisted-Pair

Design Note 65

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It is now possible to send and receive color composite video signals appreciable distances on a low cost twisted-pair. This technique is similar to the push toward twisted-pair cables in EtherNet systems to replace costly coaxial cable connections. The cost advantage of these techniques is significant. Standard 75 $\Omega$  RG-59/U coaxial cable costs between 25¢ and 50¢ per foot, but a PVC twisted-pair is only pennies per foot. This means hundreds of dollars are saved in installations as short as 1000 feet, easily paying for additional electronics. The system also provides for “drops” or receiver taps along the twisted-pair.

This bidirectional “video bus” consists of the low cost LT<sup>®</sup>1190 op amp and the LT1193 video difference amplifier shown in Figure 1. A pair of LT1190s at TRANSMIT 1, is used to generate differential signals to drive the line which is back-terminated in its characteristic impedance. These amplifiers have high 50mA load driving ability, while maintaining a very high 450V/ $\mu$ s slew rate and 50MHz gain-bandwidth. The twisted-pair receiver is an LT1193 video difference amplifier at RECEIVE 1, and it converts signals from differential to single-ended. The LT1193 offers features unavailable with other op amp

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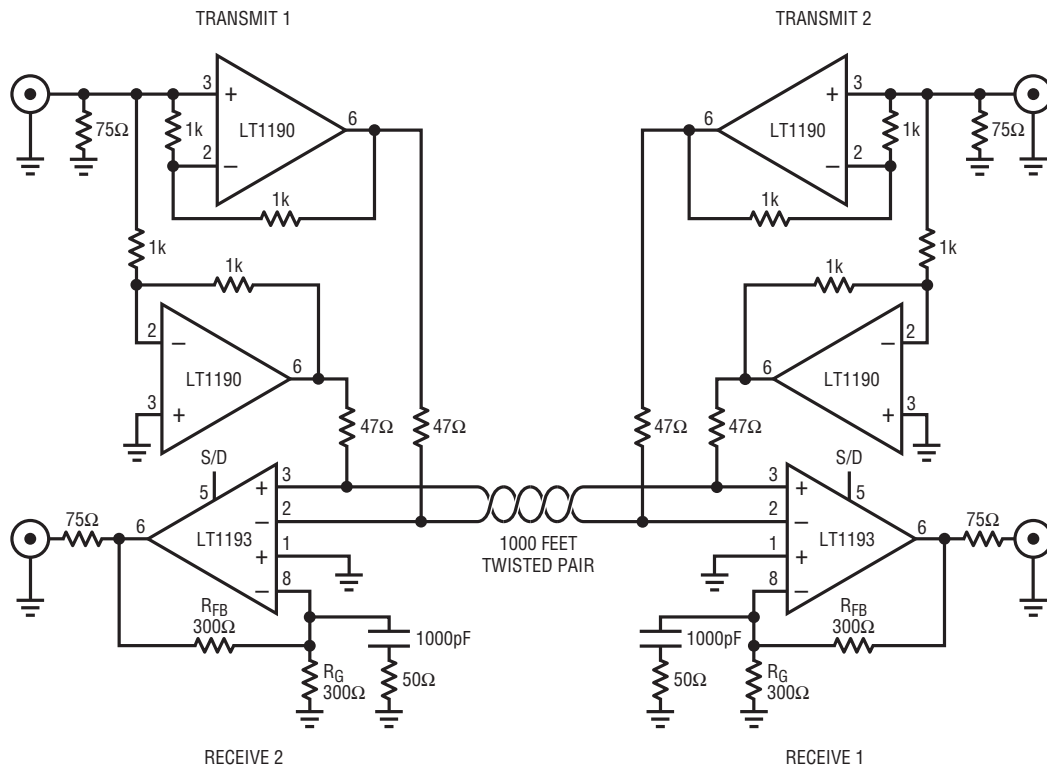
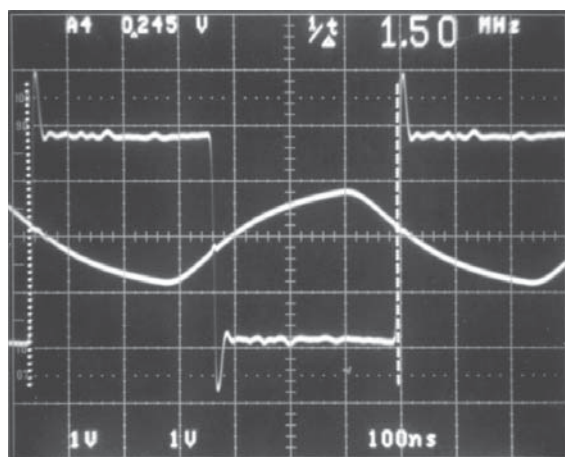
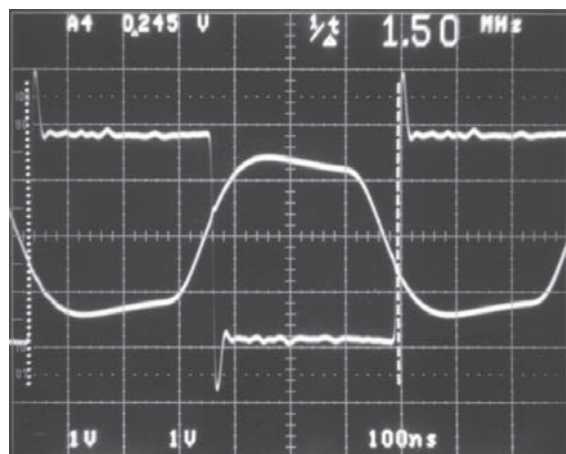


Figure 1. Bidirectional Video Bus

configurations. In addition to speed and load driving ability, the LT1193 provides high input impedance (+) and (-) inputs, and common-mode rejection in excess of 40dB at 10MHz. Because of the LT1193's unique topology, it is possible to provide cable compensation at the amplifier's feedback node as shown. In this case, 1000 feet of twisted-pair is compensated with 1000pF and 50 $\Omega$  to boost the -3dB bandwidth of the system from 750kHz to 4MHz. The effect of this compensation can be seen in Figure 2 and Figure 3. This bandwidth is adequate to pass 3.58MHz chroma subcarrier, and the 4.5MHz sound subcarrier. Attenuation in the cable can be compensated by lowering the gain-set resistor  $R_G$  in Figure 1. At TRANSMIT 2, another pair of LT1190s serves the dual function of providing cable termination via low output impedance, and generating differential signals for TRANSMIT 2.



**Figure 2. 1.5MHz Square Wave Input and Unequalized Response Through 1000 Feet of Twisted-Pair**

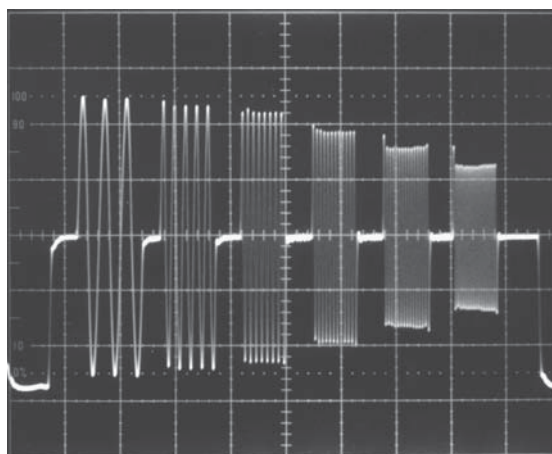


**Figure 3. 1.5MHz Square Wave Input and Equalized Response Through 1000 Feet of Twisted-Pair**

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A good indication of the system's ability to pass color composite video is shown in Figure 4. This multiburst pattern was passed through 1000 feet of low cost PVC twisted-pair, and it contains a 3.58MHz chroma subcarrier and a 4.5MHz sound subcarrier. Although the scope photo shows these frequencies to be attenuated about 3dB, a clean picture is present at the end of the twisted-pair. Additional receiver taps can be added along the twisted-pair. The trick is to leave the taps unterminated and limit their length. Longer drops cause the 3.58MHz chroma subcarrier to reflect and interfere with the phase of the transmitted subcarrier. The effect is color smudge or in the limit ghosting.



**Figure 4. Multiburst Pattern Passed Through 1000 Feet of Twisted-Pair**

The LT1190 and LT1193 include a shutdown feature that drops their dissipation to only 15mW when not in use. This feature is useful for shutdown of unused receivers, however shutdown of the drivers will result in mis-termination of the twisted-pair. If power consumption is a major concern, the LT1190 and LT1193 can be replaced with the low power LT1195 and LT1187, resulting in only a slight performance degradation.

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