APPLICATION NOTE

Single-Ended To Differential Twisted Pair Driver

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Introduction

The proliferation of personal computers and especially video applications has created a requirement for sending high speed analog signals over twisted pair for short distances (up to 200 feet). Twisted pair data transmission is easy to set up, the wire cost is very low compared to coax, so it is becoming a popular replacement for coax. Most electronic signals exist in a single-ended format, so the signal must be converted to a double-ended or differential format prior to taking advantage of twisted pair data transmission schemes. The circuit described in Figure 1 converts single-ended analog or digital signals into a differential signal capable of directly driving a twisted pair cable.

Q1, Q2, and Q3 are one half of a HFA3102 dual long-tailed pair transistor array, and they are configured in Figure 1 to function as a linear differential amplifier. Because the transistors are matched they will yield nearly identical performance depending upon their bias circuits. The base of Q2 is biased at 1.24V, and the base voltage of Q1 ranges from 1.0V to 1.6V depending on the setting of R3. When R3 is set at 1.24V the signals are amplified equally by both transistors, thus R3 becomes a symmetry adjustment which can be used to obtain equal amplitude but opposite phase outputs at the collectors of Q1 and Q2. This criteria satisfies the definition of a differential signal.

The differential gain is 5 to 7 as configured in Figure 1. The gain is set in this range because a typical video signal is less than two volts in amplitude, and these low gains will not cause distortion. R5 adjusts the current through both transistors, and because the gain is proportional to the emitter current R5 functions as a gain control. If the gain range is too high float the inverting inputs (pins 3 and 6) of the HFA1212 programmable gain amplifiers, and the gain will fall to half of it's previous value. If higher gains are required because longer twisted pairs must be driven, the differential output must be fed into a transformer which then drives the twisted pair cable. The transformer drive increases the signal amplitude without introducing distortion.

The circuit as shown will drive twisted pair cables directly. Each wire in the cable is connected to one of the differential outputs, and the cable is terminated at the receiving end in it's characteristic impedance (about 100Ω). The frequency response for linear signals is shown in Figure 2, and it indicates a -3dB bandwidth of 200MHz. The frequency response of twisted pair cables falls off at higher frequencies, so the amplifier response curve is purposely peaked at higher frequencies in an attempt to compensate for this. The combination will yield a flatter overall frequency response curve. This driver when coupled with a differential receiver will reliably transmit data over 200 feet of twisted pair cable in the presence of several hundred millivolts of single-ended noise. Digital signals should be handled the same as video signals except that wide fluctuations in the digital data rate will cause skew because of the AC coupling.

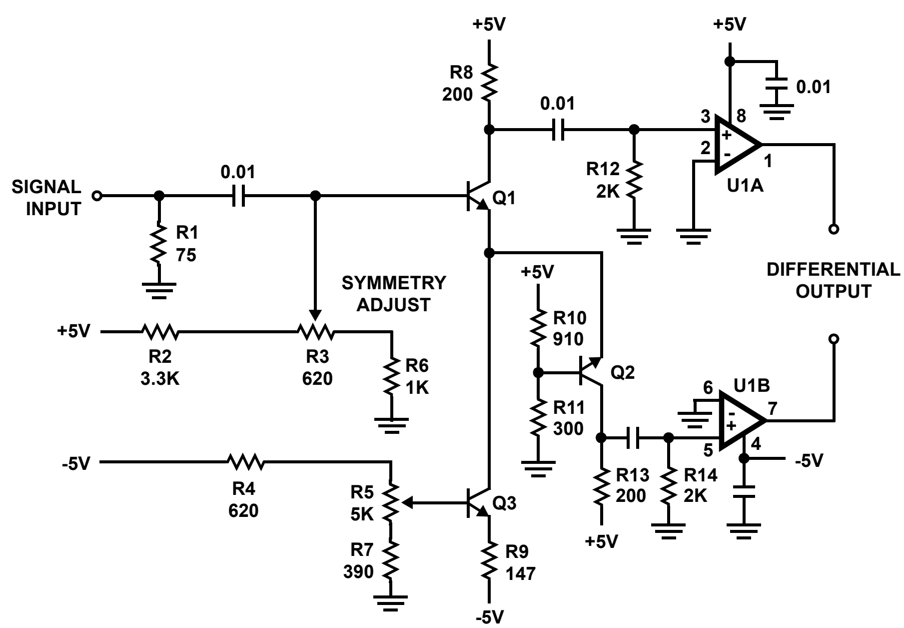

FIGURE 1. SINGLE ENDED TO DIFFERENTIAL TWISTED PAIR DRIVER

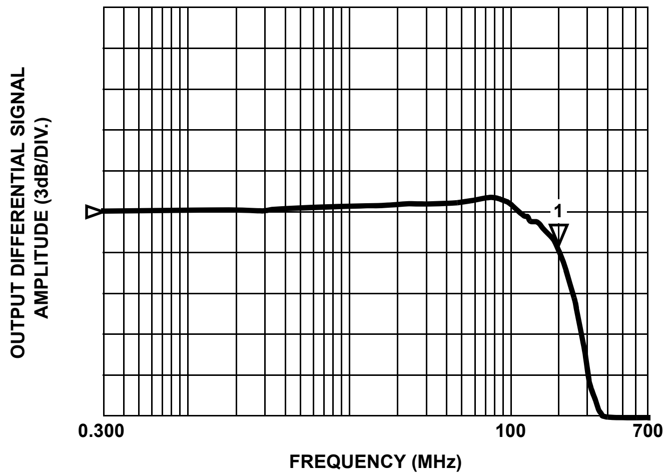

FIGURE 2. FREQUENCY RESPONSE PLOT FOR THE SINGLE-ENDED TO DIFFERENTIAL TWISTED PAIR DRIVER

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