signetics

APPLICATIONS MEMO 10124 10125

ECL 10,000 SERIES

INTRODUCTION

The 10124 QUAD TTL to ECL LEVEL TRANSLATOR/ LINE DRIVER and the 10125 QUAD ECL to TTL LEVEL TRANSLATOR/LINE RECEIVER have been designed for easy and economical implementation of interfaces such as:

TTL/DTL to ECL LEVEL TRANSLATION
ECL to TTL/DTL LEVEL TRANSLATION
TTL to TTL DIFFERENTIAL DATA TRANSMISSION

The 10124 has TTL compatible inputs and complementary open emitter outputs identical to those of a standard ECL 10,000 gate. A strobe input is common to all four translating gates to permit easy control of data flow. In addition, all inputs are diode clamped to protect against negative ringing. Thus, the 10124 may be used as an inverting/non-inverting translator or as a differential line driver for twisted pair or ribbon cable. Each output is capable of driving 50 ohm and various transmission line terminations are discussed in the appendix. The logic diagram is shown in Fig. 1a and the transfer curve in Fig. 1b illustrates typical input/output behavior of the TTL to ECL translator.

10124 QUAD TTL TO ECL TRANSLATOR

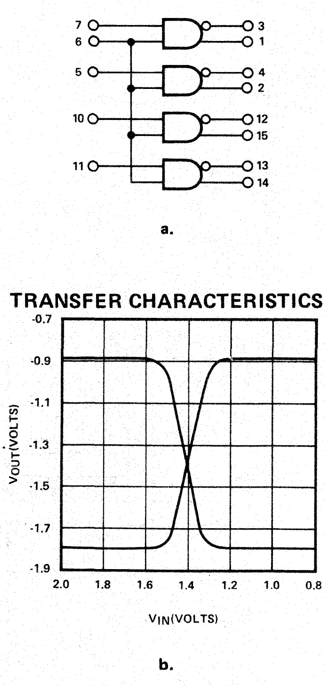


FIGURE 1

10125 QUAD ECL TO TTL TRANSLATOR (TOTEM-POLE OUTPUTS)

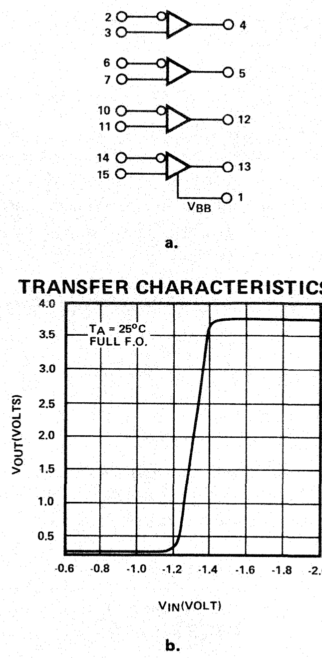


FIGURE 2

For ECL to TTL translation, the 10125 interface has complementary differential inputs and Schottky TTL outputs. As shown in the logic diagram, Fig. 2a, the device may be used as an inverting/non-inverting translator or as a differential line receiver. Input pulldown resistors that are standard with other ECL 10,000 circuits are not needed in the 10125. In single-ended applications, the unused input should be referenced to $-V_{BB}$, available on pin 1, for proper logic operation. But even if both inputs are left open, as well as during power supply turn-on, the 10125 is internally protected by a fail-safe circuit that puts the outputs in the logic "0" state.

Differential signals as low as 200mV at the inputs of the 10125 result in defined TTL output levels. A typical transfer curve is shown in Fig. 2b. Outputs are Schottky TTL "totem poles" that can fan out to 10 TTL loads. In addition, the 10125 has a ±1V common mode range when used differentially. This makes the device extremely attractive in data transmission applications where cross-talk or ground shifts are expected.

TTL/DTL to ECL LEVEL TRANSLATION

Figure 3a shows how TTL logic can be easily interfaced with high speed ECL 10,000 logic. Performing the TTL to ECL level translation on the TTL logic board with the 10124 is advantageous since it keeps noise out of the ECL system. By using differential data transmission, crosstalk will most likely appear as common mode noise on the twisted pair line driving the 10115 ECL line receiver.

The differential inputs do not respond to common mode voltage, V_{CM}, as long as it does not exceed the common mode range of the 10115 receiver, which is typically between +0.8V and −2.0V. (Note that a V_{CM} range of ±1V is guaranteed on the 10114 line receiver to be announced.)

Since the 10115 has voltage gain of about 6, differential input signals with at least 160mV amplitude will still result in defined ECL 10,000 output levels. Therefore, data transmission over long lines where signal attenuation is expected presents no problem.

As an example, performance of the 10124 driving 50 feet of twisted pair line into a 10115 line receiver is shown in Fig. 3b. Although the system may operate in the vicinity of 100MHz, only a 50 MHz data rate has been chosen to show that the system is properly terminated. Advantage has been taken of the 50 ohm drive capability of the 10124, which results in terminating the twisted pair with its characteristic impedance of approximately 100 ohms. Other termination schemes are shown in the appendix.

ECL to TTL LEVEL TRANSMISSION

When driving TTL from an ECL 10,000 source, the 10125 can be used as a differential line receiver that translates the signal levels on the TTL board which also has the advantage of isolating potential TTL noise from the ECL system. For short interconnects, such as those found on the same board, the interface between ECL and the 10125 receiver/level translator may be single ended. In that case, the unused inputs must be referenced to the bias voltage, V_{BB}, which is at the midpoint of the logic swing. For convenience V_{BB} is available on pin 1 of the 10125.

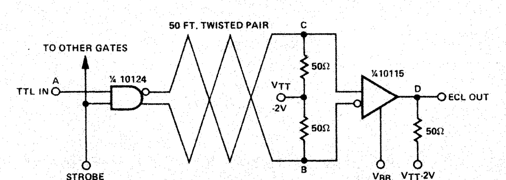
Long lines are best driven differentially as shown in Fig. 4a since it makes them less susceptible to induced noise or level shifts due to supply variations or temperature gradients. As mentioned earlier, most of the noise will appear as a common mode signal that is eliminated when using differential transmission as long as the 10125's common mode range of ±1V is not exceeded.

Because of a typical voltage gain of 8 in the input stage of the 10125, signals as low as 200mV are sufficient to guarantee TTL output levels. This fact is particularly beneficial when attenuation due to long lines or high frequency operation has to be overcome.

Figure 4 shows performance of the 10101-10125 system at 50MHz. Typically this configuration is capable of 100MHz operation. Again, advantage has been taken of the 50 ohm drive capability of the ECL 10,000 series in achieving the proper termination, but other termination possibilities are discussed later.

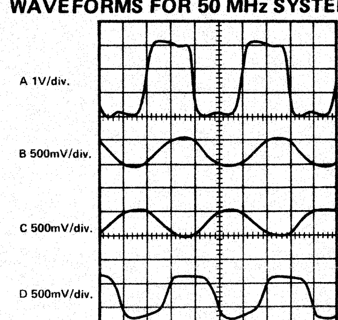
TTL TO ECL INTERFACE

10124 DRIVING 50 FT. TWISTED PAIR



a.

WAVEFORMS FOR 50 MHz SYSTEM

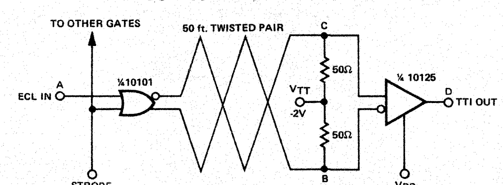


b.

FIGURE 3

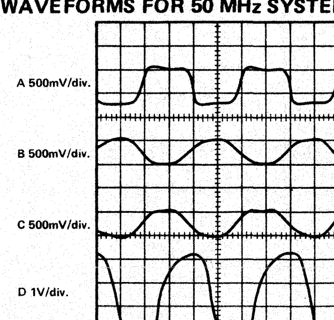
ECL TO TTL INTERFACE

10125 RECEIVING ECL SIGNAL OVER 50 FT. TWISTED PAIR



a.

WAVEFORMS FOR 50 MHz SYSTEM



b.

FIGURE 4

DIFFERENTIAL LINE DRIVER AND RECEIVER FOR TTL SYSTEMS

In TTL designs it is often desirable to drive long lines at high speed and low cost. The 10124 and 10125 can be used in an all TTL system to perform differential data transmission over twisted pair lines. Instead of conventional dual drivers and dual receivers the 10124/10125 combination only requires two IC's for four data channels.

The system shown in Fig. 5a can be used with data rates up to 100MHz. Twisted pair lines driven differentially provide maximum noise immunity for noise that is coupled into the system appears on both wires equally (i.e., common mode).

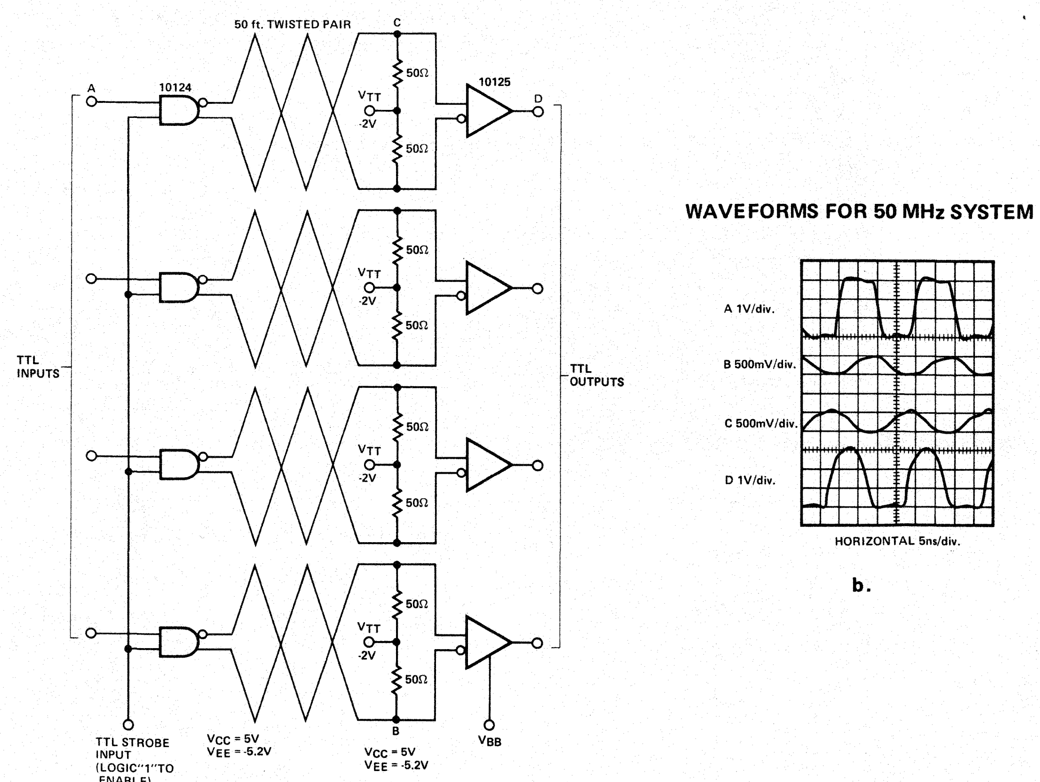
The receiver senses only differential voltage between the lines as long as the common mode range of ±1V is not exceeded. It was previously discussed that the 10125 input signal may be attenuated to 200mV which still results in guaranteed TTL output levels. Thus from d.c. considerations twisted pair in excess of 1 mile may be driven which makes signal attenuation at high frequencies the limiting factor.

Performance data for a 10124 driving 50 feet of twisted pair at 50MHz and a 10125 line receiver is shown in Fig. 5b. Other terminations schemes are possible and discussed below.

DIFFERENTIAL DATA TRANSMISSION IN TTL SYSTEMS

DATA TRANSFER OVER 50 FT. TWISTED PAIR

WAVEFORMS FOR 50 MHz SYSTEM



a.

b.

FIGURE 5

APPENDIX: TERMINATIONS FOR DIFFERENTIAL TRANSMISSION LINES

If transmission lines exceed approximately 6 inches they must be terminated in ECL 10,000 systems. The uncommitted emitter follower outputs of the ECL 10,000 series may be used with a variety of pulldown resistors depending on the available terminating voltage. The resistor values must be kept between the limits indicated in Figures 6a and 6b such that guaranteed noise margins are kept and output current capability is not exceeded.

If V_{TT} (−2V) is available, pulldown resistors as low as 50 ohms may be used. Thus, as shown in Fig. 7a, each end of the twisted pair is terminated to V_{TT} with $Z_O/2$ (50Ω) resulting in a net termination of Z_O, the lines characteristic impedance. This method of termination is most attractive since it results in minimum systems power dissipation. Furthermore, the full output swing is available at the end of the transmission line except for line attenuation.

When V_{TT} is not available, recommended pulldown resistors to V_{EE} (−5.2V) may range from 200 ohms to 500 ohms. However, the end of the transmission line must still be terminated in its characteristic impedance Z_O. Fig. 7b shows the DC equivalent circuit for differential transmission lines using this method.

The voltage at the end of the transmission line depends on the voltage divider relationship between the pulldown resistor R_L and the terminating resistor R_{TERM}. Assuming that one of the complementary outputs in Fig. 7b is high while the other is low, the voltage developed across the termination is equal to:

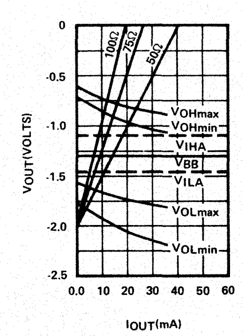
$$V_{TERM} = \frac{(V_{EE} - V_{OH})\, R_{TERM}}{R_L + R_{TERM}}$$

where: $V_{OH} = 0.9V$

For R_{TERM} = 100 ohms and R_L = 510 ohms, the differential voltage, V_{TERM}, at the input of the 10125 receiver is equal to 710mV. Notice that use of smaller pulldown resistors, R_L, in the above equation only allows the voltage, V_{TERM}, to become as large as 800mV and then the output in the low state will clamp at the low output voltage, V_{OL}.

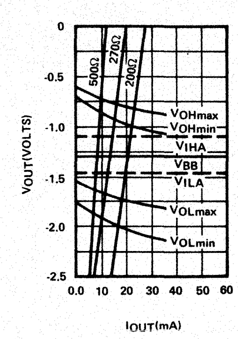
OUTPUT RESISTOR LOAD LINES FOR 10124

LOAD LINES FOR TERMINATIONS TO V_{TT}(2.0V)



a.

LOAD LINES FOR TERMINATIONS TO V_{EE}(-5.2V)

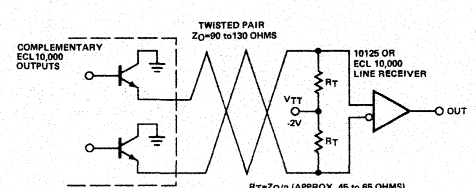


b.

FIGURE 6

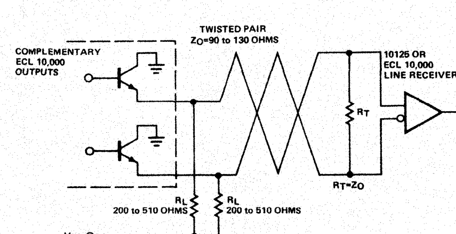
TERMINATION FOR DIFFERENTIAL DATA TRANSMISSION

IF ONLY V_{TT}(-2.0V) IS AVAILABLE



a.

IF ONLY V_{EE}(-5.2V) IS AVAILABLE



b.

FIGURE 7