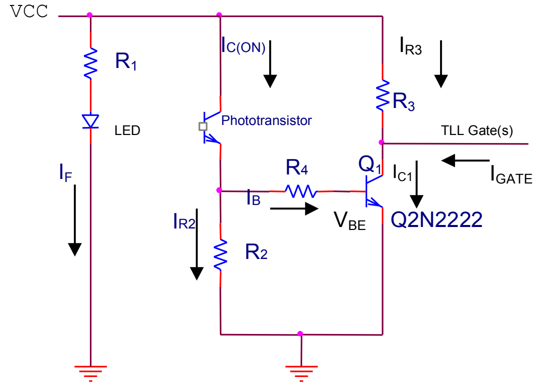
TTL Interface Circuit for Optoelectronic Devices

Application Bulletin 234

Typical TTL interfacing requires 1.6mA sinking current (IGATE) with a maximum voltage of 0.4V at the input of the TTL gate. Some optoelectronics components are not capable of sinking 1.6mA of Collector Current (IC(ON)), hence additional circuitry is needed to achieve the interface requirements. The transistor buffer, Figure 1, is a cost effective choice to interface circuits with TTL devices. If designed properly, the circuit can provide optimum noise immunity and fast switching.

The selection of R_3 depends on the gain (ß) of Q_1 and $I_{C(ON)}$ from the optoelectronic device: R_3 should be chosen for the lowest possible value.



The Equations for the above circuit:

$$I_{R3} = \frac{(V_{CC} - V_{CE(Q1)})}{R_3} \qquad (1.1)$$

$$I_{C1} = (I_{R3} + I_{GATE}) \qquad (1.2)$$

$$I_B = \frac{(I_{C1})}{\beta} \qquad (1.3)$$

$$I_{R2} = (I_{C(ON)} - I_B) \qquad (1.4)$$

$$R_2 = \frac{(V_{BE} + I_B R_4)}{I_{R2}} \qquad (1.5)$$

R_1 is the current limiting resistor for the Infrared LED.

$$R_1 = \frac{(V_{CC} - V_{F(LED)})}{I_F} \qquad (1.6)$$

TT Electronics | Optek Technology
1645 Wallace Drive, Suite 130, Carrollton, TX, USA 75006 |Ph: +1 972-323-2300
www.ttelectronics.com | sensors@ttelectronics.com

Example using the above equations:

A phototransistor with an $I_{C(ON)min}$ = 500µA

Q1 parameters:
2N2222 (β = 60 min) V_{CC} = 5 V.

Typically R_3 = 1kΩ resistor is used as a pull-up resistor for TLL interface.

From (1.1):

$$I_{R3} = \frac{(5-0.4)}{1000} = 4.6mA$$

To support TLL interface, the circuit needs to be able to sink 1.6mA = I_{GATE}.

From (1.2)

$$I_{C1} = (4.6mA - (-1.6mA)) = 6.2mA$$

From (1.3)

$$I_B = \frac{(6.2mA)}{60} = 103\mu A$$

To choose the R_2 value:

$$I_{R2} = (500\mu A - 103\mu A) = 397\mu A$$

Typically R_4 = 1kΩ base current limiting resistor for TLL interface.

From (1.5):

$$R_2 = \frac{(0.7V + 103\mu A \times 1k\Omega)}{397\mu A} \cong 2.02k\Omega$$

Complete saturation of the phototransistor is not necessary, however, adjustment to R_2 may be required if sensor is too sensitive. For example: if sensor is affected by ambient light lower the R_2 value.

To calculate the current limiting resistor for the LED use (1.6)
Desired I_F = 20mA.

$$R_1 = \frac{(5-1.3(typical))}{20mA} = 185\Omega$$

TT Electronics | Optek Technology
1645 Wallace Drive, Suite 130, Carrollton, TX, USA 75006 | Ph: +1 972-323-2300
www.ttelectronics.com | sensors@ttelectronics.com