Basic Design Ideas for Emitters and Sensors

There are some basic steps required to design-in a simple optoelectronics sensor. The first step is to get the LED to produce light. This is done by connecting the LED to a power supply using a resistor to establish the current flow. Figure 1 illustrates this schematically.

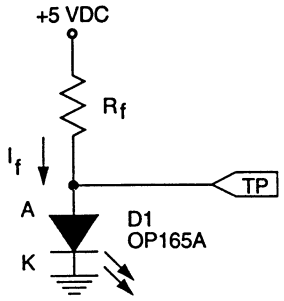

Figure 1

The LED V_F can be predicted by reviewing the forward voltage versus forward current curve in this catalog. Let's say we want to set the LED current for an OP165 at 20 mA. The V_F at this level, from the curve, will be about 1.2 V. Therefore, we must drop 3.8 V across the resistor R_f if the supply voltage is 5.0 V. From Ohm's law this calculates to be a 190 Ohm resistor. The power to the resistor will be 76 mW, so a 1/8 watt or larger resistor will work in this application. To be sure everything is connected properly, measure the voltage at TP with power applied. The V_F should be, as predicted, about 1.2 V. If it is 5 V, the LED is open or connected backwards, or there is a wiring error. If the voltage is 0 V, the LED is shorted, or a wiring problem may exist. At these currents, the LED output will be linear. Increase the current by 20%, the light output will increase by 20%. Ideally, the LED should be operated at a low drive current to conserve power and to minimize the effects of LED degradation. A good operating current for most applications is 20 mA.

Now that the LED is generating light, a phototransistor is used to sense it. A phototransistor functions just like a transistor except the base current is produced by an integral photodiode. Therefore, we only have to connect the collector and the emitter of the transistor. The current conducted by the transistor will be proportional to the incident light. If an OP505 phototransistor is coupled with an OP165 LED and the spacing between the lens tips is 0.2", the photo current will be greater than 1 mA. This current can be detected by using the circuit shown in Figure 2.

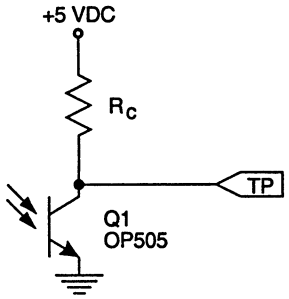

Figure 2

Assuming the phototransistor is operating in a saturated condition, the voltage drop across the phototransistor will be less than 0.4 V. Therefore, we must drop 4.6 V across R_C when the LED is on. From Ohm's law, the resistor R_C must be greater than 4600 Ohms. Therefore, a 10K Ohm resistor would be a conservative choice. This combination results in a voltage swing from less than 0.4 V to over 4.9 V when the LED is turned on and off at the test point. This is a suitable interface for a CMOS input or a voltage comparator.

There are other factors to be considered including aperture size or resolution of the sensor, effects of ambient light, switching speed and more. However, this application note is designed to assist someone who has little experience with optoelectronics.