

# Errata for *Process Control* v1.0 (#122-28176)

## Chapter 4 Opto-Reflective Switch Use

### Background

The opto-reflective switch is used predominately in Chapter 4 as a means to illustrate sensor sensitivity and response in relation to the sizing of the pull-up resistor on an Infrared (IR) phototransistor's collector. This errata note will assist in successfully completing Chapter 4 activities and demonstrating the principles intended.

The principle in operation is that an IR LED emits infrared light which is reflected to the phototransistor from a white surface in close proximity causing the phototransistor to conduct within its linear range. A black surface will absorb the IR preventing the transistor from conducting sufficiently. By adjusting the collector resistance ( $R_C$ ) the text intends to illustrate how this value affects both the sensitivity and the response of the sensor and BJT transistors in general.

Issues relating to the successful completion of Chapter 4 activities using the opto-reflective switch include:

- Ambient IR sources.
- Part substitution from authorship to publication.
- Reflectivity of inks.

Recommendations are provided, but it will rely upon the understanding of the principles of those conducting the experiments to ensure their objectives are being met by adjusting test parameters as necessary to achieve desired results.

### Ambient IR Sources

The phototransistor is extremely sensitive to IR light, and as such, care should be taken to prevent ambient light sources from affecting the experiment. Sunlight, and in some cases fluorescent light, can affect measurements of the sensor. Care should be taken to limit these sources if they appear to be affecting the experiment.

### Recommendations

When testing Activity #1, position the reflector approximately 2 cm from the detector and determine the voltage output of the sensor. Darken the area of the experiment as best as possible and measure once again. There should be no significant voltage change ( $< 0.5$  V).

## Part Substitution from Authorship to Publication

A part substitution was made during editing and formatting of the text from one which was tested and used by the author to the QRB1114. The IR phototransistor in the QRB1114 has a much higher sensitivity than the device used in the development of the material resulting in saturation of the phototransistor very easily.

### Recommendations

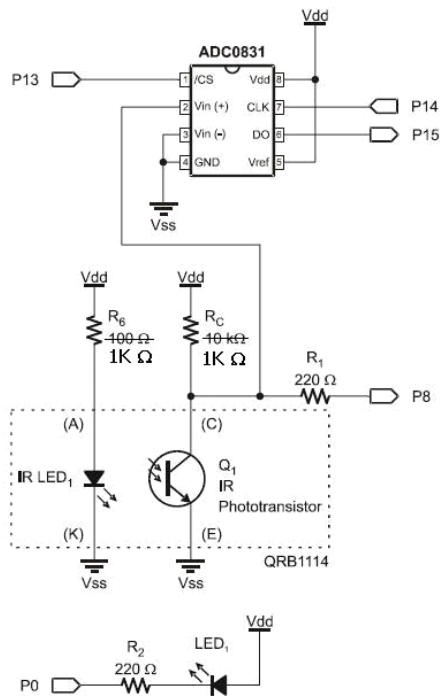
To adjust the parts and activities to compensate for this increased sensitivity, the following is recommended, though other values may be tested to achieve desired results:

- Increase the value of the IR LED resistor by a factor of 10, from 100  $\Omega$  to 1 k $\Omega$ . This will greatly reduce the emitted IR and therefore the reflected IR to be sensed by the phototransistor. This resistor is labeled  $R_6$  in Figure 4-2, page 86.
- Reduce the size of all values of  $R_C$  for the phototransistor by a factor of 10. This will greatly reduce the sensitivity of the photo transistor. This resistor is labeled  $R_C$  throughout Chapter 4.
  - 1 M $\Omega$   $\rightarrow$  100 k $\Omega$
  - 100 k $\Omega$   $\rightarrow$  10 k $\Omega$
  - 10 k $\Omega$   $\rightarrow$  1 k $\Omega$

### Specific Modifications to Chapter 4 Activities

#### Activity #1

1. Page 86, Figure 4-2: Modify  $R_6$  to 1 k $\Omega$  and  $R_C$  to 1 k $\Omega$  as shown below.



**Figure 0-1**  
Opto-Reflective  
Switch Monitoring

2. Page 87 recommends moving your hand toward and away from the QRB1114 sensor.

The box labeled VCE should show different readings as you move your hand. If the VCE readings do not change, something is amiss, and it is time to troubleshoot:

The amount of voltage drop may be very small. A white piece of paper moved in front of the sensor will be a better test.

3. Page 87, on specifying the resistor in StampPlot:

When all is working, move on:

- √ Verify that 10 is selected from the RC(K) drop-down menu in StampPlot.

Since 1K is not a choice, type the value **1** into the RC(K) drop-down box.

4. Throughout the remainder of the activity, reduce the size of RC by a factor of 10. Page 89, bottom of page, thus becomes:

- √ Replace  $R_C$  with a **10 k $\Omega$**  resistor.
- √ Select **10** from the RC(K) drop-down menu.
- √ Repeat the activity, and label the resulting line "**10 K Ohm response**"
- √ Replace  $R_C$  with a **100 k $\Omega$**  resistor.
- √ Select **100** from the RC(K) drop-down menu.
- √ Repeat the activity, and label the resulting line "**100 K Ohm response**"

5. Page 90, Figure 4-6: This figure should be representative of your response for a 10 k $\Omega$  value of  $R_C$  as opposed to 100 k $\Omega$ .

#### *Activity #2*

1. Page 94, Figure 4-9: For  $R_6$  use 1 k $\Omega$  and for  $R_C$  use 100 k $\Omega$ .

#### *Activity #6*

1. Page 117, Figure 4-18: For  $R_6$  use 1 k $\Omega$  and for  $R_C$  use 100 k $\Omega$ .

#### *Activity #7*

1. Page 128, Figure 4-9: For  $R_6$  use 1 k $\Omega$ .
2. This activity was intended to increase the response and sensitivity of the detector using a Darlington Pair. As the number of vanes increases on the encoder wheel in Activity #6, there comes a point where the detector is no longer fast enough to respond. With the higher sensitivity of the opto-reflective switch used and therefore lower value of  $R_C$ , this activity may not be absolutely required.

## **Reflectivity of Inks**

The principle employed in the tachometer projects (Activity #6) is the white vane on the encoder will reflect light causing the phototransistor to conduct, registering as a low. Dark vanes will

absorb the IR light and register as a high. The number of transitions is counted to arrive at the RPM of the fan.

### Recommendations

Not all inks absorb IR equally and some may be reflective to this wavelength of light. It is recommended to use the data monitoring set of programs from Chapter 3 (DataMonitoring.bs2, page 46, and the sic\_pc\_data\_monitoring.spm macro) to test the reflection conduction with the 1 Cycle/revolution encoder wheel.

- √ Construct the circuit in Figure 4-18, page 117. For  $R_6$  use 1 k $\Omega$  and for  $R_C$  use 100 k $\Omega$ . Do not power the fan yet.
- √ Connect the Vin+ pin of the ADC (Pin 2) to the collector of the IR phototransistor.
- √ Download and run DataMonitoring.bs2
- √ Load StampPlot with the macro sic\_pc\_data\_monitoring.
- √ Position the fan approximately 1/2 inch from the opto-reflective switch with the 1 Cycle/revolution encoder wheel.
- √ Monitor the voltage when the sensor 'sees' the white vane and then the black vane. A distinct change should be noted in the ADC's output from light (<1.4V) to a dark (>1.4V). Ideally, when seeing reflection, the voltage should be near 0.3V due to saturation. When absorbed, the voltage should be near 5V due to being in cutoff.
- √ Based on results of prior experiments with varying resistances of  $R_C$ , adjust  $R_C$  to achieve an adequate transition. If the detector appears to always be reflecting (low voltage), use markers or other dark inks to color the dark vanes to limit reflection.
- √ When proper transitions are noted, continue with Activity #6.