QTR-1RC Reflectance Sensor (2-Pack)

The QTR-1RC reflectance sensor carries a single infrared LED and phototransistor pair in an inexpensive, tiny 0.5" x 0.3" module that can be mounted almost anywhere and is great for edge detection and line following. **The output is designed to be measured by a digital I/O line.** This sensor is sold in packs of **two** units.

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Description   Specs (2)   Pictures (8)   Resources (8)   FAQs (1)   On the blog (4)

Note: The QTR-1RC reflectance sensor requires a digital I/O line to take readings. The similar **QTR-1A reflectance sensor** is available with an analog output.
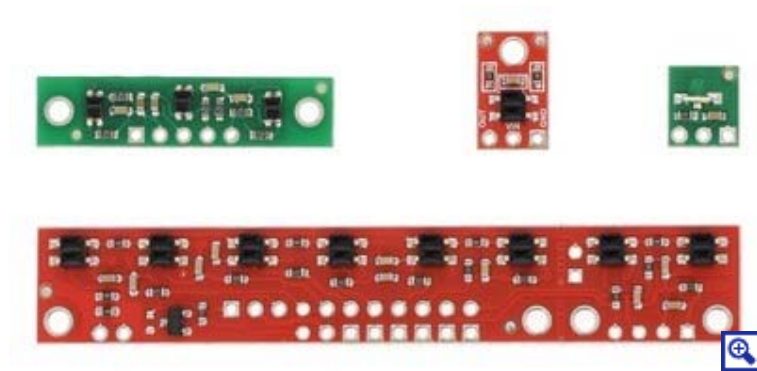
Functional description

The Pololu QTR-1RC reflectance sensor carries a single infrared (IR) LED and phototransistor pair. To use the sensor, you must first charge the output node by applying a voltage to the OUT pin. You can then read the reflectance by withdrawing the externally supplied voltage and timing how long it takes the output voltage to decay due to the integrated phototransistor. Shorter decay time is an indication of greater reflection. This measurement approach has several advantages, especially when multiple units are used:

- No analog-to-digital converter (ADC) is required
- Improved sensitivity over voltage-divider analog output
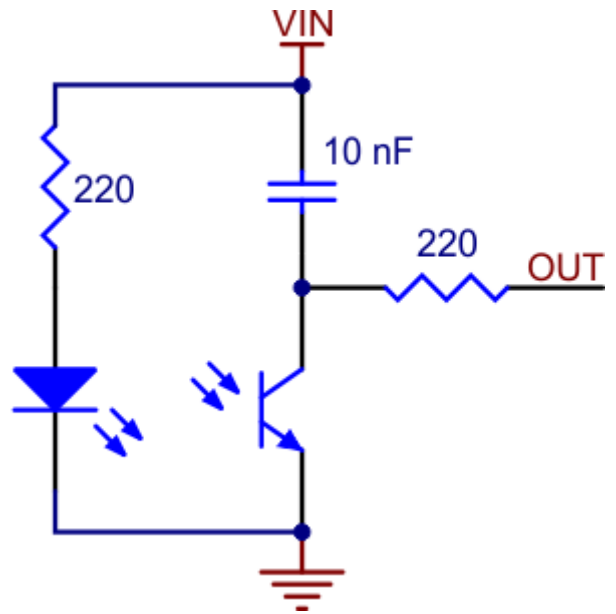- Parallel reading of multiple sensors is possible with most microcontrollers

The LED current-limiting resistor is set to deliver approximately 17 mA to the LED when VIN is 5 V. The current requirement can be met by some microcontroller I/O lines, allowing the sensor to be powered up and down through an I/O line to conserve power.

This sensor was designed to be used with the board parallel to the surface being sensed. Because of its small size, multiple units can easily be arranged to fit various applications such as line sensing and proximity/edge detection.

For a line sensor with eight of these units arranged in a row, please see the **QTR-8RC reflectance sensor array**; for a similar array of three slightly different sensor components, see the **QTR-3RC**. For a similar, smaller sensor with longer range, and intended for use with the board perpendicular to the surface, please see the **QTR-L-1RC reflectance sensor**.

QTR sensor size comparison. Clockwise from top left: QTR-3RC, QTR-1RC, QTR-L-1RC, QTR-8RC.

Specifications

- Dimensions: 0.3" x 0.5" x 0.1" (without optional header pins installed)

- Operating voltage: 5.0 V

- Supply current: 17 mA

- Output format: digital I/O-compatible signal that can be read as a timed high pulse

- Optimal sensing distance: 0.125" (3 mm)

- Maximum recommended sensing distance: 0.375" (9.5 mm)

- Weight without header pins: 0.008 oz (0.2 g)

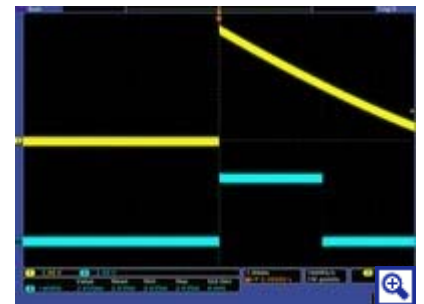## Interfacing the QTR-1RC output to a digital I/O line

Like the Parallax QTI, this sensor requires a digital I/O line capable of driving the output line high and then measuring the time for the output voltage to decay. The typical sequence for reading a sensor is:

1. Set the I/O line to an output and drive it high.

2. Allow at least 10 μs for the sensor output to rise.

3. Make the I/O line an input (high impedance).

4. Measure the time for the voltage to decay by waiting for the I/O line to go low.

QTR-1RC output (yellow) when 1/8" above a black line and microcontroller timing of that output (blue).

These steps can typically be executed in parallel on multiple I/O lines.

With a strong reflectance, the decay time can be as low as several dozen microseconds; with no reflectance, the decay time can be up to a few milliseconds. The exact time of the decay depends on your microcontroller's I/O line characteristics. Meaningful results can be available within 1 ms in typical cases (i.e. when not trying to measure subtle differences in low-reflectance scenarios), allowing up to 1 kHz sampling.

Our **Pololu AVR library** provides functions that make it easy to use these sensors with our **Orangutan robot controllers**; please see the **QTR Reflectance Sensors section** of our library command reference for more information. We also have a **Arduino library** for these sensors.
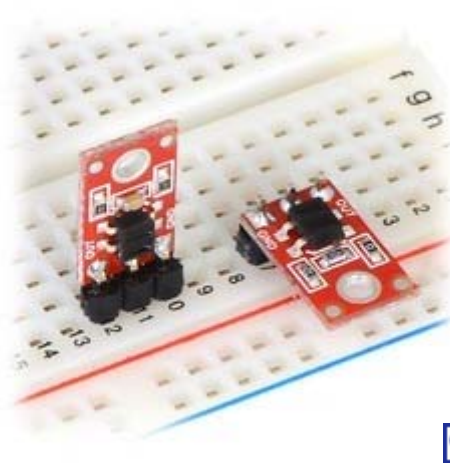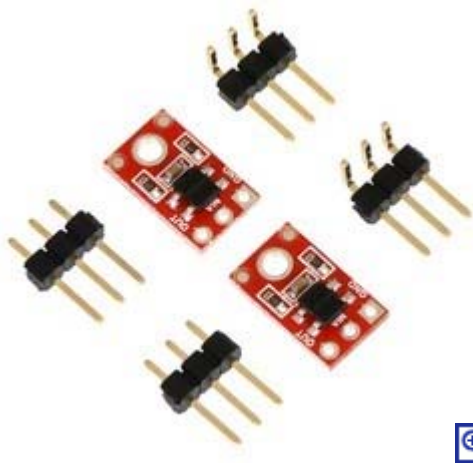
Included components

This module has a single mounting hole intended for a #2 screw (not included); if this mounting hole is not needed, this portion of the PCB can be ground off to make the unit even smaller. Each pack of two reflectance sensors includes sets of **straight male header strips** and **right-angle male header strips**, which allow you to mount them in the orientation of your choice (note: the header pins might ship as 1×6 strips that you can break into two 1×3 pieces). You can also solder wires, such as ribbon cable, directly to the pads for the most compact installation.
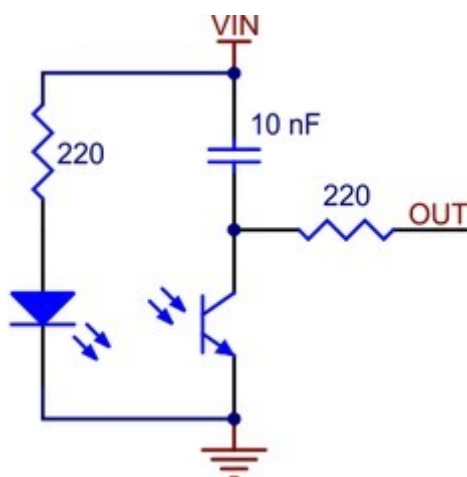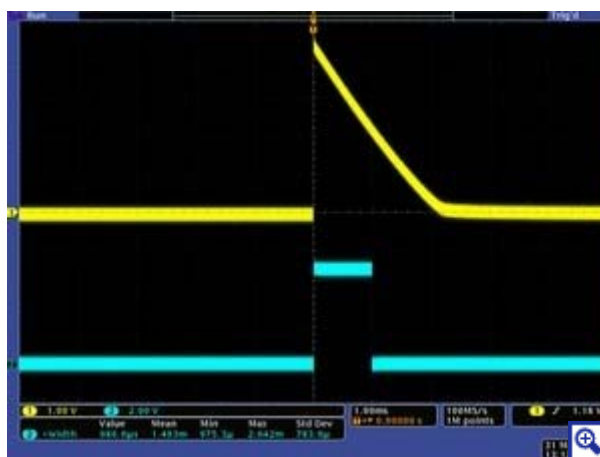

How it works in detail

With only four components (or five, if you count the coupled IR LED and phototransistor separately), the operation of this sensor is relatively basic. The emitter side is just an IR LED with an appropriate current-limiting resistor. The light from the emitter leaves the sensor, reflects off a nearby surface, and returns to the detector.

The detector side is a resistor-capacitor (RC) circuit, where the resistance comes from the phototransistor and is a measure of the incident infrared light, and the decay time is proportional to the resistance. The first step of the sensor-reading process—driving the sensor output high—discharges the integrated 10 nF capacitor and puts both sides at the same voltage (VIN). Alternatively, you can think of this as "charging the output node", and it is functionally equivalent to charging a capacitor with one side connected to ground. Once you are no longer supplying an external voltage to the output pin, the capacitor can slowly charge through the phototransistor, with the rate of charging being a function of the phototransistor's resistance (which is in turn a function of the incident IR). As the capacitor charges, the voltage on the output side drops, eventually reaching zero when the capacitor is fully charged. Alternatively, you can think of this as "discharging the output node", and it is functionally equivalent to discharging a capacitor with one side connected to ground.

The 220 Ω resistor on the OUT line serves to limit the current flow, making it possible for a microcontroller output to safely charge the output node prior to each reading. It has very little effect on the sensor output.

QTR-1RC and QTR-L-1RC reflectance sensor schematic diagram.

QTR-1RC output (yellow) when 1/8" above a white/black interface and microcontroller timing of that output (blue).

People often buy this product together with:

QTR-1A Reflectance Sensor (2-Pack)

QTR-8RC Reflectance Sensor Array

QTR-L-1RC Reflectance Sensor (2-Pack)

Related products

QTR-1A Reflectance Sensor (2-Pack)

QTR-8RC Reflectance Sensor Array

QTR-8A Reflectance Sensor Array

QTR-L-1RC Reflectance Sensor (2-Pack)

QTR-L-1A Reflectance Sensor (2-Pack)

QTR-3RC Reflectance Sensor Array

QTR-3A Reflectance Sensor Array

VL6180X Time-of-Flight Distance Sensor Carrier with Voltage Regulator, 60cm max

Sharp GP2Y0A51SK0F Analog Distance Sensor 2-15cm

Pololu 38 kHz IR Proximity Sensor, Fixed Gain, Low Brightness

0.100" (2.54 mm) Breakaway Male Header: 1×40-Pin, Right Angle

Pololu Carrier with Sharp GP2Y0D815Z0F Digital Distance Sensor 15cm

Zumo Reflectance Sensor Array

Pololu 38 kHz IR Proximity Sensor, Fixed Gain, High Brightness

Pololu 3pi Robot