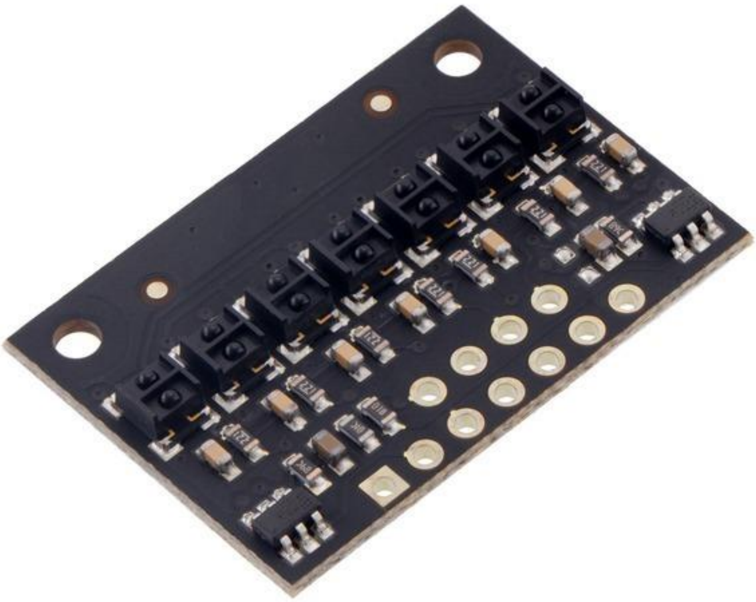
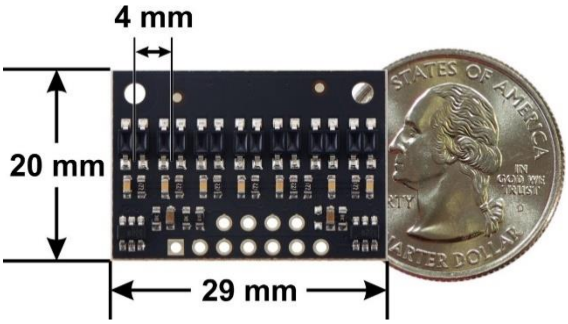
POLOLU QTRX-HD-07A REFLECTANCE SENSOR ARRAY

USER'S GUIDE



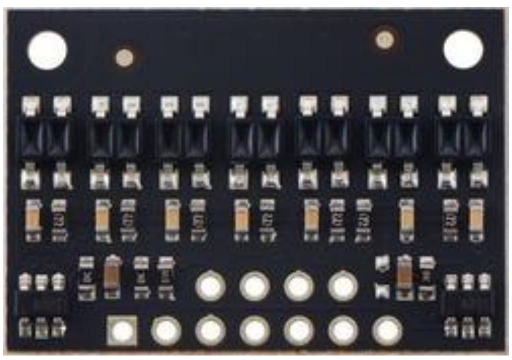
OVERVIEW

These QTR reflectance sensor arrays feature seven IR emitter/phototransistor pair modules in a high-density (4 mm pitch) arrangement, which makes them well suited for applications that require precise detection of changes in contrast,

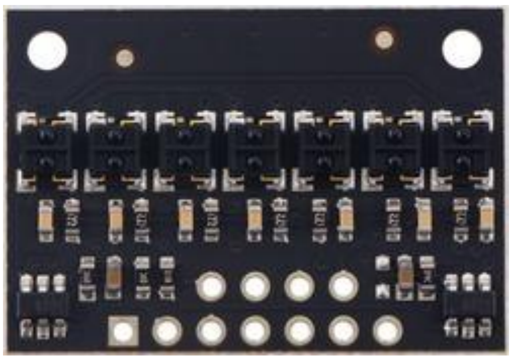


such as line sensing. Unlike our original QTR sensor modules, these units have integrated LED drivers that provide brightness control independent of the supply voltage, which can be anywhere from 2.9 V to 5.5 V, while enabling optional dimming to any of 32 possible brightness settings. There are separate controls for the odd-numbered and even-numbered LEDs, which gives you extra options for detecting light reflected at various angles. See the “Emitter control” section below for more information on using this feature.

Two different sensor options are available, denoted by “QTR” or “QTRX” in the product name. The “QTR” versions feature lower-cost sensor modules without lenses while the “QTRX” versions feature higher-performance sensor modules with lenses, which allow similar performance at a much lower IR LED current.

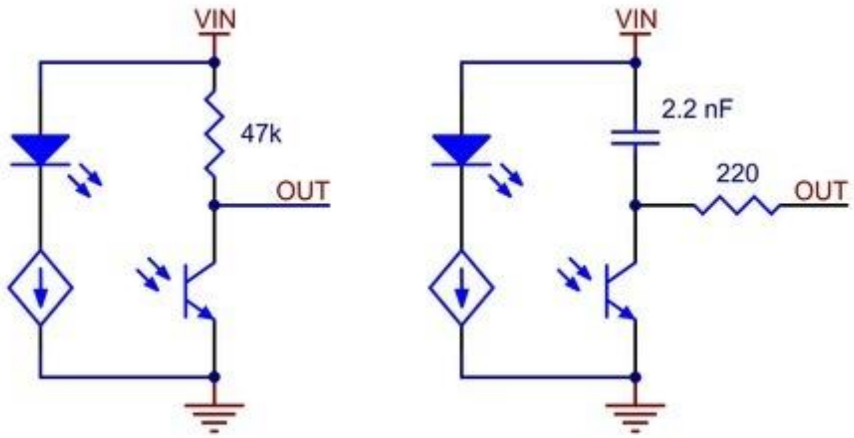


QTR-HD-07RC Reflectance Sensor Array



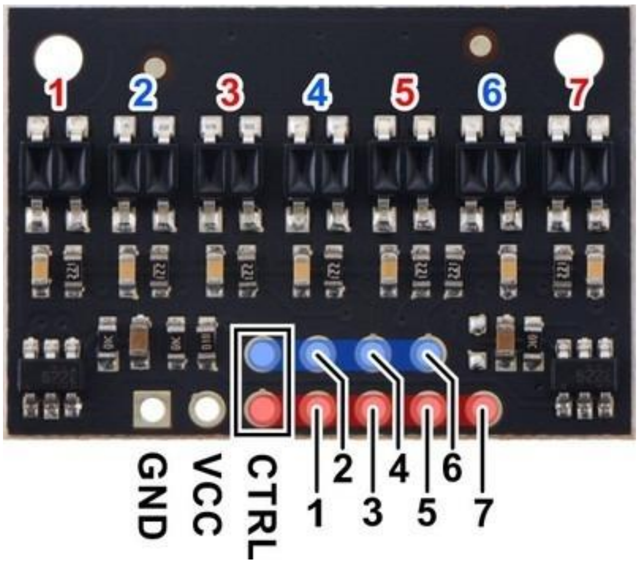
QTRX-HD-07RC Reflectance Sensor Array

Each sensor option is available in two output types: “A” versions with analog voltage outputs between 0 V and VCC, and “RC” versions with outputs that can be read with a digital I/O line on a microcontroller by first setting the line high and then releasing it and timing how long it takes to read as low (typically anywhere from a few microseconds to a few milliseconds). The lower the output voltage or shorter the voltage decay time, the higher the reflectance. The following simplified schematic diagrams show the circuits for the individual channels:



Schematic diagrams of individual QTR HD sensor channels for A version (left) and RC version (right).

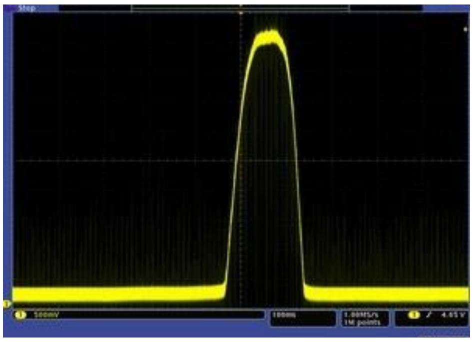
INTERFACING WITH THE OUTPUTS OF THE QTRX-HD-07A



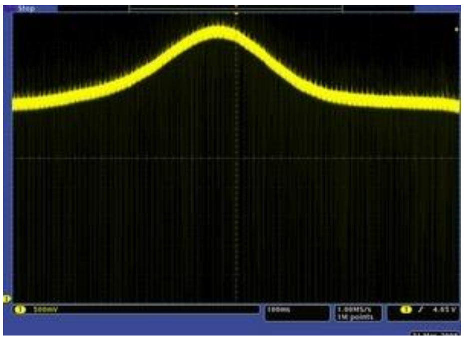
There are several ways you can interface with the analog outputs from this sensor array:

- Use a microcontroller's analog-to-digital converter (ADC) to measure the voltages.
- Use a comparator with an adjustable threshold to convert each analog voltage into a digital (i.e. black/white) signal that can be read by the digital I/O line of a microcontroller.
- Connect each output directly to a digital I/O line of a microcontroller and rely upon its internal comparator.

This last method will work if you are able to get high reflectance from your white surface as depicted in the left image, but will probably fail if you have a lower-reflectance signal profile like the one on the right.



QTR-1A output 1/8" away from a spinning white disk with a black line on it.



QTR-1A output 3/8" away from a spinning white disk with a black line on it.

Our Arduino library makes it easy to use these sensors with an Arduino or compatible controller by providing functions for reading the individual sensor values and, for line-following applications, converting those sensor readings into a line position.

EMITTER CONTROL

This reflectance sensor array maintains a constant current through its IR emitters, keeping the emitters' brightness constant, independent of the supply voltage (2.9 V to 5.5 V). The emitters can be controlled with the board's CTRL pins. By default, these are connected together with a 1 kΩ resistor and pulled up, turning on all the emitters by default and allowing them to be controlled with a signal on either pin, but the CTRL ODD and CTRL EVEN pins can be driven differently for separate control of the odd-numbered and even-numbered emitters.

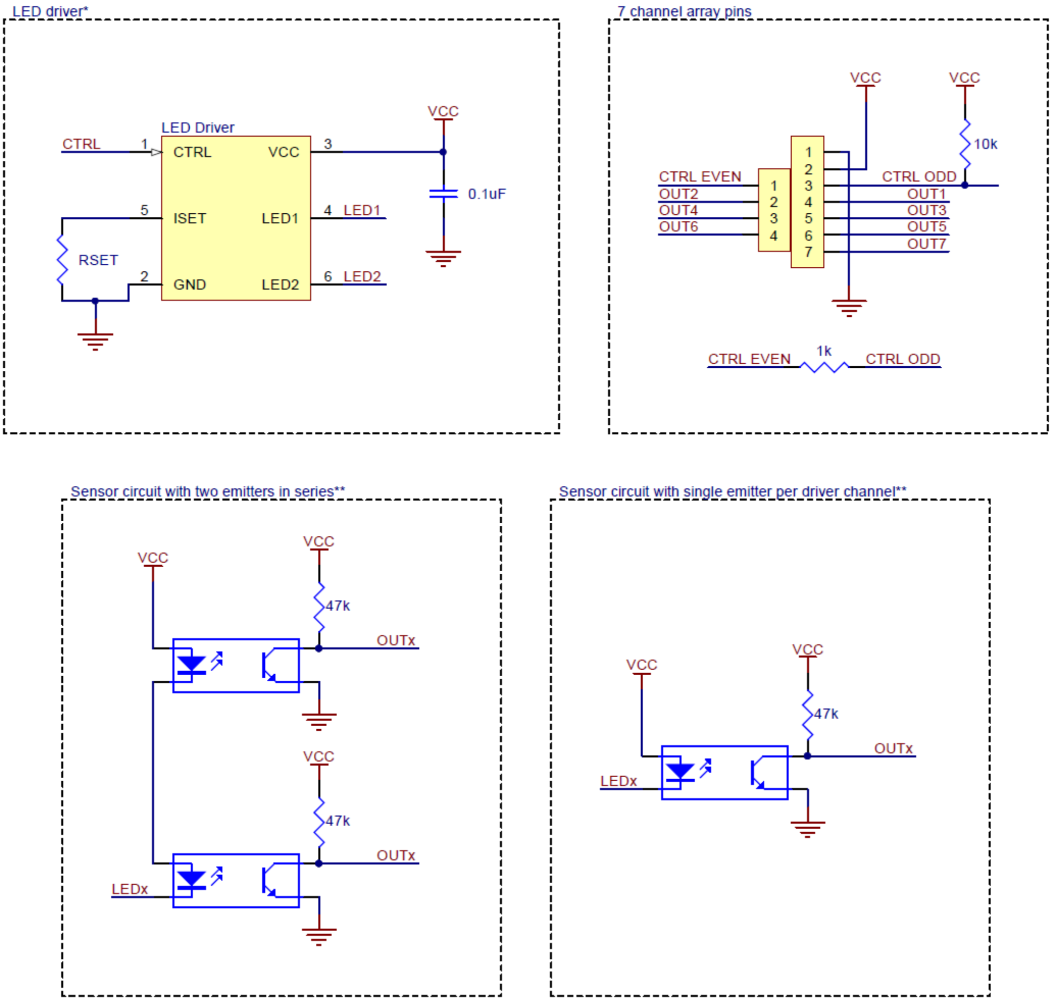
Driving a CTRL pin low for at least 1 ms turns off the associated emitter LEDs, while driving it high (or allowing the board to pull it high) turns on the emitters with the board's default (full) current of 3.5 mA. For more advanced use, the CTRL pin can be pulsed low to cycle the associated emitters through 32 dimming levels.

To send a pulse, you should drive the CTRL pin low for at least 0.5 µs (but no more than 300 µs), then high for at least 0.5 µs; (it should remain high after the last pulse). Each pulse causes the driver to advance to the next dimming level, wrapping around to 100% after the lowest-current level. Each dimming level corresponds to a 3.33% (0.12 mA) reduction in current, except for the last three levels, which represent a 1.67% (0.06 mA) reduction, as shown in the table below. Note that turning the LEDs off with a >1 ms pulse and then back on resets them to full current.

Dimming level (pulses)	Emitter current (%)	Emitter current (mA)	Dimming level (pulses)	Emitter current (%)	Emitter current (mA)
0	100.00%	3.5	16	46.67%	1.63
1	96.67%	3.38	17	43.33%	1.52
2	93.33%	3.27	18	40.00%	1.4
3	90.00%	3.15	19	36.67%	1.28
4	86.67%	3.03	20	33.33%	1.17
5	83.33%	2.92	21	30.00%	1.05
6	80.00%	2.8	22	26.67%	0.93
7	76.67%	2.68	23	23.33%	0.82
8	73.33%	2.57	24	20.00%	0.7
9	70.00%	2.45	25	16.67%	0.58
10	66.67%	2.33	26	13.33%	0.47
11	63.33%	2.22	27	10.00%	0.35
12	60.00%	2.1	28	6.67%	0.23
13	56.67%	1.98	29	5.00%	0.18
14	53.33%	1.87	30	3.33%	0.12
15	50.00%	1.75	31	1.67%	0.06

For example, to reduce the emitter current to 50% (15 mA), you would apply 15 low pulses to the CTRL pin and then keep it high after the last pulse.

SCHEMATIC



*Number of LED drivers on each array depends on the number of senseors populated
**Module constructed from combination of single and dual sensor circuits

Schematic diagram of the QTR-HD-07A and QTRX-HD-07A Reflectance Sensor Arrays.