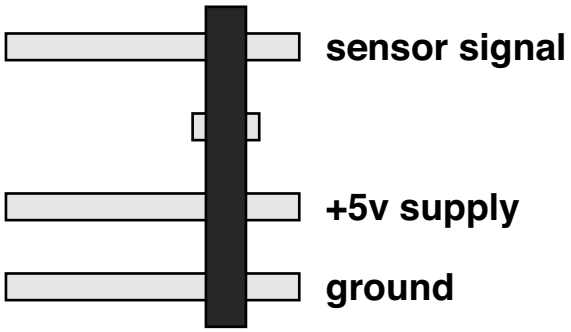
Extracted from pg. 26-30 from the document "HandyBoard Technical Reference", (by Fred G. Martin, © 1995-97 MIT Media Laboratory)
http://www.handyboard.com/techdocs/

5.3 Sensors

5.3.1 Basic Sensor Connector



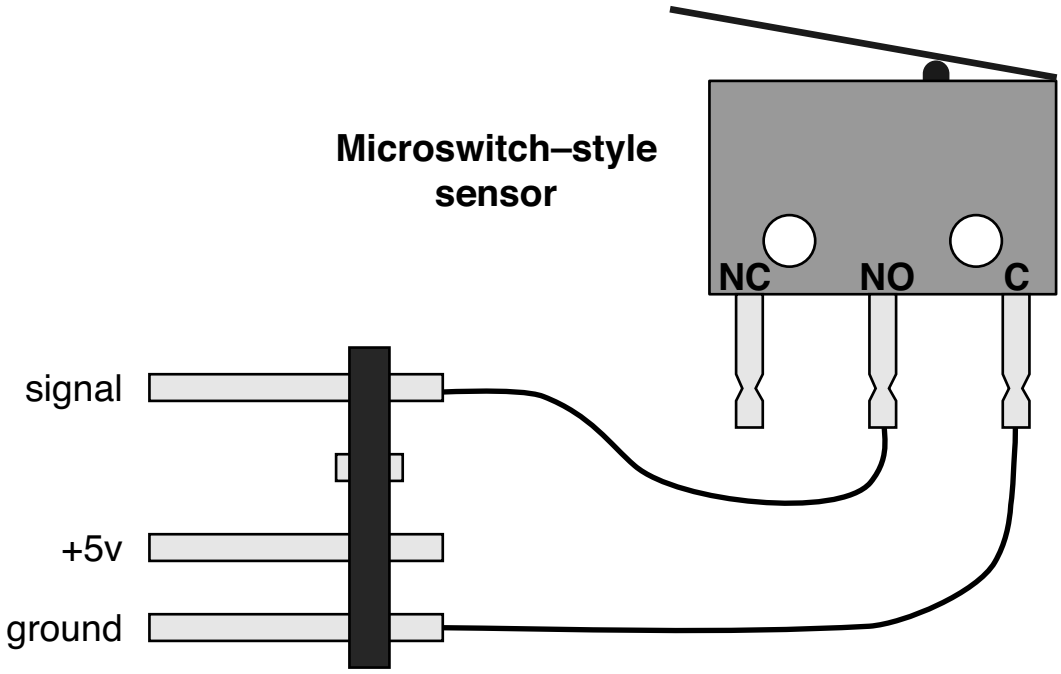
The Handy Board uses a three-conductor connector for plugging in sensor devices. As indicated in the diagram, the connector is formed from 4–prong male header pins, with one pin clipped away to polarize the connector (i.e., prevent it from being plugged in improperly).

The pin labelled "+5v supply" may be used to power an active sensor (e.g., the transmitter LED of a reflective optosensor). The pin labelled "sensor signal" is the input to the Handy Board circuitry; this must be in the range of 0 to 5 volts. The pin labelled "ground" is the system ground.

The Handy Board includes a 47K pullup resistor that is wired between the sensor signal line and the +5v supply on all of its inputs, both analog and digital. This simplifies sensor design in several regards:

- All sensors have a default level of +5v when nothing is plugged in.
- For switch-type or resistive-type sensors, the sensor device just needs to be wired from the sensor signal pin to ground. Thus many sensor devices reduce to a simple two-wire connection.

5.3.2 Switch Sensor



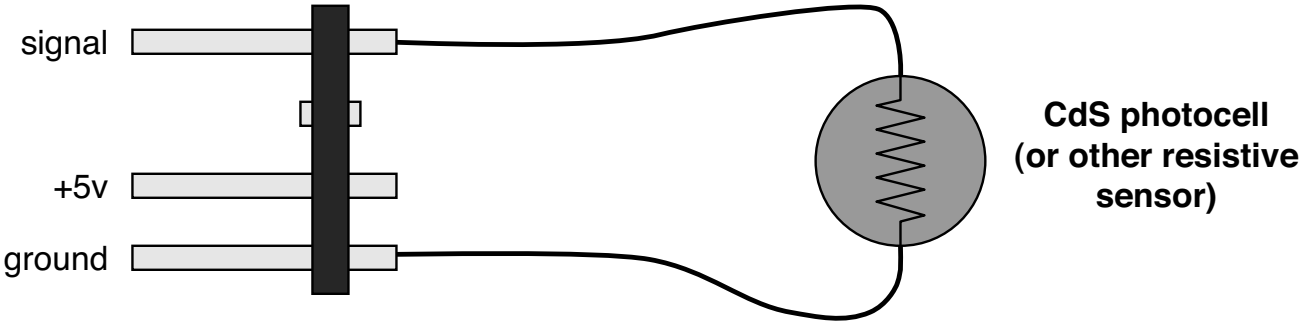
Wire to switch terminals labelled
C (common) and **NO** (normally open)

The above diagram shows how to wire a microswitch-style sensor to the Handy Board. As indicated in the diagram, the switch terminals labelled "C" (common) and "NO" (normally open) should be connected to the sensor plug.

This wiring creates a switch sensor that is normally open, or disconnected, except when the switch is pressed. The normally open case means that the sensor line is pulled high by the 47K resistor on the Handy Board. The standard software for reading the state of a switch interprets this logic high value as "not pressed" or false. When the switch is closed, the sensor line is connected to ground, and the software reads a logic low value, which is interpreted as "pressed" or true.

A pushbutton-style switch, or any simple switch, may be wired in the same fashion.

5.3.3 Photocell Sensor

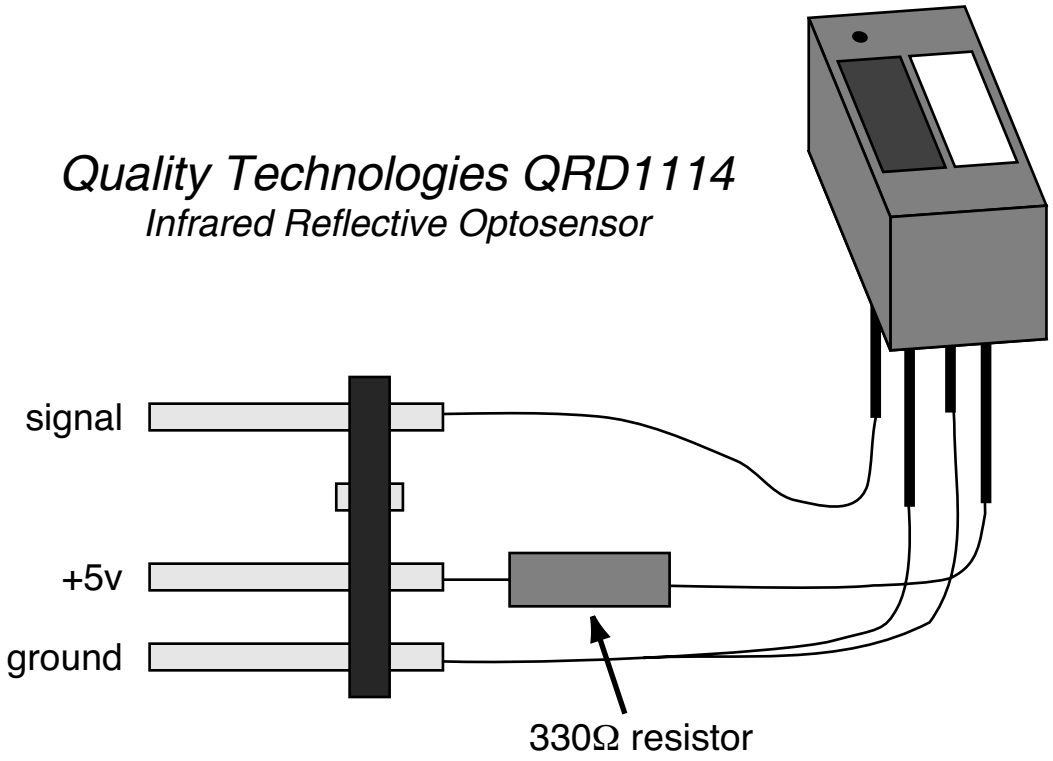


The photocell sensor wiring also makes use of the on-board 47K resistor that connects the sensor signal line to +5v. When wired from the signal line to ground, the photocell becomes part of a voltage divider circuit as indicated in the schematic to the right. The output voltage *Vout* in the circuit is the sensor signal line.

Vout varies as to the ratio between the two resistances (the fixed 47K resistance and the varying *Rphoto* resistance. When the photocell resistance is small (as when brightly illuminated), the *Vout* signal is close to zero volts; when the photocell resistance is large (as in the dark), *Vout* is close to +5 volts, with a continuously varying range between the extremes.

This means that the sensor will report small values when brightly illuminated and large values in the dark.

5.3.4 Infrared Reflectance Sensor



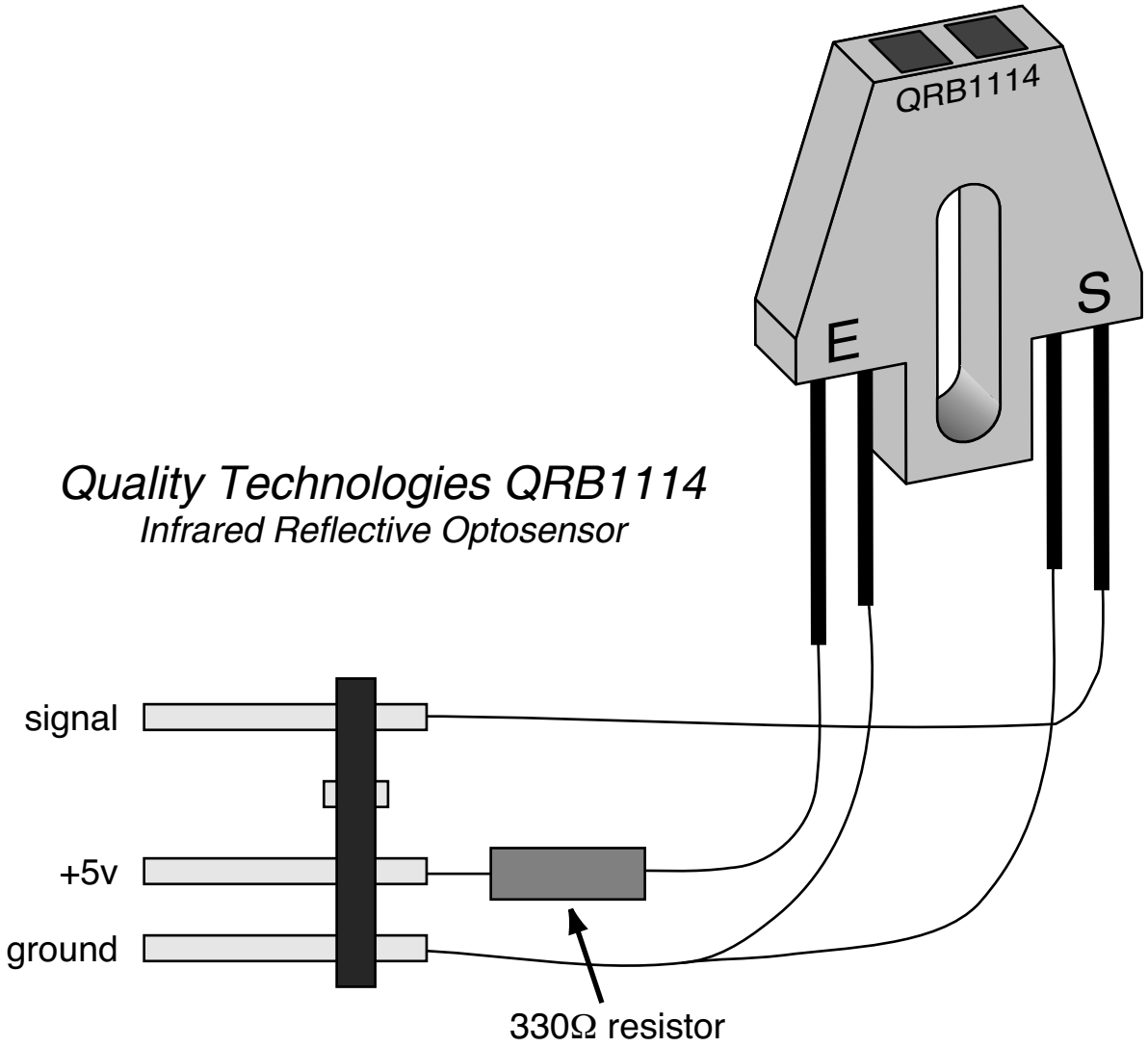
The infrared reflectance sensor consists of two discrete devices: an infrared LED emitter and an infrared phototransistor receiver. The receiver and emitter are matched, so that the peak sensitivity of the receiver is at the same wavelength of the emissions of the emitter. In the example **Quality Technologies QRD1114** sensor diagram, the detector LED is on the left and the emitter is on the right.

The wiring for the reflectance sensor is straightforward. The emitter LED is powered by the Handy Board's +5v supply, with a 330 ohm resistor in series to limit the current through the LED to an appropriate value. The detector transistor is pulled high with the Handy Board's internal 47K resistor.

When increasing amounts of light from the emitter LED is reflected back into the receiver, increasing amounts of current flow through the receiver transistor and hence the internal 47K resistor. The voltage drop across this resistor results in a lower voltage presented to the Handy Board's analog input.

Different varieties of phototransistor may perform better with a smaller resistor value than the on-board 47K resistor. If the sensitivity of the device is poor, try connecting the signal line to the +5v supply through 10K, 4.7K, or 2.2K resistors to determine the best response. For the QRD1114 device, however, the default 47K value is ideal.

> *Special note for working with infrared light:* Infrared light is indeed invisible (unless you are a bumblebee), making it hard to ascertain that a given infrared emitter LED is indeed working. Here are two methods that may be used to visualize its presence: (1) Look at the IR LED through a video-camera that has a viewfinder CRT screen. The CCD lens of a standard video-camera is sensitive to infrared light, and it will be visible on its display. (2) Purchase an infrared detector card (Radio Shack 276–099 or MCM 72–003 and 72–005), which contains a phosphorescent panel that glows visibly under infrared illumination.



The **Quality Technologies QRB1114** sensor, above, is another good reflective optosensor. In the diagram, the left-hand component, marked "E" on the device package, is the infrared emitter, and the right-hand component, marked "S," is the infrared sensor.