techno -stuff Robotics

3WRE Sensor

User Guide for the 3-wire converter.

What is a 3-wire converter?

The 3-wire converter allows easy connection of non-Lego sensors to a Lego Mindstorms RCX. The RCX sensor inputs use a 2 wire, non-polarized connector, with multiplexed power and analog data. Many off-the-shelf computer sensors use a polarized, 3-wire connector with power separated from analog signal. The 3-wire converter provides this interface.

This brick is intended for people who want to design their own sensor, but don't want to deal with the complexity of attaching directly to the RCX. The converter brick has two functions: 1) It provides regulated 5 volt power to drive your active sensor. 2) It provides a linear mapping of your sensor's output voltage to the value read by your program. A linear interface is important because it simplifies using the sensor data in your program. A simple application of the converter is to measure the position of a potentiometer. The ends of the pot are tied to +5 and ground, the wiper is connected to the converter input.

Connecting the converter.

The converter brick has a Lego bump connector that snaps directly on to your RCX. The other side of the converter has three pins: Power, Ground, and Signal.

The Power pin provides regulated +5 volts to power your sensor. Maximum current is about 6 mA.

The Signal pin is the analog signal that is output from your sensor, and input to this converter. This must be in the range of 0 to +5 volts.

Ground is common to both power output and signal input.

Technical Support

For technical support contact Pete Sevcik at Techno-stuff

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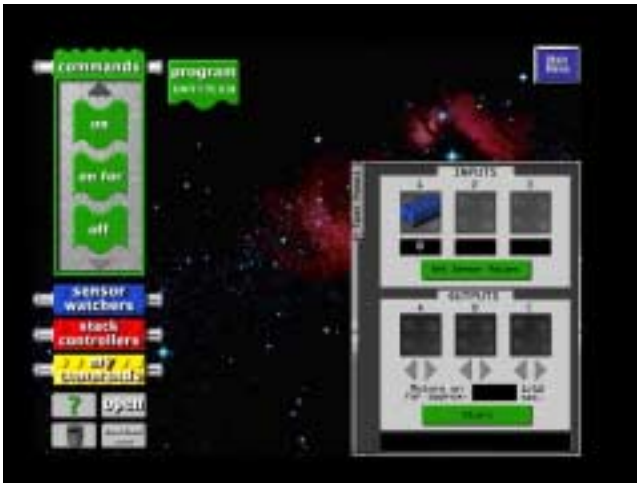
Check your Batteries

The 3WRE converter requires fresh batteries in your RCX. To check your batteries, go to the Lego Main Menu and select "getting started". Select "Set Up Options". Place the cursor on the green battery symbol. After a few seconds it will show the battery voltage. The voltage must be at least 8.0 for proper sensor operation..

Testing the Sensor

Connect the Signal input pin to Ground. (This puts zero volts on the signal pin) Connect the converter to your RCX. Use the Test Panel located in the Mindstorms programming screen to read the sensor value, as show below. Zero volts in should produce a reading of 100 on the test panel.
Connect the Signal input pin to the Power output pin. (This put +5 volts on the signal pin) Use the test panel to read the sensor. Five volts on the signal pin should produce a test panel value of zero.

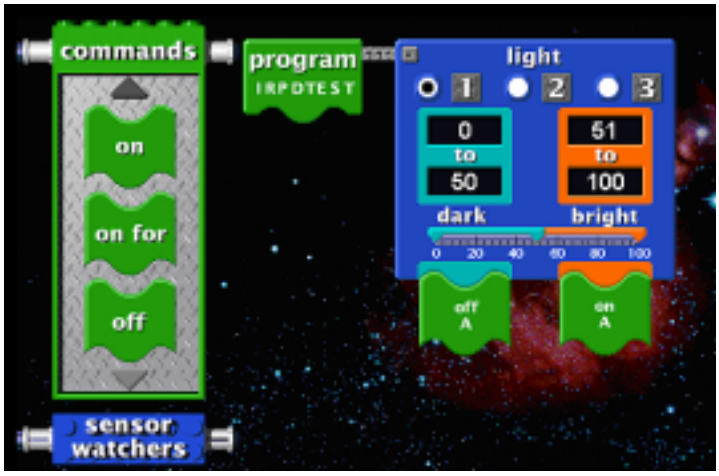


Specifications

- Sensor connection: Standard header .025" square pins on .100 centers.
- Sensor connection: Power, Ground, Signal.
- Signal input voltage range: Zero to +5 volts.
- Mindstorms value: 100 to Zero. (+5 volts in gives a Mindstorms value of zero)
- Linearity: Plus or minus one count in Mindstorms value.
- +5 volt power output: 6 mA. with fresh batteries in the RCX.

Programming

Your program reads a sensor attached through the 3-wire converter just as you would read a light sensor. See the picture below.



The program value is inversely proportional to the electrical signal. Five volts input is read as zero by the program. Zero volts in is read as 100 by the program. (Exactly backwards of what you might expect).

Signal pin	Program value
0 volts	100
2.5 volts	50
5 volts	0

Technical Description

The Mindstorms active sensor interface is difficult because it multiplexes power on the same two wires that it senses data. To make it worse, the Lego bump connector is not polarized, so you don't know in advance which wire is ground. There are simple circuits that will solve these problems, but they are not very linear, and draw more power than necessary.

The Lego bump connector is not polarized, so you never know which lead will be power and which will be ground. The simple way to overcome this is to use a bridge rectifier. A standard silicon diode bridge works fine for power extraction, but introduces non-linearity in the sense operation. During sensing, the current through the return diode (ground side) is dependent on the value being sensed. The voltage generated by this sense current is a ground shift, which is an error in the sensed value. Because this current is small, it is in a very non-linear part of the silicon diode curve. The circuit below overcomes this non-linearity, and removes the diode drop, by replacing the return diodes with FETs. This reduces the total return drop to a few millivolts, and makes the drop linear.

The non-polarized Lego connector can also create a problem when connecting the sense circuit. One way is to use diodes to isolate the return signal to the proper lead. This method again introduces non-linearity due to the diode drop. The circuit below drives the return signal through resistors (R1 and R2), and senses the result directly from the Lego interface wires. (R8 and R9) This process makes the entire circuit very linear.

The input circuit is traditional. R4 - R6 provide the 2 volt offset required by the RCX. R3 and R10 scale the 5 volt input range to a 3 volt output range.