

Building a “Beam Break” sensor

Objective: The purpose of this document is to show how to construct a simple “beam break” sensor for a robot. The concept of the beam break sensor is familiar to anyone that has walked into a store and heard a doorbell as they stepped through. This sensor has 2 parts, the emitter and the receiver. The emitter, which shines light out of its body, is placed on one side of the door. The receiver, which captures that light, is placed on the other. As long as the light beam shines on the receiver, the sensor is quiet. But when something breaks that beam of light, like you walking through it, the receiver stops seeing the light and signals with the doorbell. This is a type of “non-contact” sensor.

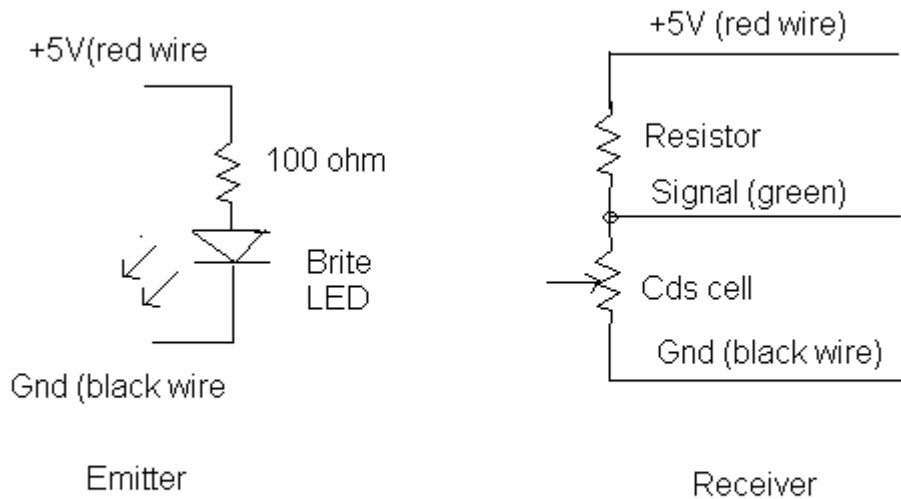
This document shows you how to construct something similar, though for a smaller scale. This sensor will not work when the emitter and receiver are spaced more than 4 inches apart. For greater distances you need a more powerful emitter circuit, and more focused receiver circuit.

Tools needed: Show below are the tools necessary to build this sensor.

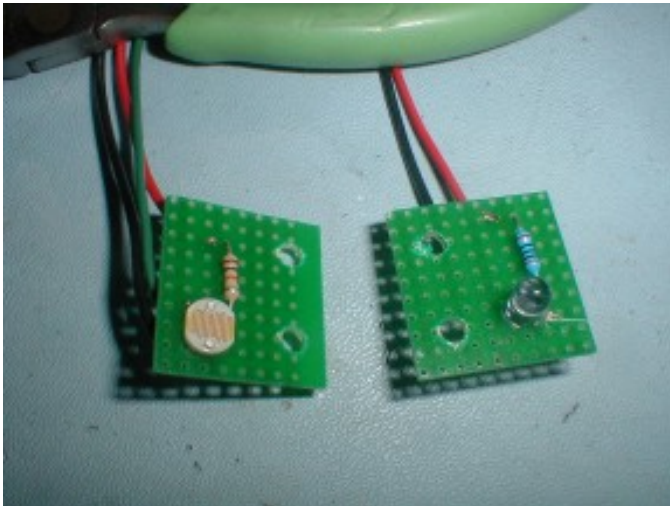


- Soldering iron and stand
- Perforated circuit board for prototyping, about 1.5 inches square for this application
- 1 Bright LED. Brite blue LED shown here. White is best though more expensive
- CdS cell (Cadmium Sulfide), also called photocell, 100K dark resistance shown here
- 1 100 ohm resistor
- 1 resistor that has value optimized for CdS cell and application, 1K used here
- Wire strippers
- Wire cutters (snippers)
- Hook up wire (shown here, 2 red, 2 black, 1 green, all 1 foot lengths)
- Multi-meter or voltmeter
- Mounting hardware (#4-40 $\frac{3}{4}$ " bolts x 2, $\frac{1}{2}$ " bolts x 2, $\frac{1}{4}$ " diameter nylon spacers, 4-40 nuts x 4

In brief, you will be building two simple circuits. Their schematics are shown below.



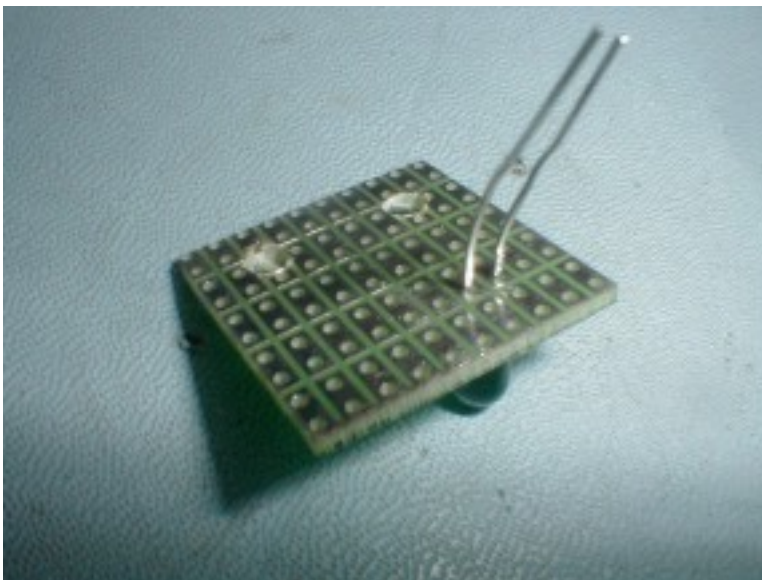
Procedure: Start with a quick look at what the end product will be. This photo shows 2 circuit boards. The emitter is on the right and receiver on left. Take careful note of the orientation of the components relative to the mounting holes. For the botball robot this is important as the LED and the CdS cell must align for best performance. Also note that the connection wires come out of the back of the sensor boards, keeping the front smooth and unobstructed.



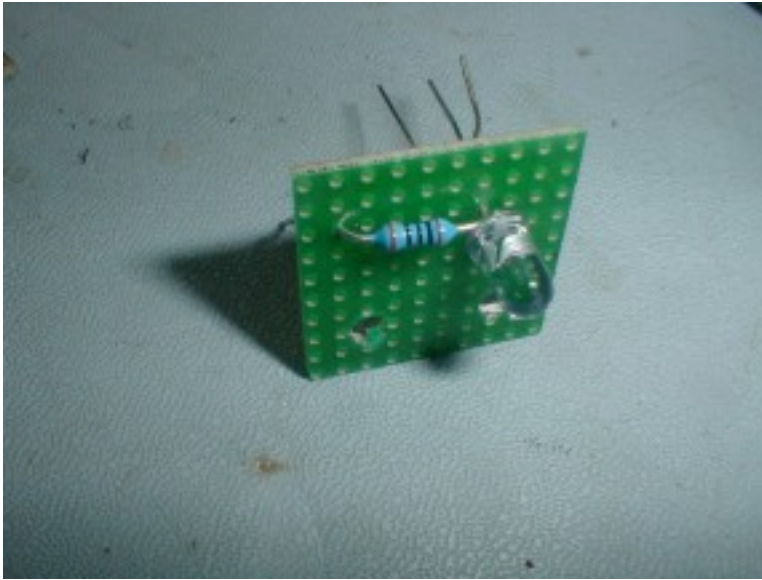
1. Start with the emitter circuit. An LED has 2 wire leads, the short one is the negative one. In the schematic this is end that goes down to bottom of drawing. This is called the cathode. Current will only flow one way through a diode, so you must be careful about how you wire the terminals. Another way to tell negative from positive terminal is looking into the clear case and seeing that one terminal's body is larger than the other. This larger body is the negative terminal. In the photo below, the bottom lead is shorter and has the larger body size.



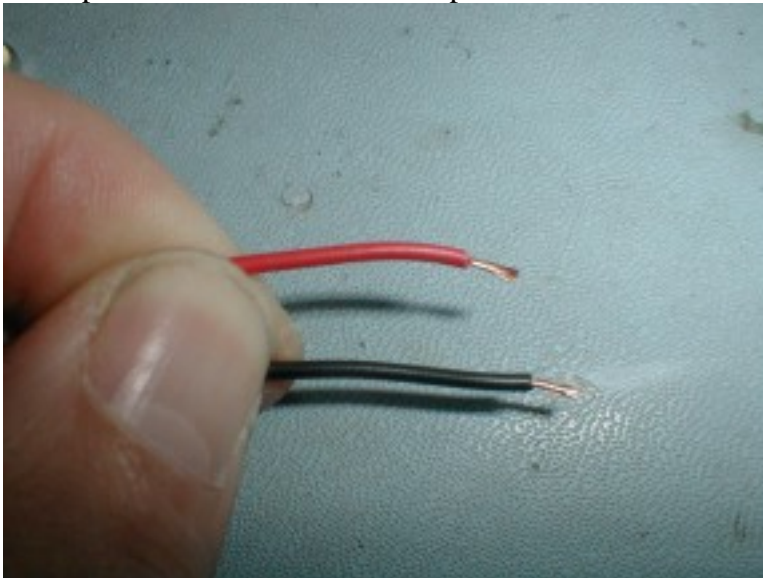
2. Insert the LED into one of the circuit boards. For the botball robot it is important that the LED be close to one of the mounting holes. The lead that is closest to the hole is the negative terminal or cathode. This positioning may not be important in a more general circuit.



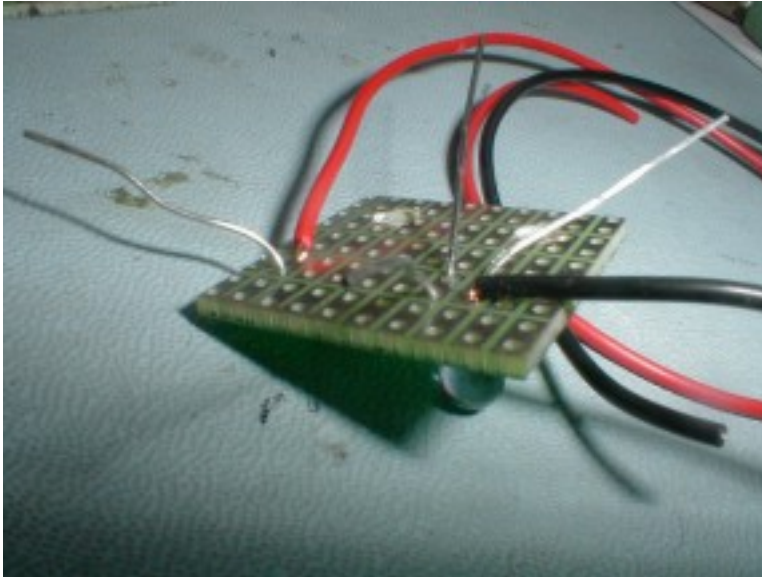
3. Next insert the 100 ohm resistor. Place the LED and resistor in the board such that the resistor lead is in a hole that is connected to the LED lead if possible. This will save some time when soldering.



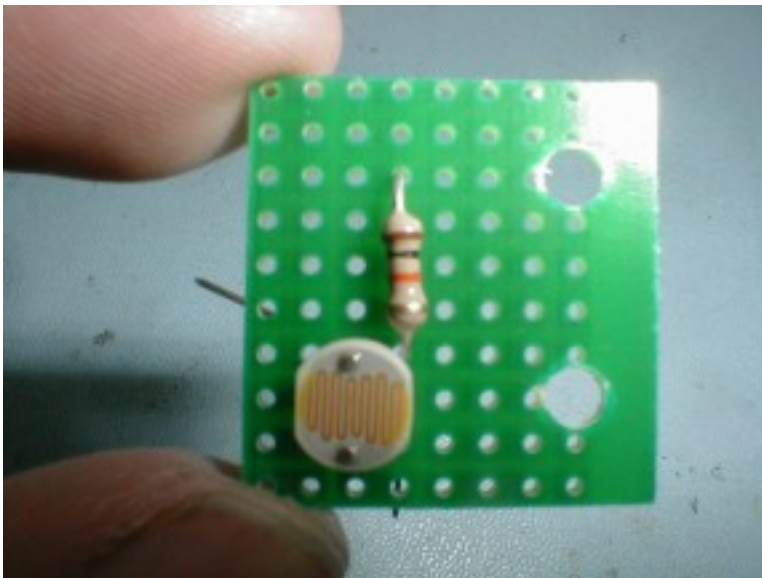
4. Strip about 1/4" of wire off of a pair of red and black wires.



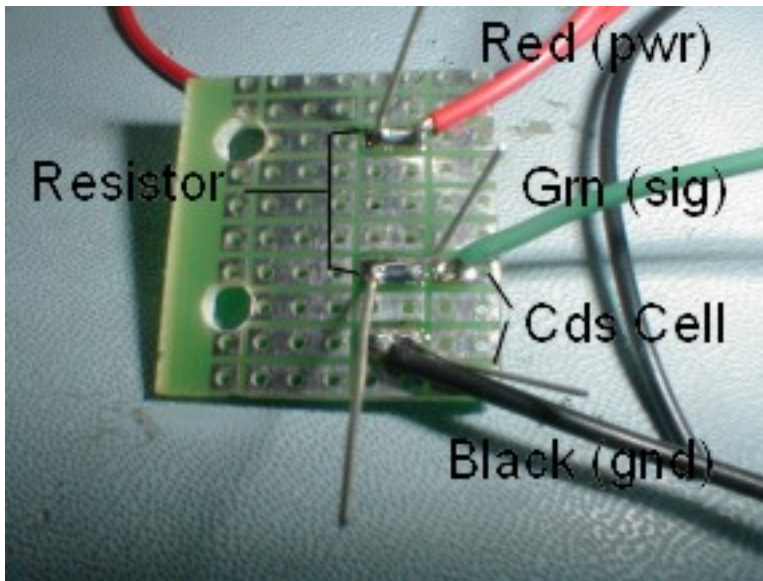
5. Then insert the wires into the board. The wires are to be inserted on the solder side of the board, rather than on the other side where the resistor and LED are. This is to avoid the LED being obstructed by the wires. Place the wires so that they are in a hole that is already connected to the appropriate lead. Red goes to the “top” terminal of the resistor. Black goes to the cathode or negative terminal of the LED. Solder all connections.



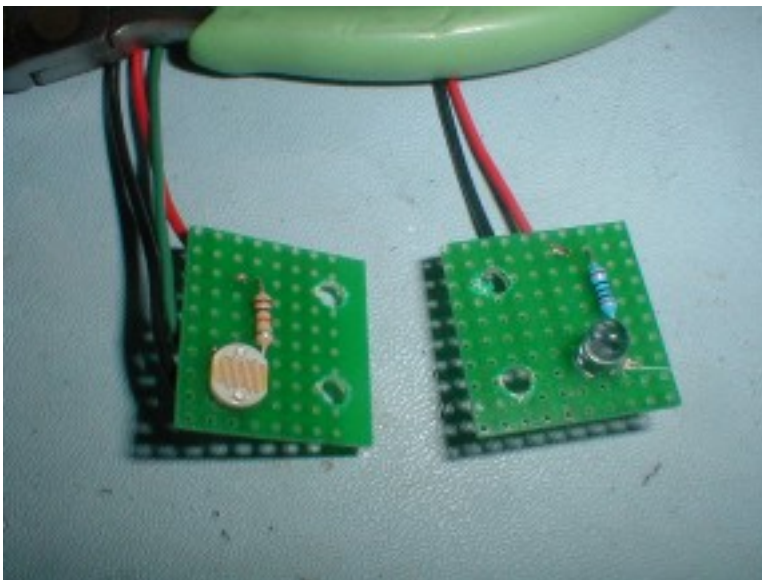
6. Then assemble the CdS cell receiver circuit. Start by inserting the CdS cell and resistor. For the botball robot, it is very important that the CdS cell be near a mounting hole as shown. The LED and CdS cell boards will be mounted so that the LED and CdS cell are at lowest point of the boards and at the same level relatively, so build these circuits as shown.



7. Insert wires to the board. As before, wires will insert on the solder side to afford best clearance on the sensor side of board. In this photo the wire leads at left and high on board are the resistor. The CdS cell leads are lower and on right. Notice how the resistor and CdS cell are connected by the built in lead row. The green wire is in a row by itself. Solder the resistor and CdS cell lead, then bend over the cds cell lead so that it is touching the row where the green wire is to make the connection easier. Then solder this connection as well as the red and black wire connections.



8. The photo below shows the completed boards. Note how when they are both mounted that the LED will face the CdS cell and will be on the same level.



Botball robot users only:

If you are using this sensor on the botball robot, mount the 2 boards on either side of the U shaped bracket of the catcher. The mounting holes go on the bracket so that they are closest to the REAR of the robot. The sensor portion goes to the FRONT of the robot.

Connection to DARC Board:

Emitter board: connect either to the REG PWR header or to the ground/power pins of an unused A/D header set.

Receiver board: This is an analog voltage output sensor similar to the QRB1134 sensors, and connects in the same way. The receiver board has 3 wires, black (gnd), red (power), and green (signal). This connects to an A/D header. Your software has to know which one. By default it will be A/D channel 0 but if you elect to connect somewhere else, just be sure that you update the software as necessary.

Testing: The emitter circuit's LED should be ON when DARC board is powered on. The receiver is tested just like the QRB1134 sensor. Connect to DARC board and probe voltage at A0 (or wherever you connect it). Voltage should be low (near 0) when sensor has light shining on it, Hi when in shadow (such as when a ball is between the sensor and the LED).