ADC Project:   
InfraRed Proximity Sensor

# Overview

For this project you will create a device uses reflected infrared (IR) light to detect if an object is nearby.

# Details

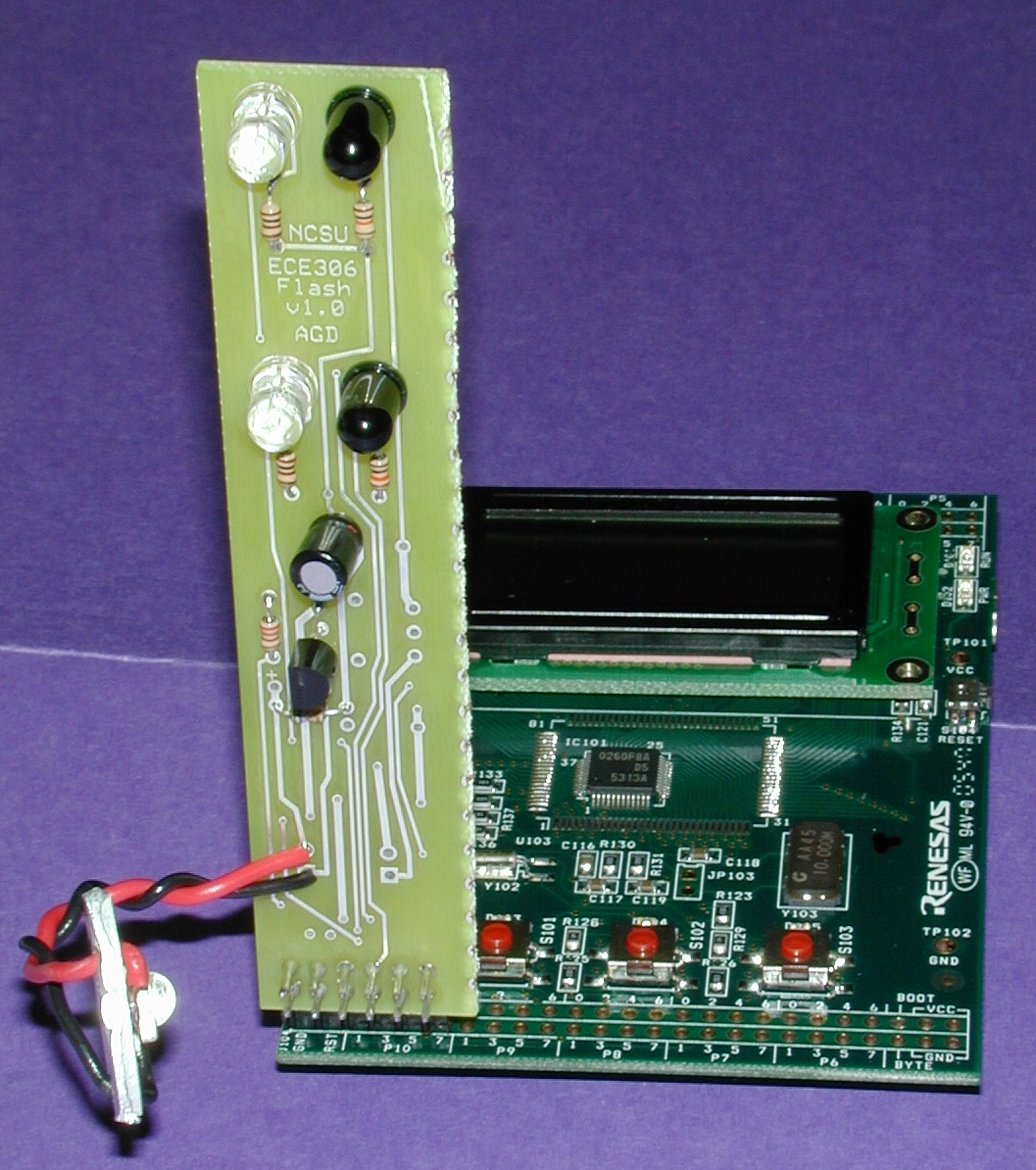


Figure 1. IR Emitting LED (clear) and IR-sensitive phototransistor (dark).

The proximity sensor uses an IR emitter (LED) and an IR detector (phototransistor) pointing in the same direction to determine if any object is reflecting IR energy from the LED.



Figure 2. Proximity sensor method of operation.

The proximity sensor works with a combination of hardware and software. Sensing occurs in two steps: First, the software must measure the IR light level (using IR-sensitive phototransistor Q1 and the analog to digital converter) when the IR-emitting LED is **turned off**. Second, the software must measure the IR light level when the IR LED is turned **on**. If the IR brightness level has increased, then there may be an object nearby reflecting the IR from D1 back to Q1. The signal strength is to be indicated by LCD Text display or an analog output.

## Hardware



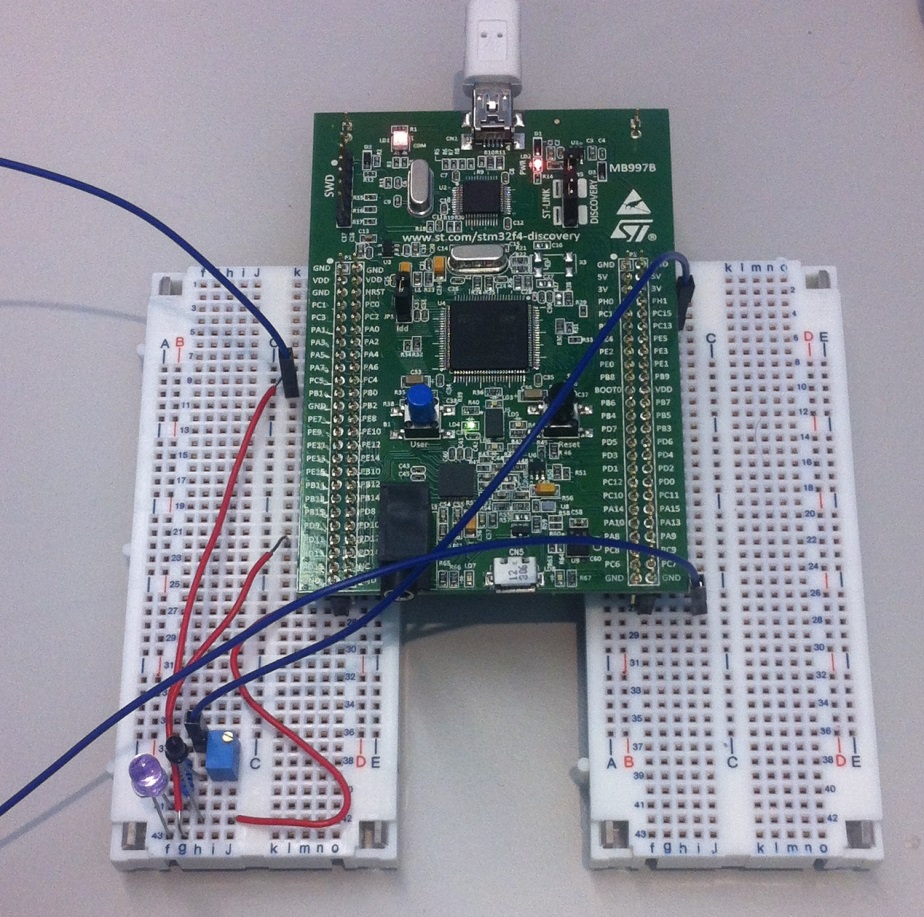
Figure 3. Schematic diagram

Figure 4. Assembled circuit connected with Discovery board

Table . Components

|  |  |  |
| --- | --- | --- |
| **Identifier** | **Description** | **Image** |
| R1 | 150 ohms (brown-green-brown-gold) | C:\Users\Alex\Documents\Teaching\Book Writin'\ARM Cortex M0Plus\Content\IntroCourse\Modules\Analog IO\Lab\IR Components.jpg |
| R2 | 10 kohms (brown-black-orange-gold) | C:\Users\Alex\Documents\Teaching\Book Writin'\ARM Cortex M0Plus\Content\IntroCourse\Modules\Analog IO\Lab\IR Components.jpg |
| D1 | Note that the flat side of the package marks the cathode (negative terminal, long lead) | C:\Users\Alex\Documents\Teaching\Book Writin'\ARM Cortex M0Plus\Content\IntroCourse\Modules\Analog IO\Lab\IR Components.jpg |
| Q1 | Note that the flat side of the package marks the emitter (negative terminal, short lead) | C:\Users\Alex\Documents\Teaching\Book Writin'\ARM Cortex M0Plus\Content\IntroCourse\Modules\Analog IO\Lab\IR Components.jpg |

|  |  |  |
| --- | --- | --- |
| C:\Users\Alex\Documents\Teaching\Book Writin'\ARM Cortex M0Plus\Content\Analog IO\Project\no-obj.BMP   1. No object present | C:\Users\Alex\Documents\Teaching\Book Writin'\ARM Cortex M0Plus\Content\Analog IO\Project\mid-obj.BMP   1. Far object present | C:\Users\Alex\Documents\Teaching\Book Writin'\ARM Cortex M0Plus\Content\Analog IO\Project\near-obj.BMP   1. Near object present |

Figure 5. Oscilloscope screenshots showing IR Output Signal (upper trace) and IR Input Signal (lower trace).

Note that increasing levels of IR increase the conductivity of the phototransistor, lowering the output voltage. Also, note that the phototransistor has a slow response, as shown by the exponential decay curves in Figures 4b and 4c above.

You can verify that the IR LED is turned on by viewing it with a digital camera (or cell phone camera), as most are sensitive to IR energy.

## Software

Write the control software using the following functions:

* Initialization function: configures GPIO pins and ADC input as needed.
* Delay function: performs delay loop based on function argument.
* Control IR LED function: turns on or off IR LED based on argument.
* Indicator DAC function: Output the voltage reading to an DAC output(Or LCD text display)
* Main function: Initializes system and then repeatedly measures difference in brightness caused by lighting LED and then calls light indicator functions. In order to eliminate noise, average at least ten measurements before each update of the DAC output.

Suggestions:

* Ambient lighting may increase the amount of noise in your readings, so some experimentation with oscilloscope monitoring is recommended.
* The sensitivity of the proximity sensor depends on how long you wait to sample the phototransistor’s voltage after changing the IRLED. Longer delays will increase sensitivity (see Figure 5 above). It would be quite helpful to use an oscilloscope to determine appropriate voltages
* To simplify calibration of the indicator light function, add your averaged difference variable to a watch window and enable periodic window updates in the View menu.

Demonstration:

* What is the maximum distance at which your sensor can reliably detect the object above? Your hand? Your thumb? Your arm?
* Does placing an opaque object between the LED and transistor change the system’s sensitivity and range? If so, how much?
* Does the ambient light level make a difference? Try shading the receiver from room lighting.
* Does the source of the ambient light matter? E.g. daylight, incandescent lamp, fluorescent lamp.
* What is the impact of reducing the resistor used to drive the IR LED?

## Optional

1. Utilize the analog watchdog to indicate if something is too close the sensor.
2. Connect 2 IR LEDs or 2 IR phototransistors in parallel to see how the intensity of the signal go.