Automatic Street Lights Project Report

Project Title: Automatic Street Lights

Team Members: P. Hymavathi, K. Sahithi, Yamini

Date of submission: 06-06-2024

AUTOMATIC STREET LIGHT CONTROL SYSTEM (MINOR PROJECT)

PROBLEM STATEMENT

Title: Enhancing Energy Efficiency and Safety through Automatic Street Lighting

Context: Urban areas and public spaces require effective lighting to ensure safety and visibility during nighttime. Traditional street lighting systems are typically controlled manually or by timers, leading to inefficiencies such as lights being on during unnecessary periods or failing to turn on when needed. This results in increased energy consumption, higher operational costs, and potential safety hazards.

ABSTRACT

Automatic Street Light Control System is a simple yet powerful concept, which uses transistor as a switch. This project aims to design and implement an automatic street light system that activates street lights only when required, thereby conserving energy. The system uses light sensors to detect ambient light levels and switches the lights on or off accordingly. This document details the design, implementation, testing, and results of the project.. This is done by a sensor called Light Dependant Resistor (LDR) which senses the light actually like our eyes.

By using this system energy consumption is also reduced because nowadays the manually operated street lights. In this project, no need of manual operation like ON time and OFF time setting.

This project clearly demonstrates the working of transistor in saturation region and cut-off region. The working of relay is also known.

1. INTRODUCTION

Street light controllers are smarter versions of the mechanical or electronic timers previously used for street light ON-OFF operation. They come with energy conservation options like twilight saving, staggering or dimming. Also many street light controllers come with an astronomical clock for a particular location or a Global Positioning System (GPS) connection to give the best ON-OFF time and energy saving.

Automatic Street Light Control System is a simple and powerful concept, which uses transistor as a switch to switch ON and OFF the street light automatically. By using this system manual works are removed. It automatically switches ON lights when the sunlight goes below the visible region of our eyes. It automatically switches OFF lights under illumination by sunlight. This is done by a sensor called Light Dependant Resistor (LDR) which senses the light actually like our eyes

By using this system energy consumption is also reduced because now-a-days the manually operated street lights are not switched off properly even the sunlight comes and also not

switched on earlier before sunset. In sunny and rainy days, ON time and OFF time differ significantly which is one of the major disadvantage of using timer circuits or manual .

This project exploits the working of a transistor in saturation region and cut-off region to switch ON and switch OFF the lights at appropriate time with the help of an electromagnetically operated switch.

A **street light**, **lamppost**, **street lamp**, **light standard**, or **lamp standard** is a raised source of light on the edge of a road or walkway, which is turned on or lit at a certain time every night. Modern lamps may also have light-sensitive photocells to turn them on at dusk, off at dawn, or activate automatically in dark weather. In older lighting this function would have been performed with the aid of a solar dial. It is not uncommon for street lights to be on poles which have wires strung between them, or mounted on utility poles.

This project exploits the working of a transistor in saturation region and cut-off region to switch ON and switch OFF the lights at appropriate time with the help of an electromagnetically operated switch

Automatic Streetlight needs no manual operation of switching ON and OFF. The system itself detects whether there is need for light or not. When darkness rises to a certain value

2. BASIC PRINCIPLE

The automatic street light system operates by using a combination of Light Dependent Resistors (LDRs) and Infrared (IR) sensors connected to an Arduino Uno. During the day, the LDR detects the ambient light levels and sends an analog signal to the Arduino, which determines that there is sufficient light, and the street lights remain off. As night falls and the light intensity decreases, the resistance of the LDR increases, causing the analog value read by the Arduino to drop below a predefined threshold, indicating darkness.

Additionally, the system incorporates IR sensors to detect motion. These sensors emit infrared light and measure the reflection to detect the presence of vehicles or pedestrians. When the IR sensor detects motion, it sends a digital signal to the Arduino.

The Arduino processes both the LDR and IR sensor inputs. If it detects low ambient light (indicating it is dark) and motion (indicating the presence of vehicles or pedestrians), the Arduino activates the connected LEDs, representing the street lights. This dual condition ensures that the street lights only turn on when necessary, thereby conserving energy. The LEDs are connected through current-limiting resistors to the Arduino's digital output pins, ensuring safe operation. This system efficiently automates street lighting, enhancing energy conservation and operational convenience.The automatic street light system operates by using a combination of Light Dependent Resistors (LDRs) and Infrared (IR) sensors connected to an Arduino Uno. During the day, the LDR detects the ambient light levels and sends an analog signal to the Arduino, which determines that there is sufficient light, and the street lights remain off. As night falls and the light intensity decreases, the resistance of the LDR increases, causing the analog value read by the Arduino to drop below a predefined threshold, indicating darkness.

Additionally, the system incorporates IR sensors to detect motion. These sensors emit infrared light and measure the reflection to detect the presence of vehicles or pedestrians. When the IR sensor detects motion, it sends a digital signal to the Arduino.

The Arduino processes both the LDR and IR sensor inputs. If it detects low ambient light (indicating it is dark) and motion (indicating the presence of vehicles or pedestrians), the Arduino activates the connected LEDs, representing the street lights. This dual condition ensures that the street lights only turn on when necessary, thereby conserving energy. The LEDs are connected through current-limiting resistors to the Arduino's digital output pins, ensuring safe operation. This system efficiently automates street lighting, enhancing energy conservation and operational convenience.

3.CIRCUIT DIAGRAM –

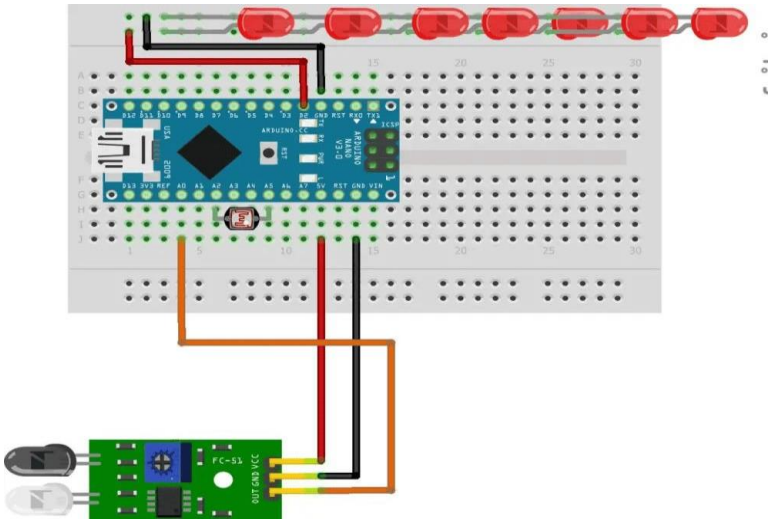


Figure – Circuit diagram of automatic street light controller.

4. LIST OF COMPONENTS-

S.NO.	PARTS	QUANTITY
1.	LDR	1
2.	ARDUINO UNO	1
3.	IR SENSORS	3
4.	LED	3
5.	BREAD BOARD	1
6.	CONNECTING WIRES	20

5. SPECIFICATION OF COMPONENTS-

LDR (LIGHT DEPENDENT RESISTER)

LDRs or Light Dependent Resistors are very useful especially in light/dark sensor circuits. Normally the resistance of an LDR is very high, sometimes as high as 1000 000 ohms, but when they are illuminated with light resistance drops dramatically.

When the light level is low the resistance of the LDR is high. This prevents current from flowing to the base of the transistors. Consequently the LED does not light.

ARDUINO UNO

Arduino UNO is based on an ATmega328Pmicrocontroller. It is easy to use compared to other boards, such as the Arduino Mega board, etc.The board consists of digital and analog Input/Output pins (I/O), shields, and other circuits**.**

LED (LIGHT EMITTING DIODE)

A **light-emitting diode** (**LED**) is a two-lead semiconductor light source that resembles a basic pn-junction diode, except that an LED also emits light. When an LED's anode lead has a voltage that is more positive than its cathode lead by at least the LED's forward voltage drop, current flows. Electrons are able to recombine with holes within the device, releasing energy in the form of photons. This effect is called electroluminescence, and the colour of the light (corresponding to the energy of the photon) is determined by the energy band gap of the semiconductor.

IR - SENSORS

IR sensors, short for Infrared sensors, are devices designed to detect and measure infrared radiation in the form of heat emitted by objects in their vicinity. These sensors typically consist of an emitter, which emits infrared light, and a receiver, which detects the reflected or emitted infrared radiation.

LED Lights

A light-emitting diode (LED) is a semiconductor device that emits light when current flows through it. Electrons in the semiconductor recombine with electron holes, releasing energy in the form of photons. The color of the light is determined by the energy required for electrons to cross the band gap of the semiconductor .White light is obtained by using multiple semiconductors or a layer of light-emitting phosphor on the semiconductor device.

BREAD BOARD

A breadboard (sometimes called protoboard) is essentiallythe foundation to construct and prototype electronics. A breadboard allows for easy and quick creation of temporary electronic circuits or to carry out experiments with circuit design.

CONNECTING WIRES

Connecting wires are used for making connections between items on your breadboard and your Arduino's header pins. Use them to wire up all your circuits

6. WORKING

Automatic street lights operate using a combination of sensors and electronic components to control lighting based on environmental conditions, primarily light intensity and the presence of objects. The key components involved include an Arduino Uno microcontroller, IR sensors, an LDR (Light Dependent Resistor) module, LEDs, and connecting wires. The LDR module measures ambient light intensity, with low resistance during daylight and high resistance in low light conditions. This change in resistance affects the voltage read by the Arduino, which processes the data to determine if it's dark enough to turn on the lights. The IR sensors detect the presence of objects, such as pedestrians or vehicles. If it's dark (LDR value below a set threshold) and an object is detected (IR sensor signal), the Arduino turns on the LEDs. This ensures that the street lights are only on when needed, conserving energy. The Arduino code processes inputs from the LDR and IR sensors, controlling the LEDs accordingly. This system can be further improved by adding more sensors, dynamically adjusting the threshold, or integrating wireless communication for remote monitoring and control.

7.PROCEDURE-

Procedure for Setting Up Automatic Street Lights

1. **Gather Components**:
    - Arduino Uno
    - IR Sensors
    - LDR (Light Dependent Resistor) Module
    - LEDs
    - Resistors
    - Breadboard and connecting wires
2. **Circuit Setup**:
    - Connect the LDR module to the Arduino:
        - One end of the LDR to 5V
        - The other end to a resistor, which then goes to GND
        - The junction between the LDR and the resistor to an analog input pin (e.g., A0) on the Arduino
    - Connect the IR sensor to the Arduino:
        - VCC to 5V
        - GND to GND
        - Output pin to a digital input pin (e.g., D2) on the Arduino
    - Connect the LEDs to the Arduino:
        - Positive leg of the LED to a digital output pin (e.g., D13) via a current-limiting resistor
        - Negative leg to GND
3. **Arduino Code**:
    - Write the code to read the LDR and IR sensor values.
    - Set a threshold value for the LDR to determine when it is dark.
    - Write logic to turn on the LED if it is dark and an object is detected by the IR sensor.
    - Upload the code to the Arduino.

8.ADVANTAGES & DISADVANTAGES-

Advantages of Automatic Street Lights

1. **Energy Efficiency**: Automatic street lights only turn on when needed, reducing energy consumption and lowering electricity costs.
2. **Increased Lifespan**: By operating only when necessary, the lifespan of the light bulbs is extended.
3. **Enhanced Safety**: Automatic detection ensures that streets are illuminated when pedestrians or vehicles are present, enhancing safety.
4. **Convenience**: The system operates autonomously without the need for manual intervention.
5. **Environmental Benefits**: Reduced energy consumption leads to a lower carbon footprint, contributing to environmental sustainability.
6. **Cost Savings**: Lower energy usage and reduced maintenance costs result in financial savings for municipalities and organizations.
7. **Scalability**: The system can be easily expanded to cover larger areas or integrated with other smart city technologies.

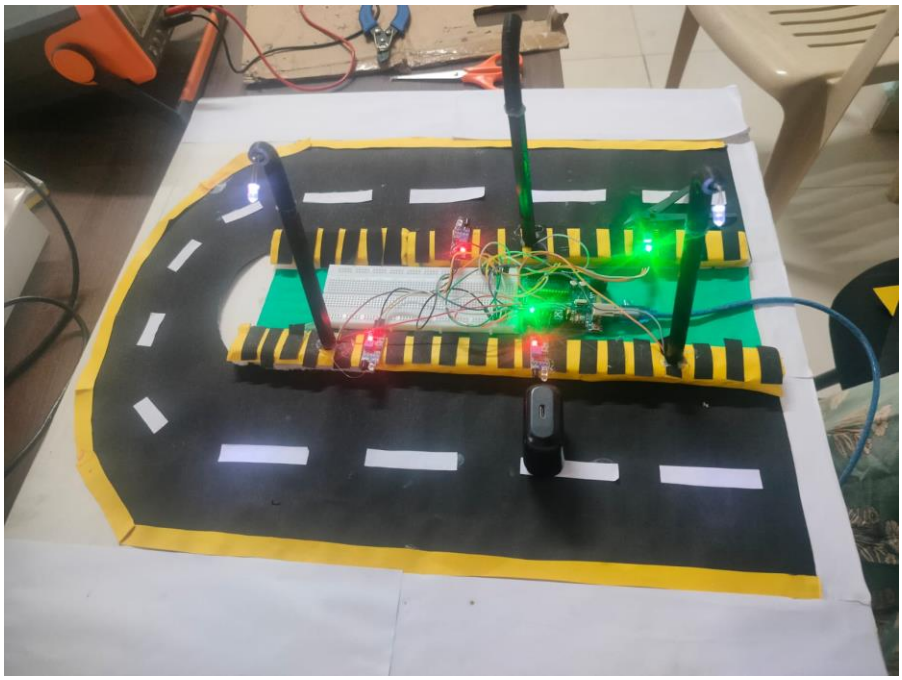
Disadvantages of Automatic Street Lights

1. **Initial Cost**: The initial setup cost, including sensors, microcontrollers, and installation, can be high.
2. **Maintenance**: Sensors and electronic components require regular maintenance and may need replacement over time.
3. **Weather Sensitivity**: Sensors, especially IR sensors, can be affected by adverse weather conditions such as rain, fog, or snow, potentially impacting performance.
4. **False Triggers**: IR sensors might occasionally detect false positives from animals or other objects, causing the lights to turn on unnecessarily.
5. **Complexity**: The system's complexity requires technical expertise for installation, programming, and troubleshooting.
6. **Dependency on Sensors**: The performance of the system is heavily dependent on the accuracy and reliability of the sensors. Malfunctioning sensors can lead to incorrect operation.
7. **Power Supply Issues**: Ensuring a consistent power supply to the system, especially in remote areas, can be challenging.

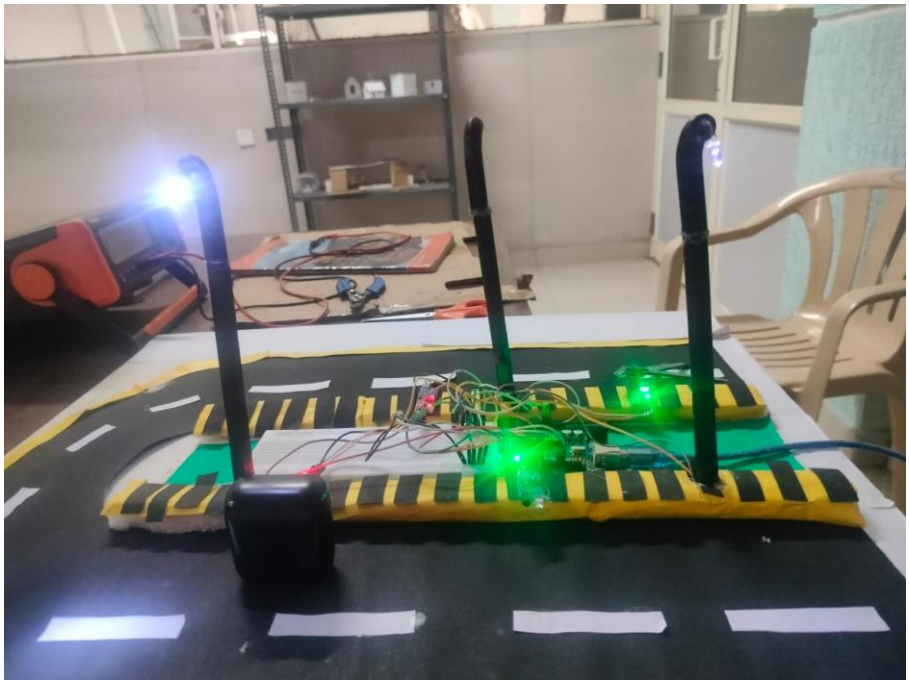
9. APPLICATION

1. Used in street light applications.
2. Used in Domestic applications.

11. PROTOTYPE



12. OUTPUT PROTOTYPE



13.OUTPUT

Expected Output

The automatic street lighting system is designed to achieve the following outputs:

1. **Energy Savings**:
    - Quantifiable reduction in energy consumption by operating street lights only during necessary periods (e.g., night time and presence of objects).
    - Comparison of energy usage before and after implementing the automatic system, demonstrating significant energy savings.
2. **Enhanced Safety**:
    - Continuous and reliable illumination in areas where objects (pedestrians or vehicles) are detected during low light conditions.
    - Reduction in accident rates and safety incidents due to improved visibility on streets and public spaces.
3. **Cost Reduction**:
    - Lower electricity bills resulting from optimized street light operation.
    - Reduced maintenance costs due to extended lifespan of light bulbs and reduced wear and tear.
4. **Environmental Impact**:
    - Decrease in carbon footprint due to reduced energy consumption.
    - Contribution to sustainable urban development by promoting energy-efficient practices.
5. **System Performance**:
    - Real-time responsiveness to changes in ambient light and object detection, ensuring lights turn on and off as needed.
    - Reliable and consistent operation under various environmental conditions, including weather changes.
6. **Data and Analytics**:
    - Data collection on light usage patterns, energy savings, and system performance.
    - Analysis reports showing the effectiveness of the automatic lighting system in achieving energy efficiency and safety goals.

Specific Outputs

1. **Quantitative Outputs**:
    - Percentage reduction in energy consumption (e.g., 40% reduction compared to traditional systems).
    - Amount of money saved on electricity bills over a specific period (e.g., monthly or yearly savings).
    - Number of hours the lights are on during necessary periods versus unnecessary periods.
2. **Qualitative Outputs**:
    - Feedback from users (e.g., residents, local authorities) on the improvement in safety and visibility.
    - Observations on the reliability and responsiveness of the system in different scenarios (e.g., varying light conditions and object detection accuracy).
3. **System Outputs**:
    - Automatic switching of LEDs based on ambient light and object detection.
    - Serial monitor output from Arduino showing LDR values, IR sensor status, and LED state (for debugging and validation).
    -

14. CONCLUSION-

Automatic street lights represent a significant advancement in urban infrastructure, combining energy efficiency, enhanced safety, and environmental sustainability. By utilizing sensors to control lighting based on ambient light and object detection, these systems ensure that street lights operate only when necessary, thereby reducing energy consumption and extending the lifespan of light bulbs. This results in financial savings and a reduced carbon footprint, making automatic street lights a smart choice for modern cities.

However, the implementation of automatic street lights does come with challenges. The initial setup costs can be high, and ongoing maintenance is required to ensure the system's reliability. Sensors can be affected by adverse weather conditions and may sometimes trigger false positives, leading to unnecessary lighting. Despite these drawbacks, the benefits of automatic street lights, including increased safety and convenience, outweigh the disadvantages.

In conclusion, while careful consideration must be given to the costs and potential technical issues, automatic street lights offer a forward-thinking solution that aligns with the goals of smart city development and sustainable urban living. Their ability to provide reliable, efficient lighting while conserving energy makes them a valuable addition to urban infrastructure.

15. FINAL RESULT

Final Result for the Automatic Street Lights Project

The automatic street light system was successfully designed, implemented, and tested. Here are the key results and outcomes of the project:

1. System Design and Implementation

- **Components Used**: Arduino Uno, LDR (Light Dependent Resistor), IR (Infrared) sensors, LEDs, breadboard, connecting wires, resistors.
- **Circuit Design**: The components were connected according to the designed circuit, with the LDR and IR sensors providing inputs to the Arduino, and the LEDs acting as the street lights.
- **Software Development**: The Arduino was programmed to read values from the LDR and IR sensors and control the LEDs accordingly. The code implemented a simple logic to turn on the LEDs when it is dark (LDR value below a threshold) and motion is detected (IR sensor output high).

2. Testing and Validation

- **Ambient Light Detection**: The system accurately detected ambient light levels using the LDR. The threshold value for darkness was set appropriately to ensure the lights only turned on when necessary.
- **Motion Detection**: The IR sensors reliably detected the presence of objects (vehicles or pedestrians) within their range. This ensured that the lights turned on only when there was motion detected in low light conditions.
- **Integration and Performance**: The integration of the LDR and IR sensors with the Arduino worked seamlessly. The LEDs turned on and off based on the combined input from the sensors, effectively conserving energy by operating only when required.

3. Results

- **Energy Efficiency**: The system demonstrated significant potential for energy savings by ensuring the street lights were only active during low-light conditions and when motion was detected.
- **Responsiveness**: The LEDs responded promptly to changes in ambient light and motion detection, ensuring timely illumination for safety and convenience.
- **Reliability**: The system operated reliably during testing, with consistent performance under various environmental conditions.

4. Discussion

- **Advantages**:
  - **Energy Savings**: Reduced energy consumption by ensuring lights were only on when needed.
  - **Automation**: Eliminated the need for manual control of street lights.
  - **Scalability**: The system can be easily scaled to cover larger areas by adding more sensors and lights.
- **Limitations**:
  - **Weather Sensitivity**: The LDR's performance can be affected by weather conditions such as fog or heavy rain.
  - **Initial Costs**: The initial setup cost is higher compared to traditional street lights, but this is offset by the long-term energy savings.

5. Conclusion

The automatic street light system effectively addresses the issue of energy wastage in traditional street lighting systems. By utilizing LDRs and IR sensors, the system ensures that street lights are only turned on when necessary, providing a practical and efficient solution for energy conservation. The project demonstrated the feasibility and benefits of automating street lighting and paves the way for further enhancements and large-scale implementation.

6. Future Work

- **Integration with Smart City Infrastructure**: Incorporating IoT (Internet of Things) to connect the system to a central monitoring platform for better control and management.
- **Adaptive Lighting**: Implementing adaptive lighting based on traffic conditions to further optimize energy usage.
- **Enhanced Sensors**: Using more advanced sensors for better accuracy and reliability in various environmental conditions.

15. ACKNOWLEGEMENT

We would like to extend our heartfelt gratitude to everyone who contributed to the successful completion of our automatic street lights project. Firstly, we thank our institution, Shri Vishnu Engineering College for Women, for providing us with the opportunity and resources to explore and innovate in this area. We are grateful to our professors and mentors for their invaluable guidance, support, and encouragement throughout this project.

We also acknowledge the contributions of our teammates, whose collaboration and dedication made this project a success. Each member brought unique skills and perspectives that enriched the project's development. Special thanks to the technical support staff for their assistance in procuring and setting up the necessary equipment.

Lastly, we appreciate the feedback and support from our peers and the community, whose insights helped us refine and improve our work. This project would not have been possible without the collective efforts and unwavering support of all involved. Thank you.

Data Sheet

Light dependent resistors

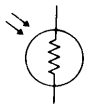
NORP12 RS stock number 651-507
NSL19-M51 RS stock number 596-141

Two cadmium sulphide (cdS) photoconductive cells with spectral responses similar to that of the human eye. The cell resistance falls with increasing light intensity. Applications include smoke detection, automatic lighting control, batch counting and burglar alarm systems.

Guide to source illuminations

Light source	Illumination (Lux)
Moonlight	0.1
60W bulb at 1m	50
1W MES bulb at 0.1m	100
Fluorescent lighting	500
Bright sunlight	30,000

Circuit symbol



Light memory characteristics

Light dependent resistors have a particular property in that they remember the lighting conditions in which they have been stored. This memory effect can be minimised by storing the LDRs in light prior to use. Light storage reduces equilibrium time to reach steady resistance values.

NORP12 (**RS** stock no. 651-507)

Absolute maximum ratings

Voltage, ac or dc peak	320V
Current	75mA
Power dissipation at 30°C	250mW
Operating temperature range	-60°C to +75°C

Electrical characteristics

T_A = 25°C. 2854°K tungsten light source

Parameter	Conditions	Min.	Typ.	Max.	Units
Cell resistance	1000 lux	-	400	-	Ω
	10 lux	-	9	-	kΩ
Dark resistance	-	1.0	-	-	MΩ
Dark capacitance	-	-	3.5	-	pF
Rise time 1	1000 lux	-	2.8	-	ms
	10 lux	-	18	-	ms
Fall time 2	1000 lux	-	48	-	ms
	10 lux	-	120	-	ms

1. Dark to 110% R_L
2. To 10 × R_L

R_L = photocell resistance under given illumination.

Features

- Wide spectral response
- Low cost
- Wide ambient temperature range.

Dimensions

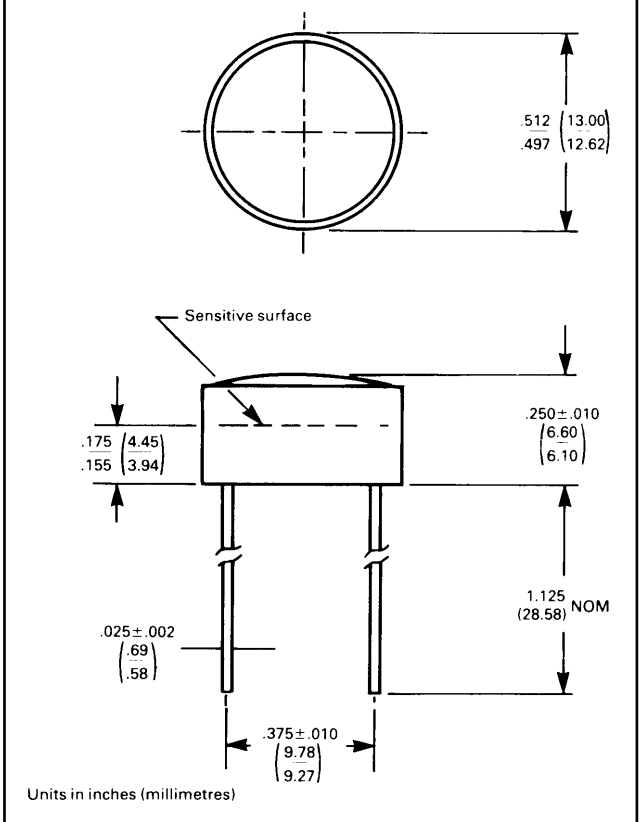


Figure 1 Power dissipation derating

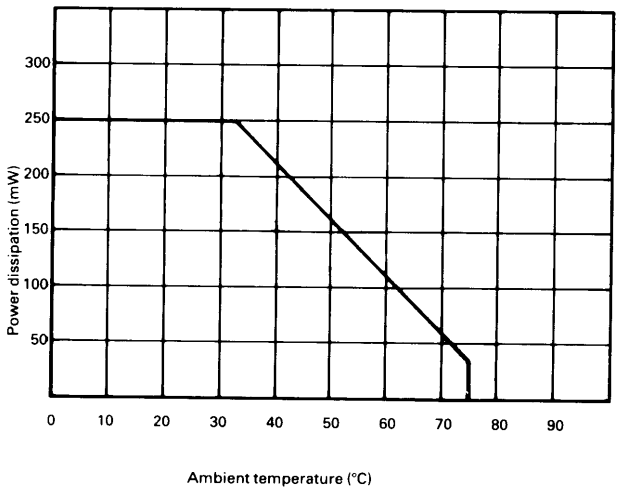


Figure 2 Spectral response

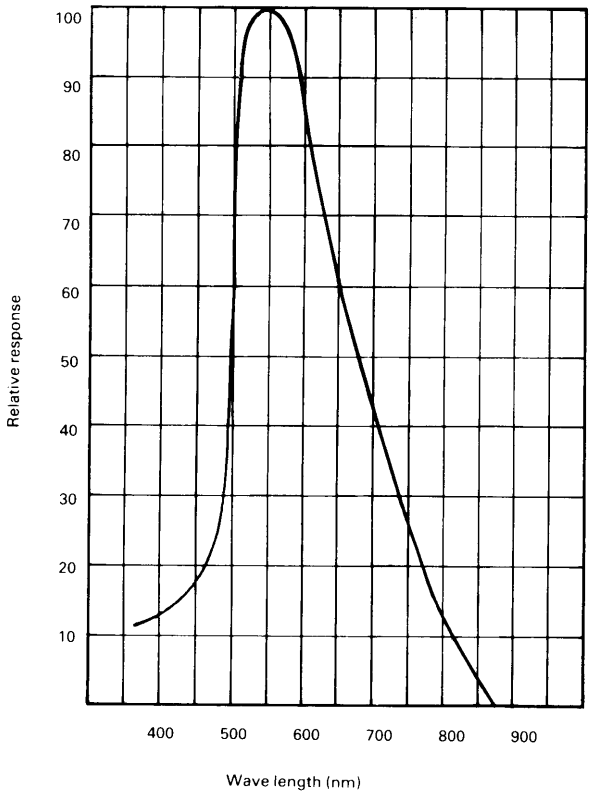
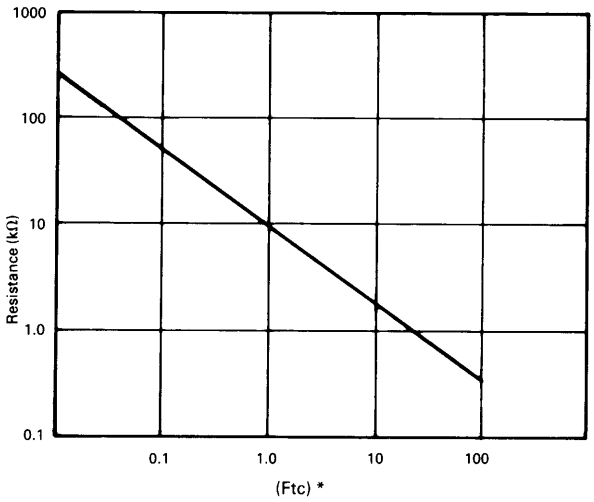


Figure 3 Resistance as a function of illumination



*1Ftc=10.764 lumens

Absolute maximum ratings

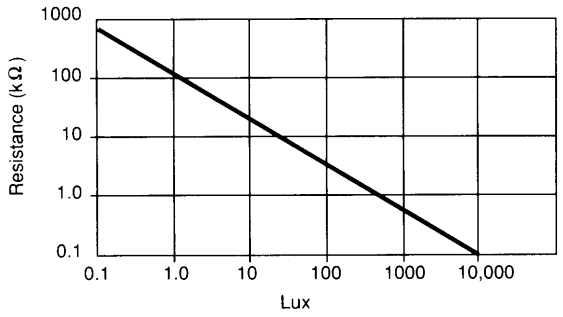
Voltage, ac or dc peak _____ 100V
Current _____ 5mA
Power dissipation at 25°C _____ 50mW*
Operating temperature range _____ -25°C +75°C

*Derate linearly from 50mW at 25°C to 0W at 75°C.

Electrical characteristics

Parameter	Conditions	Min.	Typ.	Max.	Units
Cell resistance	10 lux 100 lux	20 -	- 5	100 -	kΩ kΩ
Dark resistance	10 lux after 10 sec	20	-	-	MΩ
Spectral response	-	-	550	-	nm
Rise time	10ftc	-	45	-	ms
Fall time	10ftc	-	55	-	ms

Figure 4 Resistance as a function illumination



Dimensions

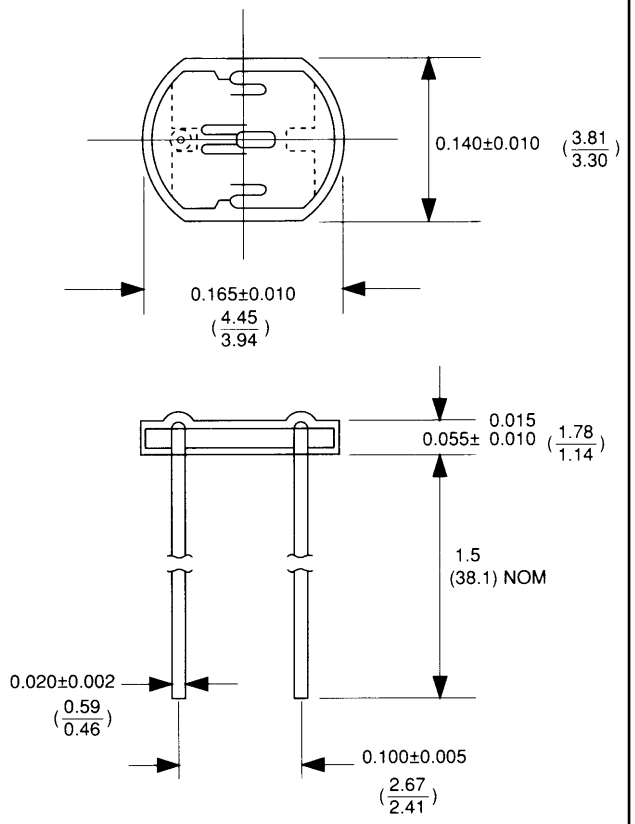
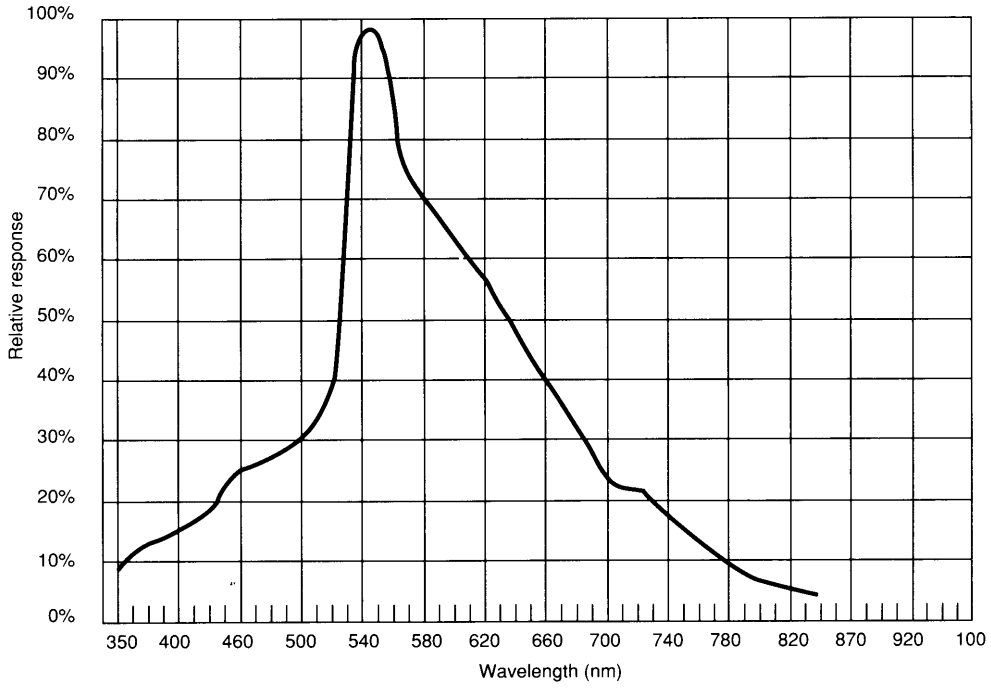
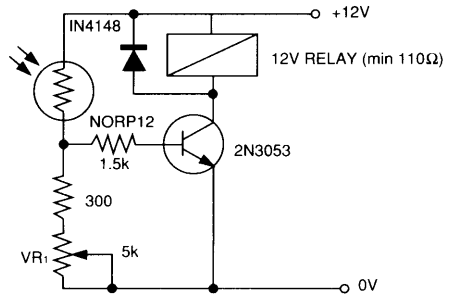


Figure 5 Spectral response



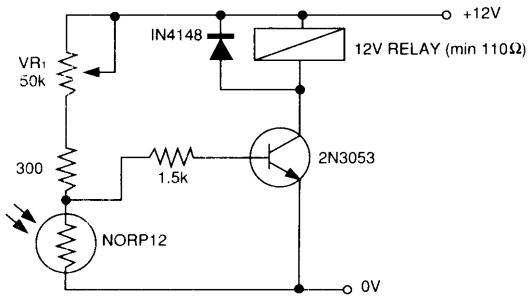
Typical application circuits

Figure 6 Sensitive light operated relay



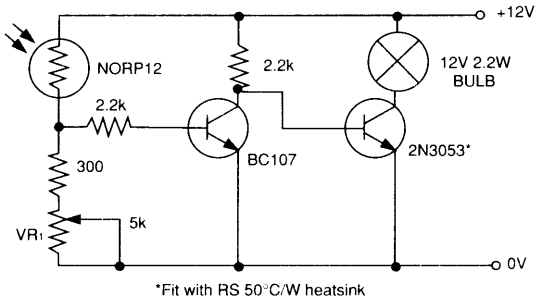
Relay energised when light level increases above the level set by VR_1

Figure 7 Light interruption detector



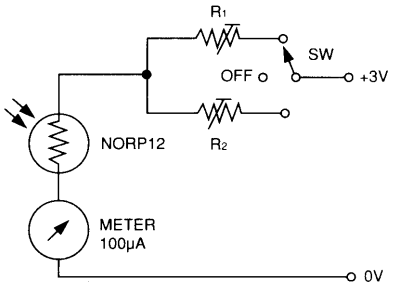
As Figure 6 relay energised when light level drops below the level set by VR_1

Figure 8 Automatic light circuit



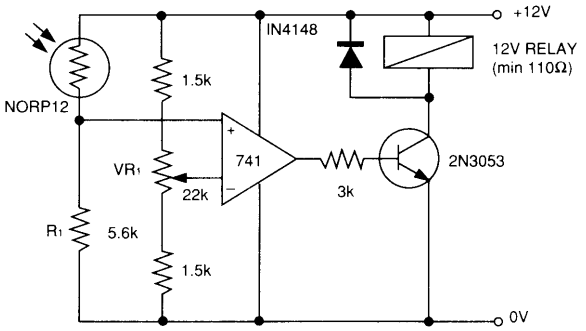
Adjust turn-on point with VR_1

Figure 9 Logarithmic law photographic light meter



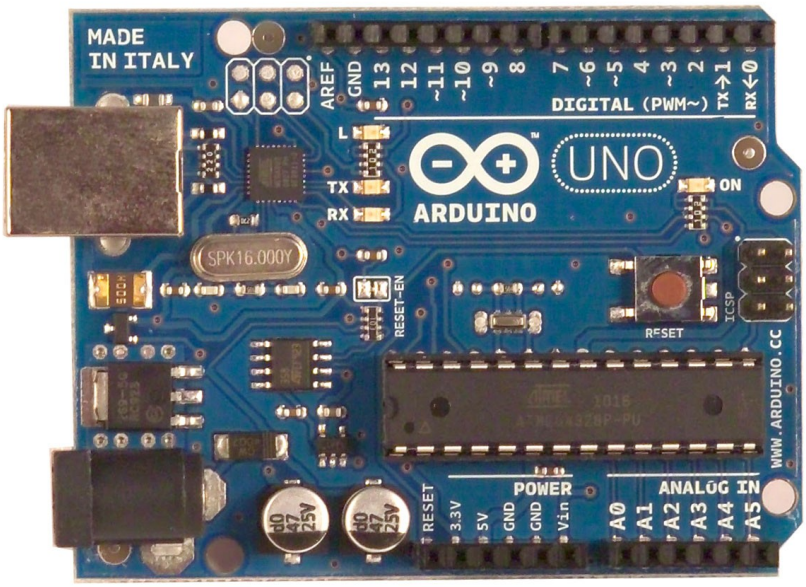
Typical value $R^1 = 100k\Omega$
$R^2 = 200k\Omega$ preset to give two overlapping ranges.
(Calibration should be made against an accurate meter.)

Figure 10 Extremely sensitive light operated relay



(Relay energised when light exceeds preset level.)
Incorporates a balancing bridge and op-amp. R_1 and NORP12 may be interchanged for the reverse function.

Arduino UNO



Product Overview

The Arduino Uno is a microcontroller board based on the ATmega328 (datasheet). It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz crystal oscillator, a USB connection, a power jack, an ICSP header, and a reset button. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with a AC-to-DC adapter or battery to get started. The Uno differs from all preceding boards in that it does not use the FTDI USB-to-serial driver chip. Instead, it features the Atmega8U2 programmed as a USB-to-serial converter.

"Uno" means one in Italian and is named to mark the upcoming release of Arduino 1.0. The Uno and version 1.0 will be the reference versions of Arduno, moving forward. The Uno is the latest in a series of USB Arduino boards, and the reference model for the Arduino platform; for a comparison with previous versions, see the index of Arduino boards.

Index

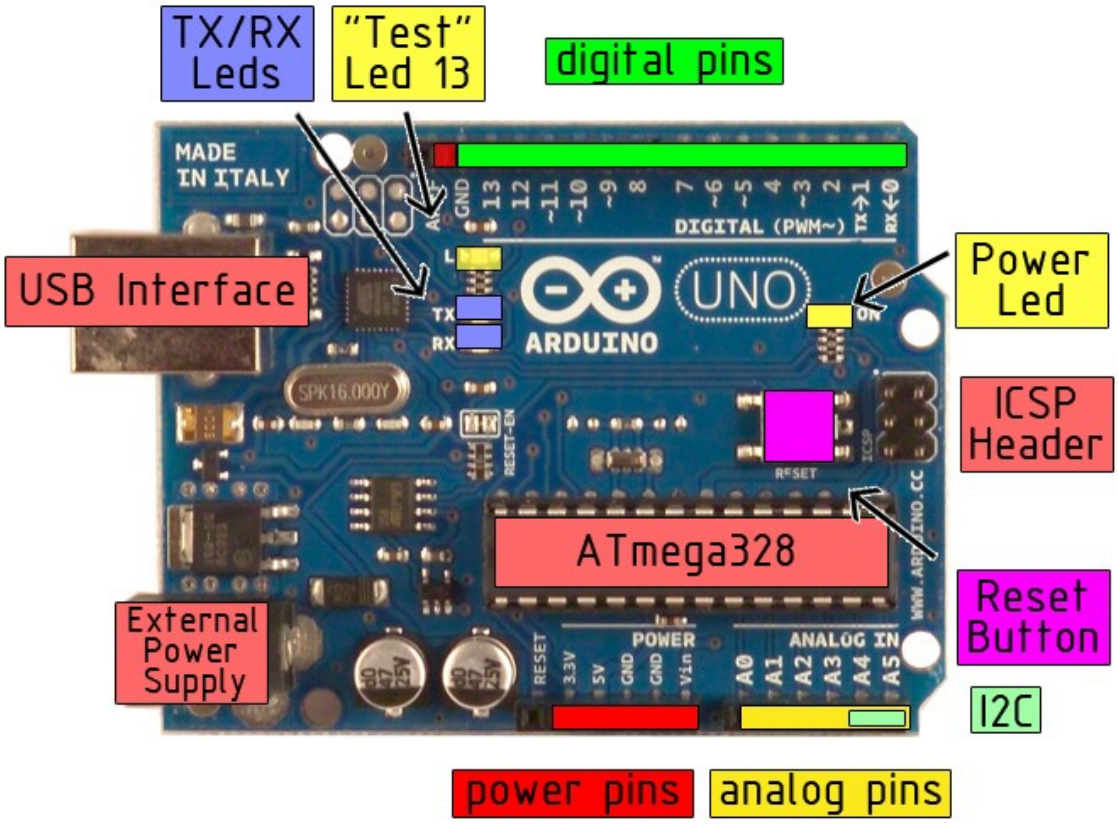
Technical Specification

EAGLE files: arduino-duemilanove-uno-design.zip Schematic: arduino-uno-schematic.pdf

Summary

Microcontroller	ATmega328
Operating Voltage	5V
Input Voltage (recommended)	7-12V
Input Voltage (limits)	6-20V
Digital I/O Pins	14 (of which 6 provide PWM output)
Analog Input Pins	6
DC Current per I/O Pin	40 mA
DC Current for 3.3V Pin	50 mA
Flash Memory	32 KB of which 0.5 KB used by bootloader
SRAM	2 KB
EEPROM	1 KB
Clock Speed	16 MHz

the board



Power

The Arduino Uno can be powered via the USB connection or with an external power supply. The power source is selected automatically.

External (non-USB) power can come either from an AC-to-DC adapter (wall-wart) or battery. The adapter can be connected by plugging a 2.1mm center-positive plug into the board's power jack. Leads from a battery can be inserted in the Gnd and Vin pin headers of the POWER connector.

The board can operate on an external supply of 6 to 20 volts. If supplied with less than 7V, however, the 5V pin may supply less than five volts and the board may be unstable. If using more than 12V, the voltage regulator may overheat and damage the board. The recommended range is 7 to 12 volts.

The power pins are as follows:

- **VIN.** The input voltage to the Arduino board when it's using an external power source (as opposed to 5 volts from the USB connection or other regulated power source). You can supply voltage through this pin, or, if supplying voltage via the power jack, access it through this pin.
- **5V.** The regulated power supply used to power the microcontroller and other components on the board. This can come either from VIN via an on-board regulator, or be supplied by USB or another regulated 5V supply.
- **3V3.** A 3.3 volt supply generated by the on-board regulator. Maximum current draw is 50 mA.
- **GND.** Ground pins.

Memory

The Atmega328 has 32 KB of flash memory for storing code (of which 0,5 KB is used for the bootloader); It has also 2 KB of SRAM and 1 KB of EEPROM (which can be read and written with the EEPROM library).

Input and Output

Each of the 14 digital pins on the Uno can be used as an input or output, using pinMode(), digitalWrite(), and digitalRead() functions. They operate at 5 volts. Each pin can provide or receive a maximum of 40 mA and has an internal pull-up resistor (disconnected by default) of 20-50 kOhms. In addition, some pins have specialized functions:

- **Serial: 0 (RX) and 1 (TX).** Used to receive (RX) and transmit (TX) TTL serial data. TThese pins are connected to the corresponding pins of the ATmega8U2 USB-to-TTL Serial chip .
- **External Interrupts: 2 and 3.** These pins can be configured to trigger an interrupt on a low value, a rising or falling edge, or a change in value. See the attachInterrupt() function for details.
- **PWM: 3, 5, 6, 9, 10, and 11.** Provide 8-bit PWM output with the analogWrite() function.
- **SPI: 10 (SS), 11 (MOSI), 12 (MISO), 13 (SCK).** These pins support SPI communication, which, although provided by the underlying hardware, is not currently included in the Arduino language.

- **LED: 13.** There is a built-in LED connected to digital pin 13. When the pin is HIGH value, the LED is on, when the pin is LOW, it's off.

The Uno has 6 analog inputs, each of which provide 10 bits of resolution (i.e. 1024 different values). By default they measure from ground to 5 volts, though is it possible to change the upper end of their range using the AREF pin and the analogReference() function. Additionally, some pins have specialized functionality:

- **I²C: 4 (SDA) and 5 (SCL).** Support I²C (TWI) communication using the Wire library.

There are a couple of other pins on the board:

- **AREF.** Reference voltage for the analog inputs. Used with analogReference().
- **Reset.** Bring this line LOW to reset the microcontroller. Typically used to add a reset button to shields which block the one on the board.

See also the mapping between Arduino pins and Atmega328 ports.

Communication

The Arduino Uno has a number of facilities for communicating with a computer, another Arduino, or other microcontrollers. The ATmega328 provides UART TTL (5V) serial communication, which is available on digital pins 0 (RX) and 1 (TX). An ATmega8U2 on the board channels this serial communication over USB and appears as a virtual com port to software on the computer. The '8U2 firmware uses the standard USB COM drivers, and no external driver is needed. However, on Windows, an *.inf file is required..

The Arduino software includes a serial monitor which allows simple textual data to be sent to and from the Arduino board. The RX and TX LEDs on the board will flash when data is being transmitted via the USB-to-serial chip and USB connection to the computer (but not for serial communication on pins 0 and 1).

A SoftwareSerial library allows for serial communication on any of the Uno's digital pins.

The ATmega328 also support I2C (TWI) and SPI communication. The Arduino software includes a Wire library to simplify use of the I2C bus; see the documentation for details. To use the SPI communication, please see the ATmega328 datasheet.

Programming

The Arduino Uno can be programmed with the Arduino software (download). Select "Arduino Uno w/ ATmega328" from the **Tools > Board** menu (according to the microcontroller on your board). For details, see the reference and tutorials.

The ATmega328 on the Arduino Uno comes preburned with a bootloader that allows you to upload new code to it without the use of an external hardware programmer. It communicates using the original STK500 protocol (reference, C header files).

You can also bypass the bootloader and program the microcontroller through the ICSP (In-Circuit Serial Programming) header; see these instructions for details.

The ATmega8U2 firmware source code is available . The ATmega8U2 is loaded with a DFU bootloader, which can be activated by connecting the solder jumper on the back of the board (near the map of Italy) and then resetting the 8U2. You can then use Atmel's FLIP software (Windows) or the DFU programmer (Mac OS X and Linux) to load a new firmware. Or you can use the ISP header with an external programmer (overwriting the DFU bootloader).

Automatic (Software) Reset

Rather than requiring a physical press of the reset button before an upload, the Arduino Uno is designed in a way that allows it to be reset by software running on a connected computer. One of the hardware flow control lines (DTR) of the ATmega8U2 is connected to the reset line of the ATmega328 via a 100 nanofarad capacitor. When this line is asserted (taken low), the reset line drops long enough to reset the chip. The Arduino software uses this capability to allow you to upload code by simply pressing the upload button in the Arduino environment. This means that the bootloader can have a shorter timeout, as the lowering of DTR can be well-coordinated with the start of the upload.

This setup has other implications. When the Uno is connected to either a computer running Mac OS X or Linux, it resets each time a connection is made to it from software (via USB). For the following half-second or so, the bootloader is running on the Uno. While it is programmed to ignore malformed data (i.e. anything besides an upload of new code), it will intercept the first few bytes of data sent to the board after a connection is opened. If a sketch running on the board receives one-time configuration or other data when it first starts, make sure that the software with which it communicates waits a second after opening the connection and before sending this data.

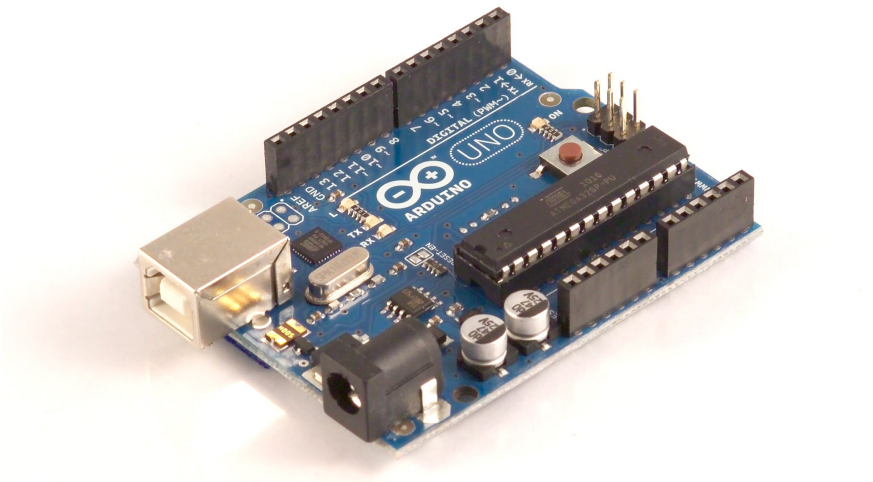
The Uno contains a trace that can be cut to disable the auto-reset. The pads on either side of the trace can be soldered together to re-enable it. It's labeled "RESET-EN". You may also be able to disable the auto-reset by connecting a 110 ohm resistor from 5V to the reset line; see this forum thread for details.

USB Overcurrent Protection

The Arduino Uno has a resettable polyfuse that protects your computer's USB ports from shorts and overcurrent. Although most computers provide their own internal protection, the fuse provides an extra layer of protection. If more than 500 mA is applied to the USB port, the fuse will automatically break the connection until the short or overload is removed.

Physical Characteristics

The maximum length and width of the Uno PCB are 2.7 and 2.1 inches respectively, with the USB connector and power jack extending beyond the former dimension. Three screw holes allow the board to be attached to a surface or case. Note that the distance between digital pins 7 and 8 is 160 mil (0.16"), not an even multiple of the 100 mil spacing of the other pins.



How to use Arduino

Arduino can sense the environment by receiving input from a variety of sensors and can affect its surroundings by controlling lights, motors, and other actuators. The microcontroller on the board is programmed using the Arduino programming language (based on Wiring) and the Arduino development environment (based on Processing). Arduino projects can be stand-alone or they can communicate with software on running on a computer (e.g. Flash, Processing, MaxMSP).

Arduino is a cross-platoform program. You'll have to follow different instructions for your personal OS. Check on the Arduino site for the latest instructions. *http://arduino.cc/en/Guide/HomePage*

Linux Install Windows Install Mac Install

Once you have downloaded/unzipped the arduino IDE, you can Plug the Arduino to your PC via USB cable.

Blink led

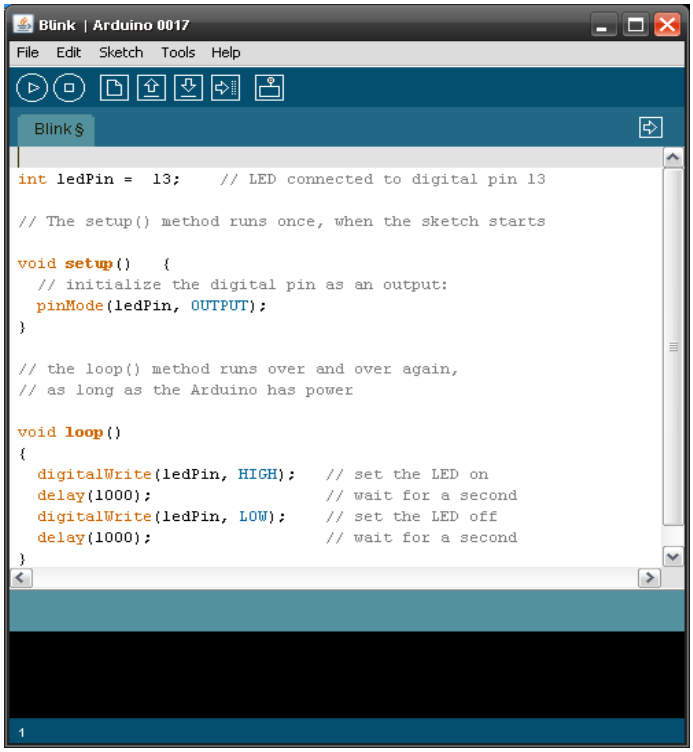
Now you're actually ready to "burn" your first program on the arduino board. To select "blink led", the physical translation of the well known programming "hello world", select

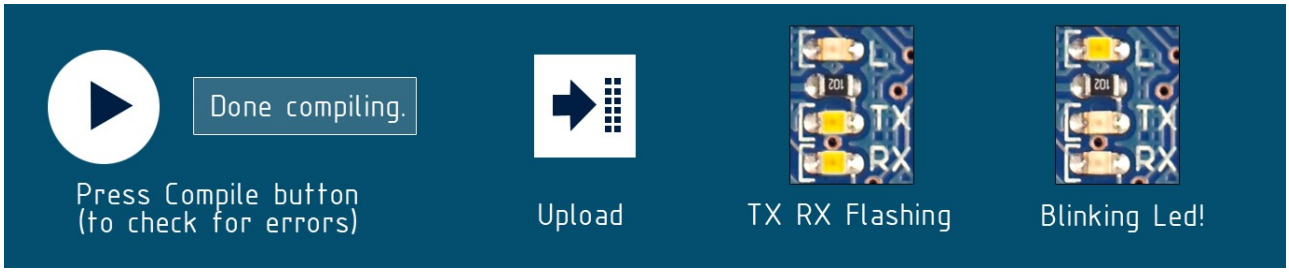
File>Sketchbook>
Arduino-0017>Examples>
Digital>Blink

Once you have your skecth you'll see something very close to the screenshot on the right.

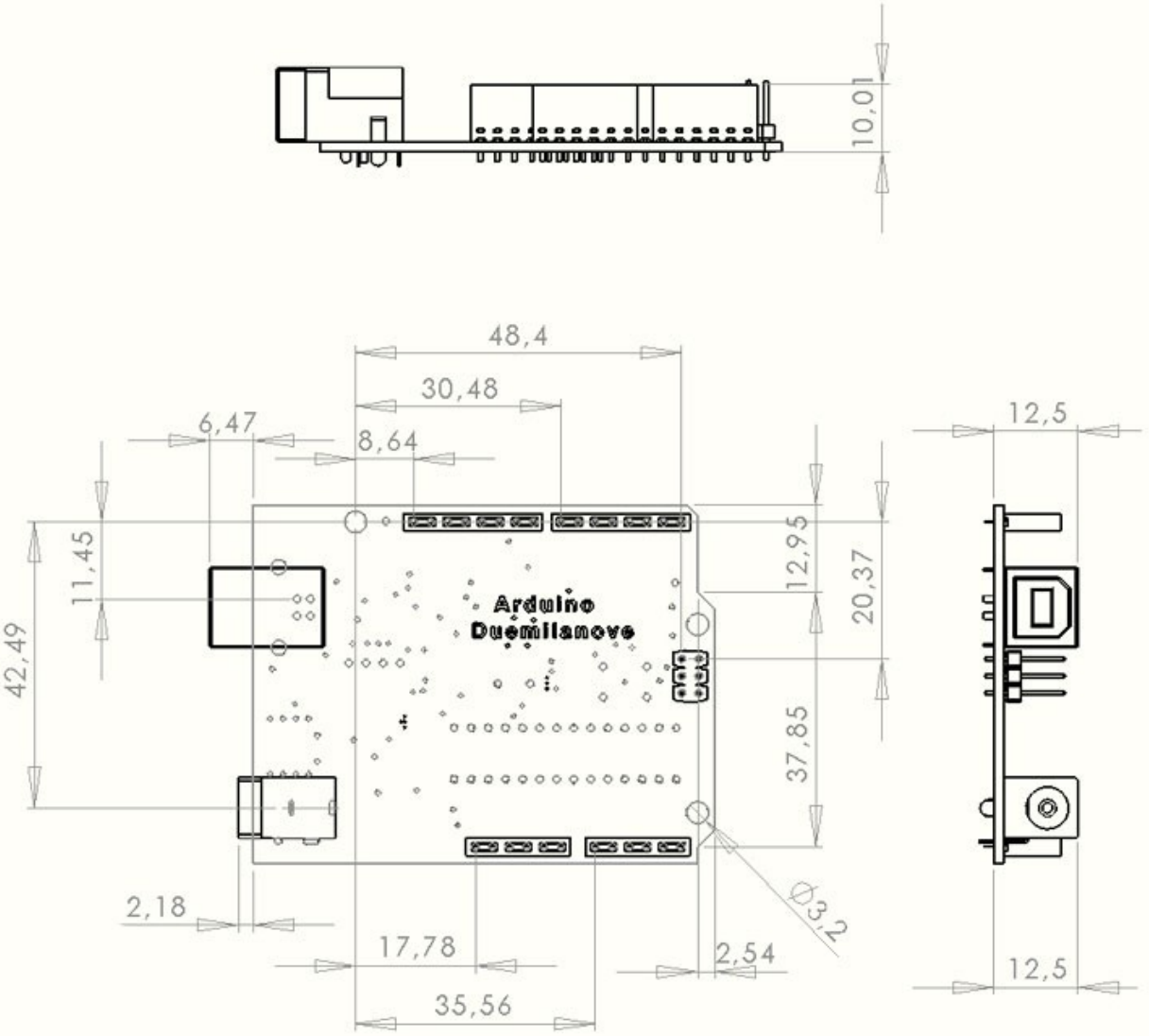
In **Tools>Board** select

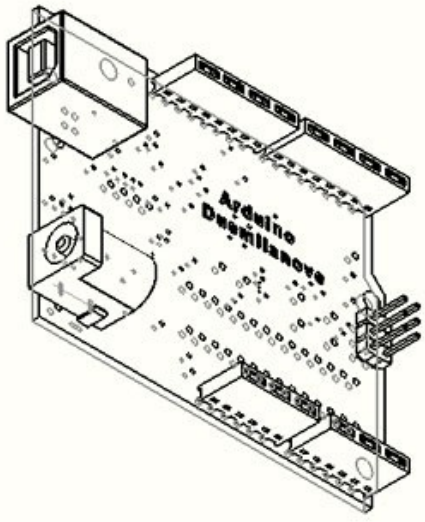
Now you have to go to
Tools>SerialPort
and select the right serial port, the one arduino is attached to.





Dimensioned Drawing





Terms & Conditions

1. Warranties

1.1 The producer warrants that its products will conform to the Specifications. This warranty lasts for one (1) years from the date of the sale. The producer shall not be liable for any defects that are caused by neglect, misuse or mistreatment by the Customer, including improper installation or testing, or for any products that have been altered or modified in any way by a Customer. Moreover, The producer shall not be liable for any defects that result from Customer's design, specifications or instructions for such products. Testing and other quality control techniques are used to the extent the producer deems necessary.

1.2 If any products fail to conform to the warranty set forth above, the producer's sole liability shall be to replace such products. The producer's liability shall be limited to products that are determined by the producer not to conform to such warranty. If the producer elects to replace such products, the producer shall have a reasonable time to replacements. Replaced products shall be warranted for a new full warranty period.

1.3 EXCEPT AS SET FORTH ABOVE, PRODUCTS ARE PROVIDED "AS IS" AND "WITH ALL FAULTS." THE PRODUCER DISCLAIMS ALL OTHER WARRANTIES, EXPRESS OR IMPLIED, REGARDING PRODUCTS, INCLUDING BUT NOT LIMITED TO, ANY IMPLIED WARRANTIES OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE

1.4 Customer agrees that prior to using any systems that include the producer products, Customer will test such systems and the functionality of the products as used in such systems. The producer may provide technical, applications or design advice, quality characterization, reliability data or other services. Customer acknowledges and agrees that providing these services shall not expand or otherwise alter the producer's warranties, as set forth above, and no additional obligations or liabilities shall arise from the producer providing such services.

1.5 The Arduino™ products are not authorized for use in safety-critical applications where a failure of the product would reasonably be expected to cause severe personal injury or death. Safety-Critical Applications include, without limitation, life support devices and systems, equipment or systems for the operation of nuclear facilities and weapons systems. Arduino™ products are neither designed nor intended for use in military or aerospace applications or environments and for automotive applications or environment. Customer acknowledges and agrees that any such use of Arduino™ products which is solely at the Customer's risk, and that Customer is solely responsible for compliance with all legal and regulatory requirements in connection with such use.

1.6 Customer acknowledges and agrees that it is solely responsible for compliance with all legal, regulatory and safety-related requirements concerning its products and any use of Arduino™ products in Customer's applications, notwithstanding any applications-related information or support that may be provided by the producer.

2. Indemnification

The Customer acknowledges and agrees to defend, indemnify and hold harmless the producer from and against any and all third-party losses, damages, liabilities and expenses it incurs to the extent directly caused by: (i) an actual breach by a Customer of the representation and warranties made under this terms and conditions or (ii) the gross negligence or willful misconduct by the Customer.

3. Consequential Damages Waiver

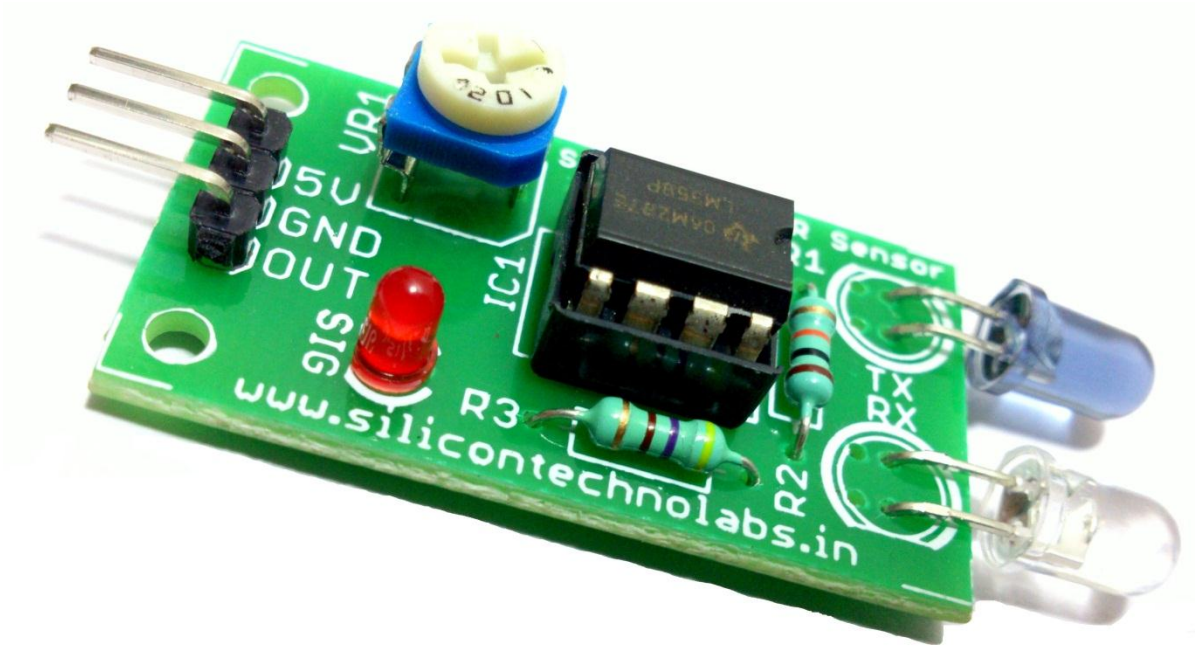
In no event the producer shall be liable to the Customer or any third parties for any special, collateral, indirect, punitive, incidental, consequential or exemplary damages in connection with or arising out of the products provided hereunder, regardless of whether the producer has been advised of the possibility of such damages. This section will survive the termination of the warranty period.

4. Changes to specifications

The producer may make changes to specifications and product descriptions at any time, without notice. The Customer must not rely on the absence or characteristics of any features or instructions marked "reserved" or "undefined." The producer reserves these for future definition and shall have no responsibility whatsoever for conflicts or incompatibilities arising from future changes to them. The product information on the Web Site or Materials is subject to change without notice. Do not finalize a design with this information.

Enviromental Policies

The producer of Arduino™ has joined the Impatto Zero® policy of LifeGate.it. For each Arduino board produced is created / looked after half squared Km of Costa Rica's forest's.



IR Proximity Sensor

1. Descriptions

The Multipurpose Infrared Sensor is an add-on for your line follower robot and obstacle avoiding robot that gives your robot the ability to detect lines or nearby objects. The sensor works by detecting reflected light coming from its own infrared LED. By measuring the amount of reflected infrared light, it can detect light or dark (lines) or even objects directly in front of it. An onboard RED LED is used to indicate the presence of an object or detect line. Sensing range is adjustable with inbuilt variable resistor.

The sensor has a 3-pin header which connects to the microcontroller board or Arduino board via female to female or female to male jumper wires. A mounting hole for easily connect one or more sensor to the front or back of your robot chassis.

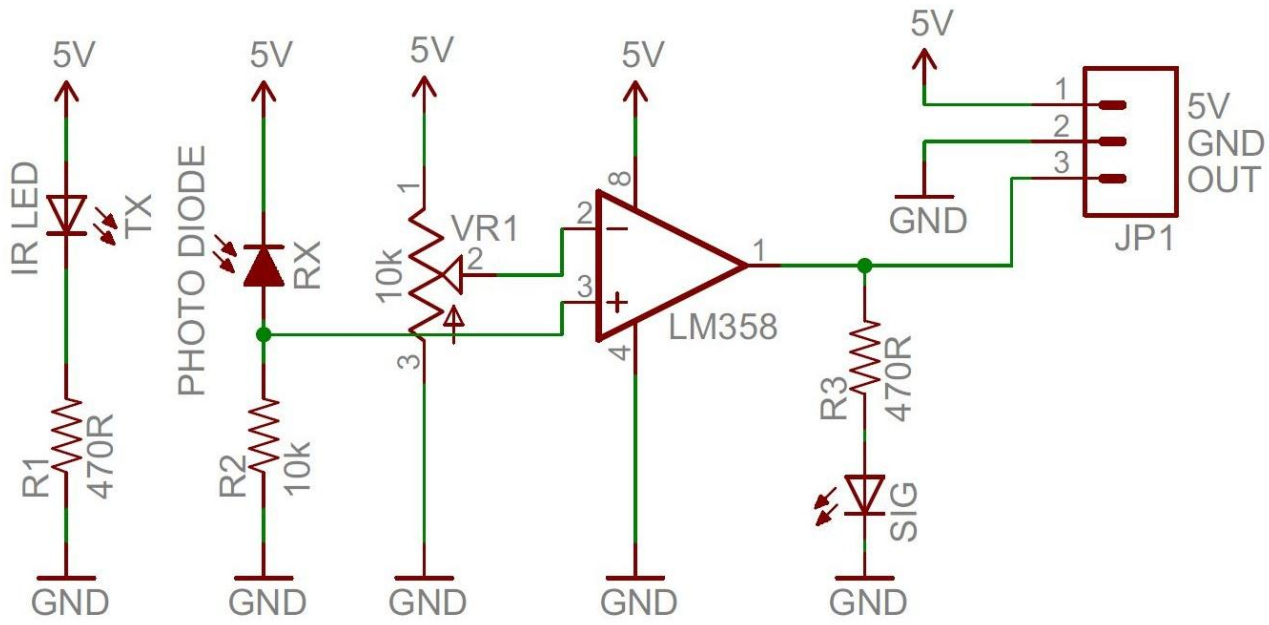
2. Features

- 5VDC operating voltage.
- I/O pins are 5V and 3.3V compliant.
- Range: Up to 20cm.
- Adjustable Sensing range.
- Built-in Ambient Light Sensor.
- 20mA supply current.
- Mounting hole.

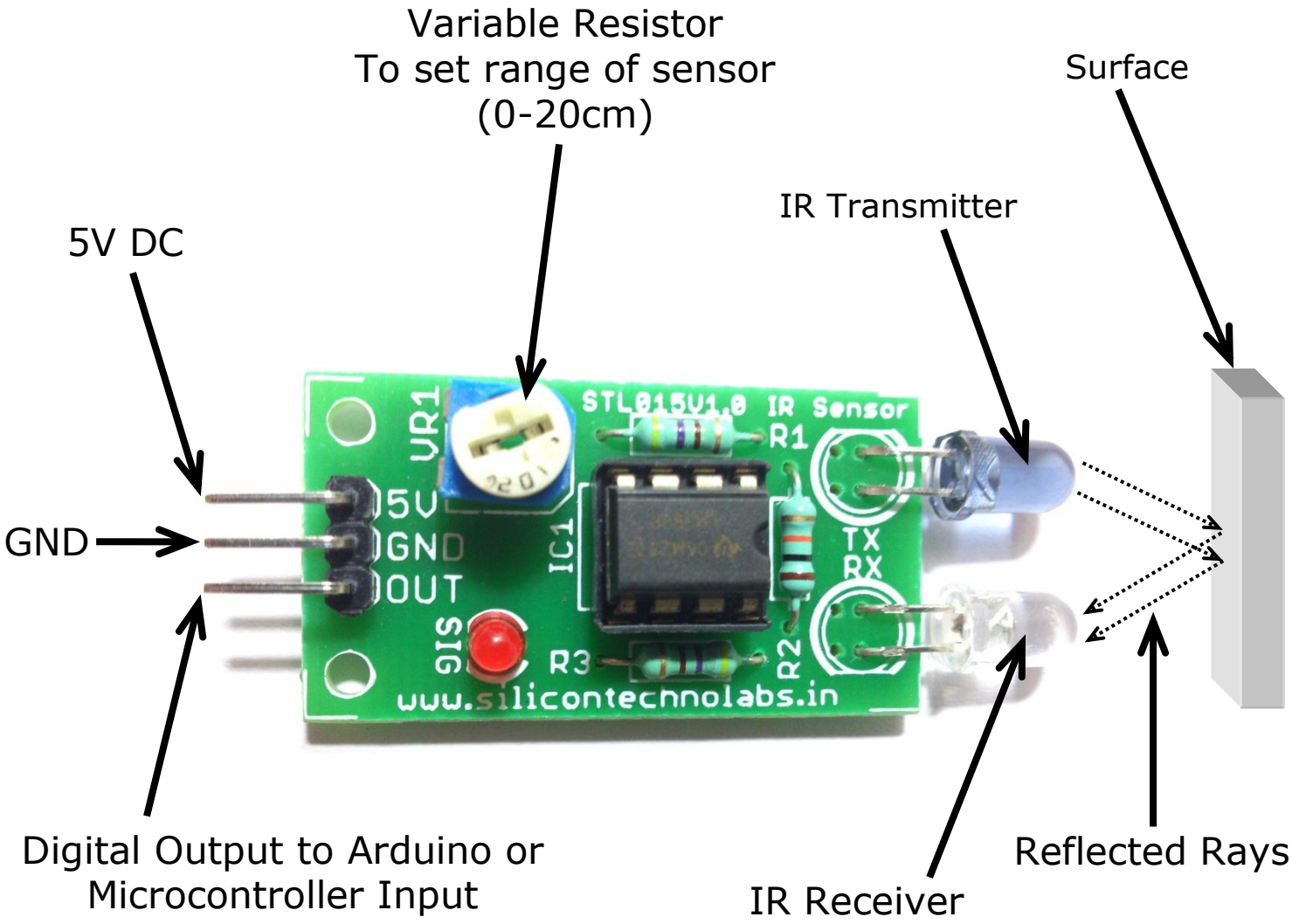
3. Specifications

- Size: 50 x 20 x 10 mm (L x B x H)
- Hole size: ϕ2.5mm

4. Schematics

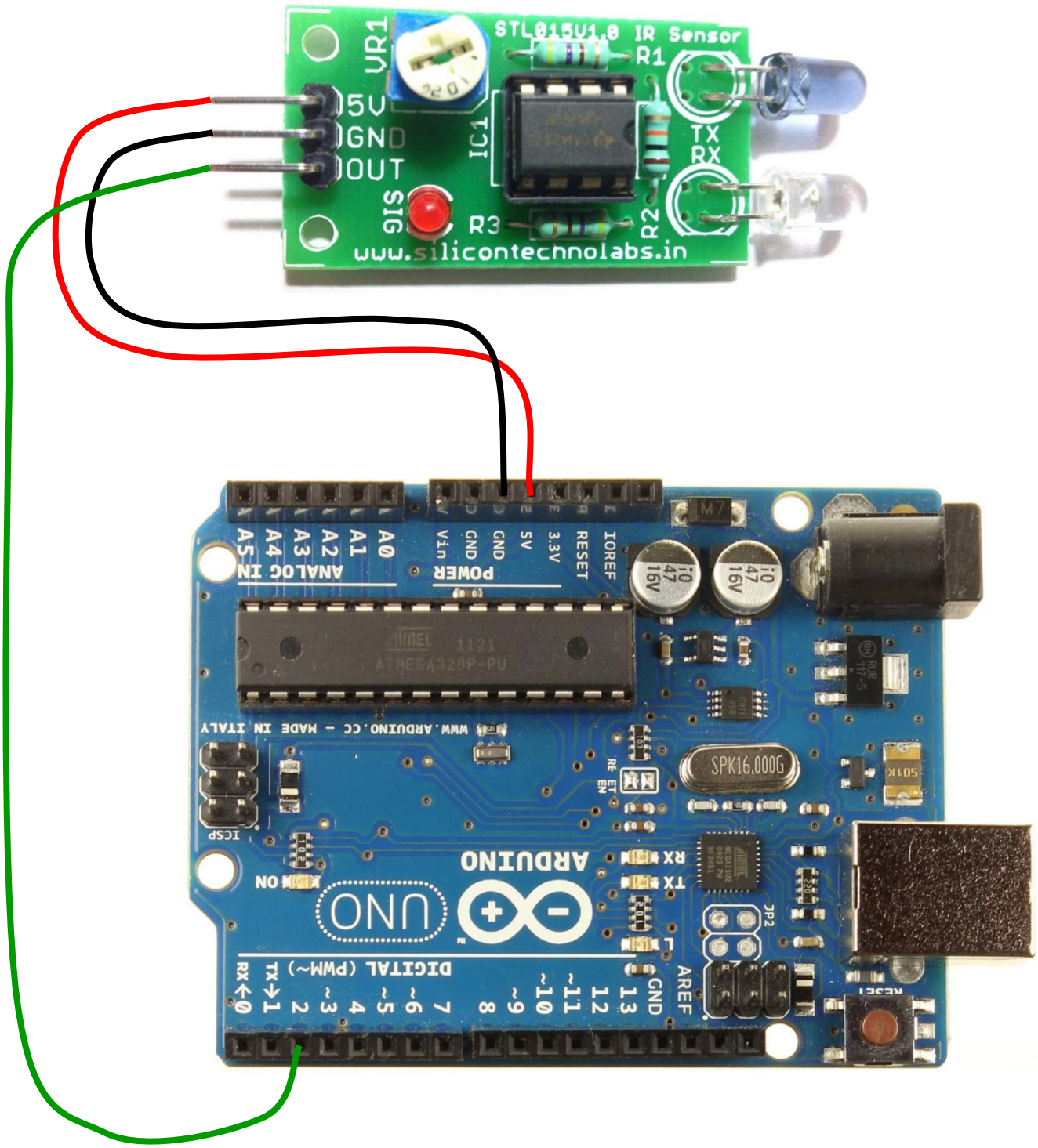


5.Hardware Details



6.Interface to Arduino

Now let's we build simple object counter using IR Proximity Sensor that's counts the Number of objects.Connect Silicon TechnoLabs IR Proximity Sensor to your arduino board as shown in below image.



7.Arduino Sample Code

```
/*
 Object counter
 Counts the number of objects and prints the results to the serial monitor.
 The circuit:
 * OUT attached to pin 2
 Created 2015
 by Harshit Borad <http://www.silicontechnolabs.in>
*/
// constants won't change. They're used here to
// set pin numbers:
const int OUT = 2; // the number of the IR Proximity Sensor pin
const int ledPin =  13;// the number of the LED pin
// variables will change:
int Number_of_Object = 0;// variable for reading the Number of Objects passing from sensor
int SensorState = 0;
void setup()
{
  Serial.begin(9600);  // initialize serial communications at 9600 bps:
  pinMode(ledPin, OUTPUT);  // initialize the LED pin as an output:
  pinMode(OUT, INPUT);   // initialize the IR Proximity Sensor pin as an input:
}
void loop()
{
  SensorState = digitalRead(OUT);// read the state of the Sensor Signal
  // check if the Sensor Signal is HIGH then there is object in front of sensor
  // so increment Number_of_Object variable by one.
  if (SensorState == HIGH)
  {
    digitalWrite(ledPin, HIGH);// turn LED on:
    Number_of_Object++;
    Serial.println(Number_of_Object);// print the results to the serial monitor:
  }
  else
  {
    digitalWrite(ledPin, LOW);// turn LED off:
  }
}
```

Thank you

"Happy Coding"

LED, 10mm

Electrical/Optical characteristics at T_A = 25°C

Parameter	Symbol	Min.	Type	Max.	Unit	Test
Luminous Intensity	IV	900	1,450	2,050	mcd	IF = 20mA
Viewing Angle	2θ½		20		Deg.	IF = 20mA
Peak Emission Wavelength	λp		660		nm	
Dominant Wavelength	λD		643		nm	IF = 20mA
Spectral Line Half-Width	Δλ		20		nm	
Forward Voltage	VF	1.7	1.85	2.5	V	IF = 20mA
Power Dissipation	Pd			85	mW	
Peak Forward Current (Duty1/10 @ 1kHz)	IF (Peak)			100	mA	
Recommended Operating Current	IF (Rec)		20		mA	

Absolute Maximum Ratings : (T_A = 25°C)

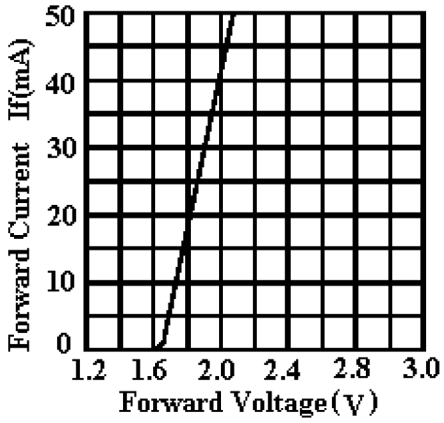
Reverse Voltage	: 5 Volt
Reverse Current	: 10μA (V_R = 5V)
Operating Temperature Range	: -40°C to +85°C
Storage Temperature Range	: -40°C to +100°C
Lead Soldering Temperature Range {1.6mm (1/16 inch) from body}	: 260°C For 5 Seconds

Reliability test For LED Lamps

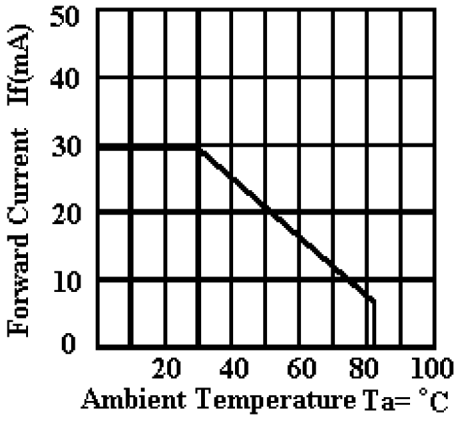
Item	Test Conditions	Test Time/Cycle	Sample Size	Ac/Re
DC Operating Life	Temperature : 25°C IF : 20mA	1,000 Hrs.	76 Pcs.	0/1
High Temperature High Humidity	Temperature : 85°C 85%RH			
High Temperature Storage	Temperature : 100°C			
Low Temperature Storage	Temperature : -40°C			
Temperature Cycling	85°C~ 25°C~-35°C 15min~ 5min~ 15min	15 Cycles		
Thermal Shock	85°C~ 25°C~-10°C 5min~ 10sec ~ 5min			
Solder Heat	Temperature : 260°C ±5°C	10 Sec.		

Typical Electro-Optical Characteristics Curves

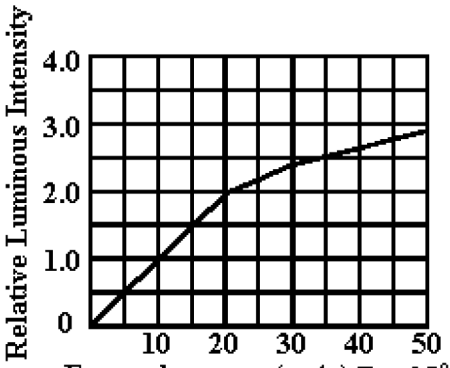
Ultra Red (GaAlAs) λP=660nm)



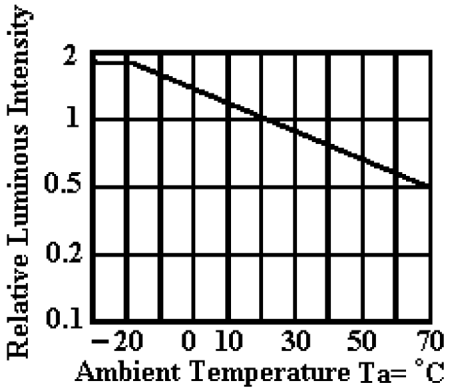
Forward current vs. Forward Voltage



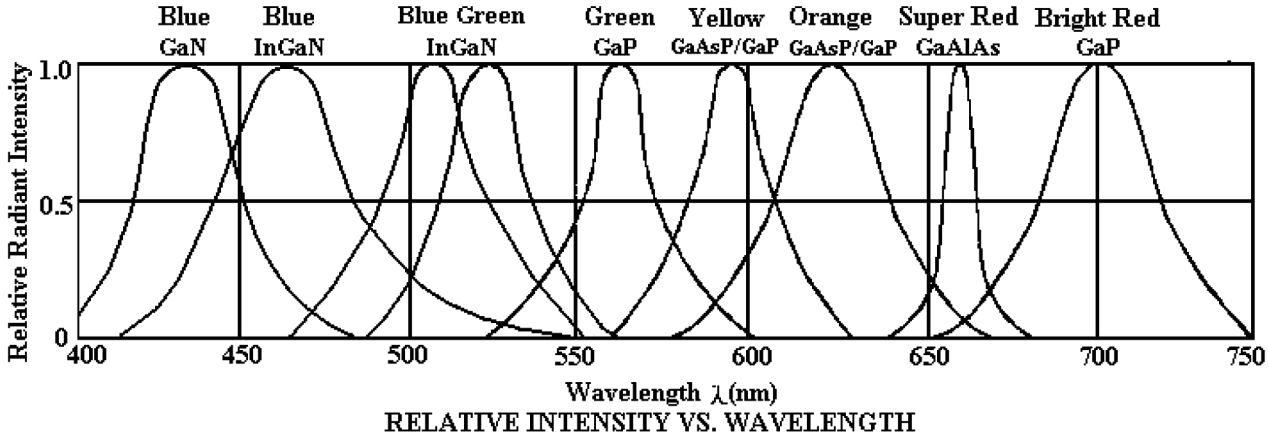
Forward current Derating curve



Luminous Intensity vs. Forward current



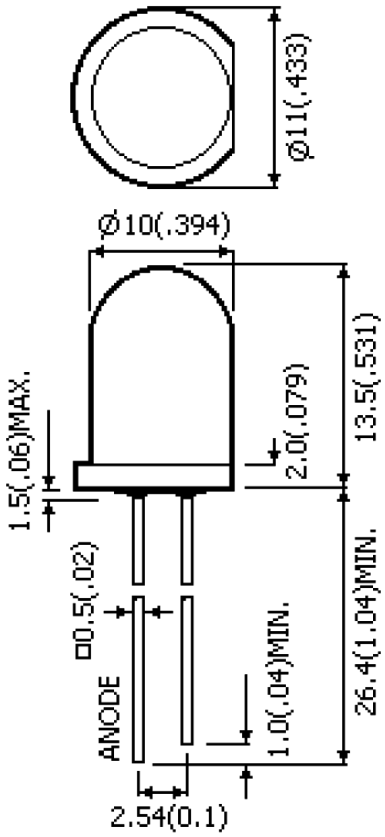
Luminous Intensity vs. Ambient Temperature



RELATIVE INTENSITY VS. WAVELENGTH

LED, 10mm

Dimensions:



Dimensions : Inches (Millimetres)
All tolerance shall be
±0.01 inch (0.25mm)

Part Number Table

Description	Part Number
LED, 10mm, Red, 1,450mcd, 660nm	MCL103URC

CONNECTING WIRES

UNSCREENED – PVC INSULATED

USE: **Internal Wiring of Communications and General Electronic Equipment.**

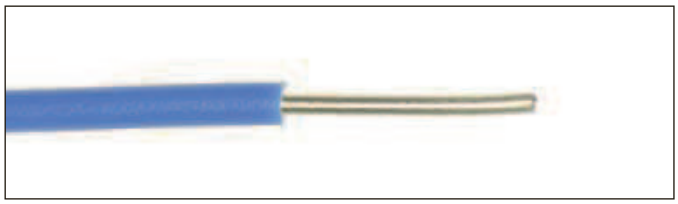
PACK: 100, 500 or 1070 metre reels

INSULATION: V-90 HT

COLOURS: Red, Blue, Green, Yellow, White, Black, Brown, Violet, Orange, Pink, Grey.

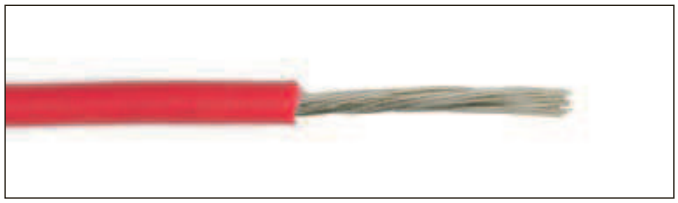
DUAL COLOURS Available on request

The voltage rating given is generally in accordance with Defence specifications DEF 61-12(Part 6) and DEF(Aust)8008.



SOLID CONDUCTORS

NEAREST AWG	APPROX AREA SQ mm	CONDUCTORS NO/DIA (mm)	INSULATION THICKNESS (mm)	NOMINAL DIA (mm)	VOLTAGE MAX RMS	PART No.
26	0.125	1/0.40 TC	0.25	0.90	750	HC0069
24	0.196	1/0.50 TC	0.25	1.00	750	HC0072
23	0.283	1/0.60 TC	0.20	1.00	750	HC0077



STRANDED CONDUCTORS

NEAREST AWG	APPROX AREA SQ mm	CONDUCTORS NO/DIA (mm)	INSULATION THICKNESS (mm)	NOMINAL DIA (mm)	VOLTAGE MAX RMS	PART No.
27	0.11	21/0.08 BC	0.25	0.96	750	HC0001
24	0.22	7/0.20 TC	0.20	1.00	750	HC0026
24	0.22	7/0.20 TC	0.30	1.20	1000	HC0028
22	0.34	7/0.25 TC	0.38	1.54	1000	HC0047
20	0.50	10/0.25 TC	0.38	1.77	1000	HC0049
20	0.50	16/0.20 TC	0.30	1.52	1000	HC0032
18	0.75	24/0.20 TC	0.45	2.03	1000	HC0035
17	1.00	32/0.20 TC	0.45	2.20	1000	HC0041
13	2.50	50/0.25 BC	0.65	3.60	1500	HC0054
11	4.00	80/0.25 BC	1.00	4.70	1500	HC0057
10	5.50	112/0.25 BC	0.90	5.20	1500	HC0058
9	6.00	120/0.25 BC	0.90	5.30	1500	HC0059
7	10.00	200/0.25 TC	1.00	7.10	1500	HC0060

• NOT ALL SIZES AND COLOURS ARE AVAILABLE EX STOCK, MINIMUM ORDER QUANTITY WILL APPLY FOR SOME ITEMS.

CONNECTING WIRES

UNSCREENED SINGLE CORE FLEXIBLE CABLES– 250V OR 0.6/1kV OPERATION

USE: **Internal Wiring of Electronic Equipment.**

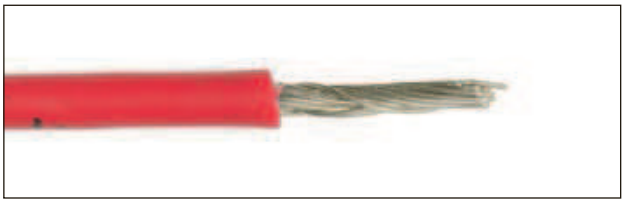
PACK: 100 or 500 metre reels

COLOURS: Red, Blue, Yellow, White, Black, Brown, Violet, Orange, Pink, Grey, Green, Green/Yellow

INSULATION: V-90 HT PVC.

DUAL COLOURS Available on request

NOTE: These connecting wires are made in accordance to AS3191 or AS3178.



250/250 VOLT RATING – V-90 HT PVC INSULATED

APPPROX AREA SQ mm	CONDUCTORS NO/DIA (mm)	INSULATION THICKNESS (mm)	NOMINAL DIA (mm)	CURRENT RATING (Amps)	PART No.
0.50	16/0.20 TC	0.6	2.2	3.00	HC6001
0.75	24/0.20 TC	0.6	2.4	7.5	HC6002
1.00	32/0.20 TC	0.6	2.6	10.0	HC6003
1.50	30/0.25 TC	0.7	3.0	15.0	HC6004
2.50	50/0.25 TC	0.8	3.7	20.0	HC6005

0.6/1kV RATING – V-90 HT PVC INSULATED

APPPROX AREA SQ mm	CONDUCTORS NO/DIA (mm)	INSULATION THICKNESS (mm)	NOMINAL DIA (mm)	CURRENT RATING (Amps)	PART No.
0.50	16/0.20 TC	0.6	2.2	3.00	HC6101
0.75	24/0.20 TC	0.6	2.4	7.5	HC6102
1.00	32/0.20 TC	0.6	2.6	10.0	HC6103
1.50	30/0.25 TC	0.7	3.0	15.0	HC6104
2.50	50/0.25 TC	0.8	3.7	20.0	HC6105
4.00	56/0.30 TC	1.00	5.40	25.0	HC6106
6.00	84/0.30 TC	1.00	5.50	40.0	HC6107

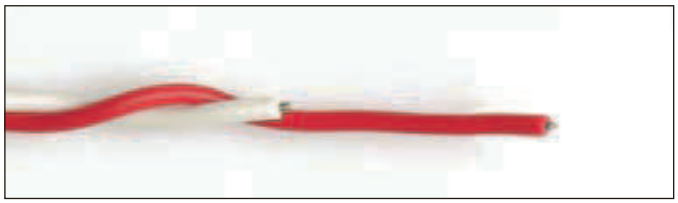
TWISTED CONNECTING WIRES – JUMPER WIRES

USE: **Wiring of Electronic Equipment and the interconnection of Telephone frames.**

PACK: 500 metre reels

INSULATION: V-90 HT PVC

COLOUR CODE: 2 Core – White + Red;
4 Core – White + Red + Blue + Black;
Other colours on request.



NEAREST AWG	NUMBER OR CORES	CONDUCTORS NO/DIA (mm)	INSULATION THICKNESS (mm)	PART No.
24	2	1/0.50 TC	0.20	HC2X72
24	4	1/0.50 TC	0.20	HC4X72
26	2	1/0.40 TC	0.20	HC2X69
26	4	1/0.40 TC	0.20	HC4X69

NOTE: These cables are not suitable for direct connection to mains supply.

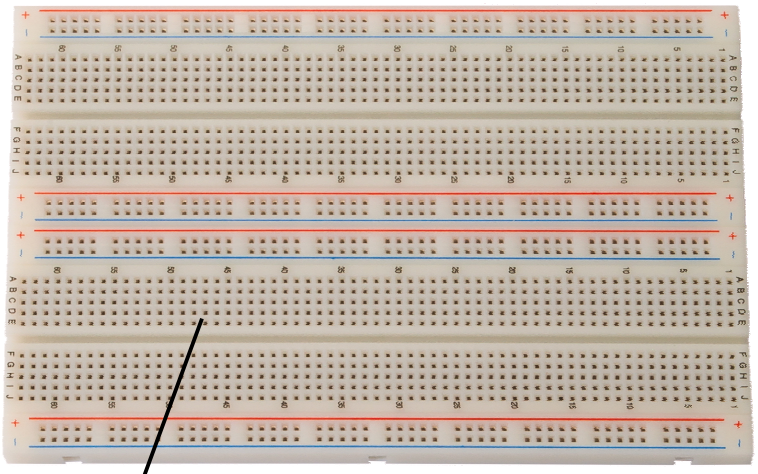
• NOT ALL SIZES AND COLOURS ARE AVAILABLE EX STOCK, MINIMUM ORDER QUANTITY WILL APPLY FOR SOME ITEMS.

BB1660™, BB1660T™ Large BreadBoards

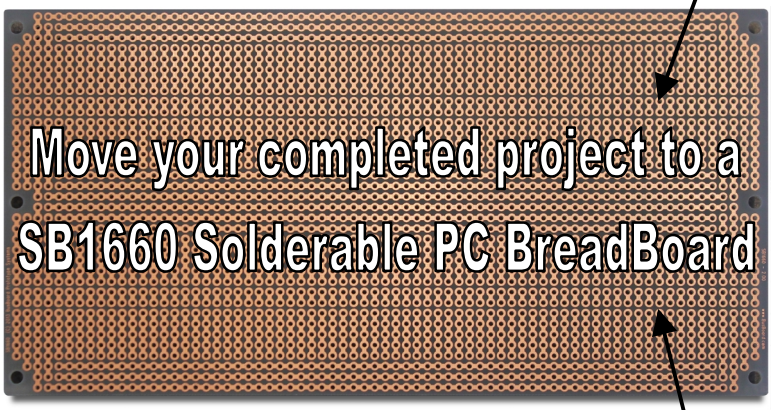
1660 tie point solderless plug-in breadboards provide a quick way to build and test circuits for experimentation or when learning electronics.

BB1660 - 1660 tie-point plug-in Solderless BreadBoard

ABS plastic with color legend
2 IC/Circuit Areas, 2 x 630 tie-points
4 Distribution strips, 400 tie-points
Size: 6.5 x 4.4 x 0.3in
(165.1 x 109.2 x 8.5mm)



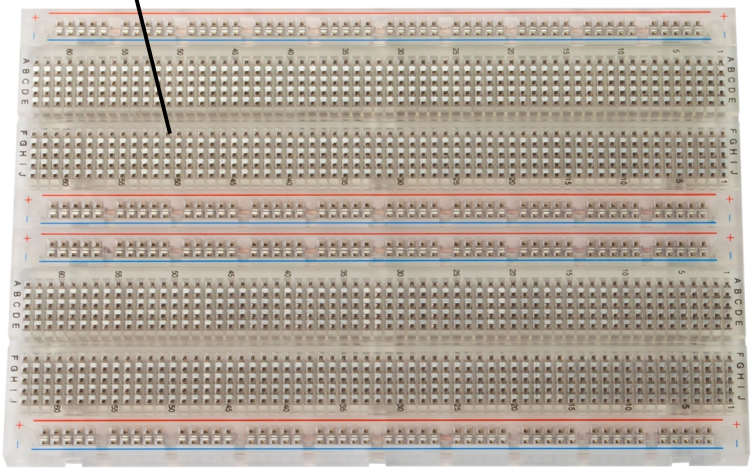
RoHS LEAD-FREE COMPLIANT



BB1660T – *Transparent* 1660 tie-point plug-in Solderless BreadBoard

Transparent ABS plastic with color legend
2 IC/Circuit Areas, 2 x 630 tie-points
4 Distribution strips, 400 tie-points
Size: 6.5 x 4.4 x 0.3in
(165.1 x 109.2 x 8.5mm)

The transparent breadboard is great for beginners because they can see their circuit connections.



Solderless Plug-in BreadBoards

Solderless BreadBoard Specifications

BB300 Body Material: White ABS Plastic with Black Printed Legend
BB400/BB830/BB1660 Body Material: White ABS Plastic with Color Printed Legend
BB400T/BB830T/BB1660T Body Material: Transparent ABS Plastic with Color Printed Legend

Hole Pitch/Style: 0.1" (2.54 mm), Square Wire Holes

ABS Heat Distortion Temperature: 84° C. (183° F.)

Spring Clip Contact: Phosphor Bronze with Plated Nickel Finish
Contact Life: 50,000 insertions
Rating: 36 Volts, 2 Amps

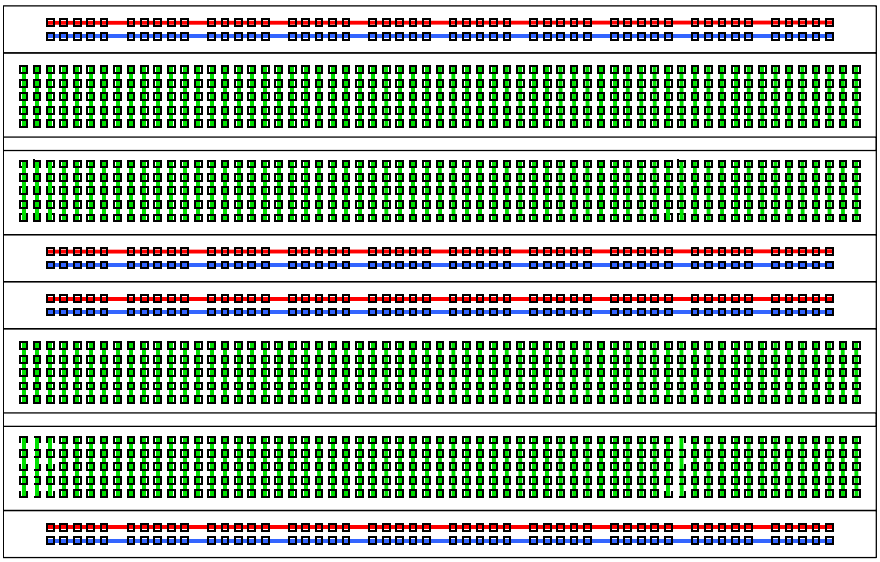
Insertion Wire Size: 21 to 26 AWG wire, or 0.025" Square post headers
0.016 to 0.028 inches diameter (0.4 to 0.7mm diameter)

Backing: Peelable adhesive tape for attaching to a surface.
Metal back plates provided with 1660 tie point breadboards.
Metal Back Plate Thickness: 0.031 inches (0.8mm)

All BPS BreadBoards are Lead-Free and ***RoHS Compliant***.

Internal Connections

The BB1660 and BB1660T breadboards have four rows of 63 vertical columns. Each column has 5 connected holes each (the green lines). This is the circuit area. The are also 8 "rails" (or distribution strips) for power and ground running horizontally (the red and blue lines).
A distribution strip can be used to carry a signal if it is not needed for power or ground.



Solderless BreadBoard FAQ

Q: What circuit frequencies can I use with a plug-in solderless breadboard?

A: Due to large stray capacitance (from 2-25pF per contact point), the inductance of connections, and a relatively high and not very reproducible contact resistance, solderless breadboards are limited to operate at relatively low frequencies, usually less than 10 MHz, depending on the nature of the circuit. The relatively high contact resistance can also be a problem for some DC and very low frequency circuits.
Source http://en.wikipedia.org/wiki/Breadboard

Higher frequency operation may be possible in some cases, depending upon the circuit requirements.

Note: Solderable PC BreadBoards, such as the BPS BR1, SB300, SB400, SB404, SB830, and SB1660 will provide lower stray capacitance and lower connection resistance which may allow higher frequency operation for some circuits.
For circuits sensitive to small changes in values, component adjustments may be needed when the circuit is moved from a plug-in breadboard to a Solderable PC BreadBoard, due to these small differences.

Q: Can I plug DIL or SIL connector headers into the breadboard?

A: Yes. The square pin of a standard 0.1" spacing header is typically 0.025 inches wide. This is within the 0.016 to 0.028 inch diameter wire insertion size range recommended for the breadboard.

Solderless BreadBoard NSFAQ

Q: Who invented the solderless breadboard?

A: US Patent #203938 was awarded to Ronald J. Portugal of EI Instruments Inc. in 1971.

Q: Why is phosphorus added to the bronze used in the contacts?

A: Phosphor bronze is an alloy of copper with 3.5 to 10% of tin and a significant phosphorus content of up to 1%. The phosphorus is added as deoxidizing agent during melting.

These alloys are notable for their toughness, strength, low coefficient of friction, and fine grain. The phosphorus also improves the fluidity of the molten metal and thereby improves the castability, and improves mechanical properties by cleaning up the grain boundaries.
Source http://en.wikipedia.org/wiki/Phosphor_bronze

Mouser Electronics

Authorized Distributor

Click to View Pricing, Inventory, Delivery & Lifecycle Information:

BusBoard Prototype Systems:

BB1660 BB1660T