D.Y.Patil Educational Academy's

D. Y. PATIL POLYTECHNIC

Sr. No. 124 & 126, A/P Ambi, Talegaon Dabhade,

Academic Year : 2021 - 22

Institute Code: 0996

A

Project Report

On

Smart street light project with smart solar tracking system.

Submitted to the Maharashtra State Board of Technical Education in the partial fulfillment of requirements of the award of the degree of

DEPLOMA IN E&TC ENGINEERING

Submitted by :

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Under the Guidance of

Ms. Bhakti Mukhedkar

CERTIFICATE

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Certificate

This is to certify that during the academic yera 2021 - 22 following students of third year of deploma in E&T.C hvae successfully completed the project entitled -

"Smart street light project with smart solar tracking system"

SUBMITTED BY

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towards the partial fulfillment of the degree of deploma in E & T.C awarded by the Maharashtra State Board of Technical Education.

Ms. Bhakti Mukhedkar.

(Guide) Head of Department. (Principal)

Project Approval

This project entitled **Smart street light project with smart solar tracking system** by **Omkar Gaikwad, Shreya Kadam, Prasad Shivsharan, Varad Patil** are approved for subject head of Industrial Project (17808) Diploma in E & TC Engineering.

Internal Examinar

External Examinar

Date :

Place :

Declaration for Academic Honesty & Integrity

We heraby declare that this written submission represents our ideas in our own words and where others ideas or words have been included, we have adequately cited and referenced the original sources. We also declare that we have adhered to all principles of academic honesty and integrity and have not misrepresented or fabricated or falsified any idea/data/fact/source in our submission. We understand that any violation of the above will be cause for disciplinary action by rhe Institute and can also avoke penal action from the source which have thus not properly cited or from whom proper permission has not been taken when needed.

Date :

Place :

Acknowledgement

We would like to express our deep sense of gratitude towards our project guide Ms. Sunita Yewle for her valuable guidance, suggestions and the help that the has extended at each and every step of this project. We are also thankful to our project coordinator and Head of the Department of E& T.C Engineering Ms. B. A. Mukhedkar for her guidance and for providing us all the necessary amenities which have helped us complete this project. We are extremely thankful to our respected Principal Mr. M. D. Kulkarni for his support and for providing us all required facilities which have helped us greatly in the completion of this project. Finally, we would like to thank all our friends for their support & suggestions. Last but not the least, we would like to thank our family for giving us support and confidence at each and every stage of this project.

Abstract

This project helps to save electricity. In this project we are using arduino which is programmable. In solar tracking system we use arduino and LDR sensor to track the sun direction and collect more electricity. The collected electricity we use as a input to the street lights. In the project we use sensors to the street lights. When the car is pass through the sensors the lights are get on automatically. Because of this we can save more electricity.

Contents

Chapter no : 1

1.1 Introduction

This project helps to save electricity. The solar panel track location of sun with the help of LDR sensor & move with the servo motors. It is programmed such that servo motor is activated in the direction of maximum sunlight intensity detected via the LDR pair. This kind of solar tracking system can be used for efficient generation of electricity in remote homes, livestock, plantation irrigation, pool filtration, solar heating. Because of this we can get more electricity. This all electricity we use as a input to the street lights. In this it based on detection of movement on the road by vehicles (mostly) and pedestrians (if any). By this way we can save more electricity.

This concept has existed in many smart Cities projects or industrial area. This way we can generate electricity by eco-friendly. This system become popular now a day & enters quickly in this emerging market. In future all countries use this strategies.

1.2 Advantages

First of all solar energy is absolutely free & is a renewable resource for generating electricity. Here are some other advantages of using the automatic solar street light system.

- Since automatic street light systems feature no moving parts, they require less maintenance than conventional street lights.
- The automatic solar street light system is a stand-alone arrangement & therefore requires no external wiring or having to connect with the grid.
- There are lower chances of the automatic street light system overheating & risk of accidents is also minimized.
- Cost of operating automatic solar street lights is far less when compared to the conventional street lights.
- The automatic street light system is eco-friendly & hence helps in reducing the carbon footprint.
- Smart solar street lights can be put up in remote areas even in places that are not accessible to the grid.

1.3 Disadvantages

- The automatic street light system requires a higher initial investment in comparison to conventional street lights.
- Generation of energy for solar street light entirely depends upon the climatic conditions.
- Risk of theft of the automatic street light system is relatively higher since they are non-wired & are much expensive.
- Rechargeable batteries of the automatic street light system are required to be replaced a few times.
- Solar trackers are generally designed for climates with little to no snow making them a more viable solution in warmer climates.

Fixed racking accommodates harsher environmental conditions more easily than tracking.

1.4 Applications

- Smart Street lights could be equipped with Radar Sensors which could detect if any object comes near the pole and the light gets brighter.
- It could act as a hub for smart applications.
- It could also be equipped with charging station for electric vehicles.
- It is also used for digital signage.
- solar tracker, a system that positions an object at an angle relative to the Sun. The most-common applications for solar trackers are positioning photovoltaic (PV) panels (solar panels) so that they remain perpendicular to the Sun's rays and positioning space telescopes so that they can determine the Sun's direction.

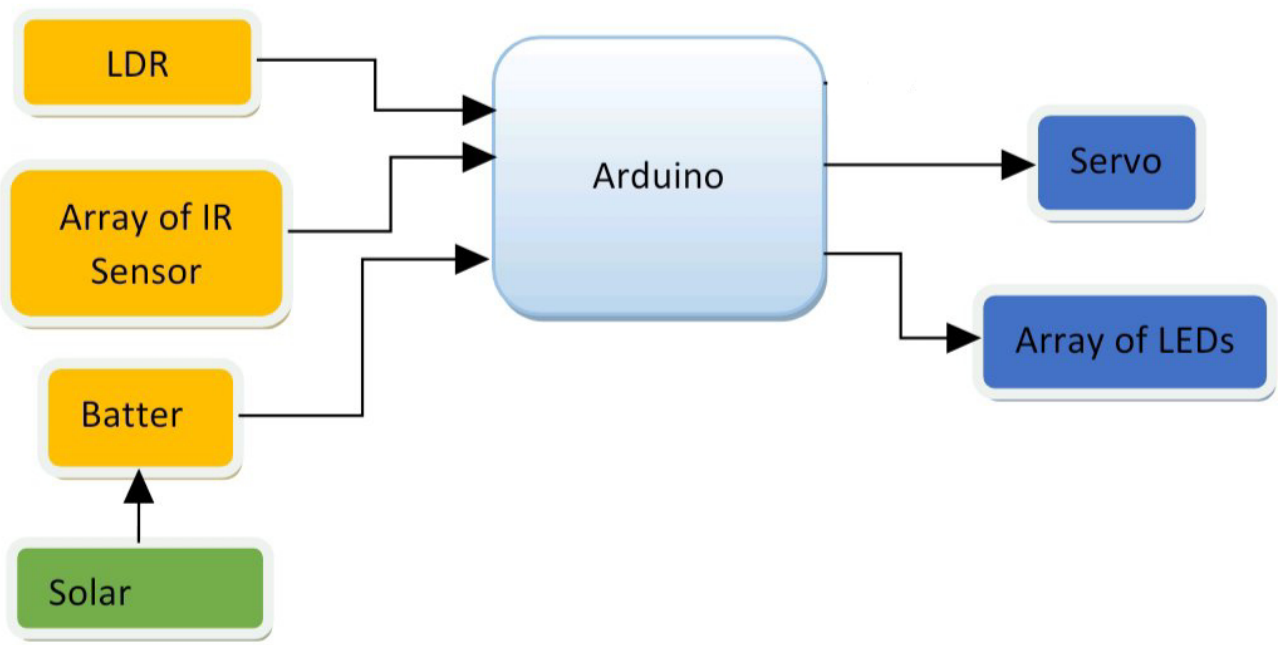
1.5 Layout of the project report

The rest of the project report is organized as follows : -

1) Chapter 1 consists of introduction part
2) Chapter 2 covers the the literature survey in which a review of the current technique is presented.
3) Chapter 3 covers the block diagram of proposed system.
4) Chapter 4 covers the circuit design and development of the proposed system.
5) Chapter 5 describes about software design.
6) Chapter 6 covers the conclusion and future scope.
7) Chapter 7 describes Components list.
8) Chapter 8 covers Reference.
9) Chapter 9 describes the data sheets.

Chapter no : 2

Block diagram and Description



Description :

The above figure shows the block diagram of Smart streetlights with smart solar tracking system.

Arduino UNO is used to control all the devices such as sensors, servo motors, LED etc.

The above figure shows the block diagram of Smart streetlights with smart solar tracking system.

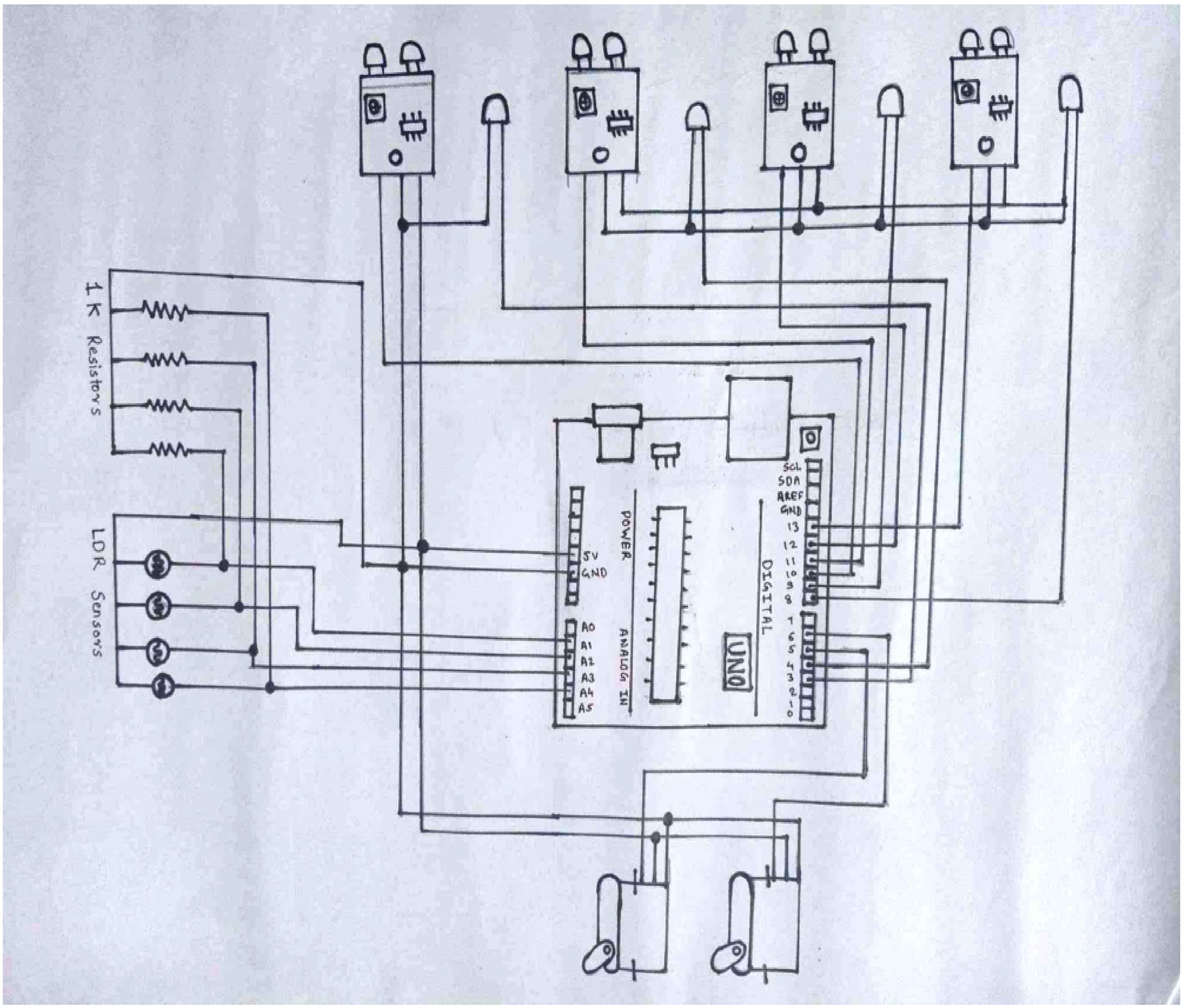
Arduino UNO is used to control all the devices such as sensors, servo motors, LED etc.

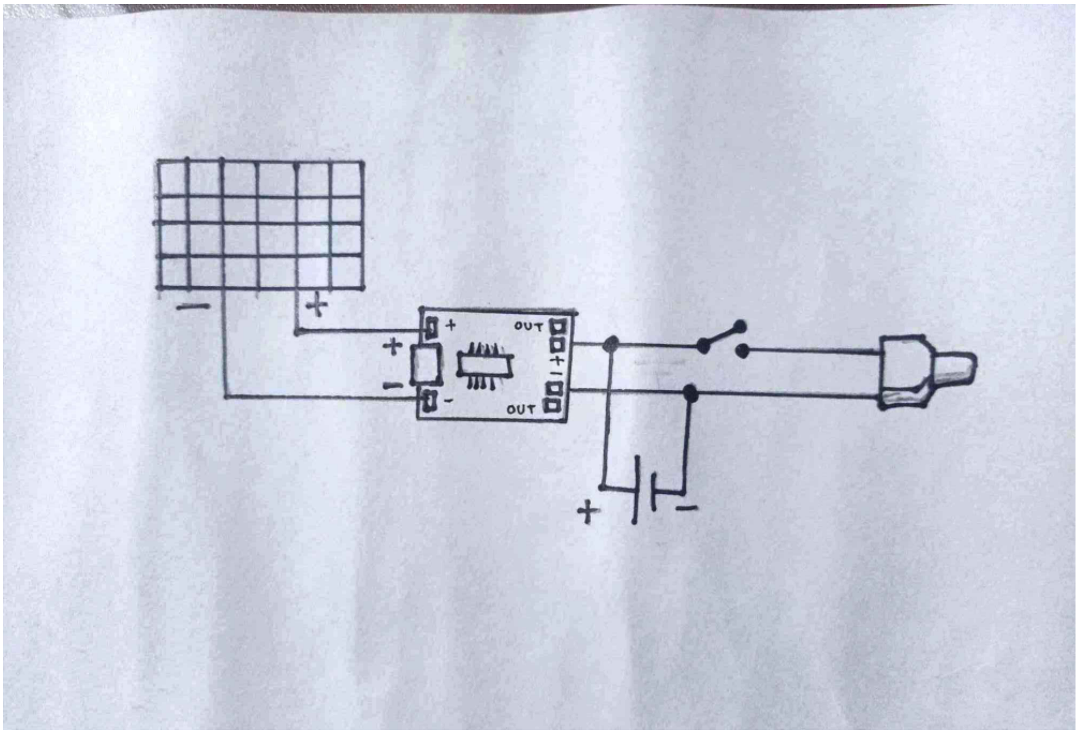
In this LDR, IR sensor and servo motors are connected to the Arduino.

First LDR sensor get the direction of sun and then the Arduino give instructions to the servos to rotate solar pannel as per suns direction.. The collected solar power we use as supply for streetlights and also it use for IR sensor which use for detect motion of cars or person on road. IF the motion detect then the streetlights turn on automatically.

Chapter no : 3

Circuit diagram design and description





OUT
OUT

3.1 Specifications :

- Power Supply : 12V
- Microcontroller : Arduino UNO
- Visibility Sensor : LDR sensor
- Motion Sensor : IR sensor
- Charging Module
- Motor for motion : Servo Motor

3.2 Working :

The circuit diagram consist of LDR sensor, IR sensor, Servo Motor, LEDs, charging module and connections of Arduino UNO.

All this devices are controlled by the Arduino UNO microcontroller.

LDR : Visibility sensor is the sensor which help us to know the intensity of light. It get the direction of sun and then Arduino change the direction of solar pannel with the help of servo motor.

IR sensor : Active infrared sensors both emit and detect infrared radiation. Active IR sensors have two parts: a light emitting diode (LED) and a receiver. When an object comes close to the sensor, the infrared light from the LED reflects off of the object and is detected by the receiver. It use to detect motion of cars or object.

Servo motor : A servomotor (or servo motor) is a rotary actuator or linear actuator that allows for precise control of angular or linear position, velocity and acceleration. It consists of a suitable motor coupled to a sensor for position feedback.

Arduino UNO : The Arduino Uno is an open-source microcontroller board based on the Microchip ATmega328P microcontroller and developed by Arduino.cc. The board is equipped with sets of digital and analog input/output (I/O) pins that may be interfaced to various expansion boards (shields) and other circuits.

3.3 Working of system :

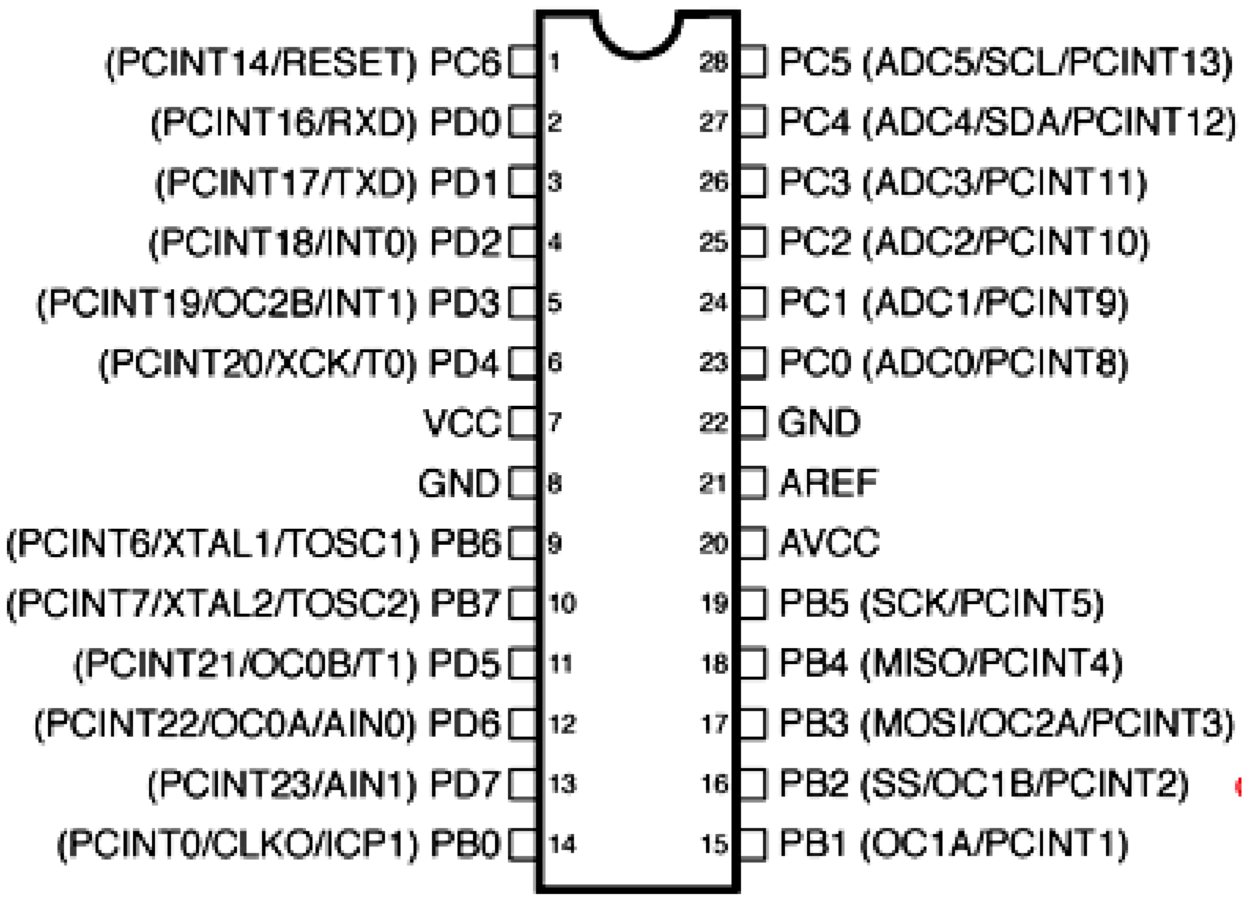


Fig : Pin diagram of Arduino UNO

The Arduino provides the following standard features:
The Arduino Uno board is a microcontroller based on the ATmega328. It has 14 digital input/output pins in which 6 can be used as PWM outputs, a 16 MHz ceramic resonator, an ICSP header, a USB connection, 6 analog inputs, a power jack and a reset button. This contains all the required support needed for microcontroller.

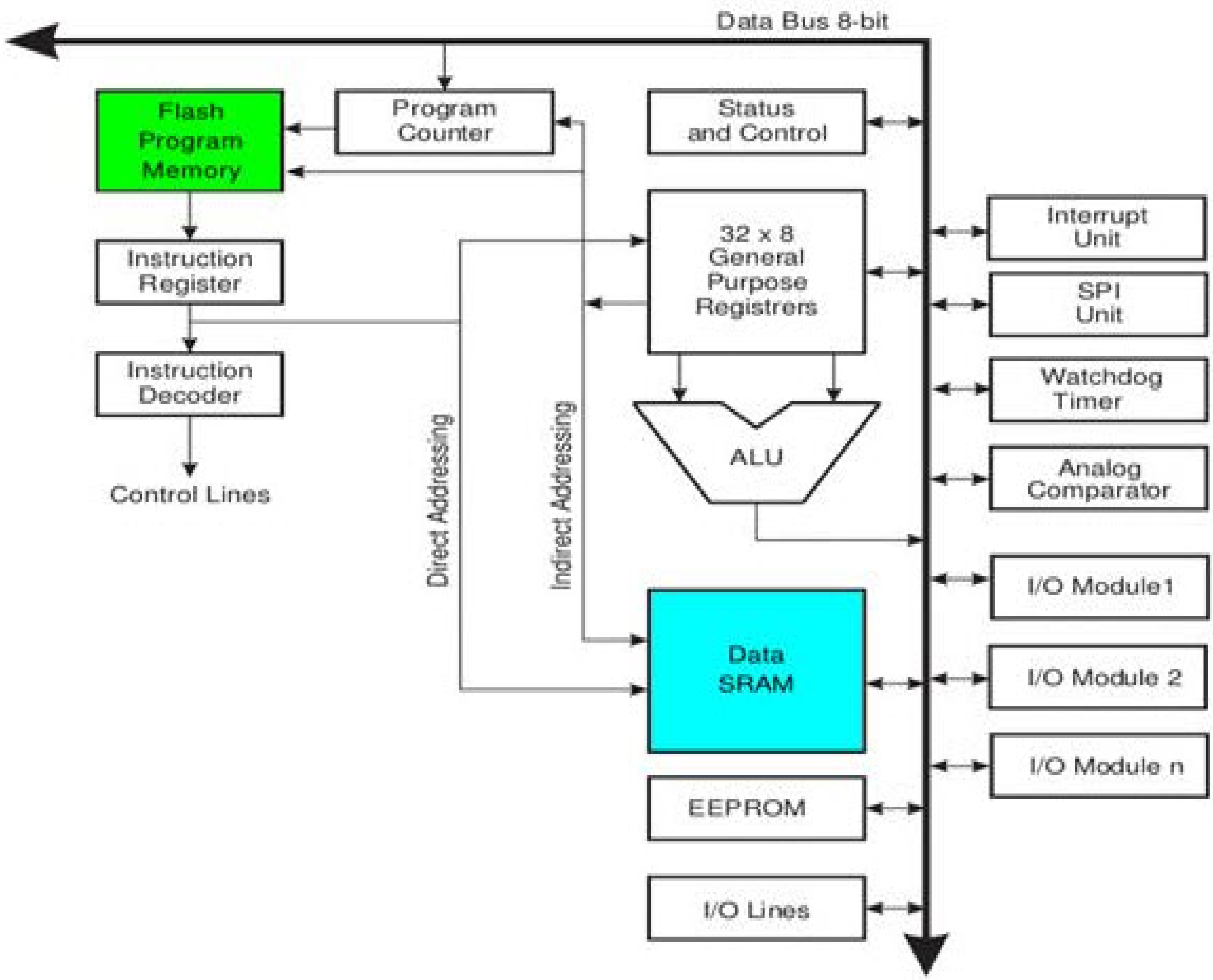


Fig : Arduino UNO architecture

Pin Description :

Vin : This is the input voltage pin of the Arduino board used to provide input supply from an external power source.

5V : This pin of the Arduino board is used as a regulated power supply voltage and it is used to give supply to the board as well as onboard components.

3.3V : This pin of the board is used to provide a supply of 3.3V which is generated from a voltage regulator on the board

GND : This pin of the board is used to ground the Arduino board.

Reset : This pin of the board is used to reset the microcontroller. It is used to Resets the microcontroller.

Analog Pins : The pins A0 to A5 are used as an analog input and it is in the range of 0-5V.

Digital Pins : The pins 0 to 13 are used as a digital input or output for the Arduino board.

Serial Pins : These pins are also known as a UART pin. It is used for communication between the Arduino board and a computer or other devices. The transmitter pin number 1 and receiver pin number 0 is used to transmit and receive the data resp.

External Interrupt Pins: This pin of the Arduino board is used to produce the External interrupt and it is done by pin numbers 2 and 3.

PWM Pins : This pins of the board is used to convert the digital signal into an analog by varying the width of the Pulse. The pin numbers 3,5,6,9,10 and 11 are used as a PWM pin.

SPI Pins : This is the Serial Peripheral Interface pin, it is used to maintain SPI communication with the help of the SPI library. SPI pins include:

SS : Pin number 10 is used as a Slave Select
MOSI : Pin number 11 is used as a Master Out Slave In
MISO : Pin number 12 is used as a Master In Slave Out
SCK : Pin number 13 is used as a Serial Clock
LED Pin : The board has an inbuilt LED using digital pin-13. The LED glows only when the digital pin becomes high.

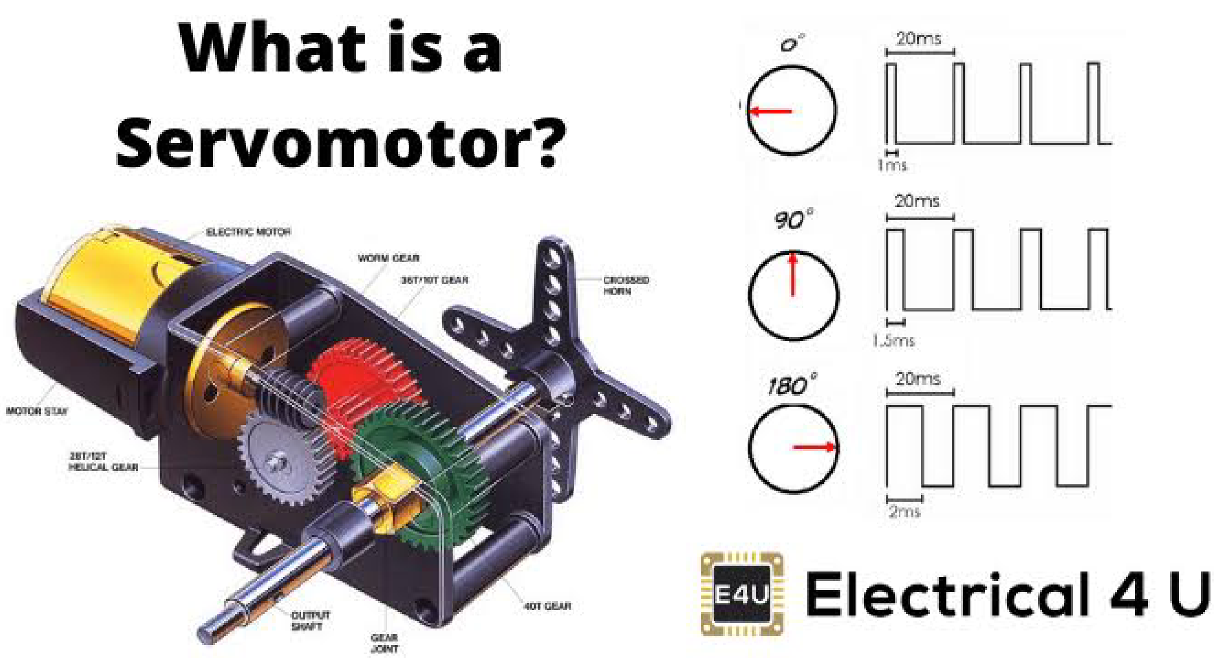
AREF Pin : This is an analog reference pin of the Arduino board. It is used to provide a reference voltage from an external power supply.

3.3.2 Motor Details :

Specifications :

- Size : 32 × 11.5 × 24mm (Include tabs) 23.5 × 11.5 × 24mm (Not include tabs)
- Weight : 8.5g (Not include a cable and a connector) 9.3g (Include a cable and a connector)
- Speed : 0.12sec/60 degrees (4.8V) 0.10sec/60 degrees (6.0V)
- Torque : 1.5 kgf-cm (4.8V) 2.0 kgf-cm (6.0V)
- Voltage : 4.8V-6.0V
- Connector type : JR type (Yellow : Signal, Red : VCC, Brown : GND)

Servo motor :



A servomotor (or servo motor) is a rotary actuator or linear actuator that allows for precise control of angular or linear position, velocity and acceleration. It consists of a suitable motor coupled to a sensor for position feedback. It also requires a relatively sophisticated controller, often a dedicated module designed specifically for use with servomotors. Servomotors are not a specific class of motor, although the term servomotor is often used to refer to a motor suitable for use in a closed-loop control system. Servomotors are used in applications such as robotics, CNC machinery, and automated manufacturing.

A servomotor is a closed-loop servomechanism that uses position feedback to control its motion and final position. The input to its control is a signal (either analogue or digital) representing the position commanded for the output shaft.

The motor is paired with some type of position encoder to provide position and speed feedback. In the simplest case, only the position is measured. The measured position of the output is compared to the command position, the external input to the controller. If the output position differs from that required, an error signal is generated which then causes the motor to rotate in either direction, as needed to bring the output shaft to the appropriate position. As the positions approach, the error signal reduces to zero and the motor stops.

The very simplest servomotors use position-only sensing via a potentiometer and bang-bang control of their motor; the motor always rotates at full speed (or is stopped). This type of servomotor is not widely used in industrial motion control, but it forms the basis of the simple and cheap servos used for radio-controlled models.

More sophisticated servomotors use optical rotary encoders to measure the speed of the output shaft and a variable-speed drive to control the motor speed. Both of these enhancements, usually in combination with a PID control algorithm, allow the servomotor to be brought to its commanded position more quickly and more precisely, with less overshooting.

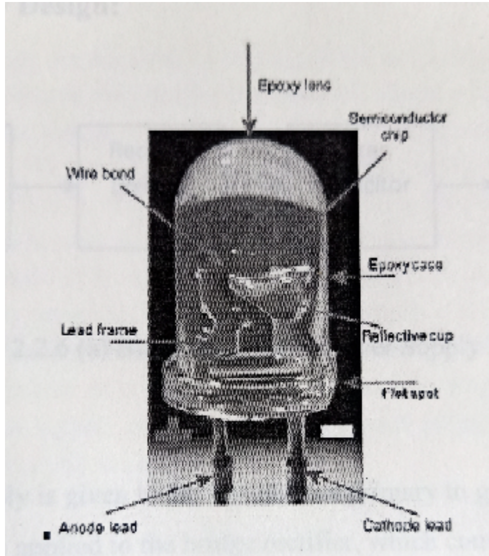
The type of motor is not critical to a servomotor and different types may be used. At the simplest, brushed permanent magnet DC motors are used, owing to their simplicity and low cost. Small industrial servomotors are typically electronically commutated brushless motors. For large industrial servomotors, AC induction motors are typically used, often with variable frequency drives to allow control of their speed. For ultimate performance in a compact package, brushless AC motors with permanent magnet fields are used, effectively large versions of Brushless DC electric motors.

Drive modules for servomotors are a standard industrial component. Their design is a branch of power electronics, usually based on a three-phase MOSFET or IGBT H bridge. These standard modules accept a single direction and pulse count (rotation distance) as input. They may also include over-temperature monitoring, over-torque and stall detection features. As the encoder type, gearhead ratio, and overall system dynamics

are application specific, it is more difficult to produce the overall controller as an off-the-shelf module and so these are often implemented as part of the main controller.
Most modern servomotors are designed and supplied around a dedicated controller module from the same manufacturer. Controllers may also be developed around microcontrollers in order to reduce cost for large-volume applications.

3.3.3 LED :

A light emitting diode (LED) is an electronic light source. The LED was discovered in the early 20 th century, and introduced as a practical electronic component in 1962. All early devices emitted low - intensity red light, but modern LEDs are available across the visible, ultraviolet and infra red wavelengths, with very high brightness.
LEDs are based on the semiconductor diode. When the diode is forward biased (switched on), electrons are able to recombine with holes and energy is released in the form of light. This effect is called electroluminescence and the colour of the light is determined by the energy gap of the semiconductor. The LED is usually small in area (less than 1 mm 2) with integrated optical components to shape its radiation pattern and assist in reflection.

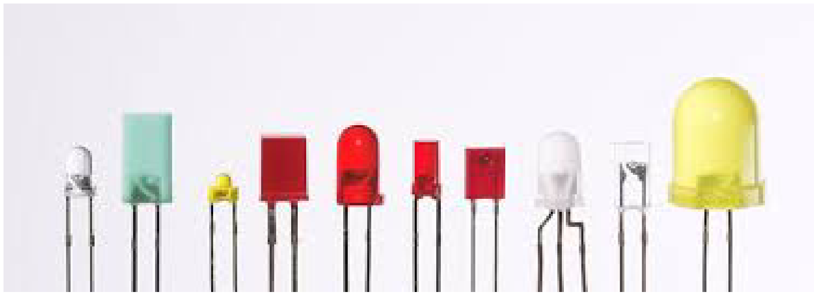


LEDs present many advantages over traditional light sources including lower energy consumption, longer lifetime, improved robustness, smaller size and faster switching. However, they are relatively expensive and require more precise current and heat management than traditional light sources.

Applications of LEDs are diverse. They are used as low - energy replacements for traditional light sources in well established applications such as indicators and automative lighting. The compact size of LEDs has allowed new text and video displays and sensors to be developed, while their.

High switching rates are useful in communications technology.

Types of LEDs :



LEDs are produced in an array of shapes and sizes. The 5 mm cylindrical pcakage (red, fifth form left) is the most common, estimated at 80% of world production. The colour of the plastic lens soften the same as the actual colour of light emitted, but not always. For instance, purple plastic is often used for infrared LEDs, and most blue devices have clear housings. There are also LEDs in SMT packages, such as those found on binkies' and on cell phone keypads.

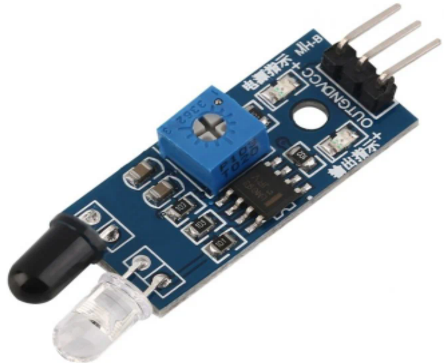
3.3.4 IR Sensor

IR sensor is an electronic device, that emits the light in order to sense some object of the surroundings. An IR sensor can measure the heat of an object as well as detects the motion. Usually, in the infrared spectrum, all the objects radiate some form of thermal radiation. These types of radiations are invisible to our eyes, but infrared sensor can detect these radiations.

The emitter is simply an IR LED (Light Emitting Diode) and the detector is simply an IR photodiode . Photodiode is sensitive to IR light of the same wavelength which is emitted by the IR LED. When IR light falls on the photodiode, the resistances and the output voltages will change in proportion to the magnitude of the IR light received.

There are five basic elements used in a typical infrared detection system: an infrared source, a transmission medium, optical component, infrared detectors or receivers and signal processing. Infrared lasers and Infrared LED’s of specific wavelength used as infrared sources.

The three main types of media used for infrared transmission are vacuum, atmosphere and optical fibers. Optical components are used to focus the infrared radiation or to limit the spectral response.

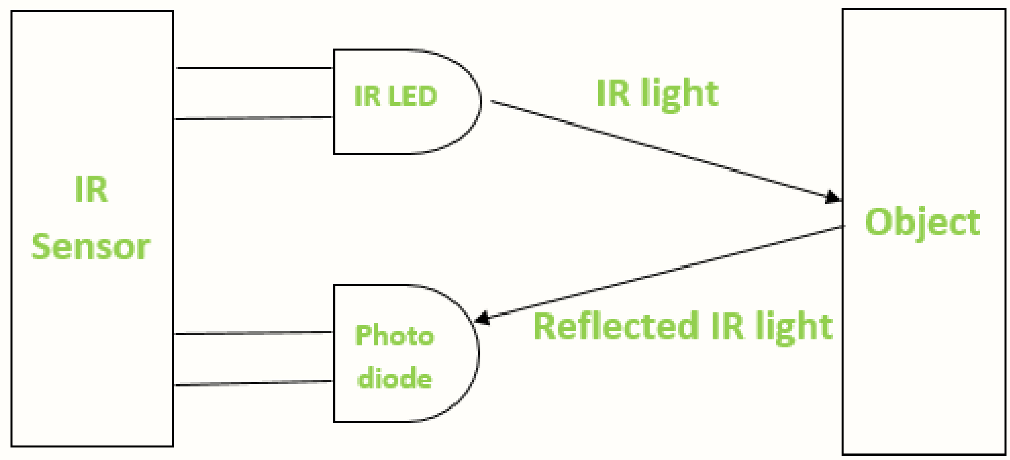


Types of IR Sensor :

There are two types of IR sensors are available and they are,

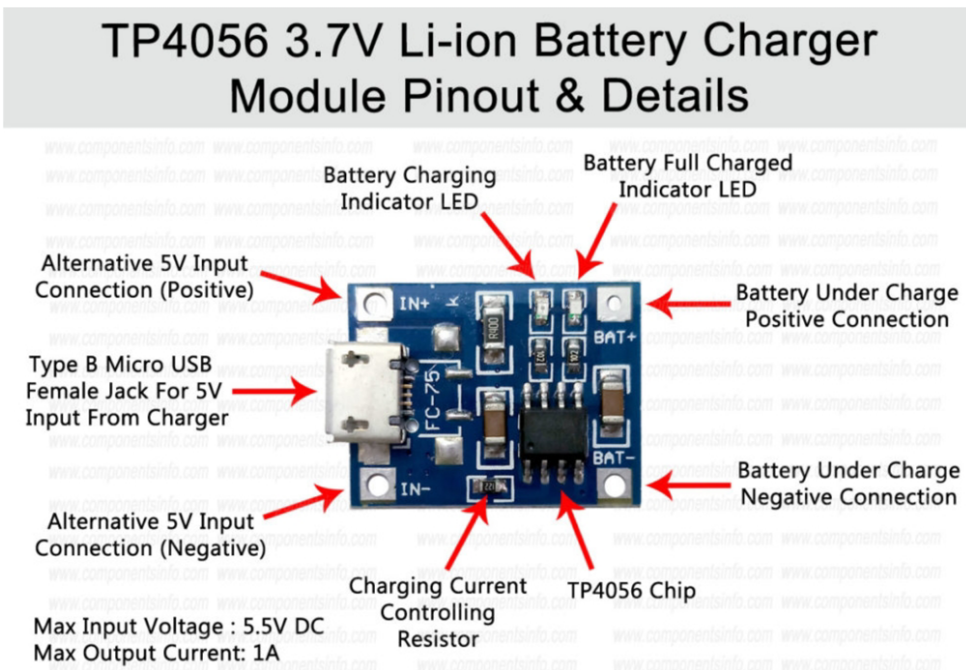
- Active Infrared Sensor
- Passive Infrared Sensor

IR Sensor Working Principle :
There are different types of infrared transmitters depending on their wavelengths, output power and response time. An IR sensor consists of an IR LED and an IR Photodiode, together they are called as PhotoCoupler or OptoCoupler.


IR LED
IR light
IR
Sensor
Object
Photo
diode
Reflected IR light

3.3.5 TP4056 3.7V Li-ion 18650 Battery Charger Module Pinouts.

TP4056 charging module is a small size li ion battery charger module. This module uses one IC and few discrete to make a high quality charging module that can provide the required charging procedure to li-ion battery which makes the battery life long and charge it effectively and to its full extent due to which the battery provides its full backup.

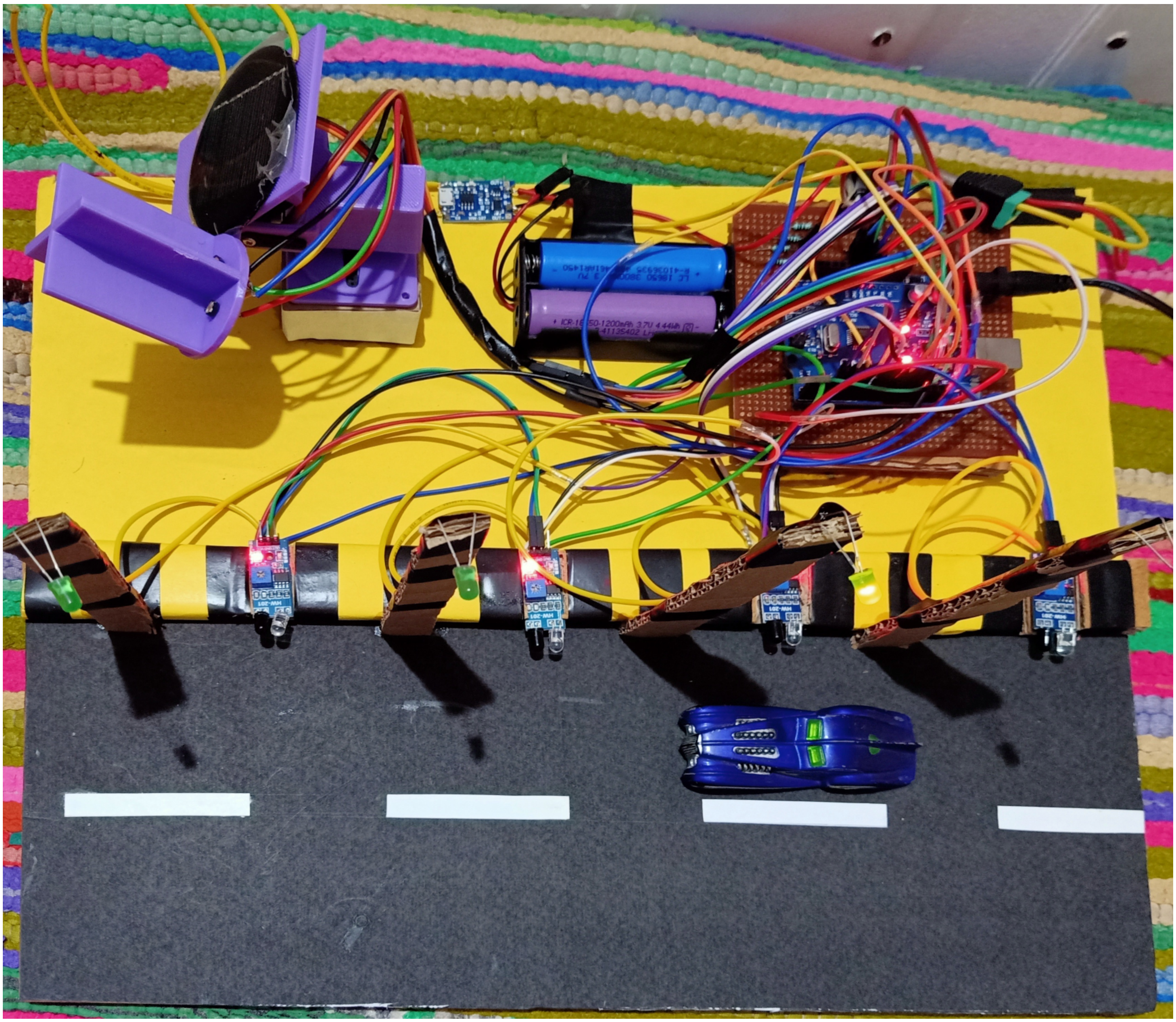


TP4056 Module Features & Technical Specs:

- Over Current Protection
- Output charging current can be controlled or adjusted from a single resistor
- General Micro USB Female Connector
- Battery Charging Indication LED
- Battery full Charged Indication LED
- Battery auto cutoff from the charging circuit when fully charged
- Soft Start Charging
- It can charge any size of 3.7V Li-ion cell
- Low cost and reliable Li-ion battery charger
- Battery temperature measurement inside (Disconnect charging when temperature of the battery goes high than normal)
- Can connected to any USB port with a USB cable

Chapter no : 04

4.1 Hardware Design



4.2 Software Design

```
#include <Servo.h> // include Servo library

// 180 horizontal MAX
Servo horizontal; // horizontal servo
int servoh = 90;   // 90;     // stand horizontal servo

int servohLimitHigh = 180;
int servohLimitLow = 65;

// 65 degrees MAX
Servo vertical;   // vertical servo
int servov = 45;    //   90;     // stand vertical servo

int servovLimitHigh = 80;
int servovLimitLow = 15;

// LDR pin connections
//  name  = analogpin;
int ldrlt = 2; //LDR top left - BOTTOM LEFT    <--- BDG
int ldrrt = 1; //LDR top rigt - BOTTOM RIGHT
int ldrld = 4; //LDR down left - TOP LEFT
int ldrrd = 3; //ldr down rigt - TOP RIGHT

int IR1 = 13;
int IR2 = 12;
```

```
int IR3 = 11;
int IR4 = 10;

int led1 = 9;
int led2 = 8;
int led3 = 4;
int led4 = 3;

int I1;
int I2;
int I3;
int I4;

void setup()
{
  Serial.begin(9600);
// servo connections
// name.attacht(pin);
  horizontal.attach(5);
  vertical.attach(6);
  horizontal.write(180);
  vertical.write(45);
  delay(3000);
  pinMode(led1, OUTPUT);
  pinMode(led2, OUTPUT);
  pinMode(led3, OUTPUT);
  pinMode(led4, OUTPUT);
  pinMode(IR1, INPUT);
  pinMode(IR2, INPUT);
```

```
  pinMode(IR3, INPUT);
  pinMode(IR4, INPUT);
}
void loop()
{
  int lt = analogRead(ldrlt); // top left
  int rt = analogRead(ldrrt); // top right
  int ld = analogRead(ldrld); // down left
  int rd = analogRead(ldrrd); // down rigt

  // int dtime = analogRead(4)/20; // read potentiometers
  // int tol = analogRead(5)/4;
  int dtime = 10;
  int tol = 50;

  int avt = (lt + rt) / 2; // average value top
  int avd = (ld + rd) / 2; // average value down
  int avl = (lt + ld) / 2; // average value left
  int avr = (rt + rd) / 2; // average value right

  int dvert = avt - avd; // check the diffirence of up and down
  int dhoriz = avl - avr;// check the diffirence og left and rigt

  I1 = digitalRead(IR1);
  I2 = digitalRead(IR2);
  I3 = digitalRead(IR3);
  I4 = digitalRead(IR4);
  Serial.print(avt);
  Serial.print(" ");
```

```
  Serial.print(avd);
  Serial.print(" ");
  Serial.print(avl);
  Serial.print(" ");
  Serial.print(avr);
  Serial.print("   ");
  Serial.print(dtime);
  Serial.print("   ");
  Serial.print(tol);
  Serial.println(" ");

  if (-1*tol > dvert || dvert > tol) // check if the diffirence is in the tolerance
else change vertical angle
  {
  if (avt > avd)
  {
    servov = ++servov;
     if (servov > servovLimitHigh)
     {
      servov = servovLimitHigh;
     }
  }
  else if (avt < avd)
  {
    servov= --servov;
    if (servov < servovLimitLow)
  {
    servov = servovLimitLow;
  }
```

```
 }
 vertical.write(servov);
 }

 if (-1*tol > dhoriz || dhoriz > tol) // check if the diffirence is in the
tolerance else change horizontal angle
 {
 if (avl > avr)
 {
   servoh = --servoh;
   if (servoh < servohLimitLow)
   {
   servoh = servohLimitLow;
   }
 }
 else if (avl < avr)
 {
   servoh = ++servoh;
    if (servoh > servohLimitHigh)
    {
    servoh = servohLimitHigh;
    }
 }
 else if (avl = avr)
 {
   // nothing
 }
 horizontal.write(servoh);
 }
```

```
  delay(dtime);
 autostreet();

}

int autostreet()
{
   if ( I1 == LOW)
  {
   //led1 = HIGH;
   digitalWrite(led1, HIGH);
   Serial.println("HIGH");
  }
  else
  {
   //led1 = LOW;
   digitalWrite(led1, LOW);
   Serial.println("LOW");

  }

  if ( I2 == LOW)
  {
   led2 = HIGH;
   digitalWrite(8, HIGH);
   Serial.println("HIGH2222");
  }
  else
  {
```

```
    led2 = LOW;
    digitalWrite(8, LOW);
  }

  if ( I3 == LOW)
  {
    led3 = HIGH;
    digitalWrite(4, HIGH);
  }
  else
  {
    led3 = LOW;
    digitalWrite(4, LOW);
  }

  if ( I4 == LOW)
  {
    led4 = HIGH;
    digitalWrite(3, HIGH);
  }
  else
  {
    led4 = LOW;
    digitalWrite(3, LOW);
  }
}
```

Chapter no : 5

5.1 Conclusion :

In this way we propose to implement smart streetlights with smart solar tracking system.
This Streetlights is useful for save energy and it is automatically operate therefore no human need to control it.

5.2 Future scope :

- Reducing the cost of mechanical structure
- Security camera
- Traffic counter
- Emergency push to talk intercome
- System can be introduced to inform the technician about the default
- If climate change we need power backup to streetlights

Chapter no : 6

6.1 Components List

Sr. No	Components Name	Quantity	Cost
1	Arduino UNO	1	900
2	Charging Module	1	50
3	LDR sensor	4	80
4	IR sensor	4	120
5	Solar pannel	1	100
6	Rechargeable battery	1	200
7	LED	4	50
8	Servo motor	2	500
9	PCB	-	50
10	Wires	-	50
11	Battery Case	1	100

Chapter no : 7

7.1 Reference

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6. ^ Muthanna, M. S. A.; Muthanna, M. M. A.; Khakimov, A.; Muthanna, A. (January 2018). "Development of intelligent street lighting services model based on LoRa technology". 2018 IEEE Conference of Russian Young Researchers in Electrical and Electronic Engineering (EIConRus): 90–93. doi:10.1109/EIConRus.2018.8317037. Retrieved 1 April 2021.
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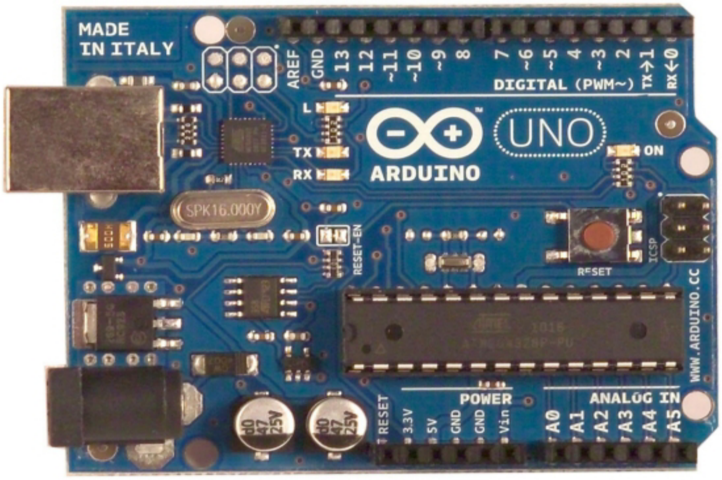
9. ^ "Oslo to cut streetlight energy costs by 30% while increasing safety". Gizmag.com. Retrieved 2015-12-24.
10. ^https://static1.squarespace.com/static/53d2cdffe4b069e965155fc8/t/5693fc26dc5cb4e20e40b151/1452538926885/20160111_NetSenseities.pdf

Chapter no : 8

8.1 Data Sheets

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

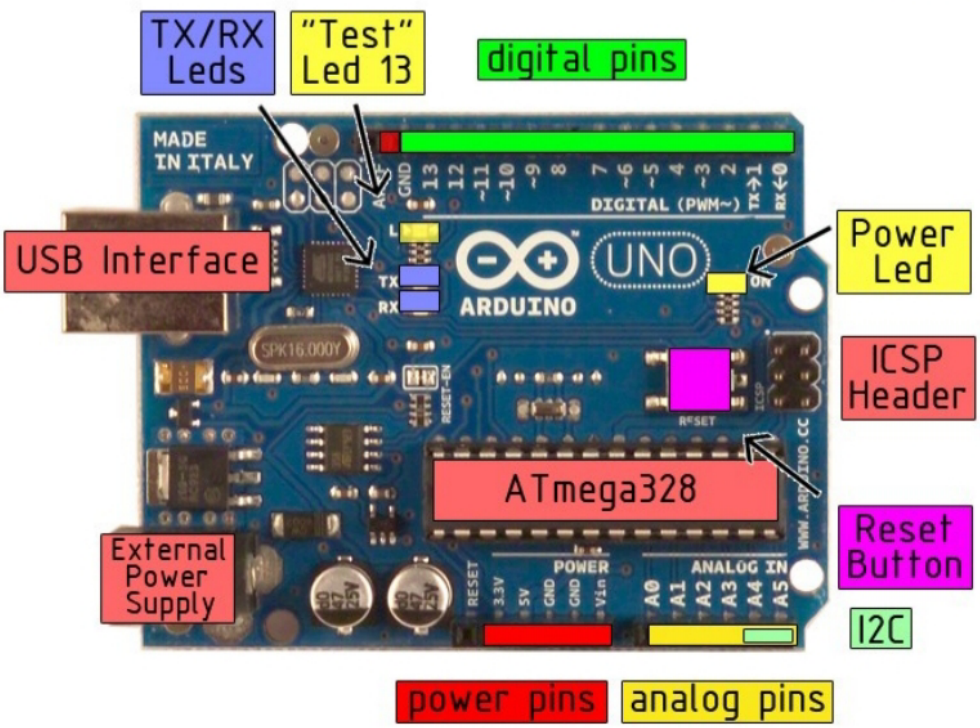
Technical Specification

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



H

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:

- I^2**C: 4 (SDA) and 5 (SCL).** Support I^2C (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.

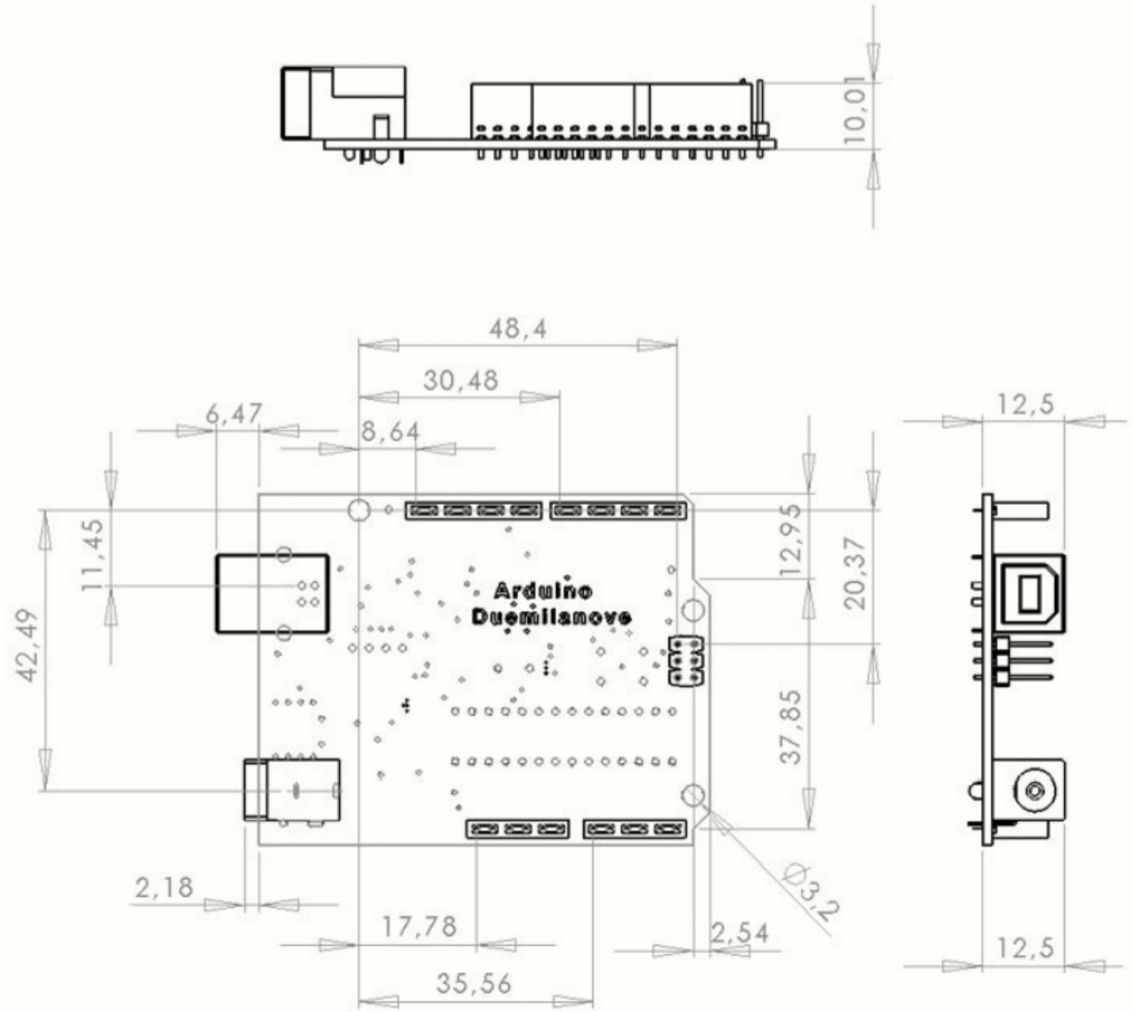
Programming

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).


10,01
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Arduino
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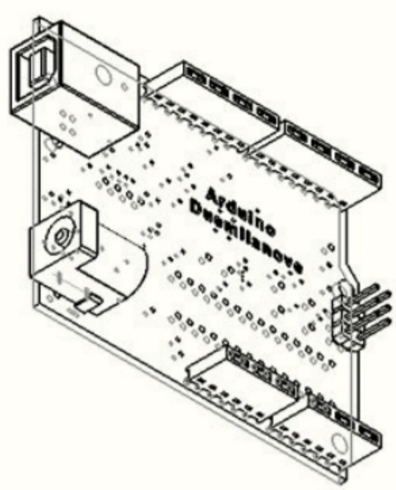

Arduino
Duemilanove

Lithium-ion Battery
DATA SHEET

Battery Model : LIR18650 2600mAh

Prepared	Authorized	Approved

Manufacturer: EEMB Co., Ltd.
Website: http://eemb.com

5. BASIC CHARACTERISTICS

5.1 Capacity（25±5℃）	Nominal Capacity: 2600mAh (0.52A Discharge，2.75V) Typical Capacity: 2550mAh（0.52A Discharge，2.75V） Minimum Capacity：2500mAh (0.52A Discharge，2.75V)
5.2 Nominal Voltage	3.7V
5.3 Internal Impedance	≤70mΩ
5.4 Discharge Cut-off Voltage	3.0V
5.5 Max Charge Voltage	4.20±0.05V
5.6 Standard Charge Current	0.52A
5.7 Rapid Charge Current	1.3A
5.8 Standard Discharge Current	0.52A
5.9 Rapid Discharge Current	1.3A
5.10 Max Pulse Discharge Current	2.6A
5.11 Weight	46.5±1g
5.12 Max. Dimension	Diameter(Ø): 18.4mm Height (H): 65.2mm
5.13 Operating Temperature	Charge: 0 ~ 45℃ Discharge: -20 ~ 60℃
5.14 Storage Temperature	During 1 month: -5 ~ 35℃ During 6 months: 0 ~ 35℃

6. Standard conditions for test

All the tests need to be done within one month after the delivery date under the following conditions : Ambient Temperature:25±5℃; Relative Huimdity:65±20%

Standard Charge	Constant Current and Constant Voltage (CC/CV) Current = 0.52A Final charge voltage = 4.2V Final charge Current = 0.052A
Standard Discharge	Constant Current (CC) Current = 0.52A End Voltage = 3.0V

7. Appearance

All surfaces must be clean, without damages, leakage and corrosion. Each product will have a product label identifying the model.

8. Characteristics

In this section, the Standard Conditions of Tests are used as described in part 6.

8.1 Electrical Performances

Items	Test procedure	Requirements
8.1.1 Nominal Voltage	The average value of the working voltage during the whole discharge process.	3.7V
8.1.2 Discharge Performance	The discharge capacity of the cell, measured with 1.3 A down to 3.0V within 1 hour after a completed charge.	≥114min
8.1.3 Capacity Retention	After 28 days storage at 25±5℃, after having been completely charged and discharged at 0.52A, discharge to 3.0V, the residual capacity is above 80%	Capacity≥2080mAh
8.1.4 Cycle Life	After 299 cycles at 100% DOD. Charge and discharge at 1.3A, and plus 1 day, measured under 0.52A charge and discharge, the residual discharge capacity is above 80% of initial capacity (Cycle life may be determined by conditions of charging, discharging, operating temperature and/or storage.)	300 cycles the residual capacity ≥2050mAh
8.1.5 Storage	(Within 3 months after manufactured) The cells is charged with 1.3A to 40-50% capacity and stored at ambient temperature 25±5℃, 65±20%RH for 12 months. After the 12 months storage period the cell is fully charged and discharged to 3.0V with 0.52A	Discharge time≥4h

8.2 Safety Performances

Items	Test procedure	Requirements
8.2.1 Short Circuit	The cell is to be short-circuited by connecting the positive and negative terminals of the cell directly with copper wire with a resistance of less than 0.05Ω.	No fire no explosion.
8.2.2 Impact Test	A test sample battery is to be placed on a flat surface. A 5/8 inch (15.8mm) diameter bar is to be placed across the center of the sample. A 20 pound (9.1kg) weight is to be dropped from a height of 24 ±1 inch (610±25mm) onto the sample.	No fire no explosion.

8.2.3 Overcharge (3C/10V)	The cell is connected with a thermocouple and put in a fume hood. The positive and negative terminals are connected to a DC power supply set at 7.8A and 10V until the cell reaches 10V and the current drops to approximately 0A. Monitor the temperature of cell. When the temperature of the cell is approximately 10℃ less than the peak value, the test is completed.	No fire, no explosion.
8.2.4 Thermal shock	After standard charging, heat the cell to 130±2℃ at a rate of 5±2℃ /min and keep it at this temperature during 30 minutes.	No fire, no explosion.

8.3 Environmental tests

Items	Test procedure	Requirements
8.3.1 High temperature performance	The fully charged cell is put at 55±2℃ for 2 hours and then discharged to 3.0V at 1.3A.	Capacity≥2080mAh
8.3.2 Low temperature performance	The fully charged cell is placed during 16-24 hours at -20±2℃ and then discharge to 2.75V at 0.52A.	Capacity≥1800mAh
8.3.3 Anti-vibration	The fully charged cell is fixed on a platform and vibrated in the X , Y and Z directions for 30minutes at the speed 10ct/min Frequency: 10~30Hz, Vibration amplitude 0.38mm. Frequency: 30~55Hz, Vibration amplitude 0.19mm.	No deformation should be visible. Not leak, smoke and/or explode. Voltage should be not less than 3.6V.
8.3.4 Drop Test	The fully charged cell is dropped from a height of 1m onto a 15~20mm hard board in X, Y and Z directions once for all axis. Then the cell is discharged at 1.3A to 3.0V followed by 3 or more cycles with the standard charge rate and a discharge at 1.3A.	No fire, no explosion. Discharge Time≥102min

9 . Packing

Cells are at a half-charged state when packed. The packing box surface will contain the following: name, type, nominal voltage, quantity, gross weight, date, capacity and impedance.

10 . Transportation

During transport, do not subject the cell(s) or the box (es) to violent shaking, bumps, rain and direct sunlight. Keep the cell(s) at a half-charged state.

11 . Long-term Storage

The cell should be used within a short period after charging because long-term storage may cause loss of capacity by self-discharging. If the cell is kept for a long time(3months or more), It is strongly recommended that the cell isstored at dry and low-temperature and Keep the cell(s) at a half-charged state. the cell should be shipped in 50% charged state. In this case, OCV is from 3.65V to 3.85V. Our shipping voltage is 3.75-3.80v . because storage at higher voltage may cause loss of characteristics.

- over a period of 1 month: -5 ~ 35℃, relative humidity: ≤75%. - over a period of 6 months: -20~ 25℃, relative humidity: ≤75%.

12 . Warranty

12.1 The warranty period of this product is 12 months starting at the date of delivery from the factory.

12.2 Warranty will be void if the cells are used outside these specifications.

12.3 EEMB will not be liable for any damages, personal, material, immaterial or otherwise, when the cells are used outside these specifications.

13 . Changes of specifications

The information in this specification is subject to change without prior notice.

14. For reference only

The information contained in this document is for reference only and should not be used as a basis for product guarantee or warranty. For applications other than those described here, please consult EEMB

15.Pack Quality Requirement for safety and quality

15.1 The battery pack's consumption current.

-Sleep Mode : Under 250uA.

-Shut Down Mode : Under 10uA / Under 3.0V.
Under 1uA / Under 2.5V.

15.2 Operating Charging Voltage of a cell.

-Normal operating voltage of a cell is 4.20V

-Max operating voltage of a cell is 4.25V.

15.3 Pre-charging function

-Pre-charge function should be implemented to prevent abnormal high rate charging after deep discharge.

-Pre-charging condition Operation : Under 3.0V

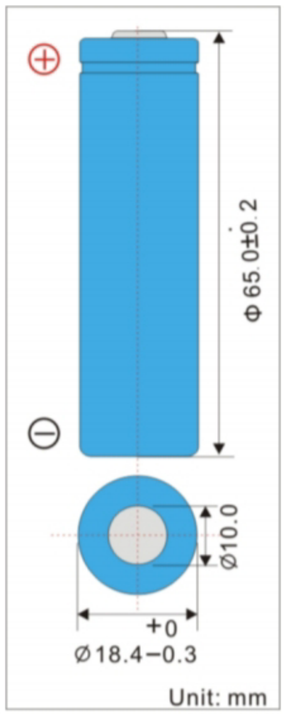
-Charging current : Under 150mA/Cell.(Continuous)

-Pre-charge stop (Normal Charge Start) : All cells reach 3.0V

15.4. Cell voltage monitoring system.

-The system (Charger or Pack) should equip a device to monitor each Cell voltage and to stop charging if a cell imbalance happened.

16. Dimension and Performance



RS Data Sheet

Light dependent resistors

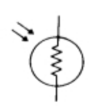
NORP12 RS stock number 651-507
NSL19-M51 RS stock number 596-141

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

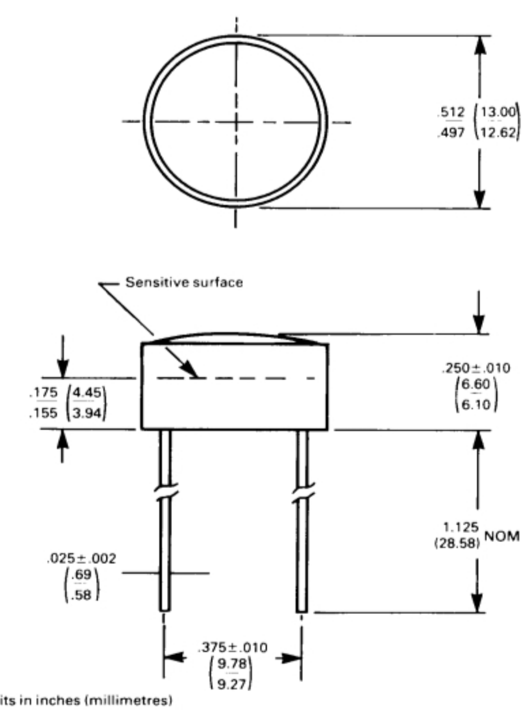
Parameter	Conditions	Min.	Typ.	Max.	Units
Cell resistance	1000 lux	-	400	-	Ω
	10 lux	-	9	-	kΩ
Dark resistance	-	1.0	-	-	MΩ
Dark capacitance	-	-	3.5	-	pF
Rise time 1	1000 lux	-	2.8	-	ms
	10 lux	-	18	-	ms
Fall time 2	1000 lux	-	48	-	ms
	10 lux	-	120	-	ms

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



Absolute maximum ratings

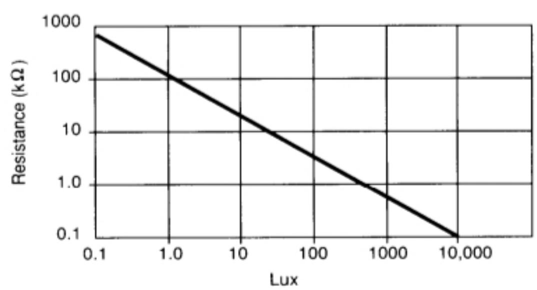
Voltage, ac or dc peak ____ 100V
Current ____ 5mA
Power dissipation at 25°C ____ 50mW*
Operating temperature range ____ -25°C +75°C

***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

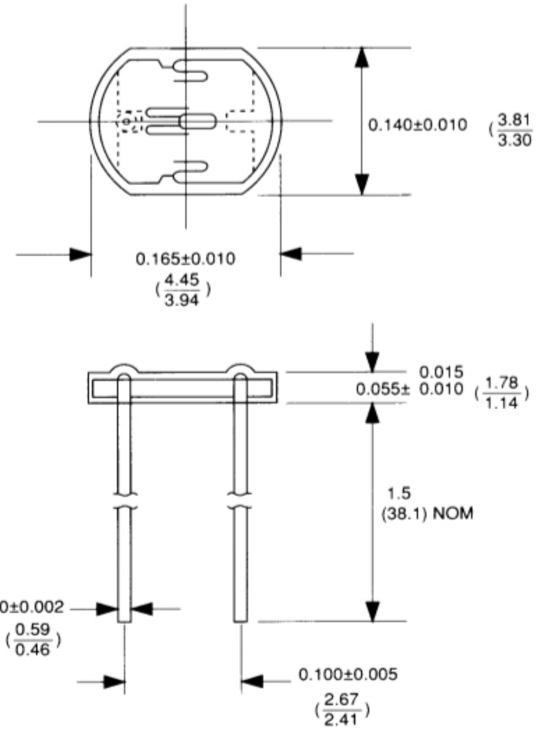
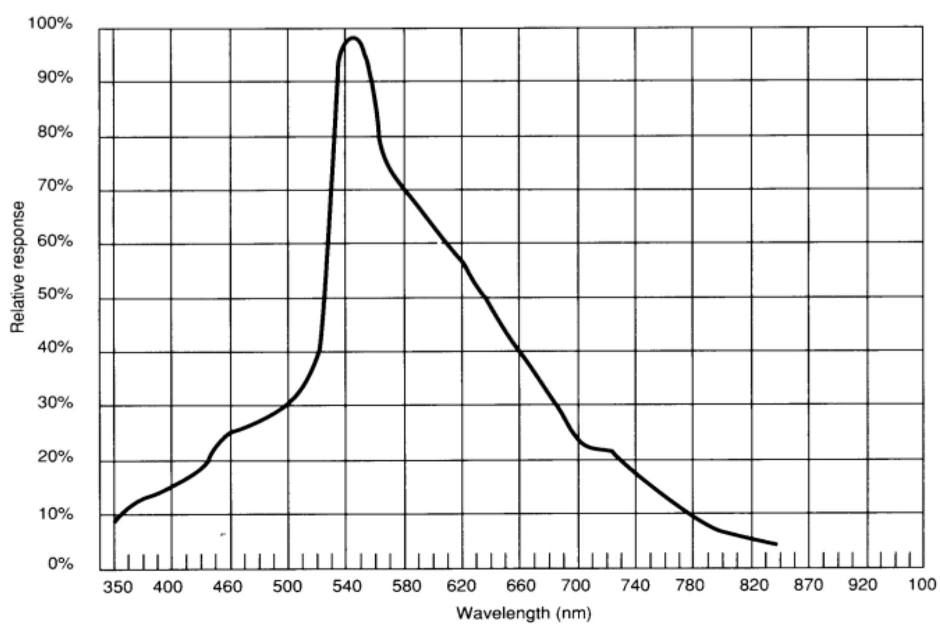


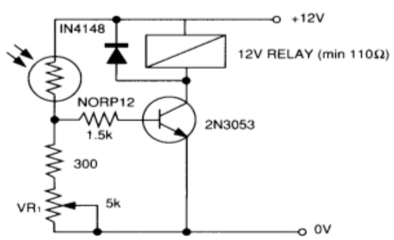
Figure 5 **Spectral response**



232-3816

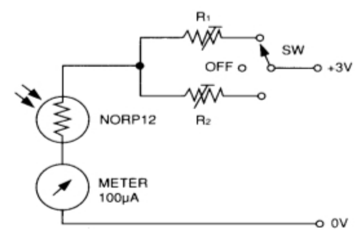
Typical application circuits

Figure 6 **Sensitive light operated relay**



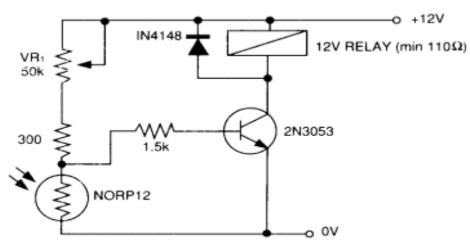
Relay energised when light level increases above the level set by VR_1

Figure 9 **Logarithmic law photographic light meter**



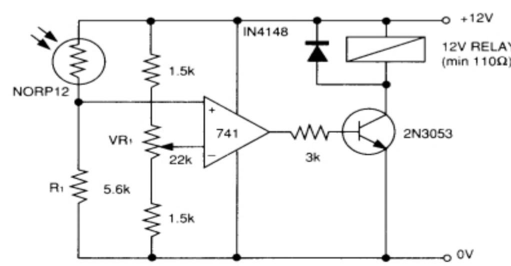
Typical value $R^1 = 100k\Omega$
$R^2 = 200k\Omega$ preset to give two overlapping ranges.
(Calibration should be made against an accurate meter.)

Figure 7 **Light interruption detector**



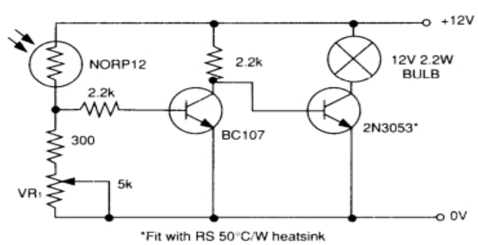
As Figure 6 relay energised when light level drops below the level set by VR_1

Figure 10 **Extremely sensitive light operated relay**

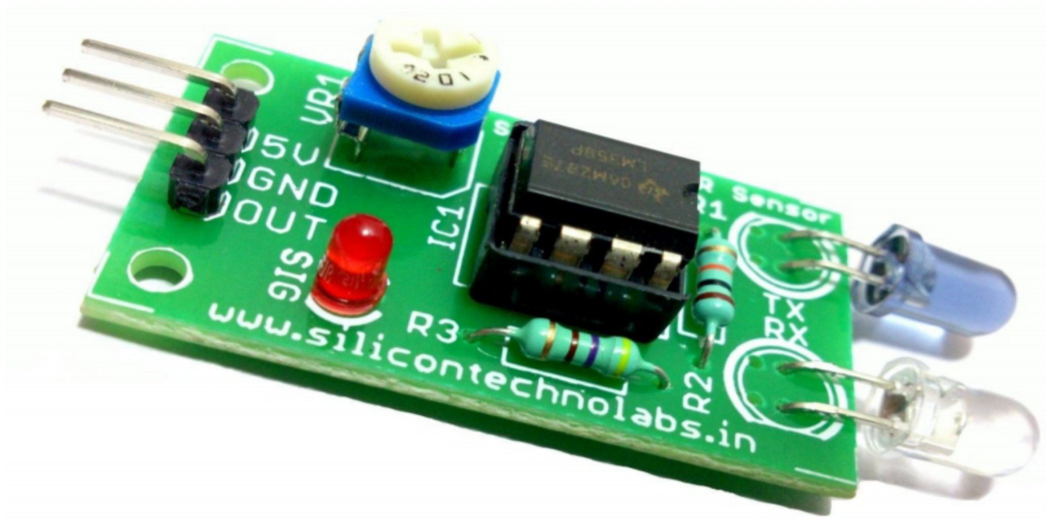


(Relay energised when light exceeds preset level.)
Incorporates a balancing bridge and op-amp. R_1 and NORP12 may be interchanged for the reverse function.

Figure 8 **Automatic light circuit**



Adjust turn-on point with VR_1



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.

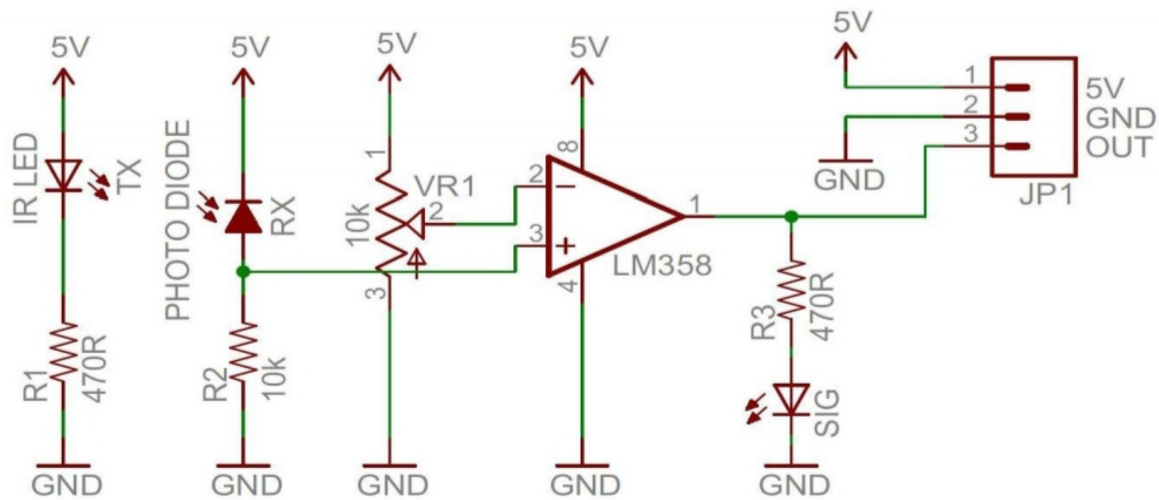
2. Features

- 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.

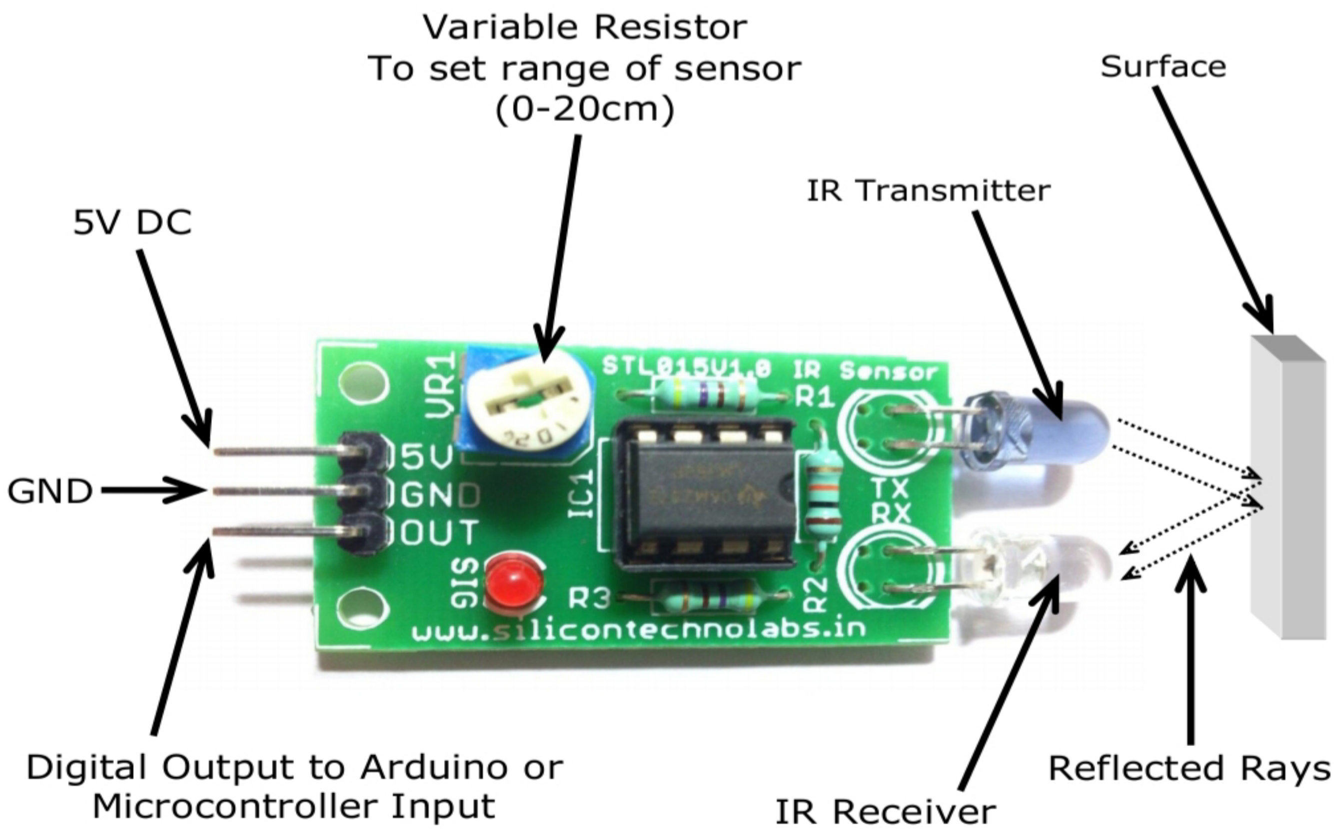
3. Specifications

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

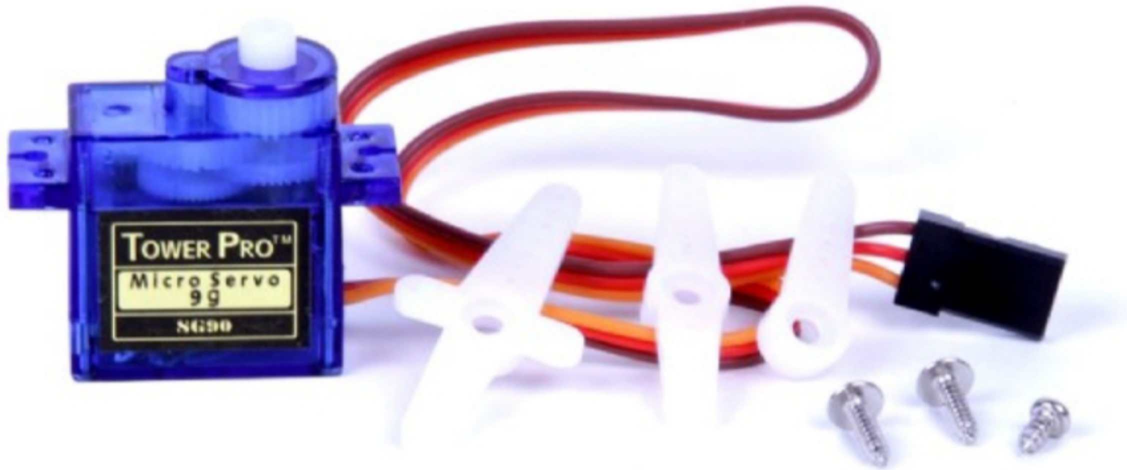
4. Schematics



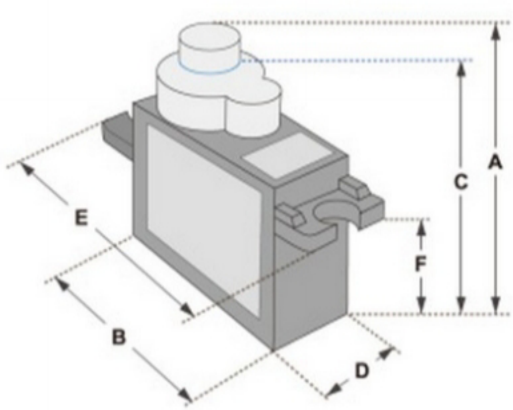
5. Hardware Details



SERVO MOTOR SG90 DATA SHEET

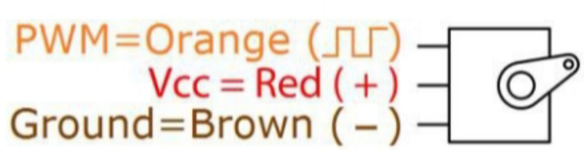


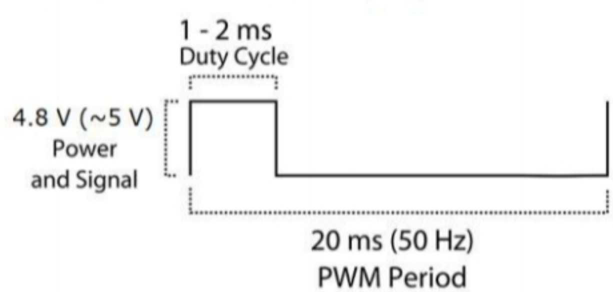
Tiny and lightweight with high output power. Servo can rotate approximately 180 degrees (90 in each direction), and works just like the standard kinds but smaller. You can use any servo code, hardware or library to control these servos. Good for beginners who want to make stuff move without building a motor controller with feedback & gear box, especially since it will fit in small places. It comes with a 3 horns (arms) and hardware.



Dimensions & Specifications
A (mm) : 32
B (mm) : 23
C (mm) : 28.5
D (mm) : 12
E (mm) : 32
F (mm) : 19.5
Speed (sec) : 0.1
Torque (kg-cm) : 2.5
Weight (g) : 14.7
Voltage : 4.8 - 6

Position "0" (1.5 ms pulse) is middle, "90" (~2ms pulse) is middle, is all the way to the right, "-90" (~1ms pulse) is all the way to the left.





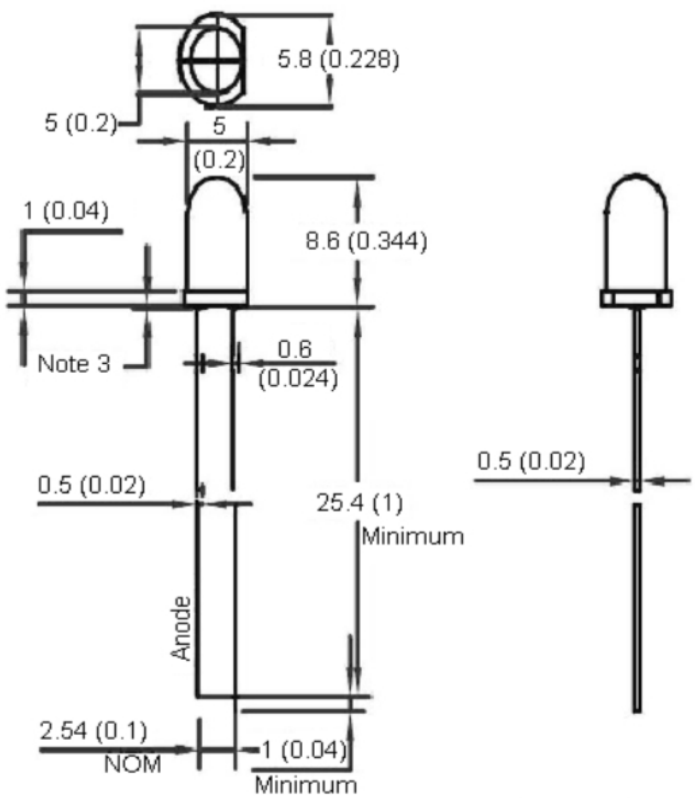
Standard LED

Red Emitting Colour

Features:

- High intensity
- Standard T-1 3/4 diameter package
- General purpose leads
- Reliable and rugged

Package Dimensions:



Dimensions : Millimetres (Inches)

Specification Table

Chip Material	Lens Colour	Source Colour	Part Number
AlGaAs	Diffused	Red	MV5754A

Notes:

1. Tolerance is ±0.25 mm (0.01") unless otherwise noted
2. Protruded resin under flange is 1 mm (0.04") maximum
3. Lead spacing is measured where the leads emerge from the package

Standard LED

Red Emitting Colour

Absolute Maximum Ratings at T_a = 25°C

Parameter	Maximum	Unit
Power Dissipation	80	mW
Peak Forward Current (1/10 Duty Cycle, 0.1 ms Pulse Width)	100	mA
Continuous Forward Current	20	mA
Derating Linear From 50°C	0.4	mA / °C
Reverse Voltage	5	V
Operating Temperature Range	-25°C to +80°C	
Storage Temperature Range	-40°C to +100°C	
Lead Soldering Temperature (4 mm (0.157) Inches from Body)	260°C for 5 s	

Electrical Optical Characteristics at T_a = 25°C

Parameter	Symbol	Minimum	Typical	Maximum	Unit	Test Condition
Luminous Intensity	I_v		40		mcd	I_f = 20 mA (Note 1)
Viewing Angle	$2\theta_{1/2}$		25		Deg	(Note 2)
Peak Emission Wavelength	λp		640		nm	I_f = 20 mA
Dominant Wavelength	λd		635		nm	I_f = 20 mA (Note 3)
Spectral Line Half-Width	$\Delta\lambda$		25		nm	I_f = 20 mA
Forward Voltage	V_f		2	2.5	V	I_f = 20 mA
Reverse Current	I_R	-	-	100	μA	V_R = 5 V

Notes:

1. Luminous intensity is measured with a light sensor and filter combination that approximates the CIE eye-response curve
2. $\theta_{1/2}$ is the off-axis angle at which the luminous intensity is half the axial luminous intensity
3. The dominant wavelength (λd) is derived from the CIE chromaticity diagram and represents the single wavelength which defines the colour of the device