<u>Sun Tracking Solar Panel With Multi Purpose Charging Point</u>

(EC 881) Project Stage – II
A Project Report Submitted in Partial Fulfillment of the Requirements For the degree of Bachelor of Technology
In Electronics and Communication Engineering by:

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Certificate (for 8th Sem)

This is to certify that **Shirsendu Bikas Acharyya, Sayan Chatterjee, Ritosom Roy & Rajarshi Giri** has carried out his project work entitled "**Sun Tracking Solar Panel**" as a part of the curriculum for the B.Tech Degree in Electronics & Communication Engineering (ECE) under Maulana Abul Kalam Azad University of Technology for the year 2021-2022.

This project report is approved by the undersigned only for the purpose for which it is submitted. The candidate is entirely responsible for the statements, opinions and conclusions contained herein.

(Prof. Abhijit Dey)

(Signature of the Mentor)

(Signature of HOD, ECE Dept, Techno Main Salt Lake, with date)

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ABSTRACT

Solar energy is fast becoming a very important means of renewable energy resources. With solar tracking, it will become possible to generate more energy since the solar panel can maintain a perpendicular profile to the rays of the sun. Even though the initial cost of setting up the racking system is relatively little high, there are cheaper options that are proposed over time.

This project discusses the design and construction of a prototype for a solar tracking system that has a single axis of freedom. Light Dependent Resistors are used for sunlight detection.

The control circuit is based on Arduino Nano. It is programmed to detect sunlight via the Light Dependent Resistors before actuating the servo to position the solar panel. The solar panel is positioned where it is able to receive maximum light. As compared to other motors, the servo motors are able to maintain torque at high speed. They are also more efficient with efficiency in the range of 80-90%. Servos can apply roughly twice their rated torque for short periods. They are also quiet and do not vibrate or suffer resonance issues. Performance and characteristics of solar panels are analyzed experimentally.

In this project we are also dealing with a multi purpose charging point using the power generated from the solar panel.

LITERATURE SURVEY

Solar radiation is light – also known as electromagnetic radiation – that is emitted by the sun. While every location on Earth receives some sunlight over a year, the amount of solar radiation that reaches any one spot on the Earth's surface varies. Solar technologies capture this radiation and turn it into useful forms of energy. One of the most promising renewable energy sources characterized by a huge potential to be converted into electrical power is solar energy. The conversion of solar radiation into electrical energy by Photo-Voltaic (PV) effect is done with the help of PV cells or solar cells. A solar cell is an electrical device that converts the energy of light directly into electricity by the photovoltaic effect, which is a physical and chemical phenomenon. It is a form of photoelectric cell, defined as a device whose electrical characteristics, such as current, voltage, or resistance, vary when exposed to light. A solar cell panel or just solar panel on the other side, is an assembly of these solar cells mounted in a framework for installation. It is a very promising technology as it is clean, silent and reliable, with very small maintenance costs and small ecological impact.

Photovoltaics (often shortened as PV) gets its name from the process of converting light (photons) to electricity (voltage), which is called the photovoltaic effect. Solar panels convert light into electricity. They are called solar after the sun because the sun is the most powerful source of the light available for use. Solar cells or PV cells rely on the photovoltaic effect to absorb the energy of the sun and cause current to flow between two oppositely charged layers. Although each solar cell provides a relatively small amount of power, many solar cells spread over a large area can provide enough power to be useful.

Solar panels consist of a number of layers, typically glass, then a protection layer and a front contact layer covering individual solar cells switched in series. Beneath those, there are metal back contacts which conduct the electricity and are laminated to waterproof the cells and insulate it from excess heat. Finally, there is a protective back layer of glass, metal or plastic. The solar cell is based on semiconducting materials which vary from system to system. Most commonly, solar cells contain two different types of semiconducting materials: a *p-type* and an *n-type* semiconductor, leading to a *p-n-junction.* When the light of appropriate wavelength impinges on the solar cell, energy is absorbed promoting electrons to the conduction band of the semiconductor and leaving behind a hole in the valence band.

While according to Shockley and Queisser, the maximum theoretical solar conversion efficiency for a single p-n junction photovoltaic cell is achieved at a bandgap of 1.34 eV, silicon with a bandgap of 1.1 eVis used in approximately 90% of solar cell semiconductors sold today. Gallium arsenide has also grown in popularity as a solar panels semiconductor in recent years. It's a compound mixture of gallium and arsenic.

It's highly effective as a semiconductor and produces a high energy yield for a small amount of material. It has a bandgap of 1.49 eV, which is better than silicon. Gallium arsenide crystals are grown especially for photovoltaic use, but silicon crystals are available in less expensive standard ingots, which are produced mainly for consumption in the microelectronics industry.

According to reports carried out by European Photovoltaic Industry Association (EPIA), the total installed power of PV conversion equipment increased from about 1 GW in 2001 up to nearly 23 GW in 2009 and by the end of 2019, a cumulative amount of 629 GW of solar power was installed throughout the world. By early 2020, the leading country for solar power was China with 208 GW, accounting for one-third of global installed solar capacity. Therefore, it is no secret that the solar industry is constantly evolving and expanding. Time has brought a lot of positive changes and over the last five years solar panels have seen a rapid rise in their installation numbers. A big reason for this growth is the falling prices in the solar industry. According to the Solar Energy Industries Association, solar prices have dropped 55 percent over the last five years. Solar power is being heavily researched, and solar energy costs have now reached within a few cents per kW/h of other forms of electricity generation, and will drop further with new technologies such as titanium oxide cells. With a peak laboratory efficiency of 32% and average efficiency of 15-20%, it is necessary to recover as much energy as possible from a solar power system. This includes reducing inverter losses, storage losses, and light gathering losses. By using solar arrays (a series of solar cells electrically connected) a DC voltage is generated which can be physically used on a load. Light gathering is dependent on the angle of incidence of the light source providing power to the solar cell's surface, and the closer to perpendicular, the greater the power. Since solar panels absorb light from the sun, and the latter always moves across the sky throughout the day, a tracking mechanism is often incorporated into the solar arrays to keep the array pointed towards the sun to receive the best angle of exposure to sunlight for absorption. So, a solar tracker which is a device onto which solar panels are fitted tracks the motion of the sun across the sky ensuring that the maximum amount of sunlight strikes the panel throughout the day. It will attempt to navigate to the best angle of exposure of light from the sun.

PROJECT PROBLEM IDENTIFICATION

Most photovoltaic solar panels are fitted in a fixed location, for example on the sloping roof of a house, or on a framework fixed to the ground, which is far from an ideal solution. The point of maximum received energy is reached when the direction of solar radiation is perpendicular on the panel surface which means that the solar panels are usually set up to be in full direct sunshine but a flat solar panel mounted on level ground, over the course of the day the sunlight will have an angle of incidence close to 90° in the morning and the evening. At such an angle, the light gathering ability of the cell is essentially zero, resulting in no output. As the day progresses to midday, the angle of incidence approaches 0°, causing a steady increase in power until at the point where the light incident on the panel is completely perpendicular, and maximum power is achieved. From this background, we see the need to maintain the maximum power output from the panel by maintaining an angle of incidence as close to 0° as possible. The sun travels through 360 degrees east to west a day, but from the perspective of any fixed location the visible portion is 180 degrees during a half day period. A solar panel in a fixed orientation between the dawn and sunset extremes will see a motion of 75 degrees on either side, thus losing 75% of the energy in the morning and evening. Rotating the panels towards the sun can help recapture these losses. A good solar tracker can typically lead to an increase in electricity generation capacity of 30-50%.

The continuous evolution of the technology determined a sustained increase of the conversion efficiency of PV panels, but nonetheless the most part of the commercial panels have efficiencies no more than 20%. A constant research preoccupation of the technical community involved in the solar energy harnessing technology refers to various solutions to increase the PV panel's conversion efficiency. Among PV efficiency improving solutions we can mention: solar tracking, optimization of solar cells geometry, enhancement of light trapping capability, use of new materials, etc.The continuous modification of the sun-earth relative position determines a continuous changing of incident radiation on a fixed PV panel. The point of maximum received energy is reached when the direction of solar radiation is perpendicular on the panel surface. Thus, an increase of the output energy of a given PV panel can be obtained by mounting the panel on a solar tracking device that follows the sun's trajectory. Unlike the classical fixed PV panels, the mobile ones driven by solar trackers are kept under optimum insulation for all positions of the Sun, boosting the PV conversion efficiency of the system. The output energy of PV panels equipped with solar trackers may increase by tens of percent, especially during the summer when the energy harnessed from the sun is more important. A tracking system must be able to follow the sun with a certain degree of accuracy and return the collector to its original position at the end of the day. This process of sensing and following the position of the sun is known as Solar Tracking and in our project a sun tracking solar panel has been implemented to increase the efficiency of the output power generated by the PV cells.

BLOCK DIAGRAM OF SUN TRACKING SOLAR PANEL WITH MULTI PURPOSE CHARGING POINT

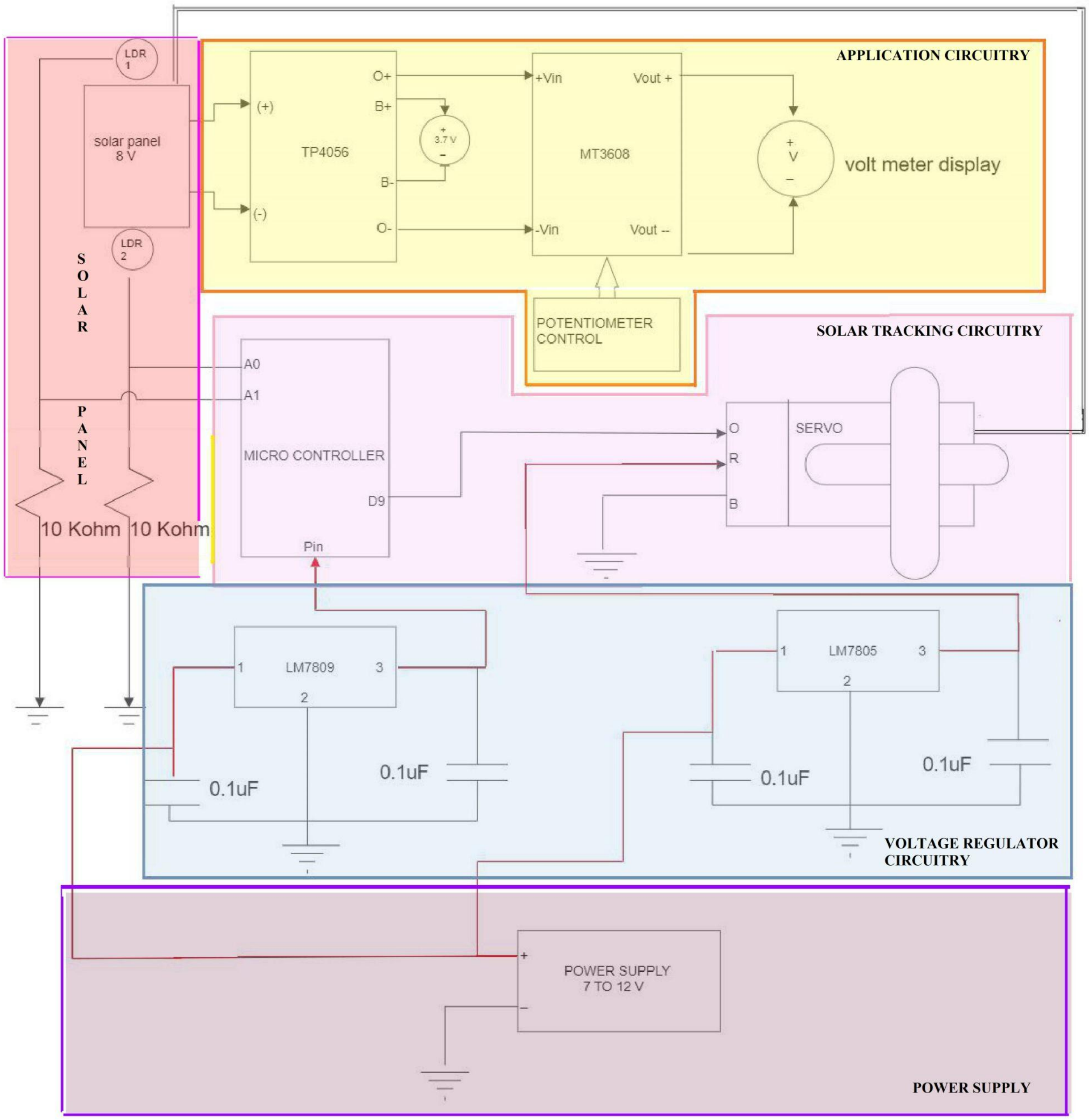
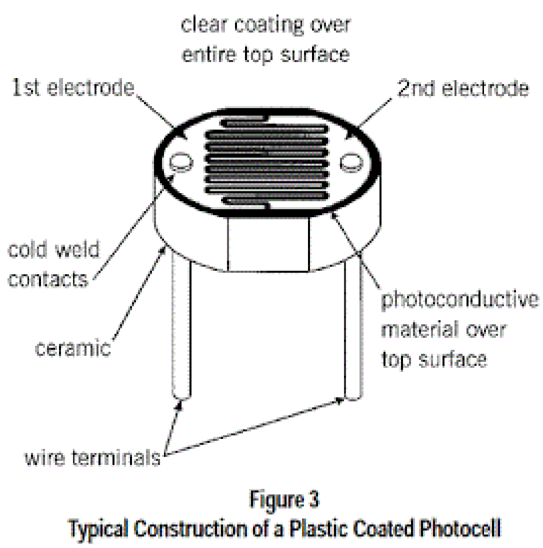


Fig. 1 : Block diagram to illustrate the working of Sun tracking Solar panel with its application circuitry.

DETAILED DESCRIPTION OF THE PROJECT EQUIPMENTS

1. Light Dependent Resistor(5mm)

Light Dependent Resistor is made of a high-resistance semiconductor. It can also be referred to as a photoconductor. If light falling on the device is of a high enough frequency, photons absorbed by the semiconductor give bound electrons enough energy to jump into the conduction band. The resulting free electron conducts electricity. thereby lowering resistance. Hence, Light Dependent Resistors are very useful in light sensor circuits. LDR is very high-resistance, sometimes as high as 10M2, when they are illuminated with light resistance drops dramatically.
In our connection the LDR is connected to a 5V pin of arduino and thereby followed by a voltage divider circuit including 10K ohm resistors. solving the potential division and determining the voltage between LDR and 10K resistor the analog voltage is fed to the arduino.



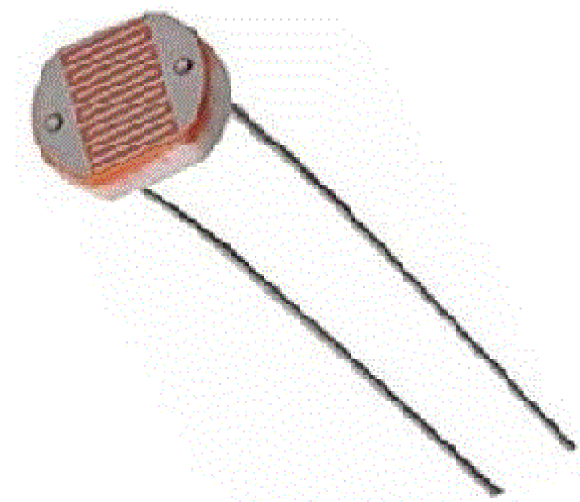


Fig 2.1 : A typical Light Dependent Resistor

Technical specification :

- **Disc Diameter: 5mm**
- **Light Resistance: 5-10k Ohm**
- **Dark resistance: up to 500k Ohm**
- **Maximum Operating Temperature: +800 degree Celsius**

2. **Servo motor**

It is a special type of motor which is automatically operated up to a certain limit for a given command with help of error-sending feedback to correct the performance. It has 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. The motor is paired with some type of 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..

TABLE 1: Servo Motor wire connection

WIRE	CONNECTED TO	DESCRIPTION
Brown	Ground pin of LM7805 IC chip	ground wire of servo motor
Red	Output pin of LM7805 IC chip	Power the motor to +5V from 7805 IC
Orrange	D9 pin of Arduino	PWM signal which drives the motor

TowerPro SG-90 Features

- Operating Voltage is +5V typically
- Torque: 2.5kg/cm
- Operating speed is 0.1s/60°
- Gear Type: Plastic
- Rotation : 0°-180°
- Weight of motor : 9gm

Fig. 2.2 : Servo Motor

Why is a servo motor used?

- The main reason behind using a servo is that it provides angular precision, i.e. it will only rotate as much as we want and then stop and wait for the next signal to take further action.This is unlike a normal electrical motor which starts rotating as and when power is applied to it and the rotation continues until we switch off the power

- The encoder and controller of a servo motor are an additional cost, but they optimize the performance of the overall system (for all of speed, power and accuracy) relative to the capacity of the basic motor.

Working of a servo motor:

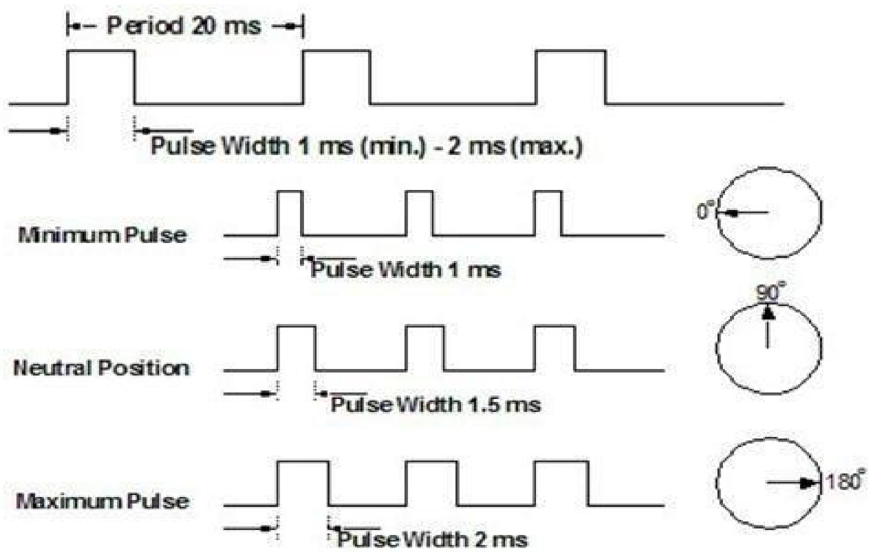


Fig 2.3: Timing cycle of a servo motor

3. **Resistor**

A resistor is a component of a circuit that resists the flow of electrical current. It has two terminals across which electricity must pass, and it is designed to drop the voltage of the current as it flows from one terminal to the other. Resistors are primarily used to create and maintain known safe currents within electrical components. Resistance is measured in ohms, after Ohm's law. This law states that electrical resistance is equal to the drop-in voltage across the terminals of the resistor divided by the current being applied. A high ohm rating indicates a high resistance to current. Materials in general have a characteristic behavior of opposing the flow of electric charge. This opposition is due to the collisions between electrons that make up the materials. This physical property, or ability to resist current, is known as resistance and is represented by the symbol R. Resistance is expressed in ohms which is symbolized by the capital Greek letter omega.

The resistance of any material is dictated by four factors:

- Material property - each material will oppose the flow of current differently.
- Length - the longer the length, the more is the probability of collisions and, hence, the larger the resistance.
- Cross sectional area - the larger the area 4, the easier it becomes for electrons to flow and, hence, the lower the resistance.
- Temperature - typically, for metals, as temperature increases, the resistance increases.

Resistors are coated with paint or enamel, or covered in molded plastic to protect them. Because they are often too small to be written on, a standardized color-coding system is used to identify them. The first three colors represent ohm value, and a fourth indicates the tolerance, or how close by percentage the resistor is to its ohm value. This is important for two reasons: the nature of its construction is imprecise, and if used above its maximum current, the value can change or the unit itself can burn up. The circuit element used to model the current-resisting behavior of a material is the resistor. For the purpose of constructing circuits we have used a 10k Ohm resistance.

Unlike other electronic components, a photoresistor(or light a variable resistor. This means its resistance can depend on light intensity. We will go first with half of the circuit diagram to understand clearly.

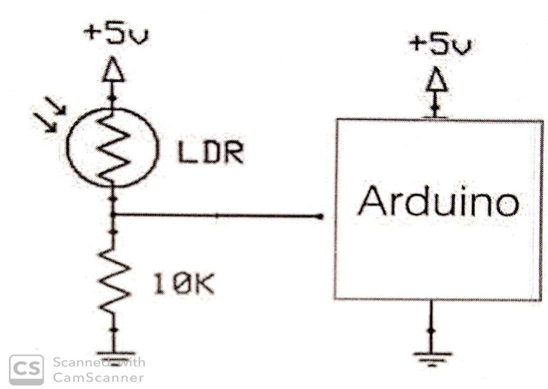


Fig 2.4: Potential divider circuit

The resistance of a photoresistor is inversely proportional to the light intensity.
Strong Light : LDR resistance(decreases to 0 ohms). So the 10k(ohm) resistor seems closer to 5V.
Dim Light : LDR resistance(increases to infinity).So, the 10k(ohm) resistor only gets a little voltage.

The key point is that the Arduino board also has Vcc(5V) and ground. So, there is no current if the potential difference is zero. Therefore, firstly, Vcc(5V) will flow through the photoresistor and go to the 10k(ohm) resistor.Then, since there is a parallel circuit, the arduino will get the same voltage as the10k(ohm) resistor. So this LDR resistor does the function of a pull-up resistor which draws the current to VCC.

4. **Arduino NANO**

Arduino Nano is a small, compatible, flexible and breadboard-friendly Microcontroller board, developed by Arduino.cc in Italy, based on ATmega328p (Arduino Nano V3.x) / Atmega168 (Arduino Nano V3.x). It comes with exactly the same functionality as in Arduino UNO but quite in small size. It has an operating voltage of 5V; however, the input voltage can vary from 7 to 12V. Arduino Nano contains 14 digital pins, 8 analog Pins, 2 Reset Pins & 6 Power Pins. Each of these Digital & Analog Pins is assigned with multiple functions but their main function is to be configured as input or output. They act as input pins when they are interfaced with sensors, but if you are driving some load then use them as output. Arduino Nano comes with a crystal oscillator of frequency 16 MHz. It is used to produce a clock of precise frequency using constant voltage. There is one limitation using Arduino Nano i.e. it doesn't come with a DC power jack, means you cannot supply an external power source through a battery. Tiny size and breadboard friendly nature make this device an ideal choice for most of the applications where sizes of the electronic components are of great concern. It is programmed using Arduino IDE which is an Integrated Development Environment that runs both offline and online.

<u>Technical Specifications</u>

Microcontroller	●	Atmega328p/Atmega168
Operating Voltage	●	5V
Input Voltage	●	7-12V
Max Current Rating	●	40mA
Flash Memory	●	16 KB or 32 KB
SRAM	●	1 KB or 2 KB
Crystal Oscillator	●	16 MHz
EEPROM	●	512 bytes or 1 KB

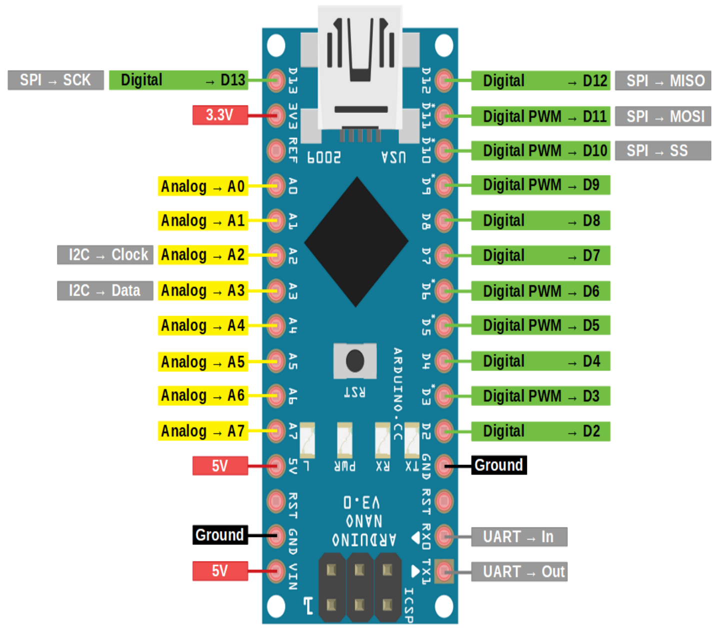


Fig 2.5: Pin Diagram of Arduino NANO Board

<u>Detailed Pin Description:</u>

- **Vin:** It is input power supply voltage to the board when using an external power source of 7 to 12 V.

- **5V:** it is a regulated power supply voltage of the board that is used to power the controller and other components placed on the board.

- **3.3V:** this is a minimum voltage generated by the voltage regulator on the board.
- **GND:** These are the ground pins on the board. There are multiple ground pins on the board that can be interfaced accordingly when more than one ground pin is required.

- **Reset:** Reset pin is added on the board that resets the board. It is very helpful when the running program goes too complex and hangs up the board. LOW value to the reset pin will reset the controller.

- **Analog Pins:** There are 8 analog pins on the board marked as A0 – A7. These pins are used to measure the analog voltage ranging between 0 to 5V.
- **Rx,Tx:** These pins are used for serial communication where Tx represents the transmission of data while Rx represents the data receiver.
- **13:** This pin is used to turn on the built-in LED

- **AREF:** This pin is used as a reference voltage for the input voltage.
- **SPI:** Four pins - 10(SS), 11(MOSI), 12(MISO), 13(SCK) are used for SPI (Serial Peripheral Interface). SPI is an interface bus and mainly used to transfer data between microcontrollers and other peripherals like sensors, registers, and SD cards.
- **WM:** Six pins 3, 5, 6, 9, 10, 11 can be used for providing 8-pit PWM (Pulse Width Modulation) output. It is a method used for getting analog results with digital sources.
- **External Interrupts:** Pin 2 and 3 are used as external interrupts which are used in case of emergency when we need to stop the main program and call important instructions at that point. The main program resumes once interrupt instruction is called and executed.
- **I2C:** I2C communication is developed using A4 and A5 pins where A4 represents the serial data line (SDA) which carries the data and A5 represents the serial clock line (SCL) which is a clock signal, generated by the master device, used for data synchronization between the devices on an I2C bus.

5. **Solar Panels (6V,03Wp)**

Solar panels generate free power from the sun by converting sunlight to electricity with no moving parts, zero emissions, and no maintenance. The solar panel, the first component of an electric solar energy system, is a collection of individual silicon cells that generate electricity from sunlight. The photons (light particles) produce an electrical current as they strike the surface of the thin silicon wafers. A single solar cell produces only about 1/2 (.5) of a volt. However, a typical 12V panel about 25 inches by 54 inches will contain 36 cells wired in series to produce about 17 volts peak output.

<u>**Technical Specification**</u>

MAXIMUM POWER - 3 WATTS
OPEN CIRCUIT VOLTAGE - 10.5V
RATED VOLTAGE - 8.3V
TOLERANCE - +/- 5%

Fig. 2.6: Layers of Solar Panel

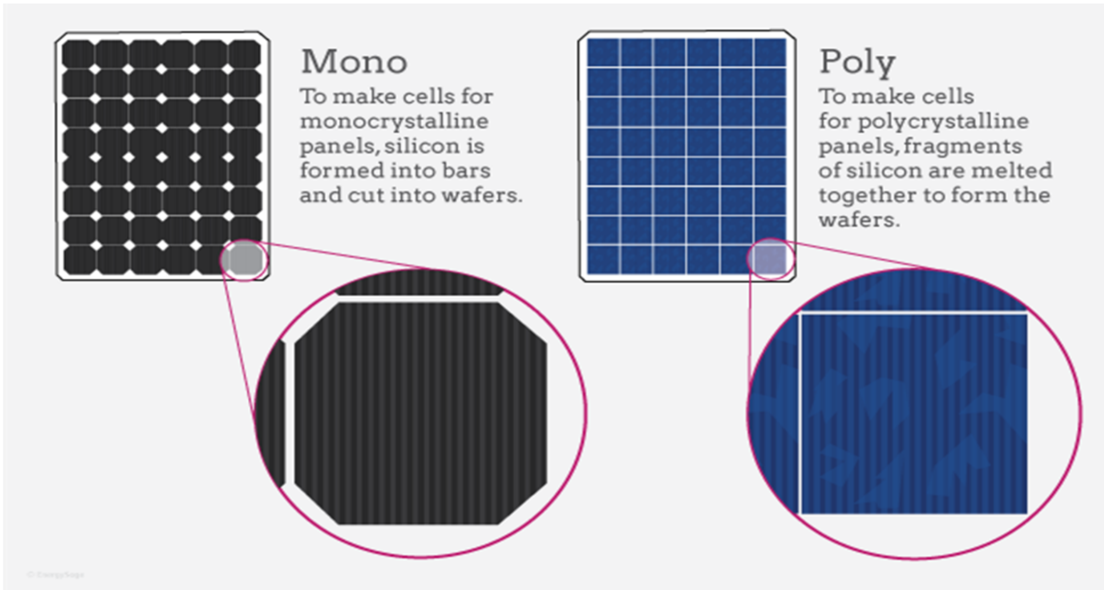


Fig 2.7: Solar panel wafer types

6. LM7809 voltage regulator IC

The name 7809 signifies two meanings, "78" means that it is a positive voltage regulator and "09" means that it provides 09V as output.

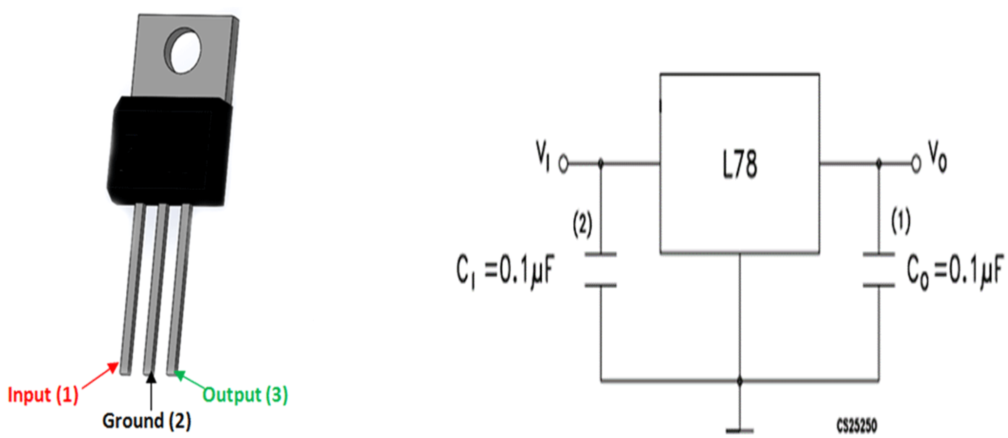


Fig 2.8: LM7809 voltage regulator IC

Table 2: LM7809 Pinout Configuration

Pin Number	Pin Name	Description
1	Input (V+)	Unregulated Input Voltage
2	Ground	Connected to Ground
3	Output (Vo)	Outputs Regulated +9V

LM7809 Regulator Features

- 9V Positive Voltage Regulator
- Minimum Input Voltage is 11V
- Maximum Input Voltage is 35V
- Output Current: 1.5 A
- Output Type: Fixed
- Internal Thermal Overload and Short circuit current limiting protection is available.
- Junction Temperature maximum of 125 degree Celsius

7. LM7805 voltage regulator IC

The name 7805 signifies two meanings, “78” means that it is a positive voltage regulator and “05” means that it provides 5V as output. So our 7805 will provide a +5V output voltage.

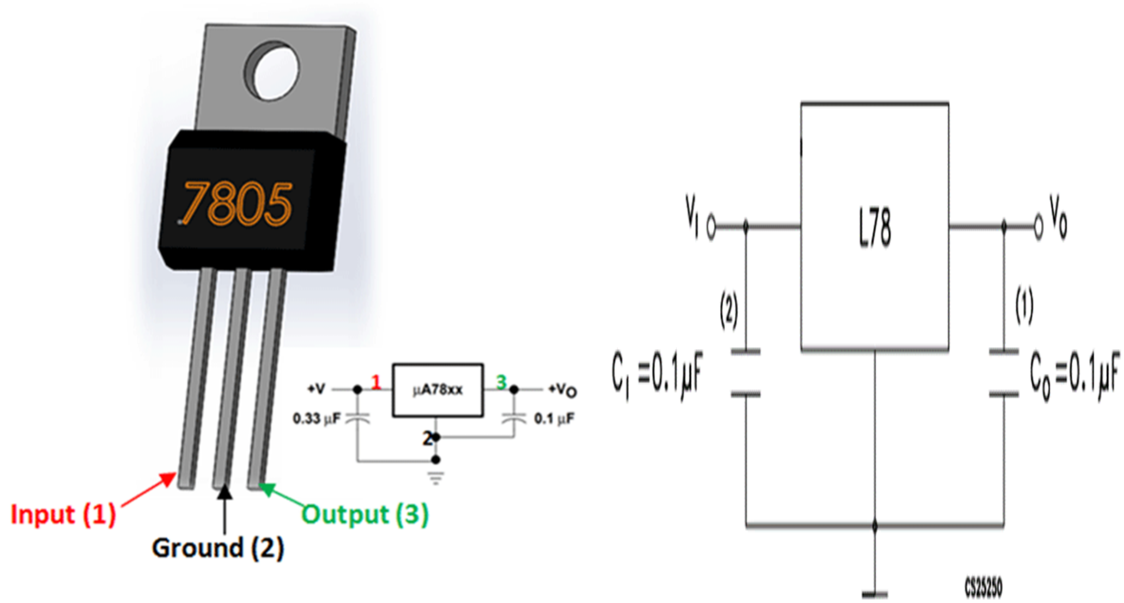


Fig 2.9: LM7805 voltage regulator IC

Table 3: LM7805 Pinout Configuration

Pin Number	**Pin Name**	**Description**
1	Input (V+)	Unregulated Input Voltage
2	Ground (Gnd)	Connected to Ground
3	Output (Vo)	Outputs Regulated +5V

LM 7805 Regulator Features

- 5V Positive Voltage Regulator
- Minimum Input Voltage is 7V
- Maximum Input Voltage is 25V

- Operating current(I_Q) is 5mA
- Internal Thermal Overload and Short circuit current limiting protection is available.
- Junction Temperature maximum 125 degree Celsius

8. TP4056 3.7V Lithium Battery Charging/Discharging Module

TP4056 is a complete constant current-voltage linear charging module for single-cell 3.7 V lithium batteries. It will continuously monitor the voltage level of the battery during charging and discharging. Typically The module operates with 5V 1A DC voltage, can be provided by the USB mini cable, and commonly used in smartphone chargers. Lithium-Ion and Lithium-Polymer cells may explode if shorted, overcharged, charged, or discharged with too high currents. TP4056 module is a combination of charger and protection for a single cell 3.7V lithium batteries. Hence this module will monitor the voltage level of the lithium battery during charging and discharging.

Table 4: TP4056 module Specifications

Type	Charger, Protection Board
Module	TP4056
Battery Type	Li-Ion
Battery Voltage	3.7V to 4.2V
Input Current Max.	1A
Input Voltage	4-8V
Output Voltage	4.2V
Connector Type	USB Mini
Charging Method	Linear Charging
Charging Precision	1.5%
Package	SMD

TP4056 module Features

- Include Current Monitor

- Under Voltage Lockout
- Automatic Recharge
- Charger and Protection Circuit in One Module
- Two Status Pin to Indicate Charge Termination
- Indicate the Presence of an Input Voltage
- Preset 4.2V Charge Voltage with 1.5% Accuracy

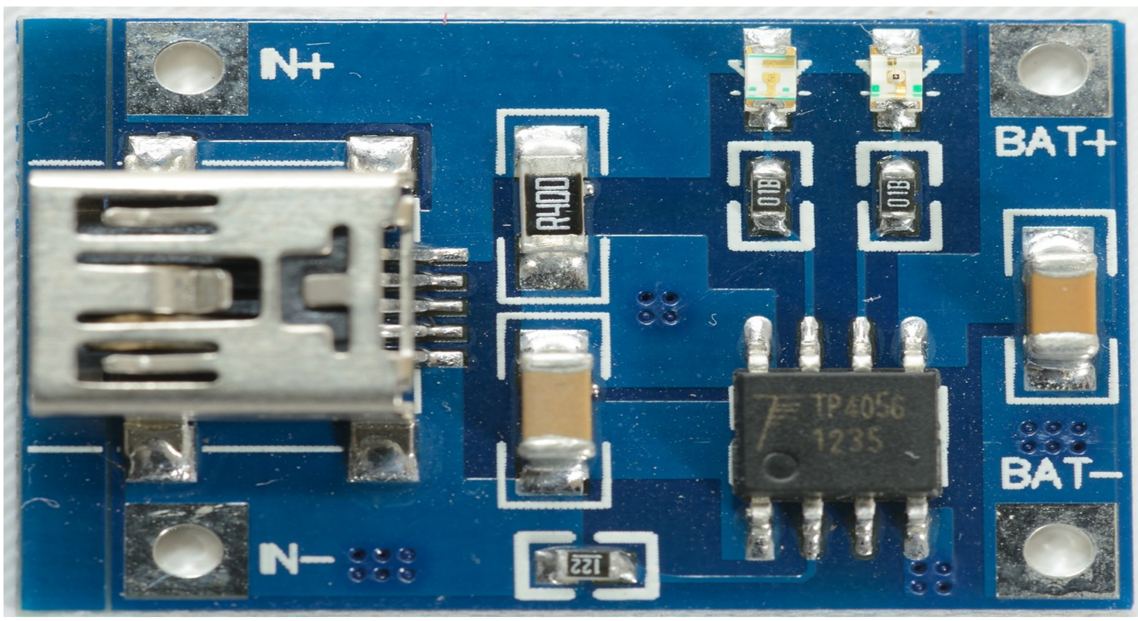


Fig 2.10: Overview routing in the chip

The input voltage Vin+ is connected to out+ via TP4056A controller which provides constant charging current . The B+ and out+ are s/ckted but the B- and out- are not s/ckted . The B- are connected to out- via FS8205A 2 n mosfet whose gate terminals are connected to DW1A module which ultimately acts the control action to charging and discharging of battery.

Inside the module IC TP4056A, DW01A, and N-type MOSFET FS8205A are used.

TP4056à.The charging process is controlled by the TP4056A Liner voltage IC, charge current is set by connecting a 1.2KΩ resistor from R_{PROG} (Pin: 2) to GND. It is responsible for providing a constant charging current of 1 mA and also protects from overcharging of the Li-ion battery

The DW01Aà battery protection IC is designed to protect *lithium-ion/polymer batteries* from damage or degrading the lifetime due to overcharge, over discharge.

A FS8205AàNo blocking diode is required due to the FS8205A internal N CHANNEL MOSFET architecture and has prevented negative charge current circuit.

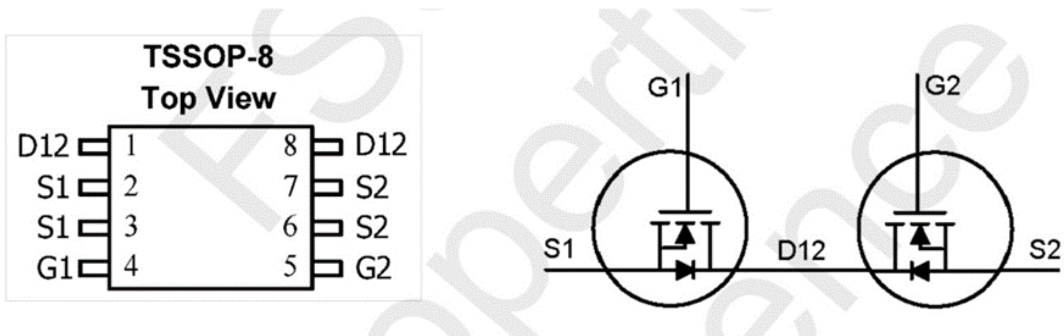


Fig. 2.11 : FS8205A circuitry

The drain of both the T/T is s/ckted. And in top view the 2 and 3 pins , 7 and 6 pin are mutually s/ckted

The recommended operating voltage for the TIP4056 module circuit is 4-8V, 1A DC supply. Iprog=(Vprog/Rprog)*1200 , Vprog=1V,Rprog=1.2Kohm(122)

You can use any type of mobile charger and its cable to power this module. When the charger is turned ON, the RED led will go high indicating that the battery is being charged. Once the module charges the battery completely, it will automatically stop charging and the Red LED will turn OFF and the Blue LED will turn ON to indicate the completion.

Circuit diagram:

The schematic of a TP4056, 3.7 V lithium battery charging and discharging module circuit shown below. For simplicity LED tube is taken as load

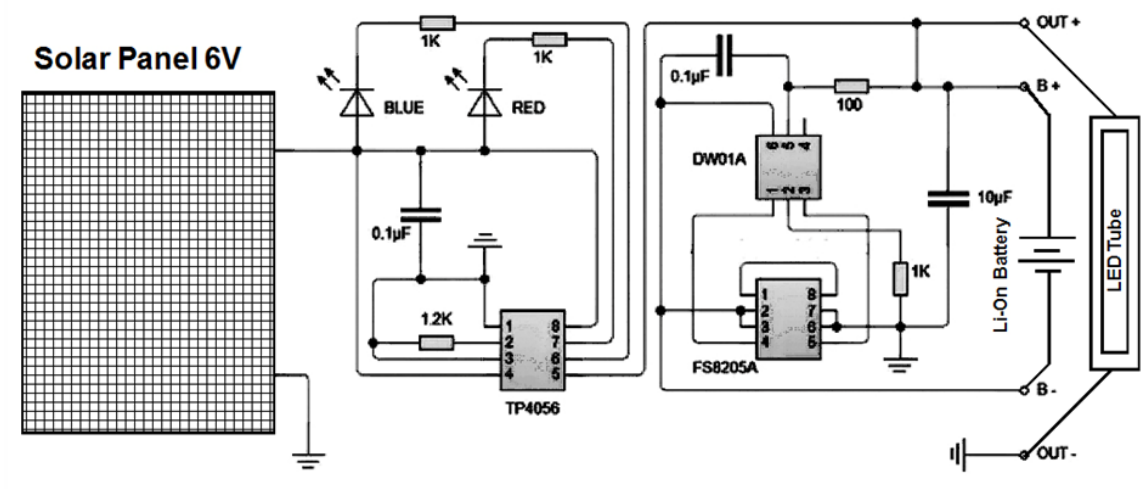


Fig. 2.12. Circuit connection

Our circuit connection-

The power jack from the solar panel is connected to +Vin and -Vin .

Between the Vin terminals and solar panel power jack there is 0.1uF capacitor so as to block spicks due to noise

The 3.7V battery is connected between the B+ and B-

OUT+ is connected to one terminal of switch

Other terminal of switch is connected to Vin- of MT3608 (underneath the board) and above the board both the OUT-(of TP4056 module) and Vin+(of MT3608) are s/ckted

9. MT3608 2A DC to DC Step-up Power Boost Converter Module

The MT3608 module is a step-up power boost converter, which can regulate the output voltage from 5V to 28V at 1.2 MHz and deliver an output current of a maximum of 2A. its internal soft-start results in a small inrush current and extends battery life. The compact-sized power boost module with 93% efficiency, intended for small and low-power applications.

MT3608 Module Specifications

Input Voltage: DC 2-24V

Output Voltage: DC 3-28V

Maximum Output Current: 2A

Switching Frequency: 1.2MHz (Fixed)

Operating Temperature: -40°C to +90°C

Output Ripple: <100mV

Efficiency: 93%

Dimensions: 37 x 17 x 7 mm

Weight: 4gm

Table 5: Pin configuration of MT3608

PIN	NAME	FUNCTION
1	SW	Power Switch Output. SW is the drain of the internal MOSFET switch. Connect the power inductor and output rectifier to SW. SW can swing between GND and 28V.
2	GND	Ground Pin
3	FB	Feedback Input. The FB voltage is 0.6V. Connect a resistor divider to FB.
4	EN	Regulator On/Off Control Input. A high input at EN turns on the converter, and a low input turns it off. When not used, connect EN to the input supply for automatic startup.
5	IN	Input Supply Pin. Must be locally bypassed.
6	NC	NC

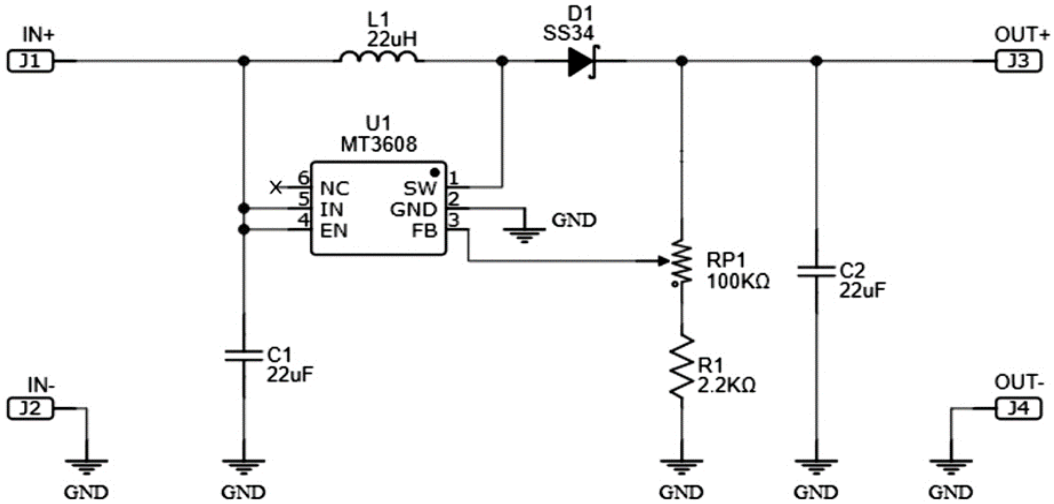


Fig. 2.13. MT3608 Circuit Diagram

Components are used in the circuit -

U_1: MT3608 IC, RP_1(B100K) 100KΩ Potentiometer, R_1: 2.2KΩ Resistor, C_1 & C_2: 22µF Ceramic Capacitor, and L_1: 22µH Inductor.

The internal reference VREF is 0.6V (Typical).The output voltage is divided by a resistor divider,Rp1 and R1 to the FB pin. The output voltage is given by Vout=Vref(1+(Rp1/R1)); The Rp1 is variable according to potentiometer adjustment.

The recommended values of the inductor are 4.7 to 22µH. The inductor should have low core loss at 1.2MHz

For better voltage filtering, ceramic capacitors of 22µF are recommended for MT3608 applications.

Schottky diode is a good choice for MT3608 because of its low forward voltage drop and fast reverses recovery The diode' is reverse breakdown voltage should be larger than the output voltage

Working Principle of MT3608 Module:

The working principle of the MT3608 module circuit is simple, where the main component is the 6-pin MT3608 integrated circuit.

When the boost converter module gets the input power, the capacitor C1 is charged. Initially, the IC (U_1) starts to switch and also the current is passed through the inductor (L_1) directly from the input source, which induces some magnetic field. The IC (U_1) uses a fixed 1.2 MHz frequency peak current mode booster architecture to regulate the voltage at the feedback pin-3 and change the current level passing through L_1. Therefore, at the IC turns ON stage, the magnetic field collapses, and it generates a high voltage spike because there is sudden discontinuity in current flow.

Again, when IC turns OFF stage, the voltage spike passes through the Schottky diode (D_1), where it blocks a reverse current to the circuit and gets stored the power in the capacitor (C_2). Hence, it increases the voltage of the capacitor (C_2), and the output obtains a higher voltage level across the capacitor up to 28 volts

Circuit Connection-

From one end of Switch a wire is connected to Vin+ of MT3608 module underneath the board, and out- and Vin- is s/ckted.

A low turn potentiometer(B100K) is connected replacing on package multi tern 100K potentiometer which.

An external Voltmeter is also added in the whole setup.

The voltmeter draws the power directly from the input terminal V+ AND V- of MT3608 module and the measuring probe wire is attached to out+ of the same module.

adjust the variable resistor until the multimeter shows required output voltage.

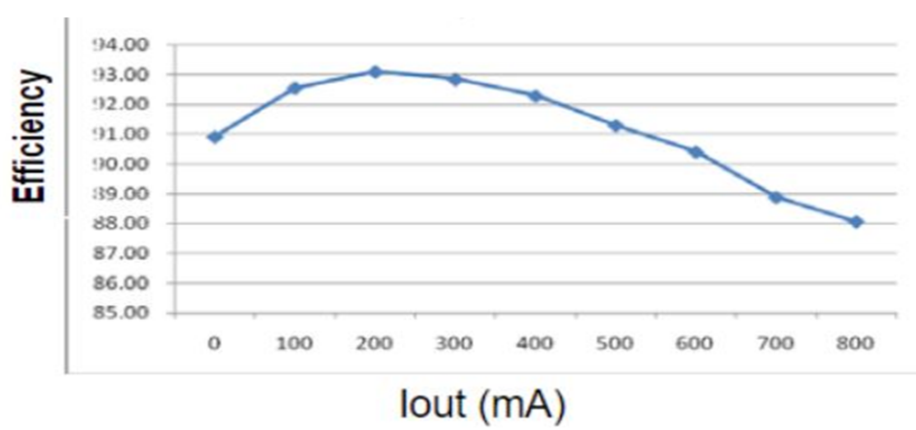


Fig. 2.14: Efficiency V/S output current curve

10. Making a Single Axis Tracking Stand

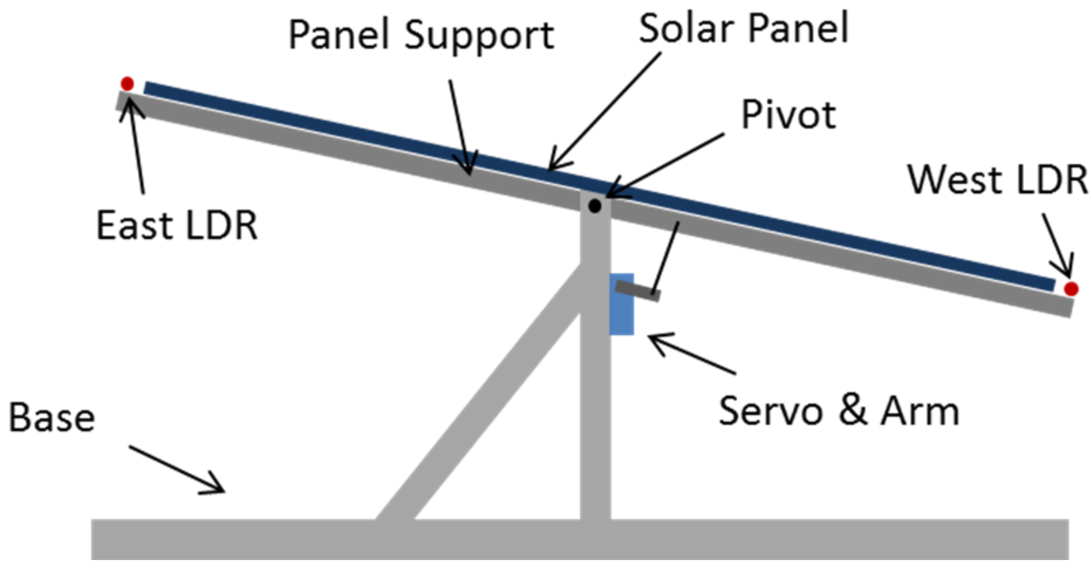


Fig 2.15 Supporting Stand Structure

Ideally the stand should be made from aluminum angle as it is strong, durable and suitable for outdoor use but it can also be made from wood, plywood or PVC piping.

The stand is essentially made in two parts, the base and the panel support. They are joined around a pivot point on which the panel support rotates. The servo is mounted onto the base and the arm actuates the panel support.

The panel should protrude from the panel support as little as possible to keep the out of balance load on the servos to a minimum. Ideally, the pivot point should be placed at the Center of gravity of the panel and panel support together so that the servo has an equal load placed on it no matter which direction the panel is facing although this is not always practically possible

.

11. Usb single port type A 4 pin connector and 5mm 2 pin wire to board connector screw terminal block

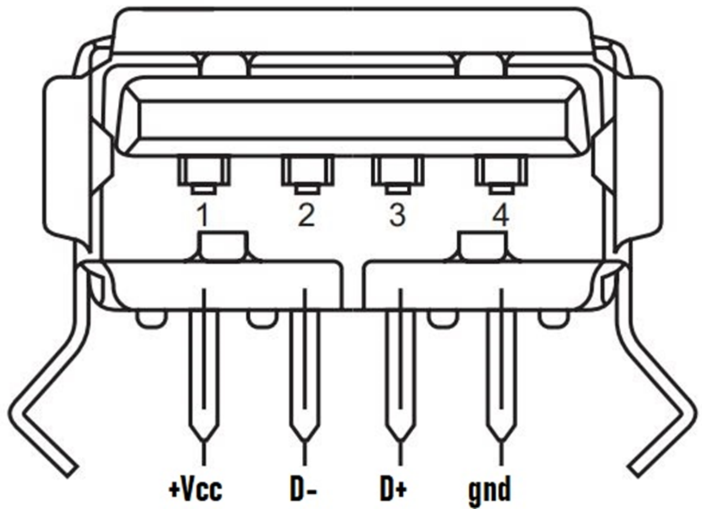


Fig. 2.16: Type A 4 pin connector

Table 6: Pin Configuration of Type A USB

Pin Configuration

Pin No:	Pin Name:	Description
1	Vcc	This pin should be provided with +5V, through which the device is powered
2	D-	Differential pair D-, must be connected to D- of the host for data transfer
3	D+	Differential pair D+, must be connected to D+ of the host fo data transfer
4	gnd	Connected to the ground pin of the host.

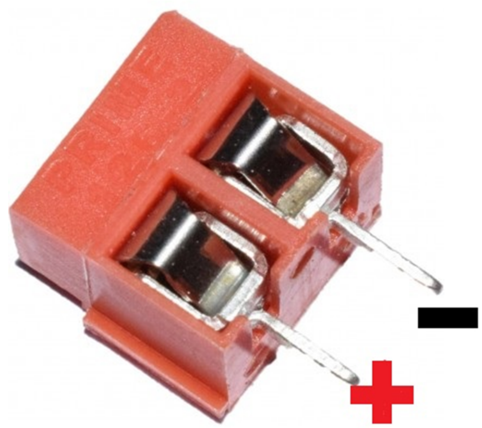


Fig 2.17: 2 pin Board to Wire Connector (5mm)

Obviously the "+" stands for +Vcc connection and "-" stands for ground connection.

Our connection

The connection is quite simple: the pin1 of usb connector and positive pin of 5mm wire to board connector are shorted together and finally connected to Out + of MT3608 module and the pin4 and negative pin are shorted and connected to Out – of the same module.

12. 3 wire Volt meter module

Table 7: Volt Meter Specification

Supply Power Range	+4.5V DC to +28V DC
Measurement Range	+0V DC to +99.9V DC
Operating Current	2 to 3mA
Accuracy	+/- 0.1V
Dimensions:	
Length	33 mm (1.3")
Width	14 mm (0.55")
Height	11 mm (0.43")
Digit Height	9 mm (0.36")
Weight	5.4 g (0.19 oz)
Wire Length	20cm (7.8")

Fig 2.18: 3 wire Volt Meter

Our connections –

The power line red wire is connected to Vin+ and black wire is connected to Vin- of MT3608 module The measuring wire (yellow) is connected to the output terminal OUT of the same module Overall the voltmeter measures minimum voltage 3.7V to 35V max.

The output voltage is of course adjustable using potentiometer

13. 100kΩ 0.2W 6 Pin 2 Gang Rotary Carbon Potentiometer (15mm)

Resistance (Ω)	100k
Rated Power (W)	0.2W
Tolerance	±20%
Shaft Length (mm)	15mm

Fig. 2.19: Potentiometer and its specification

RESOURCE UTILIZATION

Table 8: A detailed price format of different components being used in our project.

Serial No.	Component Name	Specification	Quantity	Price per Piece	Total Price
1.	Arduino NANO	9V,	1	900	900
2.	Solar Panel	6V, 3 Watt	1	600	600
3.	Servo Motor	sg90,5V	1	145	145
4.	LDR	5mm, 5~10 Kohm	2	5	10
5.	Resistors	10K	2	8	16
6.	SMPS power adaptor	12V, 1A	1	260	260
7.	Wooden Stand Structure	18x1.5x1cm	4	NA	25
8.	Aluminum Plate	10 cm	2	NA	25
9.	Perf board	7.5 X 5 PCB	4	17.25	69
10.	LM7809 voltage regulator IC	9V	1	12	12
11.	LM7805 voltage regulator IC	5V	1	9	9
12.	Capacitor	0.1uF	5	3	15
13.	Li-ion battery	3.7V	1	40	40
14.	Single Cell Li-ION Battery Holder	NA	1	140	140
15.	TP4056 module	4.5~5.5V	1	24	24
16.	MT3608 module	5~28V	1	44	44

17.	Potentiometer	100k Ohm	1	29	29
18.	Self-Lock Push Button Switch	250V,1.5A	1	23	23
19.	Three Wire DC Voltmeter Red	0-100V	1	129	129
20.	Screw Terminal Block -2 Pin Wire to Board Connector	320V	1	14	14
21.	USB Type C Connector.	20~28V	1	19	19
22.	Connecting Wire	15m	1	249	249
23.	Multimeter	DT830D	1	189	189
24.	Soldering iron and wire	25 Watt	1	149	149
25.	Screw and Screwdriver	NA	1	50	50
26.	Sticky Tape	3m	1	30	30
27.	Plywood	5x4 inch			

OVERALL CONNECTION : Recall the block diagram the top yellow shaded region is the application circuitry.

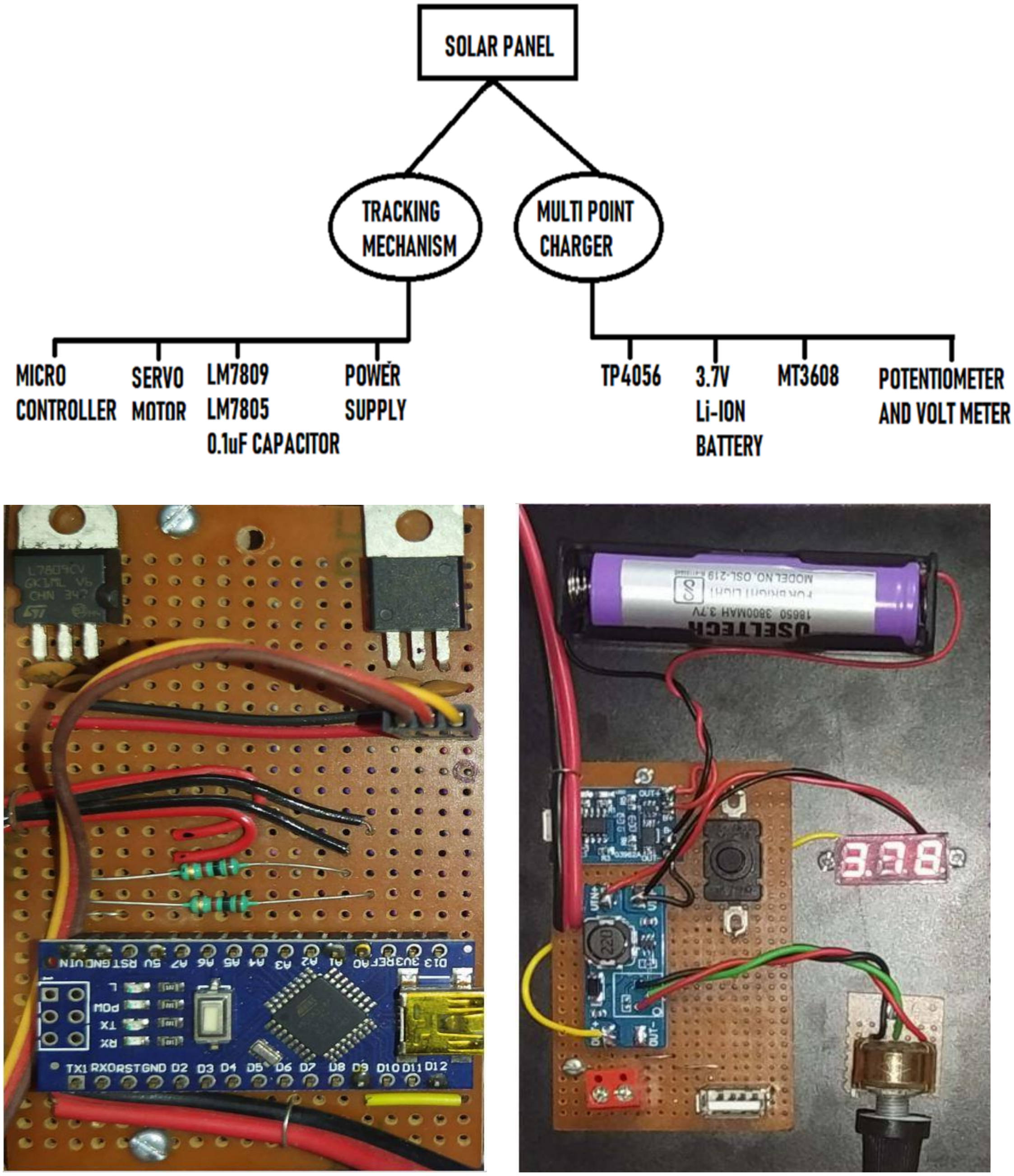


Fig 4.1 Detailed description of main project

1.**<u>MOST PROMINENTLY IN THE TRACKING MECHANISM CONNECTION</u>**-

There is the solar panel where 2 LDR have been attacked by the principles of LDR as light falls on the LDR the resistivity Vary Now as the resistivity varies the corresponding voltage of the system also changes which needed to be feed into the microcontroller this feeding is done by the potential divider circuit the a0 and a1 is the analog pin of the Arduino nano now it's time for the Arduino nano for the execution of the sets of instructions as follows-

```
#include <Servo.h>

Servo myservo;

int pos = 0;  // Variable to store the servo position.

int inputPhotoLeft = 1; // Easier to read, instead of just 1 or 0.

int inputPhotoRight = 0;

int Left = 0; // Store readings from the photoresistors.

int Right = 0; // Store readings from the photoresistors.

void setup()

{

myservo.attach(9); // Attach servo to pin 9.

}

void loop()

{

// Reads the values from the photoresistors to the Left and Right variables.

Left = analogRead(inputPhotoLeft);

Right = analogRead(inputPhotoRight);

// Checks if right is greater than left, if so move to right.

if (Left > (Right +20))
```

```
// +20 is the deadzone, so it wont jiggle back and forth.

{

if (pos < 55)

pos++;

myservo.write(pos);

}

// Checks if left is greater than right, if so move to left.

if (Right > (Left +20))

// +20 is the deadzone, so it wont jiggle back and forth.

{

if (pos > 1)

pos -= 1;

myservo.write(pos);

}

// Added some delay, increase or decrease if you want less or more speed.

delay(60);

}
```

output signal from the nano comes from the d9 pin the point to be noted is that the Arduino microcontroller works with 7-to-12-volt power supply but for safety of such expensive and important component it is good to have extensive safety expenditure in such note what we have the implementation of voltage regulator ic chips The ic7809 takes power directly from 12v smps power adapter and converts to 9v dc power and then fed to arduino power input pinOne other such similar case we can say the servo motor works typically with 5v power supply thus the same 12v smps supply is converted to 5 volt dc supply with help of lm7805.With the previously mentioned supply connection of servo motor we made the connection as it should beNow the motor rotates as per the command issued by d9 pin of microcontroller rotates the panel as per requiredThus this concludes the tracking mechanism of the panel

2. <u>MULTI POINT CHARGING CONNECTION</u>

The power jack from the solar panel is connected to +vin and -vin .Between the vin terminals and solar panel power jack there is 0.1uf capacitor so as to block spicks due to noiseThe 3.7v battery is connected between the b+ and b-Out+ is connected to one terminal of switch Other terminal of switch is connected to vin- of mt3608 (underneath the board) and above the board both the out-(of tp4056 module) and vin-(of mt3608) are s/cktedA low turn potentiometer(b100k) is connected replacing on package multi tern 100k potentiometer which.An extern al voltmeter is also added in the whole setup.The voltmeter draws the power directly from the input terminal v+ and v- of mt3608 module and the measuring probe wire is attached to out+ of same module.Adjust the variable resistor until the multimeter shows required output voltage. Typically from 3 to 28vNow this concludes the multi point charging concept point to be noted one may ask – remember at the bottom level of the block diagram there was where we used a 7 to 12 v power supply. Now what if the voltage produced in the output terminal of the booster circuit is connected as a power supply to deliver power to the same arduino and servo via the regulator ic; is such a thing possible? The answer is yes and no. Yes because such a thing is definitely possible but is it possible in our case, answer is no because the solar panel we are using draws typically an input current of 700ma and we have already discussed that the booster circuit’s efficiency depends in output current, where maximum efficiency 93% is achieved around 200ma, so in our case if we try to use the output of booster circuit as power supply to arduino and servo the booster circuit may burn out. To implement so we need the booster circuit of high capacity where maximum efficiency can be achieved to higher output current.

APPLICATION

Multi-Point Charging Connection Description

We have designed a circuit through which we are able to charge different electronic gadgets like mobile phones, laptops, smart watches, etc by using solar energy. The circuit is capable of delivering an output voltage of 3.7V to typically 28V but has maximum output capacity of 38V. Basically we have installed a Li-ion battery which will be charged with the help of solar energy via TP4056 charging/discharging module and have used voltmeter to read the final output voltage available at output of MT3608 module, which is again adjustable using a potentiometer according to need basis. Our main circuit will track the Solar rays and with the help of it we will be able to generate optimum power using a solar panel throughout the day, which is used to charge the Li battery. Now, we will use this battery to charge other gadgets.

Now at this point of the report when we have individually discussed the nuts and bolts related above mentioned modules(TP4056 Li-ION charging/discharging module and MT3608 DC-DC booster module) let us now discuss the connectivity among them.

In our project we will demonstrate the application by charging a mobile phone through usb, a chargeable cooler, and light up an led using the 2 point board to wire connection.

Advantages

- Trackers generate more electricity than their stationary counterparts due to increased direct exposure to solar rays. This increase can be as much as 10 to 25% depending on the geographic location of the tracking system.
- There are many different kinds of solar trackers, such as single-axis and dual-axis trackers, all of which can be the perfect fit for a unique jobsite. Installation size, local weather, degree of latitude and electrical requirements are all important considerations that can influence the type of solar tracker best suited for a specific solar installation.
- Solar trackers generate more electricity in roughly the same amount of space needed for fixed-tilt systems, making them ideal for optimizing land usage.
- The charging Circuitry is small and detachable, hence it is portable and can be used like a power bank for charging electrical equipments ranging from 3.7V to 35V
- The circuit provides with multi charging ports, compatible with USB devices and wired connector type devices.

Discussion

Remember at the bottom level of the block diagram (pg:9 fig:1) where we used a 7 to 12 v power supply, Now what if the voltage produced in the output terminal of the booster circuit is connected as power supply to deliver power to the same arduino and servo via the regulator ic; is such a thing possible? The answer is yes and no. Yes, because such a thing is definitely possible but is it possible in our case? The answer is no because the solar panel we are using draws typically an input current of 700ma and we have already discussed that the booster circuit's efficiency depends in output current, where the maximum efficiency of 93% (pg:26 fig:2.14) is achieved around 200ma, so in our case if we try to use the output of booster circuit as power supply to arduino and servo, the booster circuit may get burnt. To implement this we need the booster circuit of high capacity where maximum efficiency can be achieved at a higher output current.

Future Scope

Generation of solar energy has tremendous scope in India. The geographical location of the country stands to its benefit for generating solar energy. The reason being India is a tropical country and it receives solar radiation almost throughout the year, which amounts to 3,000 hours of sunshine. This is equal to more than 5,000 trillion kWh. Almost all parts of India receive 4-7 kWh of solar radiation per sq meters. This is equivalent to 2,300–3,200 sunshine hours per year. States like Andhra Pradesh, Bihar, Gujarat, Haryana, Madhya Pradesh, Maharashtra, Orissa, Punjab, Rajasthan, and West Bengal have great potential for tapping solar energy due to their location. Since the majority of the population live in rural areas, there is much scope for solar energy being promoted in these areas. Use of solar energy can reduce the use of firewood and dung cakes by rural households. Many large projects have been proposed in India, some of them are:

i).Thar Desert of India has the best solar power projects, estimated to generate 700 to 2,100 GW,

ii). The Jawaharlal Nehru National Solar Mission (JNNSM) launched by the Center is targeting 20,000 MW of solar energy power by 2022,

iii).Gujarat's pioneering solar power policy aims at 1,000 MW of solar energy generation, and Rs. 130 billion solar power plan was unveiled in July 2009, which projected to produce 20 GW of solar power by 2020. Apart from above, about 66 MW is installed for various applications in the rural area, amounting to be used in solar lanterns, street lighting systems and solar water pumps, etc.

iv). With the increase in demand of Electric Vehicles, it is very important for the manufacturers to plan about providing the charging services for smooth running of EVs. As per official report, our Indian Government is planning to change the combustible car engines into electric ones, completely by 2040.

Tata Motors is already leading in this EV sector in India and has already started setting charging points, here charging through solar energy will be a game changer. It is not only cost efficient but is a clean and excessive available energy.

Thus, India has massive plans for Solar Energy generation that may not only fulfill the deficit of power generation but also contribute largely in Green Energy Production to help to reduce the Climatic Changes globally.

Conclusion:

An arduino solar tracker was designed and constructed in the current work. LDR light sensors were used to sense the intensity of the solar light occurrence on the photo-voltaic cells panel. Conclusions of this project are summarized as ,The existing tracking system successfully sketched the light source even if it is a small torch light, in a dark room, or it is the sun light rays. The Arduino solar tracker with servo motor is employed by means of Arduino ATmega328p microcontroller. The essential software is developed via Arduino nano. The cost and reliability of this solar tracker creates it suitable for rural usage. The purpose of renewable energy from this paper offered new and advanced idea to help the people.

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