K. J. SOMAIYA POLYTECHNIC

THIRD YEAR INDUSTRIAL ELECTRONICS

2019-2020

"Hybrid Solar Converter with LDR Automation and Automated Error Detection"

Submitted by

Yameen Shaikh	**FIEG17120**
Vivek Wangwad	**FIEW17123**
Roshan Yadav	**FIEG17124**
Rahul Chavan	**FIEG17126**
Farid Ahmed Shaikh	**FIEG18348**

Under The Guidance Of:

Mrs. Archana V. Sambhe

CERTIFICATE

K. J. SOMAIYA POLYTECHNIC

Vidyanagar, Vidyavihar, Mumbai
Pin Code: 400 077

This is to certify that students of Final Year Full Time Diploma in **INDUSTRIAL ELECTRONICS ENGINEERING** have done group project on:

"**Hybrid Solar Converter with LDR Automation and Automated Error Detection**"

As a part of project work prescribed by the board of studies of the institute during the Year **2019-2020.**

And I have instructed and guided them for the said work from time to time, and found them satisfactorily progressive and their contribution as proportionate.
The following students were associated with me for this work:

Name of the Students	Enrollment Number
Yameen Shaikh	**FIEG17120**
Vivek Wangwad	**FIEW17123**
Roshan Yadav	**FIEG17124**
Rahul Chavan	**FIEG17126**
Farid Ahmed Shaikh	**FIEG18348**

GUIDE	H.O.D	PRINCIPAL	EXTERNAL
Mrs. A. V. SAMBHE	Mr. R. H. GHADYALJI	Mrs. B. PADMAJA	EXAMINER

ACKNOWLEDGEMENT

With a deep sense of gratitude, we wish to express our sincere thanks to our guide, **Mrs. A. V. SAMBHE**, From **Industrial Electronics Engineering Department** for giving us the opportunity to work under her for this project. We truly appreciate and value her esteemed guidance and encouragement from the beginning to the end of this thesis. We are extremely grateful to her. Her knowledge and company at the time of crisis would be remembered lifelong.

We would like to express our deep regards and gratitude
To our respected principal **Mrs. B. PADMAJA** and our respected
Head of Department **Mr. R. H. GHADYALJI.**

We would also like to tender our sincere thanks to the staff members, non-teaching staff and friends for their co-operation and help in one or other way. We would like to thank all those who directly and indirectly supported and helped us for completing the project in time.

We would also like to Thank **K. J. SOMAIYA POLYTECHNIC** to give us the wonderful opportunity to learn, making, organizing a project and problem solving technique within it. We would thank the Institution for the moral support during the overall assessment of project.

INDEX:

Chapter No.1

Introduction:

1. Introduction:

This system has a hybrid solar converter which works on both AC supply as well as solar power and it also has sun tracking which detects the sun rays by using ldr's and moves the solar panel in response to the sun rays and has an automated error detection system with the help of ESP 8266 Wi-Fi Module and Host Ifttt sends a message on desired phone number or an e-mail when output voltage error is detected form solar panel.

The Sun tracking solar panel consists of four LDRs, solar panel and a servo motor and ATmega328P Micro controller (On Arduino UNO R3 Board). Four light dependent resistors are arranged on the edges of the solar panel. Light dependent resistors produce low resistance when light falls on them. The servo motor connected to the panel rotates the panel in the direction of Sun.

Solar Panel is arranged in such a way that light on four LDRs i.e. Analog Output is compared via Arduino Board and panel is rotated with the help of Servos towards LDR which have high intensity i.e. low resistance compared to other. Servo motor rotates the panel at certain angle.

When the intensity of the light falling on right LDR is more, panel slowly moves towards right and if intensity on the left LDR is more, panel slowly moves towards left. Similar action occurs on Top and bottom LDRs. In the noon time, Sun is ahead and intensity of light on both the panels is same. In such cases, panel is constant and there is no rotation.

Chapter No.2

Circuit Diagram:

2. Circuit Diagram:

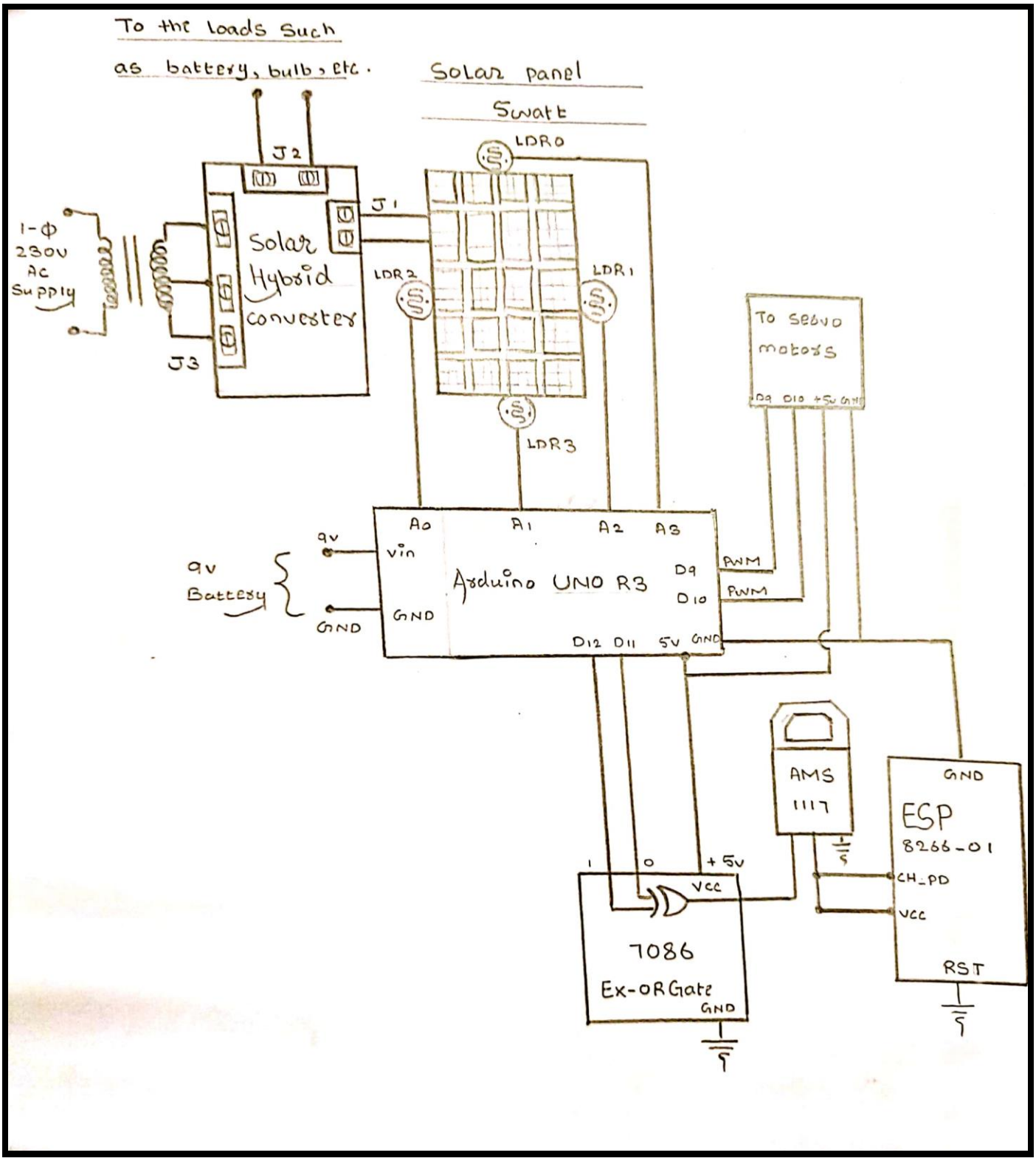


Figure 1: Circuit Diagram

Chapter No.3

Working:

3. Working:

3.1: Solar Hybrid Converter:

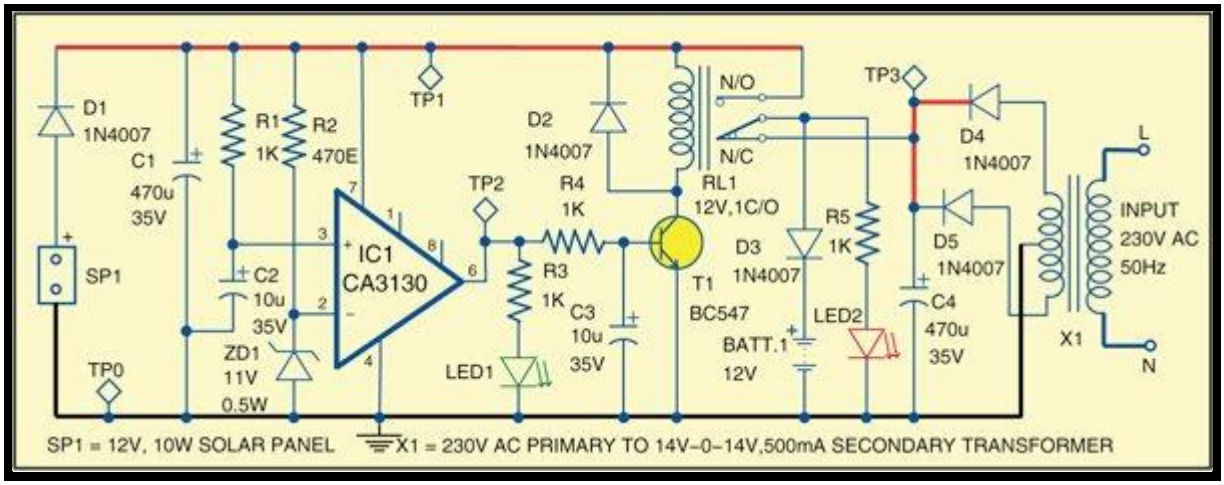


Figure 2 (a): Schematic Diagram

Efficiency of a solar converting system depends on the weather conditions. Usually the solar panel gets four to five hours of bright sunlight in a day. If the weather is cloudy or rainy, it affects the charging process and the battery does not attain full charge. This simple hybrid solar converter can solve the problem as it can charge the battery or load using both solar power as well as AC mains supply.

The above figure (a) is designed to give required output on the following conditions:

- When output from the solar panel is above 12 volts, the battery charges using the solar power.
- When the output drops below 12 volts, the battery charges through AC mains supply.

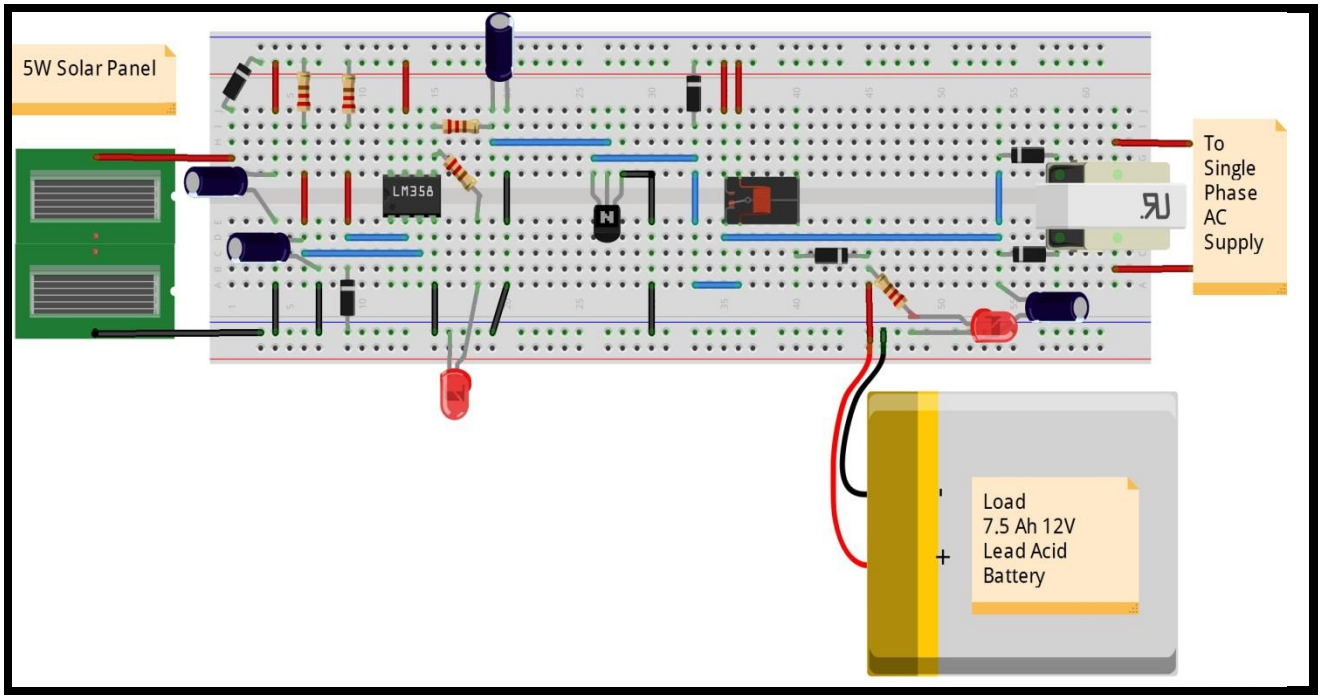


Figure 2 (b): Practical Circuit Diagram

Circuit Operation:

When Solar panel is connected to SP1, supply flows through CA 3130 Op Amp and it turns ON. Diode D1 is used to protect the circuit from reverse connection of the supply which would allow negative voltage (voltage with reverse polarity) to be connected to Op Amp.

When output from the solar panel is above 12 volts, the output of Op Amp becomes High and Green LED turns ON. As Output of CA3130 is connected to base of transistor T1 the Transistor turns ON and the relay is energized. As soon as the Relay is energized the Common terminal is connected to N/O terminal of the Relay. Thus the Output of solar is connected to the Load in this case Battery.

When the output drops below 12 volts, the relay De-energizes and the common terminal is connected to the N/C terminal and the Red LED turns ON. Thus the DC supply from Full wave rectifier is connected to the load.

Hence, in any case Supply is connected to the Load.

3.2: Dual Axis Sun tracking System:

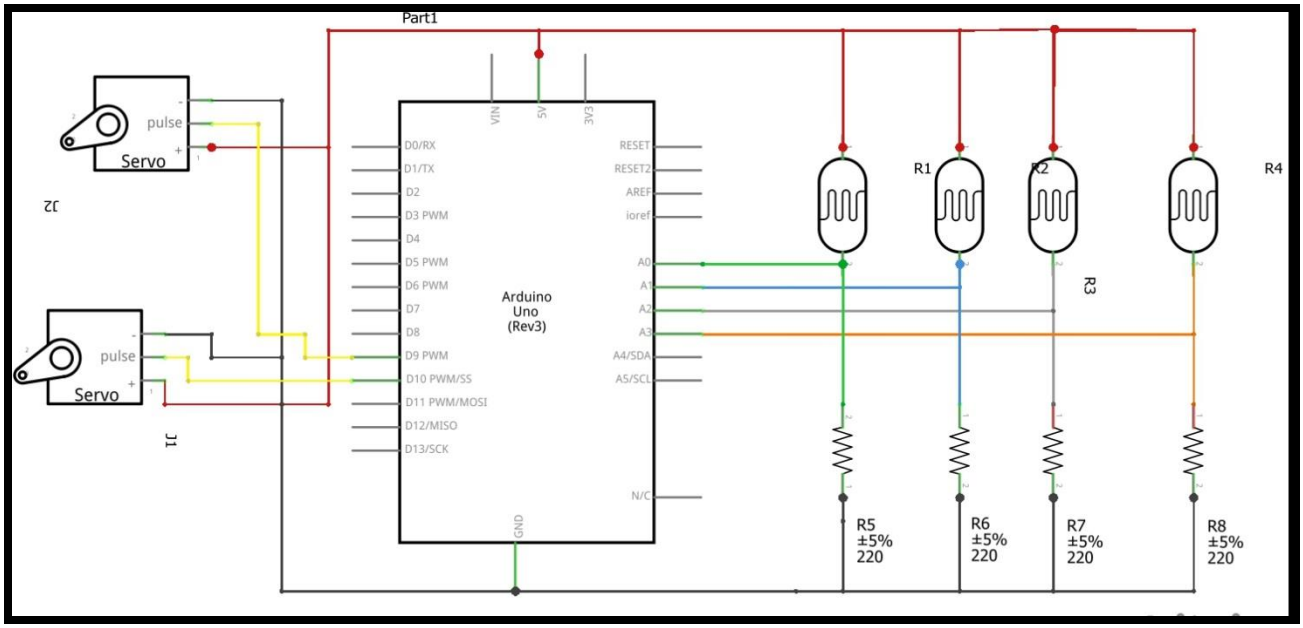


Figure 3 (a): Schematic Diagram

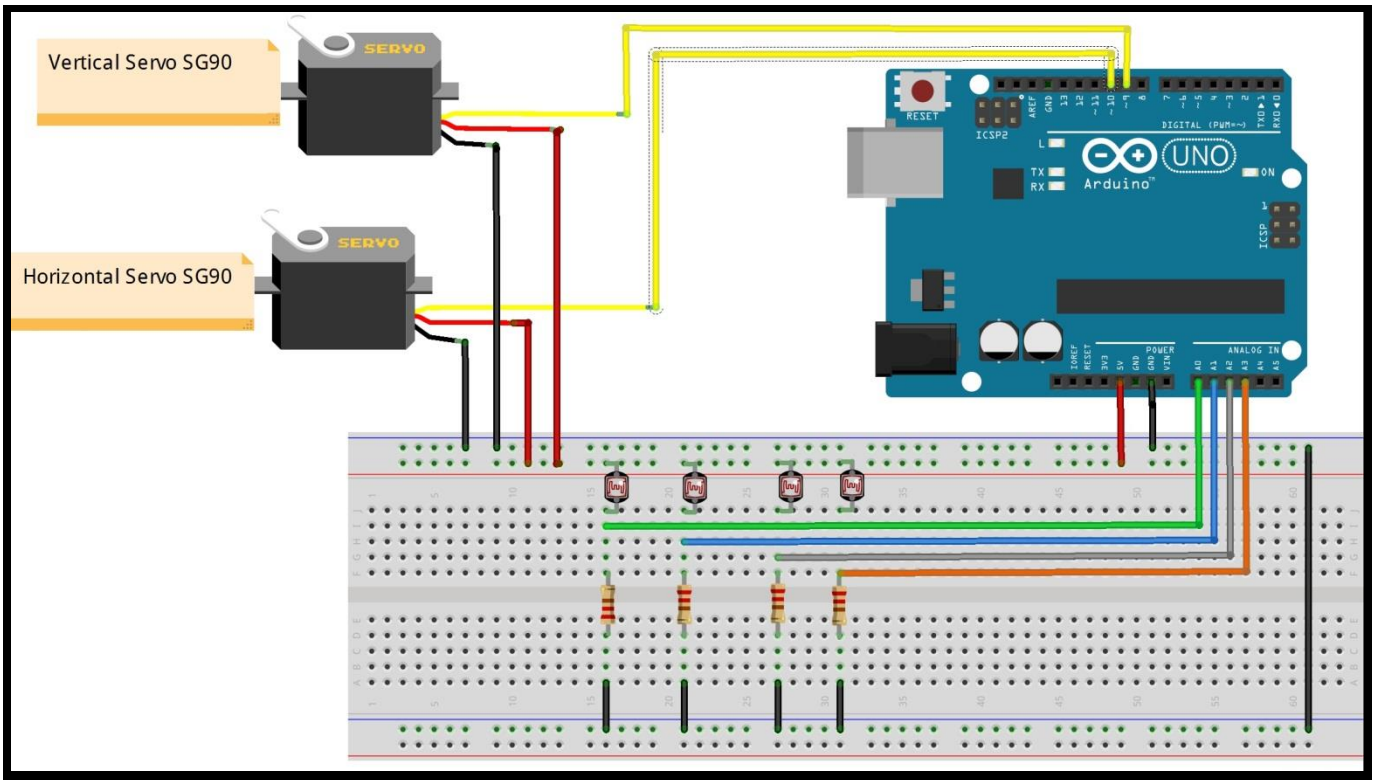


Figure 3 (b): Practical Circuit Diagram

Circuit Operation:

The proposed system consists of ATmega328P micro controller in Arduino UNO R3, Solar panel, Light Dependent resistors and Servo Motor. The position of the Sun with respect to the solar panel is not fixed due to the rotation of the Earth. For an efficient usage of the solar energy, the Solar panels should absorb energy to a maximum extent. This can be done only if the panels are continuously placed perpendicular towards the direction of the Sun. So, solar panel should continuously rotate in the direction of Sun.

The Sun tracking solar panel consists of four LDRs, solar panel and a servo motor and ATmega328P Micro controller (On Arduino UNO R3 Board). Four light dependent resistors are arranged on the edges of the solar panel. Light dependent resistors produce low resistance when light falls on them. The servo motor connected to the panel rotates the panel in the direction of Sun.

Solar Panel is arranged in such a way that light on four LDRs i.e. Analog Output is compared via Arduino Board and panel is rotated with the help of Servos towards LDR which have high intensity i.e. low resistance compared to other. Servo motor rotates the panel at certain angle.

When the intensity of the light falling on right LDR is more, panel slowly moves towards right and if intensity on the left LDR is more, panel slowly moves towards left. Similar action occurs on Top and bottom LDRs. In the noon time, Sun is ahead and intensity of light on both the panels is same. In such cases, panel is constant and there is no rotation.

3.3: Automated Error detection:

Connection for Programming of ESP8266-01:

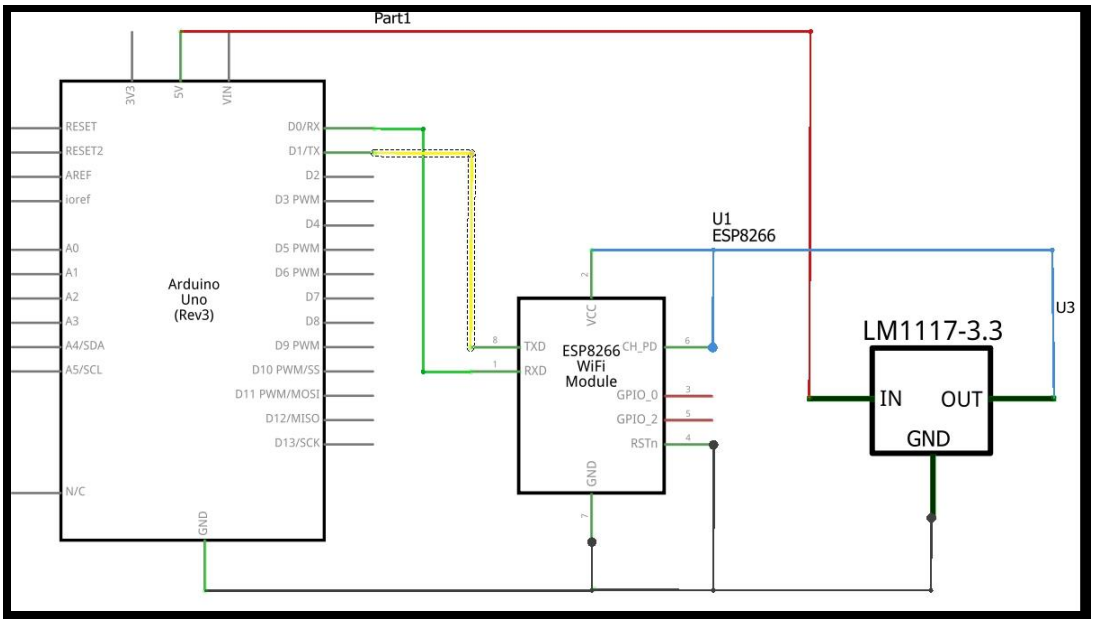


Figure 4 (a): Programing Schematic Diagram

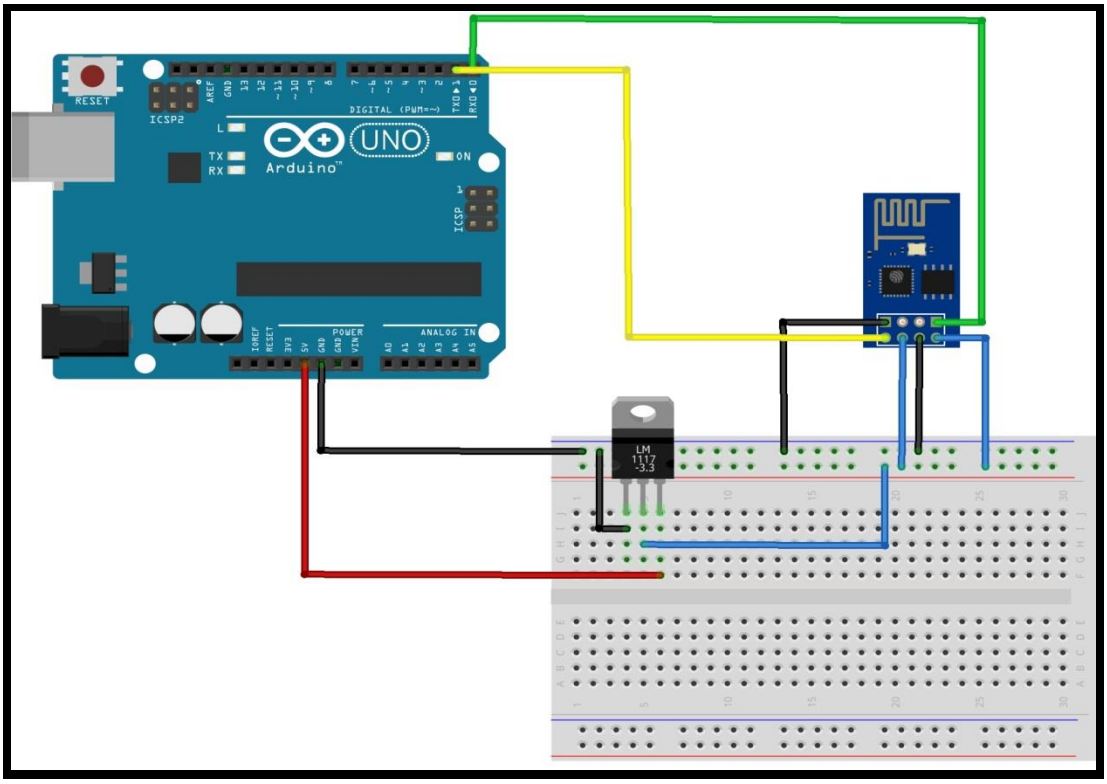


Figure 4 (b): Programing Practical Diagram

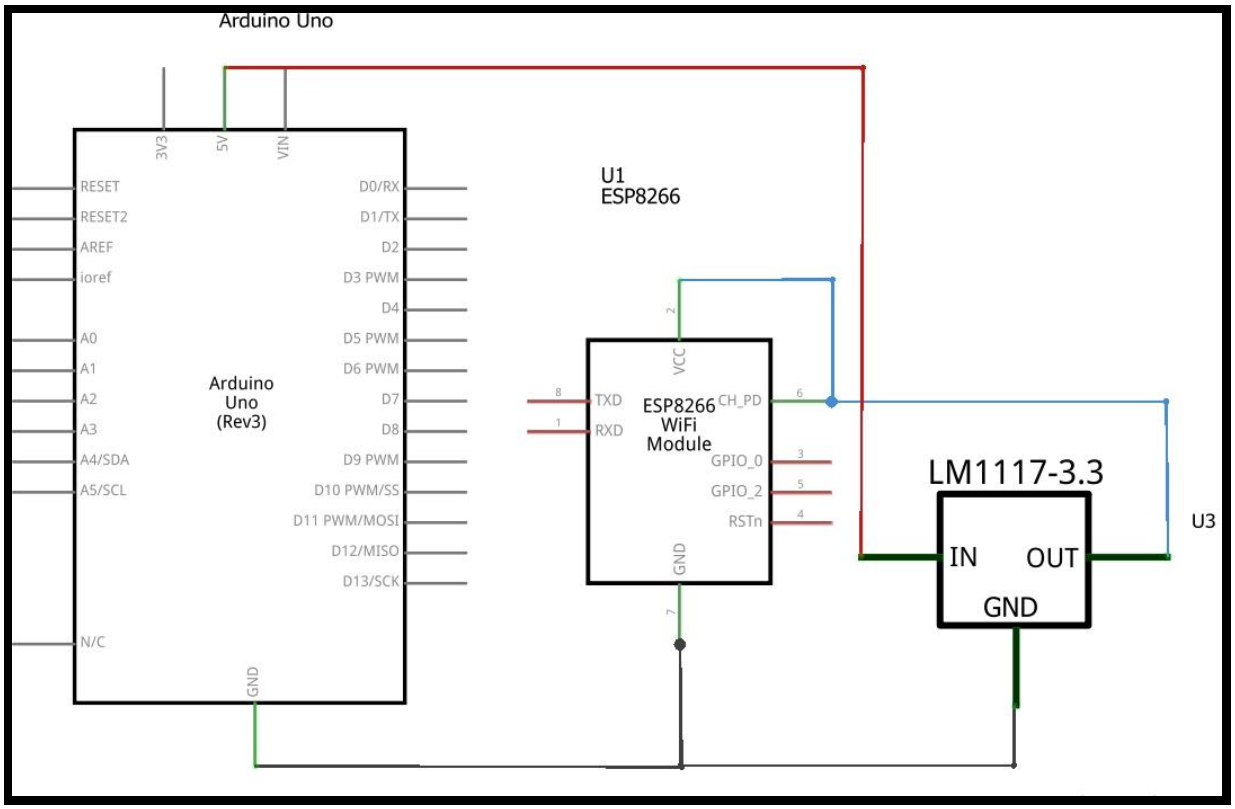


Figure 5 (a): Schematic Diagram

In Today's Day and Age, the word "Automation" signifies many possibilities. Using Ex-OR Gate, ESP8266 Wi-Fi Module and other simple components we made a Simple Circuit which would notify us via a message when Solar Energy is not available and it switched to Ac mains Supply. This proposed system will detect any errors in the output of hybrid charger.

This system consists of an Ex-or gate, ESP8266 WIFI MODULE and Voltage Regulator. The inputs to the Ex-or gate are from Arduino Uno and output of Ex-or gate is connected to input terminal of voltage regulator ASM1117.The GND pin of ESP8266 is Grounded along with GND of Arduino board. The output of Voltage regulator i.e. 3.3V is connected to terminal CH_PD and Vcc of ESP8266 Wi-Fi Module.

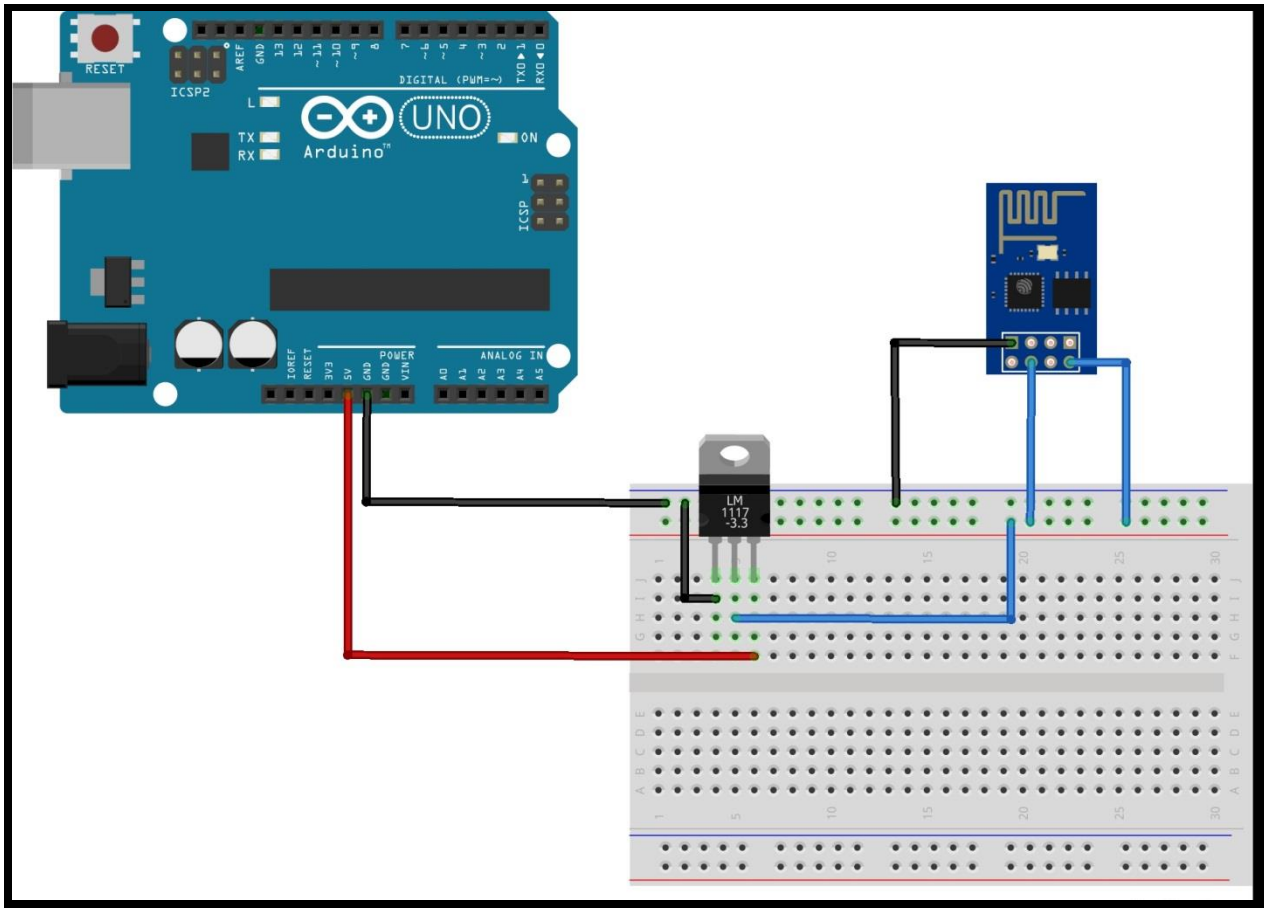


Figure 5 (b): Practical Circuit Diagram

Circuit Operation:

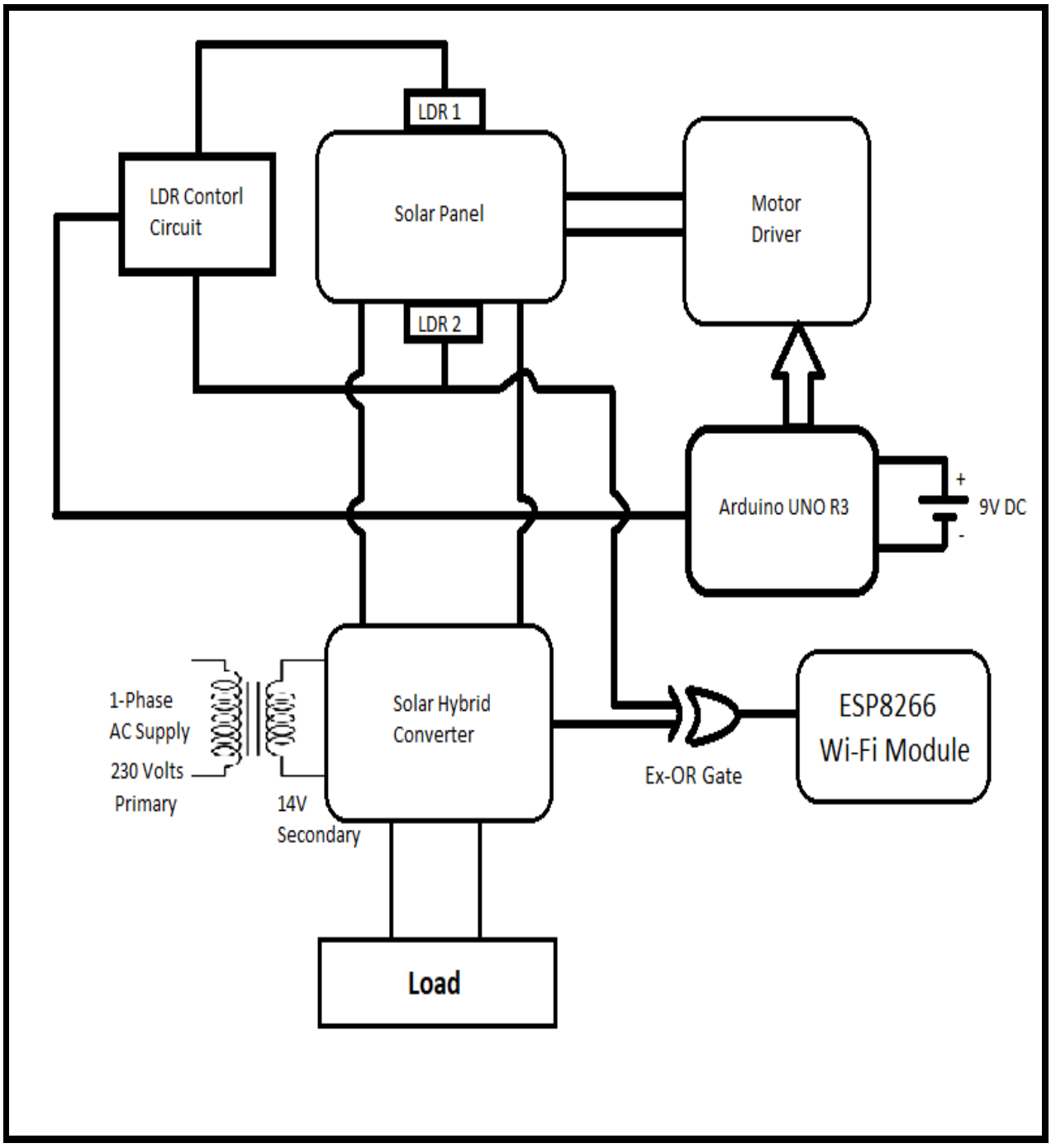
One input terminal of Ex-OR gate is permanently kept ground and other input terminal is from Arduino Uno. When the terminal of Arduino is high the ESP8266 is triggered and an automated message is sent on desired phone number/E-mail.

For Operation of this Circuit, An open source website called as Ifttt.com also known as (If This Then That) is used. The Wi-Fi Module sends a signal to this website if the Ex-OR output is High then Website sends a message to registered number after arrival of signal.

Chapter No.4

Block Diagram:

4. Block Diagram:



Chapter No.5

List of Components:

5. List of Components:

5.1: Solar panel:

Figure 6: Solar Panel

Photovoltaic modules use light energy (photons) from the Sun to generate electricity through the photovoltaic effect. Most modules use wafer-based crystalline silicon cells or thin-film cells. The structural member of a module can be either the top layer or the back layer. Cells must be protected from mechanical damage and moisture. Most modules are rigid, but semi-flexible ones based on thin-film cells are also available. The cells are connected electrically in series, one to another to a desired voltage, and then in parallel to increase amperage.

The wattage of the module is the mathematical product of the voltage and the amperage of the module. Most modules are rigid, but semi-flexible ones based on thin-film cells are also available. The cells are connected electrically in series, one to another to a desired voltage, and then in parallel to increase amperage.

A 5 Watt Solar Panel is used in our demonstration to convert Light energy into Electrical energy and power a load.

5.2: Light Dependent Resistor:

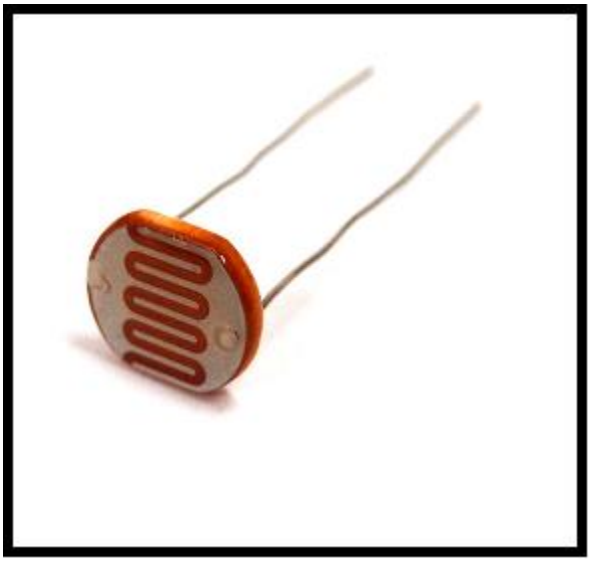


Figure 7: Light Dependent Resistor (LDR)

A Light Dependent Resistor is a light-controlled variable resistor. The resistance of a photoresistor decreases with increasing incident light intensity;

In other words, it exhibits photoconductivity. A Photoresistor can be applied in light-sensitive detector circuits, and light-activated and dark-activated switching circuits.

A photoresistor is made of a high resistance semiconductor. In the dark, a photoresistor can have a resistance as high as several Mega Ohms (MΩ), while in the light; a photoresistor can have a resistance as low as a few hundred ohms. If incident light on a photoresistor exceeds a certain frequency, photons absorbed by the semiconductor give bound electrons enough energy to jump into the conduction band. The resulting free electrons (and their Hole partners) conduct electricity, thereby lowering resistance.

The resistance range and sensitivity of a photoresistor can substantially differ among dissimilar devices. Moreover, unique Photoresistors may react substantially differently to photons within certain wavelength bands.

4 LDRs are used to detect the amount of light present in the atmosphere and the output signal of LDs is given to Arduino board to create a PWM signal to operate the Servo Motors.

5.3: Arduino Uno R3:

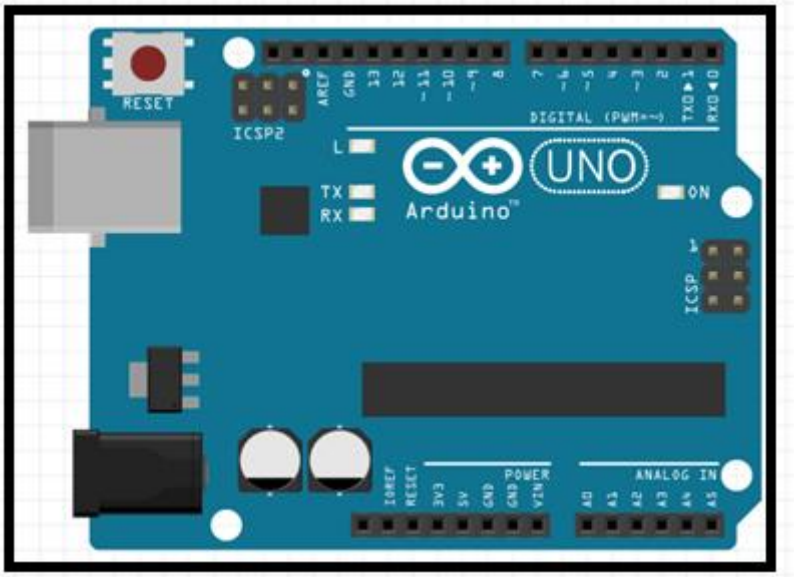


Figure 8: Arduino UNO R3

Description:

The Arduino UNO is an open-source microcontroller board based on the Microchip ATmega328P microcontroller. 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. The board has 14 Digital pins, 6 Analog pins, and programmable with the Arduino IDE (Integrated Development Environment) via a type B USB cable. It can be powered by the USB cable or by an external 9-volt battery, though it accepts voltages between 7 and 20 volts.

The Wiring platform consisted of a printed circuit board (PCB) with an ATmega168 microcontroller, an IDE based on Processing and library functions to easily program the microcontroller. The 14 digital input/output pins can be used as input or output pins by using pinMode(), digitalRead() and digitalWrite() functions in arduino programming. Each pin operate at 5V and can provide or receive a maximum of 40mA current, and has an internal pull-up resistor of 20-50 KOhms which are disconnected by default.

Out of these 14 pins, some pins have specific functions as listed below:

1. **Serial Pins 0 (Rx) and 1 (Tx):** Rx and Tx pins are used to receive and transmit TTL serial data. They are connected with the corresponding ATmega328P USB to TTL serial chip.
2. **External Interrupt Pins 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.
3. **PWM Pins 3, 5, 6, 9 and 11:** These pins provide an 8-bit PWM output by using analogWrite() function.
4. **SPI Pins 10 (SS), 11 (MOSI), 12 (MISO) and 13 (SCK):** These pins are used for SPI communication.
5. **In-built LED Pin 13:** This pin is connected with an built-in LED, when pin 13 is HIGH – LED is on and when pin 13 is LOW, it's off.

Along with 14 Digital pins, there are 6 analog input pins, each of which provides 10 bits of resolution, i.e. 1024 different values. They measure from 0 to 5 volts but this limit can be increased by using AREF pin with Analog Reference() function.

6. Analog pin 4 (SDA) and pin 5 (SCA) also used for TWI communication using Wire library.
7. **AREF:** Used to provide reference voltage for analog inputs with analogReference() function.
8. **Reset Pin:** Making this pin LOW, resets the microcontroller.

Technical specifications of ATmega328P:

- Microcontroller: Microchip ATmega328P
- Operating Voltage: 5 Volts
- Input Voltage: 7 to 20 Volts
- Digital I/O Pins: 14 (of which 6 provide PWM output)
- Analog Input Pins: 6
- DC Current per I/O Pin: 20 mA
- DC Current for 3.3V Pin: 50 mA
- Flash Memory: 32 KB
- SRAM: 2 KB
- EEPROM: 1 KB
- Clock Speed: 16 MHz

Pin Diagram:

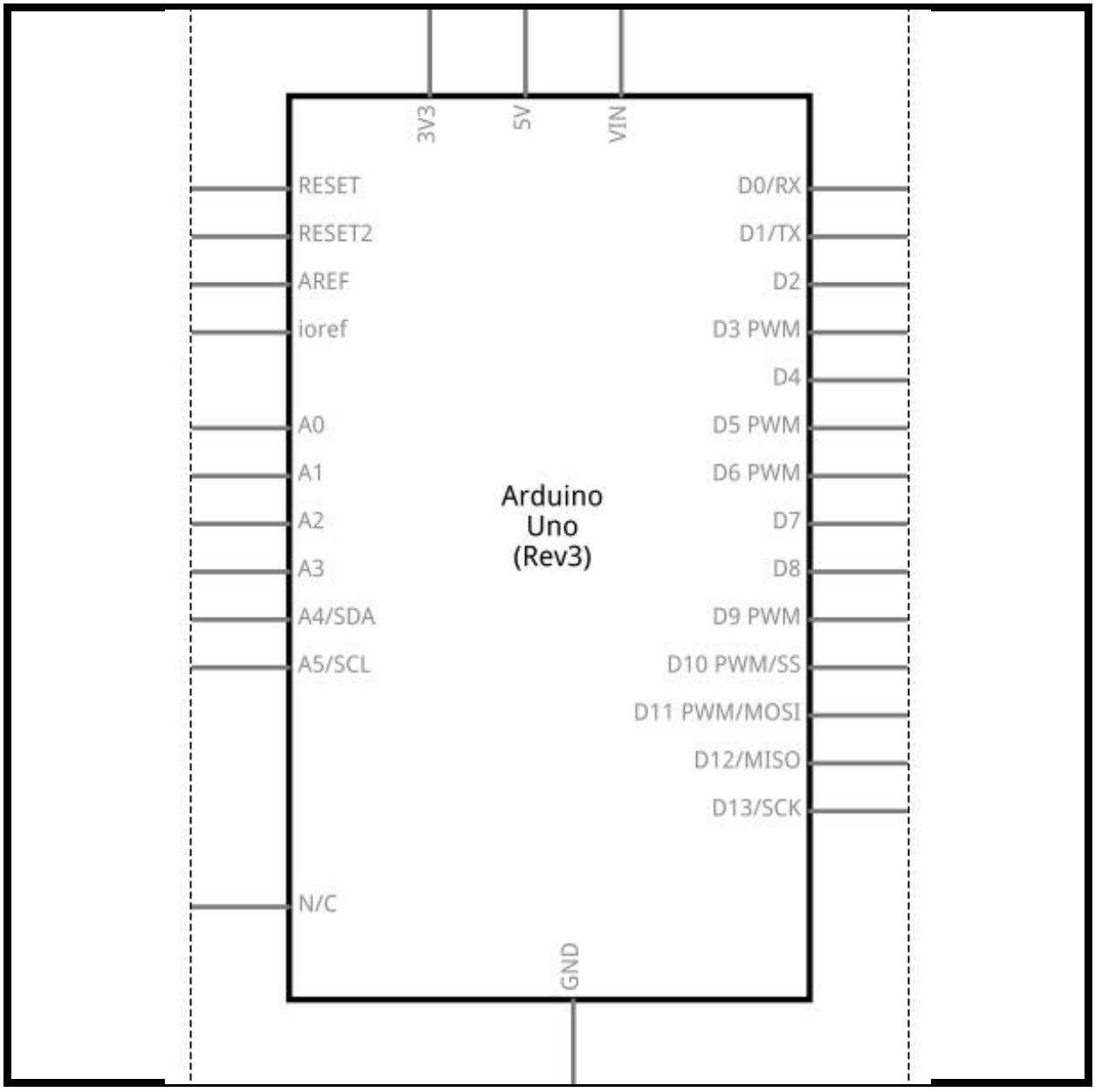


Figure 9: Pin Diagram of Arduino Uno R3

Pin description:

Pin Category	Pin Name	Features
Power	Vin, 3.3V, 5V, GND	Vin: Input voltage to Arduino when using an external power source. 5V: Regulated power supply used to power microcontroller and other components on the board. 3.3V: 3.3V supply generated by on-board voltage regulator. Maximum current draw is 50mA. GND: ground pins.
Reset	Reset	Resets the microcontroller.
Analog Pins	A0 – A5	Used to provide Analog input in the range of 0-5V
Input/output Pins	Digital Pins 0 - 13	Can be used as input or output pins.
Serial	0(Rx), 1(Tx)	Used to receive and transmit TTL serial data.
External Interrupts	2, 3	To trigger an interrupt.
PWM	3, 5, 6, 9, 11	Provides 8-bit PWM output.
SPI	10(SS), 11(MOSI), 12(MISO) and 13 (SCK)	Used for SPI communication.
Inbuilt LED	13	To turn on the inbuilt LED.
TWI	A4 (SDA), A5 (SCA)	Used for TWI communication.
AREF	AREF	To provide reference voltage for input voltage.

5.4: Servo motors:

Figure 10: Servo motor

A servo motor is an electrical device which can push or rotate an object with great precision. If you want to rotate and object at some specific angles or distance, then you use servo motor. It is just made up of simple motor which run through servo mechanism.

It is a closed-loop servomechanism that uses position feedback to control its motion and final position. The input to its control is a signal representing the position commanded for the output shaft. 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.

The input of the servo is produced by Arduino UNO in form of a PWM Signal to operate the Servos. Two Servo SG90 are used to rotate the Solar Panel on Both the Axis

5.5: Voltage regulator AMS1117:

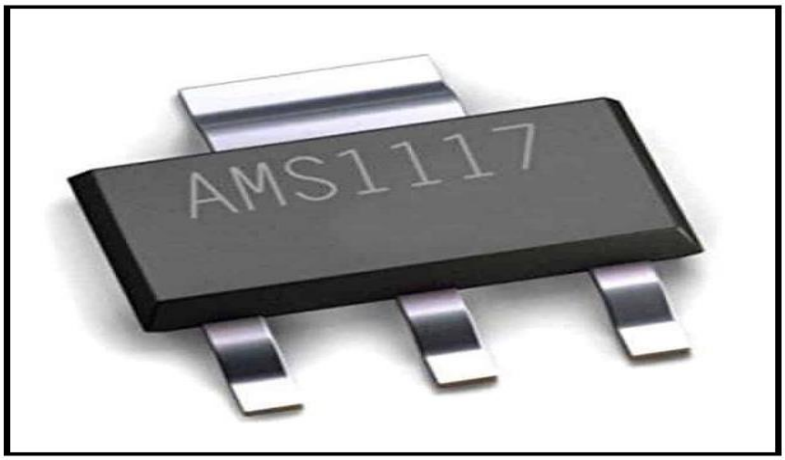


Figure 11: Voltage regulator (AMS1117)

The **AMS1117 3.3** is a popular SMD package 3 pin voltage regular that is available in many models for fixed and adjustable voltage requirements. The IC can deliver a maximum current of 1A and the output voltage can vary from1.5Vto 5V. It also has a low drop out voltage of 1.3V when operating at maximum current. The ASM1117 series of adjustable and fixed voltage regulators are designed to provide 1A output current and to operate down to 1V input-to-output differential. The dropout voltage of the device is guaranteed maximum 1.3V at maximum output current, decreasing at lower load currents. On-chip trimming adjusts the reference voltage to 1.5%. Current limit is also trimmed, minimizing the stress under overload conditions on both the regulator and power source circuitry. The ASM1117 devices are pin compatible with other three-terminal SCSI regulators and are offered in the low profile surface mount SOT-223 package, in the 8L SOIC package and in the TO-252 (DPAK) plastic package.

AMS 1117 3.3 Voltage regulator is used to power ESP8266-01 which has strict regulations on input supply of 3.3V.The input of Regulator must be +1.5V of the Output Supply. In our case, it is approximately 5V.

Features:

- Fixed/Adjustable 3-terminal Linear voltage regulator
- Fixed Voltage type: 1.5V, 1.8V, 2.5V, 2.85V, 3.3V and 5V
- Output current is 1000mA
- Maximum Drop-out Voltage: 1.3V
- In-built Current Limiting and thermal protection.
- Operating junction temperature is 125°C
- Available in SOT-223, TO-252 and SO-8 Package

Pin diagram:

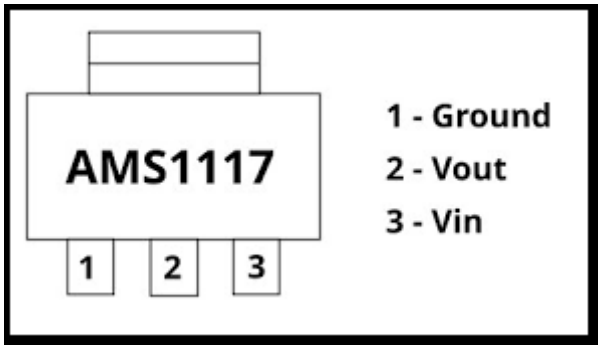


Figure 12: Pin out diagram

Pin Description:

Pin No.	Description	Mnemonic
1.	Ground	GND
2.	Output Voltage: Regulated 3.3V with 40mA source current	Vout
3.	Input Voltage: 4.5V to 7V	Vin

5.6: IC 3130D Operational amplifier:

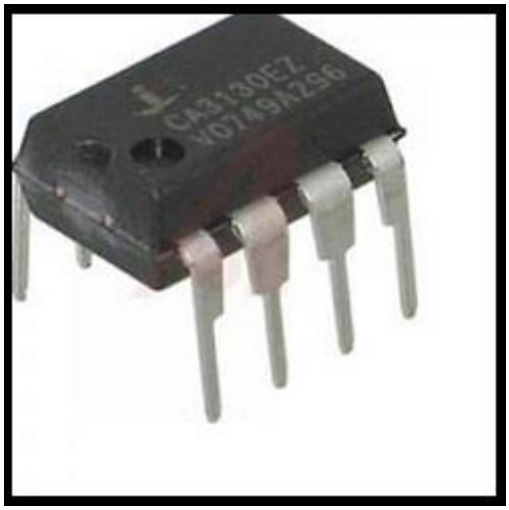


Figure 13: IC 3130D Operational amplifier

Description:

The **CA3130** is a **BiMOS Operational Amplifier with MOSFET.** The term BiMOS implies that it combines the advantage of both Bipolar and CMOS op-amp technology. Bipolar op-amps perform well under high bandwidths (fast switching) and CMOS op-amps perform well by consuming less current. So the CA3130 being a BiMOS op-amp has the advantage of high bandwidth operation and less current consumption.

T**he op-amp is built using MOSFETS** and hence it has high input impedance. Meaning, when a sensor's output voltage is connected to the inverting or non-inverting pin of the op-amp, the op-amp will not act as a load to the sensor and thus the output voltage from sensor will not be disturbed.

It is excellent Op Amp that requires very low input current requirements. Its output will be in the zero state in the off mode. CA3130 is the 15MHz BiMOS IC with MOSFET inputs and a bipolar output. MOSFET transistors are present in the inputs that provide very high input impedance. The input current can be as low as 10pA. The IC shows very high speed of performance and combines the advantage of both CMOS and bipolar transistors.

The presence of PMOS transistors at the inputs results in common mode input voltage capacity down to 0.5 volts below the negative rail. So it is ideal in single supply applications. The output has CMOS transistor pair that swings the output voltage within 10mV of either supply voltage terminal. IC CA3130 works off 5 to 16 volts and can be phase compensated with a single external capacitor. It also has terminals to adjust the offset voltage and strobing.

CA3130 Specifications:

- Op-amp coupled with MOSFET at output
- Wide power supply Range
- Input Terminal current: 1mA
- Maximum Output Voltage: 13.3V
- Maximum source current: 22mA
- Maximum sink current: 20mA
- Supply current: 10mA
- Common Mode Rejection Ration (CMRR): 80dB

Pin diagram:

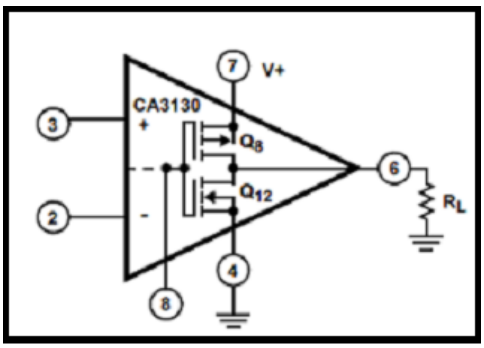


Figure 14: Pin diagram of CA3130D

Pin Description:

Pin Number	Pin Name	Description
1,5	Offset Null Pins	Optionally used to remove the offset voltage at the output pin to make it perfect 0V during off state.
2	Inverting Input (IN-)	The Inverting pin is also given a fixed voltage which is compared with the (IN+)
3	Non-Inverting Input (IN+)	The Non-Inverting Pin of the comparator is give a variable voltage to compare
4	Ground (VCC-)	This pin is connected to the ground of the system (Negative voltage can also be used)
6	Output	This is the output pin of the op-amp
7	VCC+	Provide the operating voltage for the Op-Amp. For CA3130 it is upto +16V
8	Strobe	Allows you to turn off output stage

5.7: IC 7486 (Exclusive OR Gate):

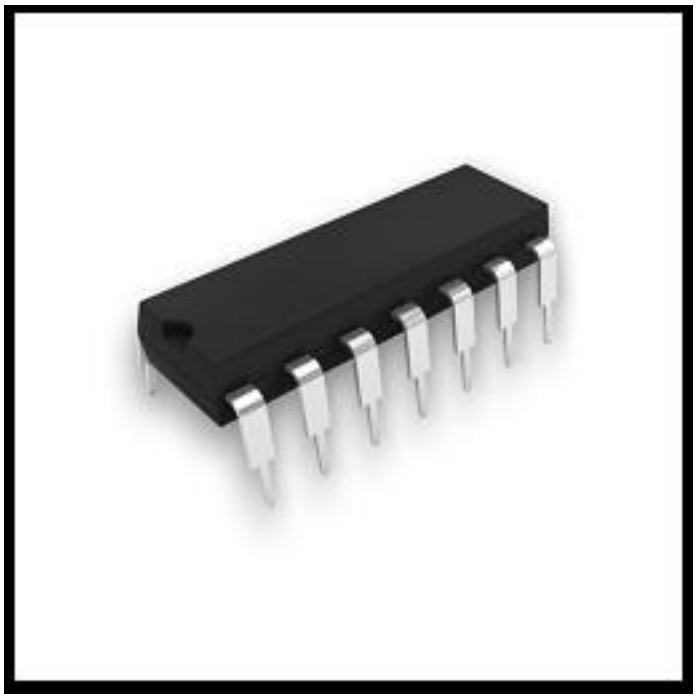


Figure 15: IC 7486 (Exclusive OR Gate)

Description:

Exclusive OR is a digital logic gate that gives a true (1 or HIGH) output when the number of true inputs is odd. An XOR gate implements an exclusive or; that is, a true output results if one, and only one, of the inputs to the gate is true. If both inputs are false (0/LOW) or both are true, a false output results. XOR represents the inequality function, i.e., the output is true if the inputs are not alike otherwise the output is false. A way to remember XOR is "one or the other but not both".

XOR can also be viewed as addition module 2. As a result, XOR gates are used to implement binary addition in computers. A half adder consists of an XOR gate and an AND gate. Other uses include subtractors, comparators, and controlled inverters.

Symbol of Ex or Gate:

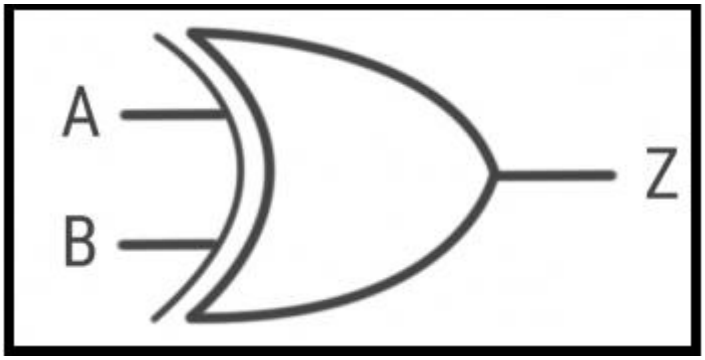


Figure 16: Exclusive OR Gate Symbol

Truth table of Ex-or gate:

Inputs		Output(Y)
A	B	
0	0	0
0	1	1
1	0	1
1	1	0

Figure 17: Truth table of ex or gate

Pin Diagram of EX-OR gate:

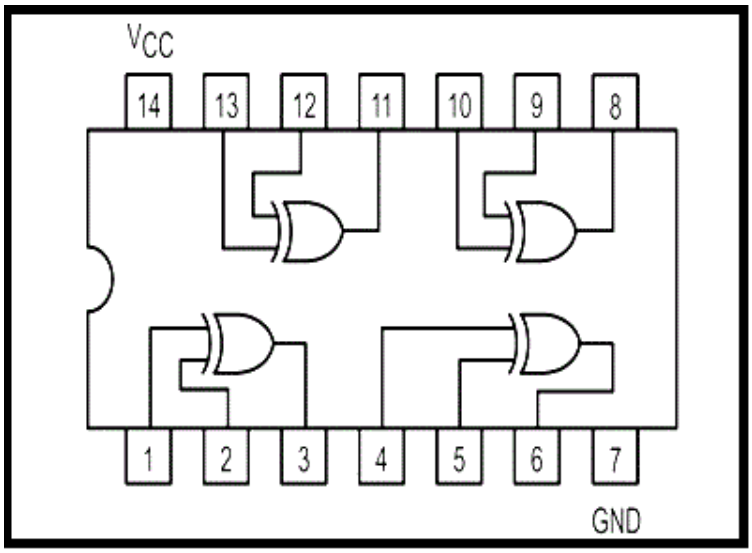


Figure 18: Pin diagram of Ex-Or Gate

Pin Description:

Pin Number	Description
1	Input Gate 1
2	Input Gate 1
3	Output Gate 1
4	Input Gate 2
5	Input Gate 2
6	Output Gate 2
7	Ground
8	Output Gate 3
9	Input Gate 3
10	Input Gate 3
11	Output Gate 4
12	Input Gate 4
13	Input Gate 4
14	Positive Supply

5.8: ESP8266-01 (WIFI MODULE):

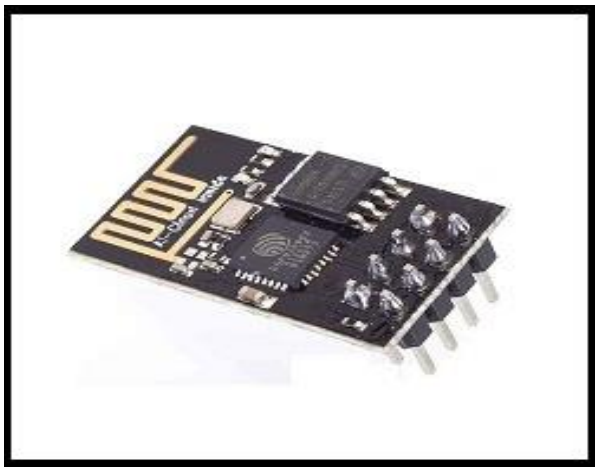


Figure 19:ESP8266 Wi-Fi Module

Description:

The ESP8266 is a low cost Wi-Fi microchip with full TCP/IP stack and microcontroller capability. The ESP8285 is an ESP8266 with 1 MB of built-in flash, allowing for single-chip devices capable of connecting to Wi-Fi.

The ESP8266 Wi-Fi Module is a self contained SOC with integrated TCP/IP protocol stack that can give any microcontroller access to your WiFi network. The ESP8266 is capable of either hosting an application or offloading all Wi-Fi networking functions from another application processor. Each ESP8266 module comes pre-programmed with an AT command set firmware, meaning, you can simply hook this up to your Arduino device and get about as much WiFi-ability as a WiFi Shield offers The ESP8266 module is an extremely cost effective board with a huge, and ever growing, community.

This module has a powerful enough on-board processing and storage capability that allows it to be integrated with the sensors and other application specific devices through its GPIOs with minimal development up-front and minimal loading during runtime.

Its high degree of on-chip integration allows for minimal external circuitry, including the front-end module, is designed to occupy minimal PCB area. The ESP8266 supports APSD for VoIP applications and Bluetooth co-existence interfaces, it contains a self-calibrated RF allowing it to work under all operating conditions, and requires no external RF parts.

ESP 8266 Wi-Fi Module is to send a message to registered mobile number via An Open source website known as ifttt.com. An Id is necessary to create a key link which when triggered will send an customizable message to registered mobile number.

Features:

- Processor: L106 32-bit RISC microprocessor core based on the Tensilica Xtensa Diamond Standard 106Micro running at 80 MHz
- Memory:
  - 32 KiB instruction RAM
  - 32 KiB instruction cache RAM
  - 80 KiB user-data RAM
  - 16 KiB ETS system-data RAM
- External QSPI flash: up to 16 MiB is supported (512 KiB to 4 MiB typically included)
- IEEE 802.11 b/g/n Wi-Fi
  - Integrated TR switch, balun, LNA, power amplifier and matching network
  - WEP or WPA/WPA2 authentication, or open networks
- 16 GPIO pins
- SPI
- I^2C (software implementation)
- I^2S interfaces with DMA (sharing pins with GPIO)
- UART on dedicated pins, plus a transmit-only UART can be enabled on GPIO2
- 10-bit ADC (successive approximation ADC)

Pin Out of ESP8266:

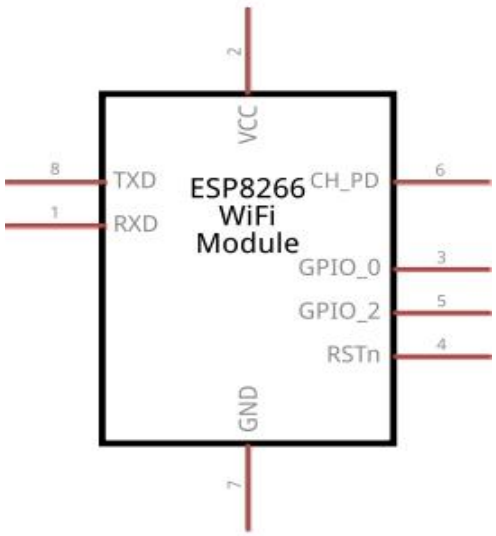


Figure 20:Pinout of ESP8266

Pin Description:

The pinout is as follows for the common ESP-01 module:

PIN	DESCRIPTION
1	VCC, Voltage (+3.3 V; up to 3.6 V)
2	GND, Ground (0 V)
3	RX, Receive data bit X
4	TX, Transmit data bit X
5	CH_PD, Chip power-down
6	RST, Reset
7	GPIO 0, General-purpose i/o No. 0
8	GPIO 2, General-purpose i/o No. 2

5.9: 9V Battery:

Figure 21(a): 9V Battery

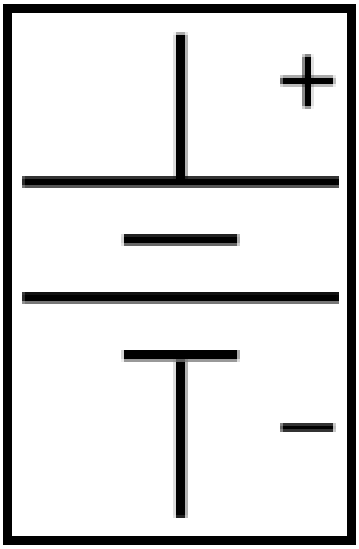


Figure 21 (b): Battery Symbol

Description:

An electrical battery is a combination of one or more electrochemical cells, used to convert stored chemical energy into electrical energy. The battery has become a common power source for many household and industrial applications. It is used to power up the Arduino board.

Batteries may be used once and discarded, or recharged for years as in standby power applications. Miniature cells are used to power devices such as hearing aids and wristwatches; larger batteries provide standby power for telephone exchanges or computer data centers. A battery is a device consisting of one or more electrochemical cells with external connections provided to power electrical devices such as flashlights, mobile phones, and electric cars. When a battery is supplying electric power, its positive terminal is the cathode and its negative terminal is the anode. The terminal marked negative is the source of electrons that will flow through an external electric circuit to the positive terminal.

5.10: Center tapped Transfromer:

Figure 22: Center tapped transfromer

Description:

A **centre-tapped transformer** also known as **two phase three wire transformer** is normally used for rectifier circuits. When a digital project has to work with AC mains a Transformer is used to step-down the voltage (in our case, to 24V or 12V) and then convert it to DC by using a rectifier circuit. In a center-tapped transformer the peak inverse voltage is twice as in bridge rectifier hence this transformer is commonly used in full wave rectifier circuits.

The operation and theory behind a Center tapped transformer is very similar to a normal secondary transformer. A primary voltage will be induced in the primary coil (I1 and I3) and due to magnetic induction the voltage will be transferred to the secondary coil. Here in the secondary coil of a centre tapped transformer, there will be an additional wire (T2) which will be placed exactly at the center of the secondary coil, hence the voltage here will always be zero.

If we combine this zero potential wire (T2) with either T1 or T2, we will get a voltage of 12V AC. If this wire is ignored and voltage across T1 and T2 is considered then we will get a voltage of 24V AC. This feature is very useful for the function of a full wave rectifier.

- **Features :**

- Step-down Centre tapped Transformer
- Input Voltage: 220V AC at 50Hz
- Output Voltage:12V ,0V
- Output Current: 1A
- Vertical mount type
- Low cost and small package

- **Transformer wiring terminals:**

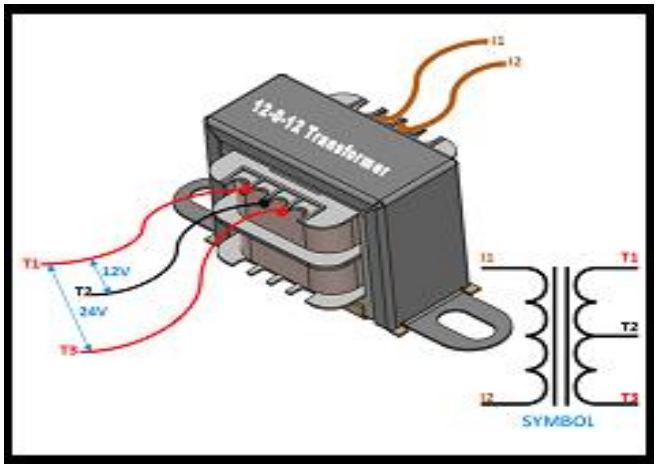


Figure 23: Terminals of a Center tapped transformer

- **Transformer terminal description:**

No:	Terminal Name	Description
1	I1 and I2	These are the input wires for the transformer, it is connected to the phase and neutral of AC mains
2	T1 and T3	There are the output terminals of the Transformer, the voltage across it will be 24V AC
3	T2	This is the centre tapped wire of the transformer; this wire can be combined with either T1 or T3 to get 12V AC across it. It's very useful for rectifier circuits

5.10: Full Wave Rectifier:

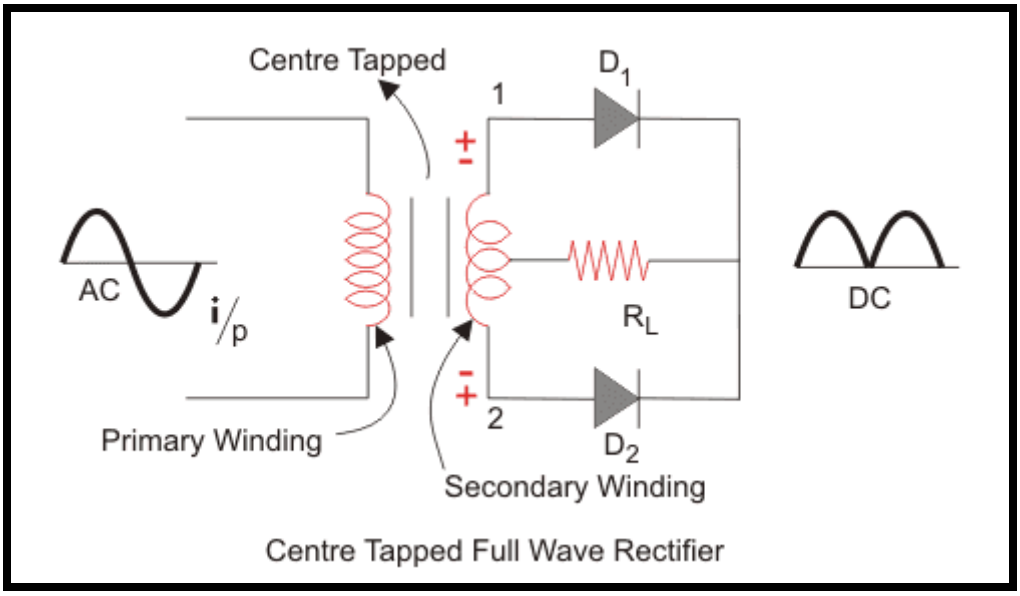


Figure 24: Full Wave Centre Tapped Rectifier

Description:

A Full Wave Rectifier is a circuit, which converts an ac voltage into a pulsating dc voltage using both half cycles of the applied ac voltage. It uses two diodes of which one conducts during one half cycle while the other conducts during the other half cycle of the applied ac voltage.

During the positive half cycle of the input voltage, diode D1 becomes forward biased and D2 becomes reverse biased. Hence D1 conducts and D2 remains OFF. The load current flows through D1 and the voltage drop across R_L will be equal to the input voltage.

During the negative half cycle of the input voltage, diode D1 becomes reverse biased and D2 becomes forward biased. Hence D1 remains OFF and D2 conducts. The load current flows through D2 and the voltage drop across R_L will be equal to the input voltage.

To Get a pure DC output with freq=0 from the Full wave Rectifier circuit we have to use a Filter Circuit which usually consists of:

- Series Inductor
- Shunt Capacitor
- LC Circuit
- CLC Circuit (π Filter)

5.11: Shunt Capacitor Filter:

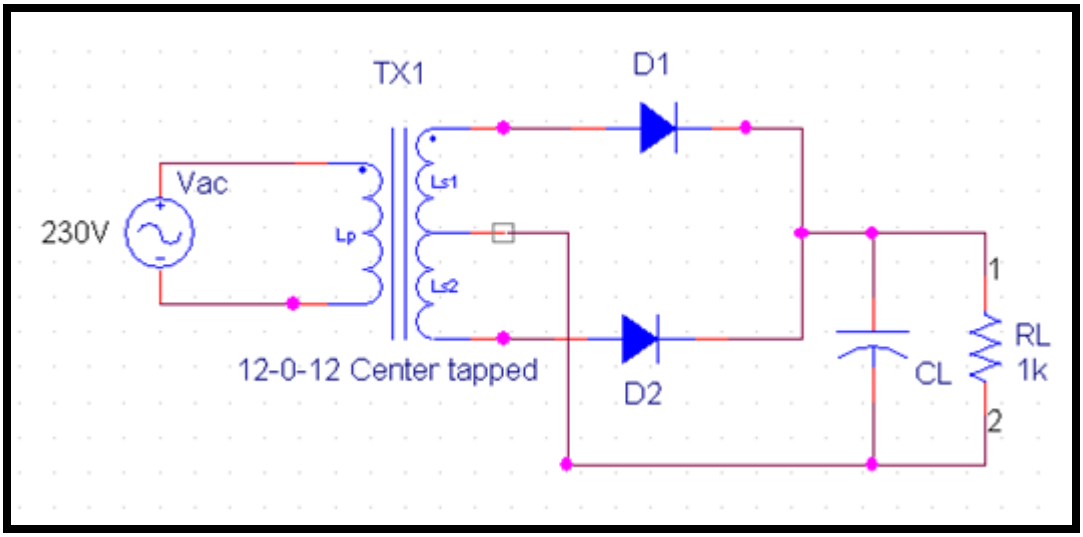


Figure 25: Full Wave Centre Tapped Rectifier with Filter

During the complete sinusoidal input cycle, the output of the center tapped rectifier repeat itself twice. In other words, the time-period of the output is π instead of 2π.

An Electrolytic Capacitor with value 470uF is used as Filter.

And the effect of Capacitor used as filter will be to smooth out the DC waveform into a constant DC. Therefore, the average of the output waveform will be:

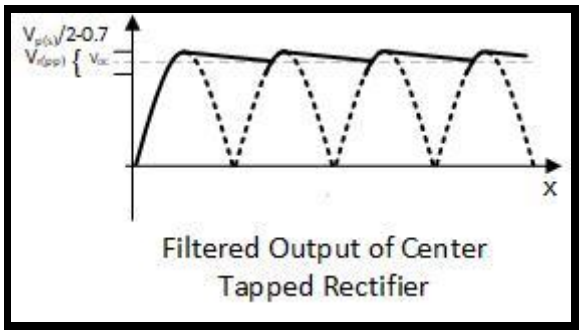


Figure 26: Output Waveform of

Full Wave Centre Tapped Rectifier with Filter

5.12: Relays:

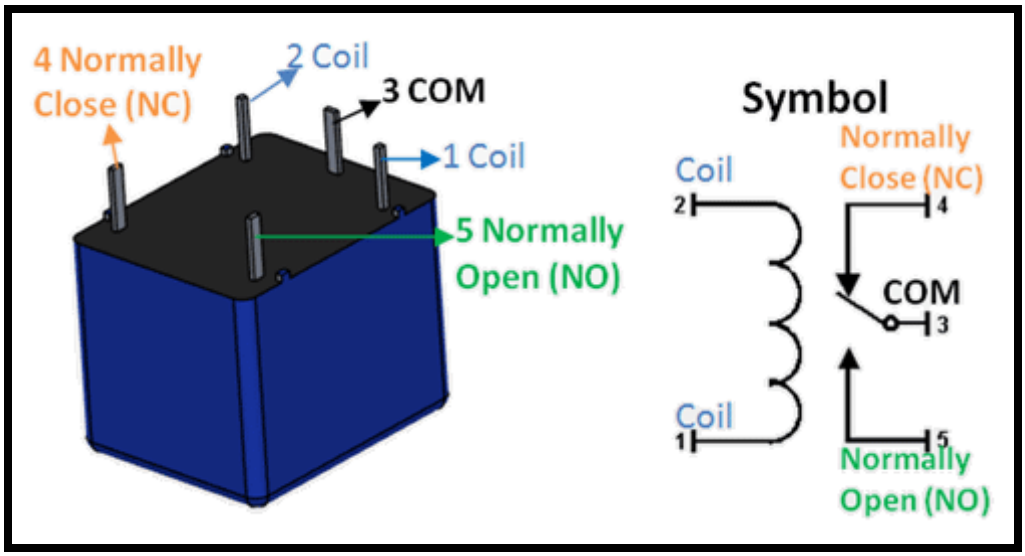


Figure 27: 12V Relay

A relay is an electrically operated switch. It consists of a set of input terminals for a single or multiple control signals, and a set of operating contact terminals. The switch may have any number of contacts in multiple contact forms, such as make contacts, break contacts, or combinations thereof.

Relays are used where it is necessary to control a circuit by an independent low-power signal, or where several circuits must be controlled by one signal. Relays were first used in long-distance telegraph circuits as signal repeaters: they refresh the signal coming in from one circuit by transmitting it on another circuit. Relays were used extensively in telephone exchanges and early computers to perform logical operations.

The traditional form of a relay uses an electromagnet to close or open the contacts, but other operating principles have been invented, such as in solid-state relays which use semiconductor properties for control without relying on moving parts.

Chapter No.6

Features:

6. Features:

6.1: Solar Hybrid Converter:

Efficiency of a solar converting system depends on the weather conditions. Usually the solar panel gets four to five hours of bright sunlight in a day. If the weather is cloudy or rainy, it affects the charging process and the battery does not attain full charge. This simple hybrid solar converter can solve the problem as it can charge the battery or load using both solar power as well as AC mains supply.

When output from the solar panel is above 12 volts, the battery charges using the solar power. When the output drops below 12 volts, the battery charges through AC mains supply.

6.2: Dual Axis Sun tracking System:

The proposed system consists of ATmega328 micro controller, Solar panel, Light Dependent resistors and Servo Motor. The position of the Sun with respect to the solar panel is not fixed due to the rotation of the Earth. For an efficient usage of the solar energy, the Solar panels should absorb energy to a maximum extent. This can be done only if the panels are continuously placed towards the direction of the Sun. So, solar panel should continuously rotate in the direction of Sun.

6.3: Automated Error detection:

This system consists of an Ex-or gate, ESP8266 WIFI MODULE and Voltage Regulator. The inputs to the Ex-or gate are from Arduino Uno and output of Ex-or gate is connected to input terminal of voltage regulator ASM1117.The GND pin of ESP8266 is Grounded along with GND of Arduino board. The output of Voltage regulator i.e. 3.3V is connected to terminal CH_PD and Vcc of ESP8266 Wi-Fi Module. Message is sent to registered mobile number via an Open Source website known as Ifttt.com.

Chapter No.7

Advantages and Disadvantages:

7(a). Advantages:

I. Load is continuously ON.
II. No visible fluctuations will occur while switching from solar power to AC supply or vice versa.
III. Error detection.
IV. Maximum Efficiency if solar panel is perpendicular to sun rays.
V. Real time feedback via ESP8266.
VI. No man power needed to monitor and control.
VII. The solar energy can be used as it is renewable energy resource.
VIII. This also saves money as there is no need to pay for energy used (excluding the initial setup cost).
IX. Helps in maximizing the solar energy absorption by continuously tracking the sun via Dual Axis Sun Tracker.

7(b). Disadvantages:

I. Heating of Transformer Overtime due to continuous Operation.

II. Expensive One-time Cost.

III. Though solar energy can be utilized to maximum extent this may not be as effective alternative and cause problems in rainy season.

IV. Although solar energy can be saved to batteries, they are heavy and occupy more space and required to change time to time.

Chapter No.8

External Hardware/Software Requirements:

8. External Hardware/Software Requirements:

8.1: Introduction to Eagle software:

EAGLE is a scriptable electronic design automation (EDA) application with schematic capture, printed circuit board (PCB) layout, auto-router and computer-aided manufacturing (CAM) features. EAGLE stands for Easily Applicable Graphical Layout Editor.

EAGLE contains a schematic editor, for designing circuit diagrams. Schematics are stored in files with .SCH extension; parts are defined in device libraries with .LBR extension. Parts can be placed on many sheets and connected together through ports.

The PCB layout editor stores board files with the extension .BRD. It allows back-annotation to the schematic and auto-routing to automatically connect traces based on the connections defined in the schematic.

EAGLE saves Gerber and PostScript layout files as well as Excellon and Sieb & Meyer drill files. These are standard file formats accepted by PCB fabrication companies, but given EAGLE's typical user base of small design firms and hobbyists, many PCB fabricators and assembly shops also accept EAGLE board files (with extension .BRD) directly to export optimized production files and pick-and-place data themselves.

EAGLE provides a multi-window graphical user interface and menu system for editing, project management and to customize the interface and design parameters. The system can be controlled via mouse, keyboard hotkeys or by entering specific commands at an embedded command line. Multiple repeating commands can be combined into script files (with file extension .SCR). It is also possible to explore design files utilizing an EAGLE-specific object-oriented programming language (with extension .ULP).

8.2: Introduction to Adruino IDE:

Arduino board is a simple and easy to use electronic prototyping platform. The cool thing about Arduino hardware is that it's been provided with free Arduino IDE, code libraries and plenty of example projects. Also, we would not have to care much about driver installation. It will be managed by IDE itself while installing Arduino IDE. It has ATmega328 as a central processing unit and few components on board.

The Arduino integrated development environment (IDE) is a cross-platform application (for Windows, macOS, Linux) that is written in the programming language Java. It is used to write and upload programs to Arduino compatible boards, but also, with the help of 3rd party cores, other vendor development boards.

The source code for the IDE is released under the GNU General Public License, version 2. The Arduino IDE supports the languages C and C++ using special rules of code structuring. The Arduino IDE supplies a software library from the Wiring project, which provides many common input and output procedures. User-written code only requires two basic functions, for starting the sketch and the main program loop, that are compiled and linked with a program stub main() into an executable cyclic executive program with the GNU toolchain, also included with the IDE distribution. The Arduino IDE employs the program avrdude to convert the executable code into a text file in hexadecimal encoding that is loaded into the Arduino board by a loader program in the board's firmware.

Technical specifications of ATmega328P on Arduino UNO R3:

- Microcontroller: Microchip ATmega328P
- Operating Voltage: 5 Volts
- Input Voltage: 7 to 20 Volts
- Digital I/O Pins: 14 (of which 6 provide PWM output)
- Analog Input Pins: 6
- DC Current per I/O Pin: 20 mA
- DC Current for 3.3V Pin: 50 mA
- Flash Memory: 32 KB
- SRAM: 2 KB
- EEPROM: 1 KB
- Clock Speed: 16 MHz

Chapter No.9

Conclusion:

9. Conclusion:

As the Non-renewable energy resources are decreasing, use of renewable resources for producing electricity is increasing. Solar panels are becoming more popular day by day. Solar panel absorbs the energy from the Sun, converts it into electrical energy and stores the energy in a battery. This energy can be utilized when required or can be used as a direct alternative to the grid supply. Utilization of the energy stored in batteries is mentioned in below given applications. The position of the Sun with respect to the solar panel is not fixed due to the rotation of the Earth. For an efficient usage of the solar energy, the Solar panels should absorb energy to a maximum extent. This can be done only if the panels are continuously placed towards the direction of the Sun. So, solar panel should continuously rotate in the direction of Sun. Automated error detections will not require any man power to monitor and control.

Thus the project "**Hybrid Solar Converter with LDR Automation and Automated Error Detection**" is useful in all aspects.

Chapter No.10

Future Scope and Application:

10. Future Scope and applications:

The project "**Hybrid Solar Converter with LDR Automation**" is designed for use in developing countries. Automated error detection is our own idea. This project can further be developed by adding more features and making it cost effective so that a common man can use it. This project will lead to increase in technological trends and this will help the people in many ways. The technological changes can be made by saving electricity by using solar power. The electricity which is saved can be used in street lights in the areas where there is shortage.

Applications:

- These panels can be used to power the traffic lights and streetlights.
- These can be used in home to power the appliances using solar power and AC supply as a Backup.
- These can be used in large industries as more energy can be saved by making the panel perpendicular to the Sun light.

11. Reference:

- www.arduino.cc
- www.ifttt.com
- www.circuitdigest.com
- www.esp8266.net
- www.electronicshub.org