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Design of Solar Canopy With Multiple Applications

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Abstract: Solar Canopy are starting to become more popular for people taking advantage of existing outdoor parking spaces to generate their energy needs. Solar canopies are renewable source of energy which is used for multiple purpose. A solar canopy is a structure lined with solar panels on top where you can park your car underneath. The electricity from the solar panels feed the energy to your home and it can also be used in industrial areas, just the same way as if you had the panels mounted on your roof. You can link the solar carport to a car charging unit, facilitating the process and eliminating regular power from your electric car system. Just with some changes in design we can harvest rain water, later on the harvested rain water can be used for car washing, solar panel cleaning and for drinking by purifying it.
The savings in your electricity bills will finance the entire purchase and installation of the canopy. It will also increase to your home value when it comes time to sell in terms of aesthetic and energy savings for prospective buyers. Whatever structure is right for you, a carport or canopy, an experienced solar installer can help you in setting them up.

1. Introduction

The world is constantly looking for more sustainable sources of energy, and the latest development in this effort to reduce our dependence on fossil fuels is the solar panel canopy. Solar canopies are a revolutionary way to bring renewable energy production into the public spaces we use every day, such as parking lots. By taking advantage of cc space, solar canopies harness the power of the sun to generate electricity.
Solar panel canopies are rapidly becoming popular for businesses and public places to take advantage of the sun's rays to power their vehicles. As more people become aware of the potential benefits that these solar canopies offer, there is growing interest in how they will shape the future of modern parking lots.

1.2 What is Solar Panel Canopy?

Commercial solar parking canopies are typically seen in malls and other locations with lots of parking, as was already indicated. Customers are given a shaded parking space and protection from the elements thanks to solar-powered canopies for parking spaces.
The carport, also known as a canopy, is an excellent place for a charging station and will protect the automobile or truck. A business owner or industrialist might decide to add a solar panel canopy to their existing solar array or choose a solar parking canopy instead of a roof or ground mount installation.

1.3 Need for Solar Canopy

The world is constantly looking for more sustainable sources of energy, and the latest development in this effort to reduce our dependence on fossil fuels is the solar panel canopy. Solar canopies are a revolutionary way to bring renewable energy production into the public spaces we use every day, such as parking lots. By taking advantage of unused space, solar canopies harness the power of the sun to generate electricity.
Solar panel canopies are rapidly becoming popular for businesses and public places to take advantage of the sun's rays to power their vehicles. As more people become aware of the potential benefits that these solar canopies offer, there is growing interest in how they will shape the future of modern parking lots.

2. Design

There are several researches on the enhancement of solar energy technology and the efficiency of solar battery chargers among whom are who analyses ways to increase the solar photovoltaic energy capture on sunny and cloudy days. a 12 volts batteries charger using a solar panel of 12 volts, but his circuit does not have indicators to show when it is fully charged. Worked on an automatic solar battery charger circuit that has the capacity to charge lead- acid batteries of 6v to 24volts but without a heat sink to absorb excess heat. Built a solar battery charger for 12 volts lead acid batteries using components like the Schottky diode combined with a Field Effect Transistor (FET) and some passive components. The charger stops charging once the pre-set voltage has been reached and commences charging when the voltage has dropped off sufficiently. It uses less than 0.5mA when using comparators, and burns less than 20mW of power in FETs when charging at 0.5A.

Constructed an electronic control circuit for a 6v and 12volts solar battery charging circuit. Used a solar panel of 12 volt and an Op-Amp as a shunt regulator to construct a 12-volt battery solar charger. Implemented a solar panel of 12 volts with an LM 317T IC as a voltage regulator, and a Schottky diode to prevent the discharging of the battery, a potentiometer for voltage adjustment, but added a 1N4007 diode to construct a solar battery charger for 6 volts lead acid battery.

2.1 Block Diagram

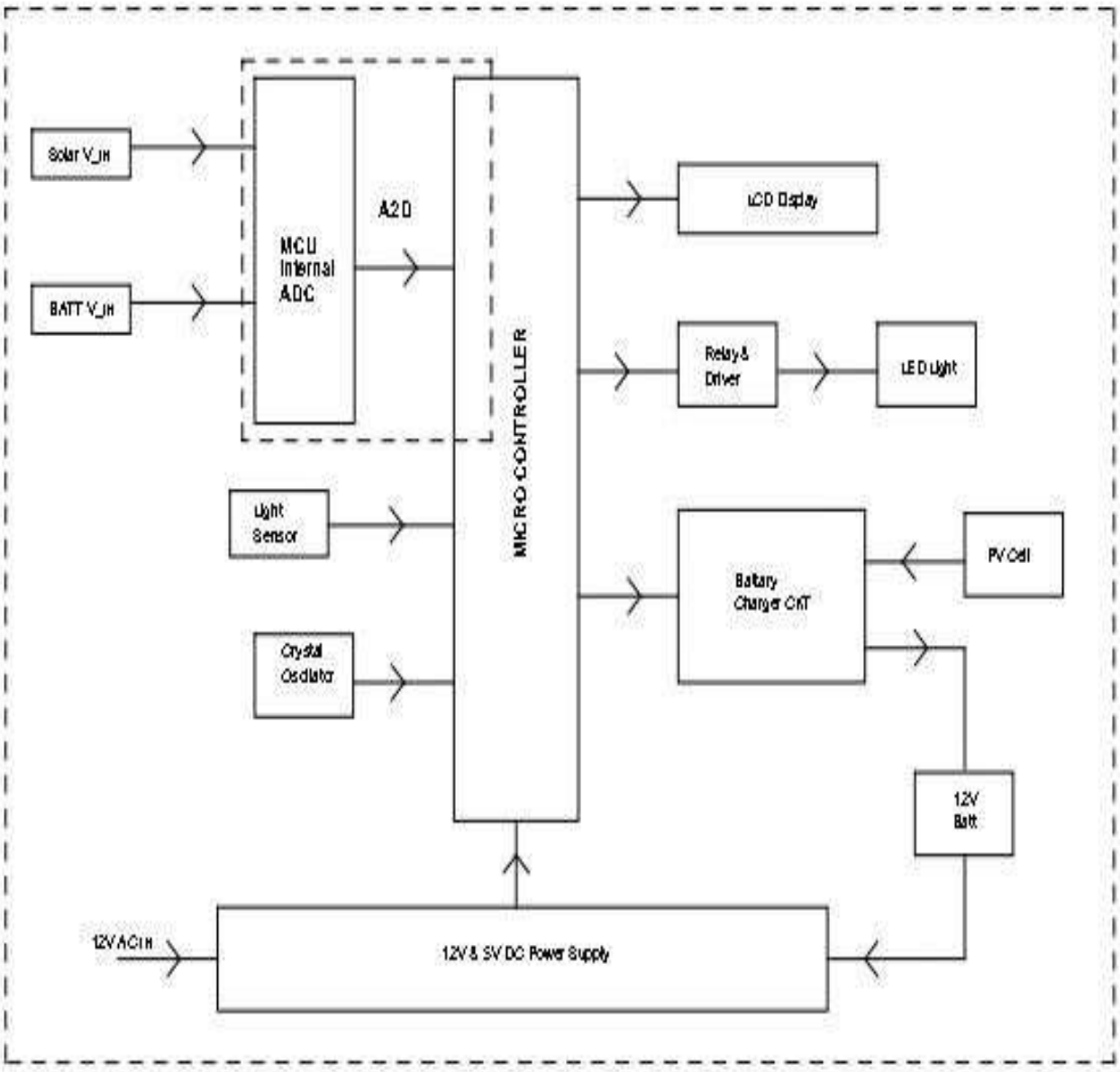


Fig. 2.1 Block Diagram

2.2 Circuit Diagram

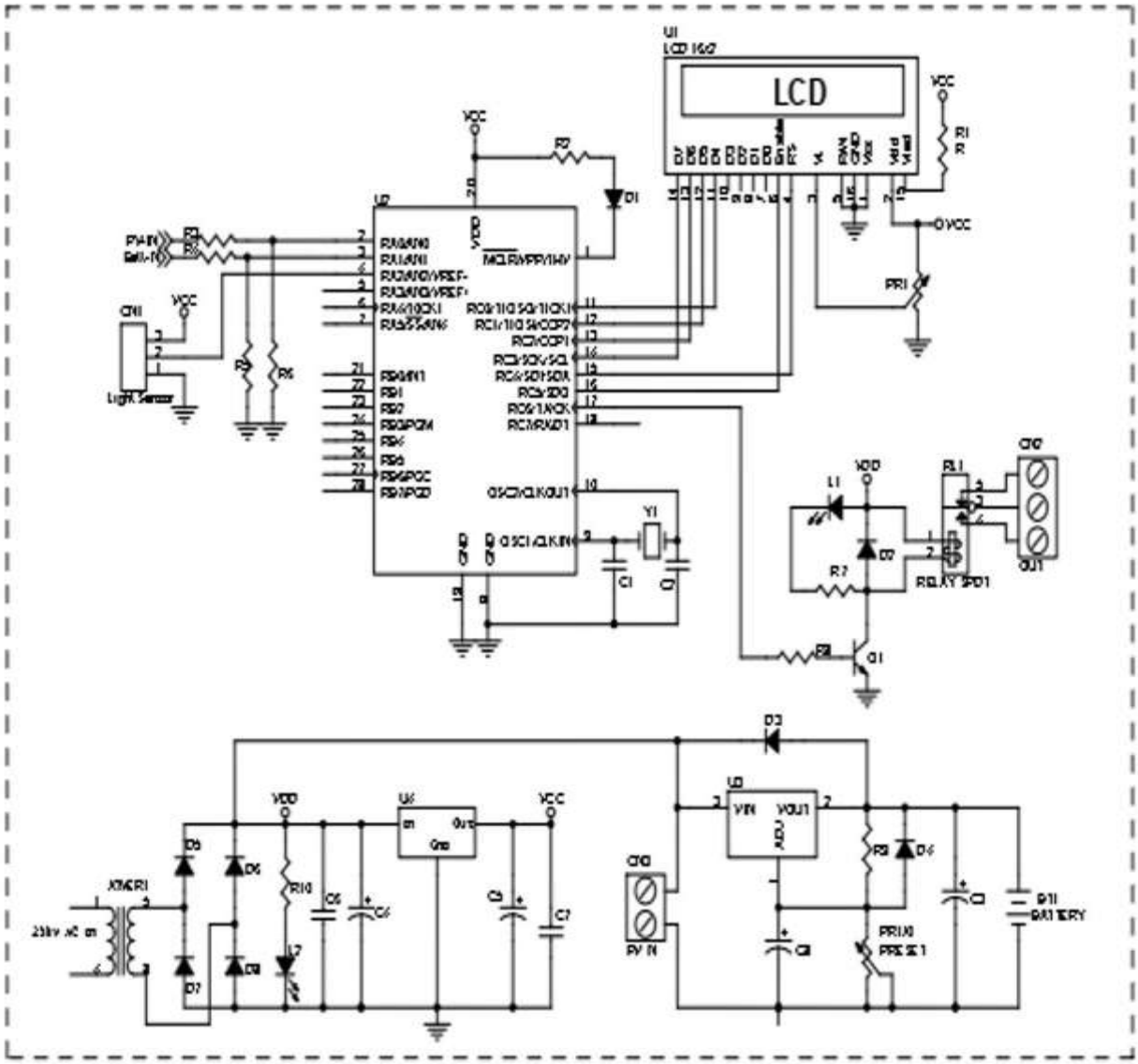


Fig. 2.2 Circuit Diagram

3. Programming

```
Include PIC16F88x.Lib
Include LCD.Lib
Include ADC.lib
Include variable.lib

Define Osc 4

Define     RLY     PORTB.0
Define     LDR     PORTB.1

DelayMS 1500


    Cls
    Print,1, "SOLAR & RAIN"
    Print,2, "HARWESTING SYS"
    DelayMS 30
```

```
Main:

    GoSub Read_ADC

    If RLY = 1 Then
      Str Msg = "ON "
    Else
     Str Msg = "OFF"
    EndIf

    Print,1, "PV=", VOLT, ".", VOLT/10
    Print,2, "LIGHT STS:", Msg\3
    DelayMS 100

    If LDR = 0 Then
        RLY = 1
         DelayMS 1000
    EndIf

    If LDR = 1 Then
      If RLY = 1 Then
        If Temp > 30 Then
          RLY = 0
          DelayMS 100
        Else
          Temp = Temp + 1
        EndIf
      EndIf
    EndIf
  Wend
GoTo Main

Read_ADC:
  VOLT = ADIn 0
  DelayMS 10
Return
```

4. Working Principle

4.1 Micro controller

The project is based on a pre-programmed PIC micro controller. The complete system divided in different sections. Analog sensor interfacing, Digital Sensor interfacing, relay Control, and LCD Display section.

The circuit used in this kit uses only one IC – the PIC. It is one of the RISC architectures Based high-performance flash micro controllers from MICROCHIP. The IC is preprogramed. Using a micro controller greatly reduces the component count while providing more features than could be found using dedicated logic ICs. Cost is also lower. It is pre-programmed with software to provide all the timing functions.

PIC is an 8-bit, low-cost, high-performance flash micro controller. Its key features are 8k words of flash program memory, 192 bytes of data RAM, eleven interrupts, three I/O ports, 10-bit ADC and only 35 powerful single- cycle instructions (each 14-bit wide). The ADC simplifies the overall embedded system design by providing a direct interface for voltage temperature, pressure, motion, and other sensors.

4.2 MCU Clock

A 4 MHz crystal provides accurate timing and an easily divisible clock source for the internal hardware timers. This high frequency clock source is used to control the sequencing of CPU instruction.

4.3 LCD INTERFACE

The dot-matrix liquid crystal display controller and driver LSI displays alphanumeric, characters, and symbols. It can be configured to drive a dot-matrix liquid crystal display under the control of a 4 or 8-bit microprocessor. Since all the functions such as display RAM, character generator, and liquid crystal driver, required for driving a dot-matrix liquid crystal display are internally provided on one chip, a minimal system can be interfaced with this controller/driver. A single HD44780U can display up to two 8-character lines (16 x 2).

Data transfer between the MCU and the LCD module will occur in the 4-bit mode. The R/W pin (5) of the LCD module is permanently grounded as there will not be any data read from the LCD module. MCU port pin 14 ~ 19 serves the 4-bit data lines (D4-D7, pins 11-14) of the LCD module. Control lines, RS and E, are connected to 14 and 15. Thus, altogether 6 I/O pins of the microcontrollers are used by the LCD module. The contrast adjustment is done with a 20K preset (potentiometer) as shown below. If your LCD module has backlight LED, use a 22Ω resistance in series with the pin 15 or 16 to limit the current through the LED. The detail of the circuit diagram is shown below.

4.4 Solar & battery voltage measuring

See the functional block diagram of digital volt meter. The input voltage ranging from 0 - 35V is scaled down to the output Va = 0 - 5V using resistor divider network circuits. That is applied to the micro controller internal ADC Input. The analogue signal is converted into digital format by the inbuilt analogue-to-digital converter (ADC) of the micro controller. Doing some math with ADC conversion, this number can be converted to the actual measured voltage. The voltage is displayed on three-digit seven segment LED display.

You cannot feed a 35V signal directly to a PIC microcontroller's ADC input channel. It is too higher than its operating voltage, and the microcontroller could be damaged. So, first we need a voltage scalar that will scale down the input voltage to the safe operating voltage range of PIC MCU. It can be achieved by a simple resistor divider network shown below.

4.5 Voltage divider

The I/P voltage ranging from VIN = 0 - 35V is scaled down to the output Va = 0 - 5V

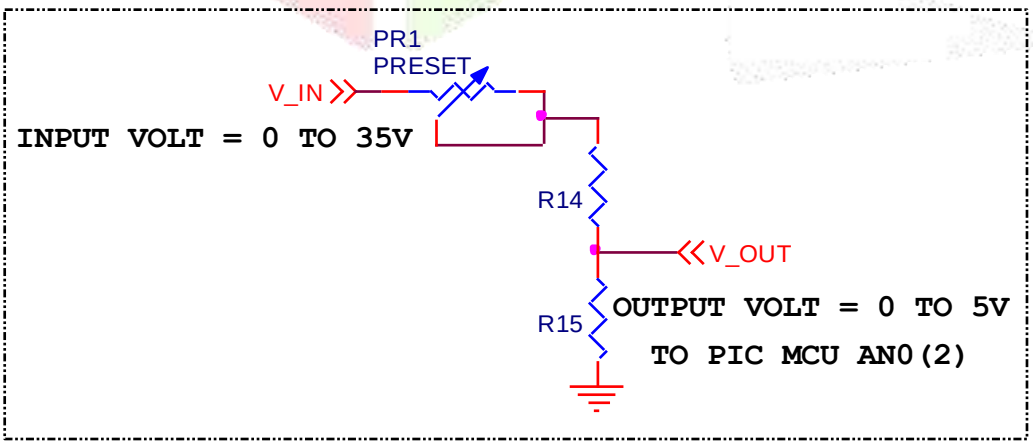


Fig. 4.1 Voltage Divider Circuitry

resistors, R14 and R15, the input voltage ranging from 0-35V can be down converted to 0-5V. For the chosen values of R1 and R2, you can see that the output (Va) from the resistor divider network is 1/4th of the input voltage. If the input voltage goes beyond 35V, Va will exceed 5V, and this could be harmful for the PIC microcontroller. This will protect the microcontroller from any possible damage due to high voltage input.

The voltage Va will go to AN0 (pin 2) channel of the PIC microcontroller. The rest of the circuit is shown below.

4.6 Analog to Digital Converter (ADC)

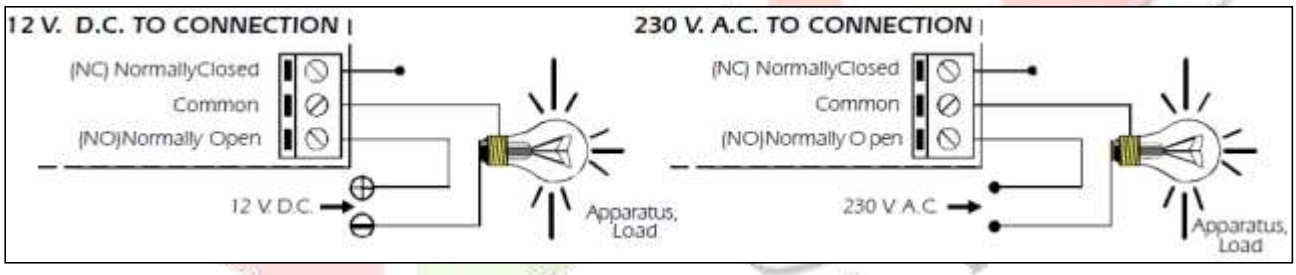
An ADC is an electronic device that converts an input analog voltage or current to a digital number proportional to the magnitude of the voltage or current.

We need to do some math related to AD conversion. You know that any application that uses analog-to-digital converters (ADCs), requires a fixed reference voltage to provide accurate digital count for input analog signal. If the reference voltage is not stable, the ADC output is meaningless. In this project, the reference voltage for ADC operation is selected to be Vdd (= +5 V). Therefore, the ADC will convert any input voltage between 0-5 V in to a digital count between 0-1023. A major source of error in this project is the accuracy of R14 and R15 resistors. You are recommended not to use the rated values of the resistors. Rather measure their values with a good quality digital multi meter, and use those values for your calculation.

4.7 RELAY INTERFACE

A single pole dabble throw (SPDT) relay is connected to port RB0 of the micro controller through a driver transistor (Q1). The relay requires 12 volts at a current of around 100 ma, which cannot provided by the micro controller. So, the driver transistor is added. The relay is used to operate external electronic lock, or any other electrical device ETC. Normally the relay remains off. As soon as pin of the micro controller goes high, the relay operates. When the relay operates and releases. Diode D6 is the standard diode on a mechanical relay to prevent back EMF from damaging Q2 when the relay releases. LED L2 indicates relay is operated. LED has a current limiting resistor in series. The LED / resistor combination is simply in parallel with the relay.

4.8 HOW to Connect Load with Relay?



The output of the projects is controlled by a relay, allowing any load until 230V AC / 3 Amp. as maximum consumption. The relay has 3 output terminals the normally open at quiescent (NO), the normally closed at quiescent (NC) and the common. The operating of this mechanism is the same as a switch with two (2) terminals NO and common, if you wish that the output will be activated during the timer, or between the NC and the common to obtain the reverse operating. In the drawing, you could appreciate the typical connection for a device operating at 12 VDC and to operate at 230 VAC.

When the project is working and according to its load, it could happen an incorrect operating of the output. If it is the case, you have to install a circuit between 2 relay's contacts used for the connection. See the drawing map.

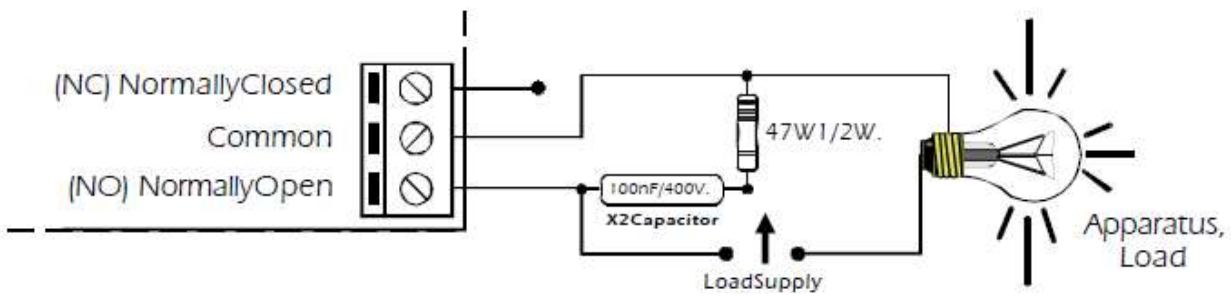


Fig. 4.2 Connection of Relay

4.9 External Outputs

Output (CN1 to CN4), Its controlled by a 12V SPDT relay and can switch up to 230V AC/DC This is more than enough for all common signal sources such as electronic lock, door strike, motor light or any other appliances.

4.10 POWER SUPPLY

The power supply circuit. It is based on 3 terminal voltage regulators, which provide the required regulated +5V and unregulated +12V.

Power is delivered initially from standard 12V AC/DC adapter or 12V_1000ma Transformer. This is fed to bridge rectifier the output of which is then filtered using 1000uf electrolytic capacitor and fed to voltage regulator. Regulator IC +5V output powers the micro controller and other logic circuitry. LED and its associate 1K current limiting resistors provide power indication. The unregulated voltage of approximately 12V is required for relay, and Relay Driver circuit.

4.11 Light Sensor

LDR sensor module is a low-cost digital sensor as well as analog sensor module, which is capable to measure and detect light intensity. This sensor also is known as the Photoresistor sensor. This sensor has an onboard LDR (Light Dependent Resistor), that helps it to detect light. This sensor module comes with 4 terminals. Where the “DO” pin is a digital output pin and the “AO” pin is an analog output pin. The output of the module goes high in the absence of light and it becomes low in the presence of light. The sensitivity of the sensor can be adjusted using the onboard potentiometer. The LDR sensor module consists mainly of the LDR, LM358 Comparators, Variable Resistor (Trim pot), output LED.

6. Conclusion:

- Efficient use of space – adding additional uses to the same square footage of space.
- Protecting people from the elements.
- Providing shade to pedestrians and autos – beyond the comfort aspect of shade to pedestrians and cooler cars, the shade also provides an improvement to the fuel economy of the car by reducing the need for heavy air conditioning use.
- Canopies can be angled for maximum production, whereas rooftop solar installations are limited by the characteristics of the roof on which it is installed.
- Provides an alternative to rooftop solar panels if a roof is unable to host solar panels or if the property’s electricity needs are large to support a rooftop solar system

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