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# Solar Energy Measurement System

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**ABSTRACT**

*The aim of this project is to measure solar cell parameters through multiple sensor data acquisition. In this project, a solar panel is used which keeps monitoring the sunlight. Here, different parameters of the solar panel like the light intensity, voltage, current and the temperature are monitored. The microcontroller used here is PIC16F8 family. The light intensity is monitored using an LDR sensor, voltage by voltage divider principle, current by current sensor and temperature by temperature sensor. All these data are displayed on a 16X2 LCD interfaced to PIC microcontroller. The power supply consists of a step down transformer 230/12V, which steps down the voltage to 12V AC. This is converted to DC using a bridge rectifier. The ripples are removed using a capacitive filter and it is then regulated to +5V using a voltage regulator 7805 which is required for the operation of microcontroller and other circuits.*

**Introduction**

This project is designed to measure an energy of solar panels. In this project, you will get an idea how to measure solar energy using different sensors and pic microcontroller.

**What is Embedded System?**

An Embedded System is a combination of computer hardware and software, and perhaps additional mechanical or other parts, designed to perform a specific function. An embedded system is a microcontroller-based, software driven, reliable, real-time control system, autonomous, or human or network interactive, operating on diverse physical variables and in diverse environments and sold into a competitive and cost conscious market.

An embedded system is not a computer system that is used primarily for processing, not a software system on PC or UNIX, not a traditional business or scientific application. High-end embedded & lower end embedded systems. High-end embedded system - Generally 32, 64 Bit Controllers used with OS. Examples Personal Digital Assistant and Mobile phones etc .Lower end embedded systems - Generally 8,16 Bit Controllers used with an minimal operating systems and hardware layout designed for the specific purpose. Examples Small controllers and devices in our everyday life like Washing Machine, Microwave Ovens, where they are embedded in.

**Characteristics of Embedded System :**

- An embedded system is any computer system hidden inside a product other than a computer.
- They will encounter a number of difficulties when writing embedded system software in addition to those we encounter when we write applications
  - Throughput : Our system may need to handle a lot of data in a short period of time.
  - Response : Our system may need to react to events quickly
  - Testability : Setting up equipment to test embedded software can be difficult
  - Debugability : Without a screen or a keyboard, finding out what the software is doing wrong (other than not working) is a troublesome problem

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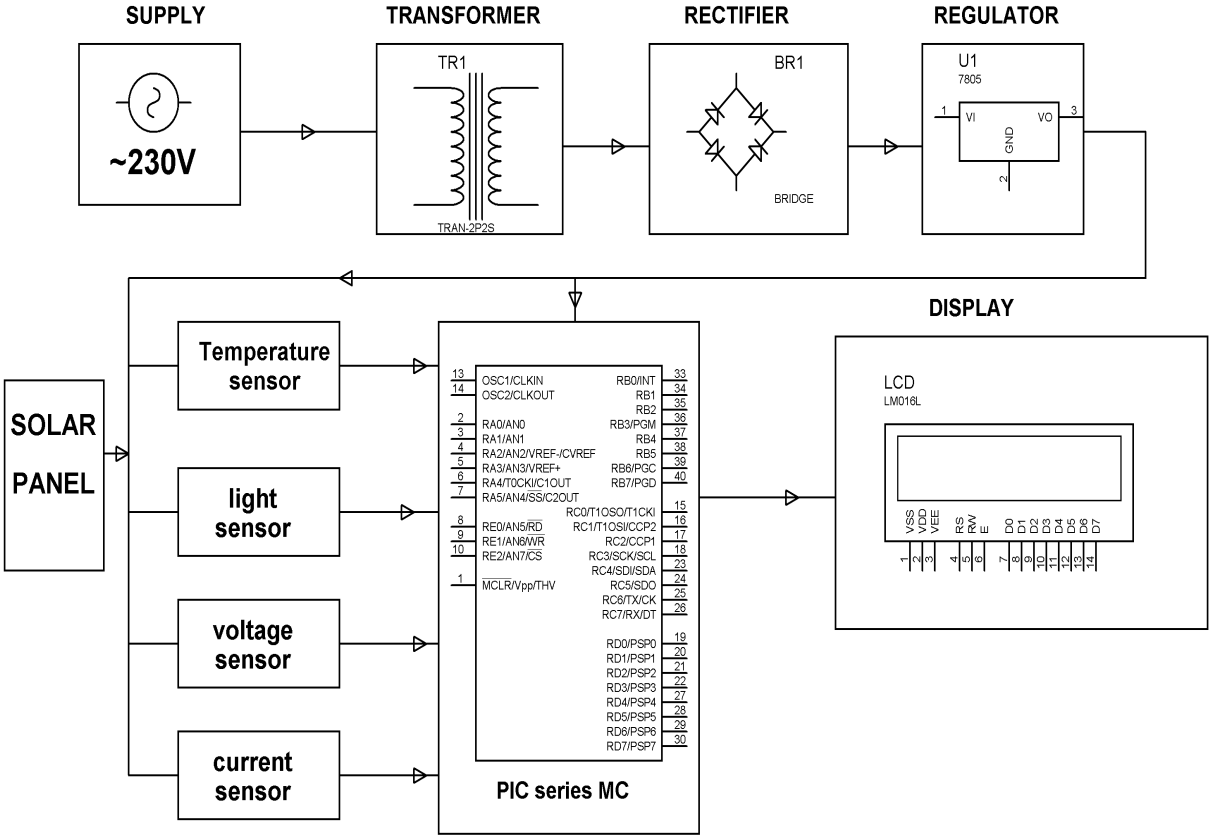
- Reliability : embedded systems must be able to handle any situation without human intervention
- Memory space : Memory is limited on embedded systems, and you must make the software and the data fit into whatever memory exists
- Program installation : you will need special tools to get your software into embedded systems
- Power consumption : Portable systems must run on battery power, and the software in these systems must conserve power
- Processor hogs : Computing that requires large amounts of CPU time can complicate the response problem
- Cost : Reducing the cost of the hardware is a concern in many embedded system projects; software often operates on hardware that is barely adequate for the job.

• Embedded systems have a microprocessor/ microcontroller and a memory. Some have a serial port or a network connection.

BLOCK DIAGRAM



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## HARDWARE REQUIREMENTS

### TRANSFORMER

Transformers convert AC electricity from one voltage to another with a little loss of power. Step-up transformers increase voltage, step-down transformers reduce voltage. Most power supplies use a step-down transformer to reduce the dangerously high voltage to a safer low voltage.

FIG 4.1: A TYPICAL TRANSFORMER

The input coil is called the primary and the output coil is called the secondary. There is no electrical connection between the two coils; instead they are linked by an alternating magnetic field created in the soft-iron core of the transformer. The two lines in the middle of the circuit symbol represent the core. Transformers waste very little power so the power out is (almost) equal to the power in. Note that as voltage is stepped down and current is stepped up.

The ratio of the number of turns on each coil, called the turn's ratio, determines the ratio of the voltages. A step-down transformer has a large number of turns on its primary (input) coil which is connected to the high voltage mains supply, and a small number of turns on its secondary (output) coil to give a low output voltage.

TURNS RATIO: (Vp / Vs) = (Np / Ns )

Where,

Vp = primary (input) voltage.

Vs = secondary (output) voltage

Np = number of turns on primary coil

Ns = number of turns on secondary coil

Ip = primary (input) current

Is = secondary (output) current.

## VOLTAGE REGULATOR 7805

**Features:**

- Output Current up to 1A.
- Output Voltages of 5, 6, 8, 9, 10, 12, 15, 18, 24V.
- Thermal Overload Protection.
- Short Circuit Protection.
- Output Transistor Safe Operating Area Protection.

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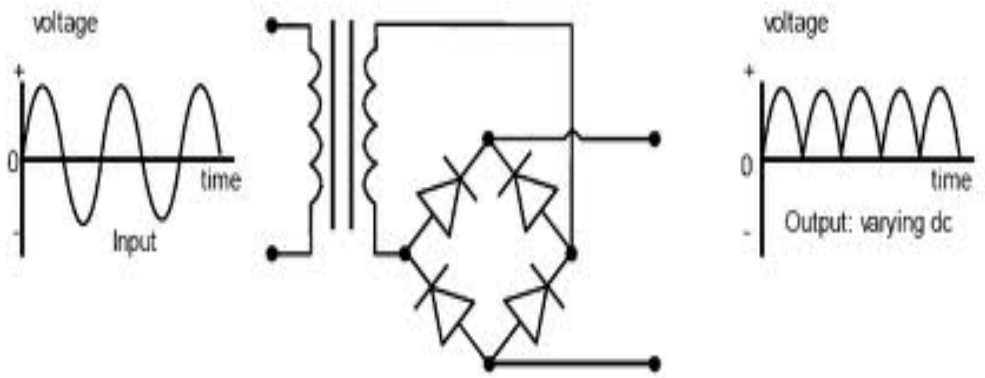
## RECTIFIER

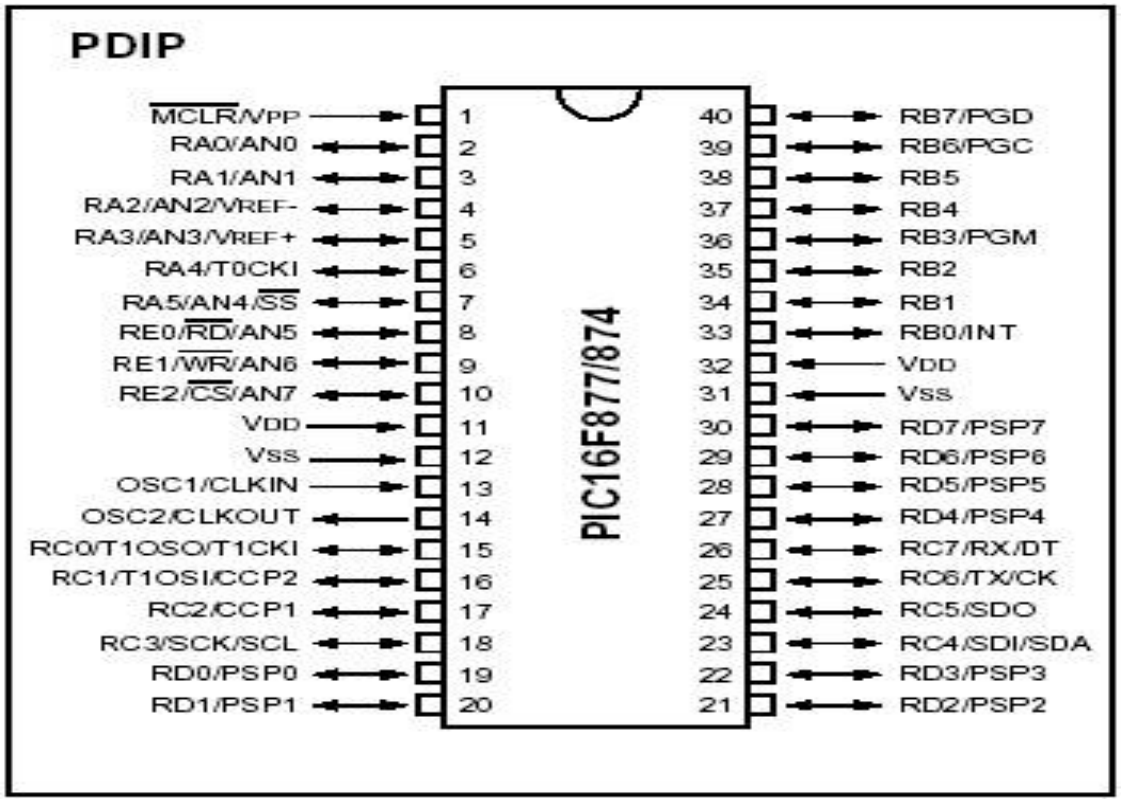
A rectifier is an electrical device which that converts alternating current (AC), h periodically reverses direction, to direct current (DC), current that flows in only one direction, a process known as rectification. Rectifiers have many uses including as components of power supplies and as detectors of radio signals. Rectifiers may be made of solid state diodes, vacuum tube diodes, mercury arc valves, and other components. The output from the transformer is fed to the rectifier. It converts A.C. into pulsating D.C. The rectifier may be a half wave or a full wave rectifier. In this project, a bridge rectifier is used because of its merits like good stability and full wave rectification. In positive half cycle only two diodes (1 set of parallel diodes) will conduct, in negative half cycle remaining two diodes will conduct and they will conduct only in forward bias only.




## 4.4 FILTER

## MICRO CONTROLLER PIC16F877A

### 28/40/44-Pin Enhanced Flash Microcontrollers



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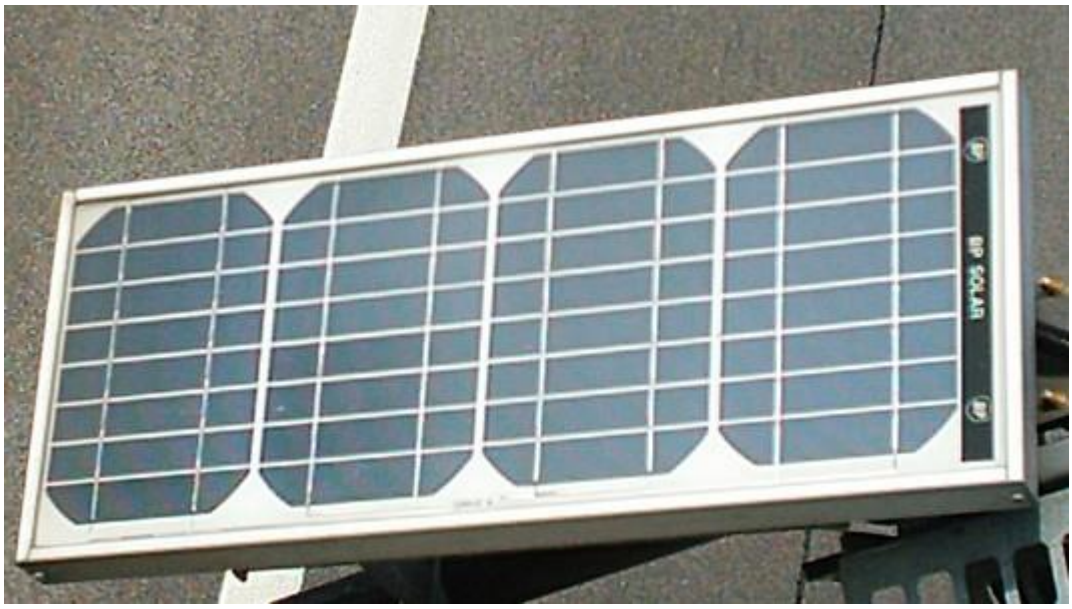
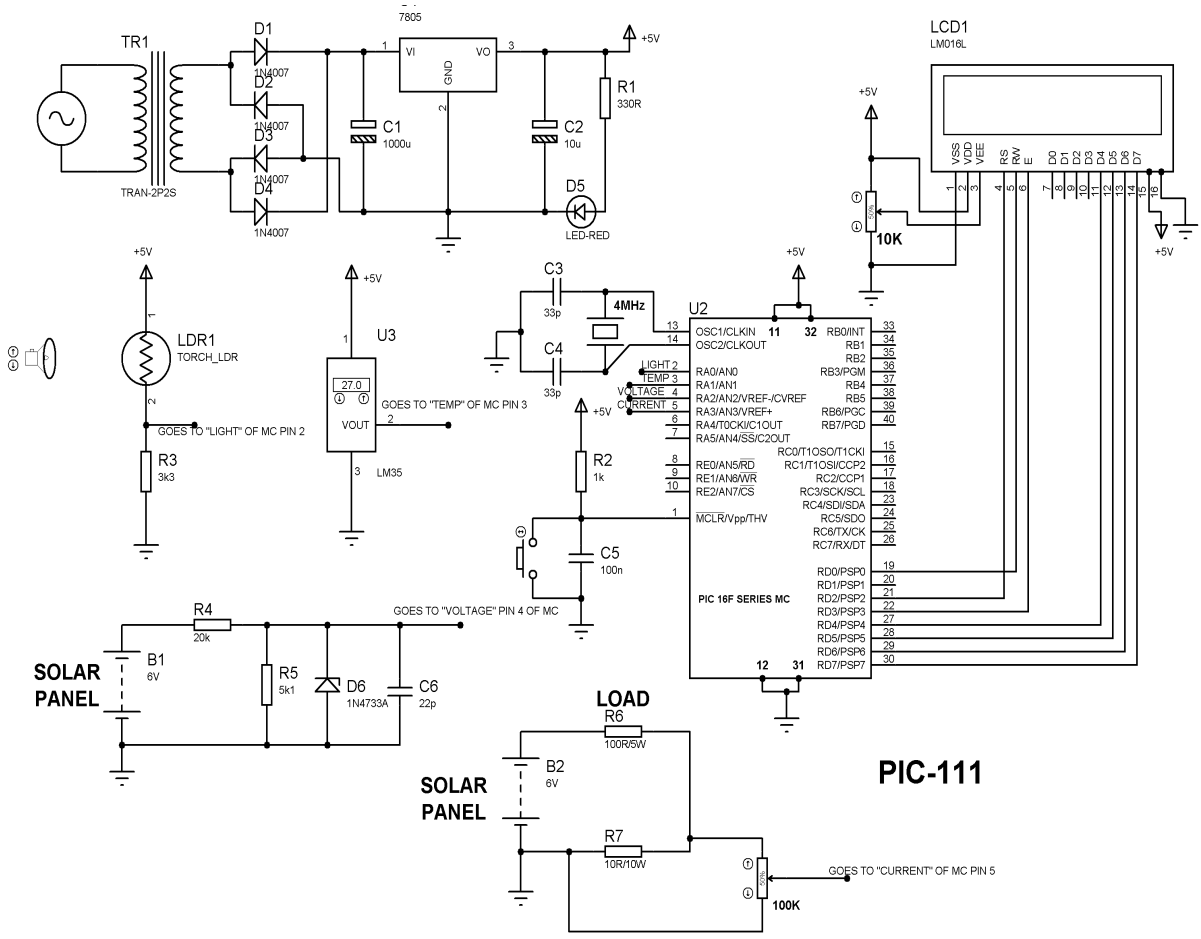
## SOLAR PANEL

A **solar panel** (**photovoltaic module** or **photovoltaic panel**) is a packaged interconnected assembly of solar cells, also known as *photovoltaic cells*.




## SCHEMATIC DIAGRAM



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# DESCRIPTION

## POWERSUPPLY

The circuit uses standard power supply comprising of a step-down transformer from 230v to 12v and 4 diodes forming a Bridge Rectifier that delivers pulsating dc which is then filtered by an electrolytic capacitor of about 470microf to 100microF. The filtered dc being unregulated IC LM7805 is used to get 5v constant at its pin no 3 irrespective of input dc varying from 9v to 14v. The input dc shall be varying in the event of input ac at 230volts section varies in the ratio of v1/v2=n1/n2.

The regulated 5volts dc is further filtered by a small electrolytic capacitor of 10 micro f for any noise so generated by the circuit. One LED is connected of this 5v point in series with a resistor of 330ohms to the ground i.e. negative voltage to indicate 5v power supply availability. The 5v dc is at 12v point is used for other applications as on when required.

## OPERATION

## CONNECTIONS

The output of the power supply which is 5v is connected to 11 and 32 pins of micro controller and GND is connected to its 12 and 31 pins. Pin 2 of controller is connected to pin 2 of LDR sensor, Pin 3 of controller is connected to pin 2 of LM35 temperature sensor, Pin 4 of controller is connected to voltage sensing ckt & Pin 5 of controller is connected to current sensing ckt.

## WORKING

The Voltage from the solar panel is fed to the MC pin no 4 through a potential divider comprising of R4 & R5. Zener diode D6 is used to protect the input to the microcontroller exceeding 5V. a 100ohm, 5W resistor R6 is used as load in series with another resistor R7 of 10ohm, 10W. a variable resistor 100K is used for setting/ calibrating the current parameters. The voltage drop across the resistor R7 is proportional to the load current which is fed to pin 5 of MC in a small portion by the variable resistor. Light input is sensed by LDR1 in combination with resistor R3 the common point of which is fed to MC pin 2. A temperature sensor LM35 (U3) delivers the output in analog voltage proportional to the heat on its surface being connected to pin 3 of MC. Thus, four analog varying voltage parameters are fed to the internal ADC of the MC out of total avalaibility of 8 channels. A LCD is used to display all the output parameters such as light intensity, temperature, voltage and current of solar panel. The unit can be used either from the power supply comprising of TR1, D1-D4, C1, 7805, C2 R1 & D5 or can be directly fed from 6V source of the solar panel.

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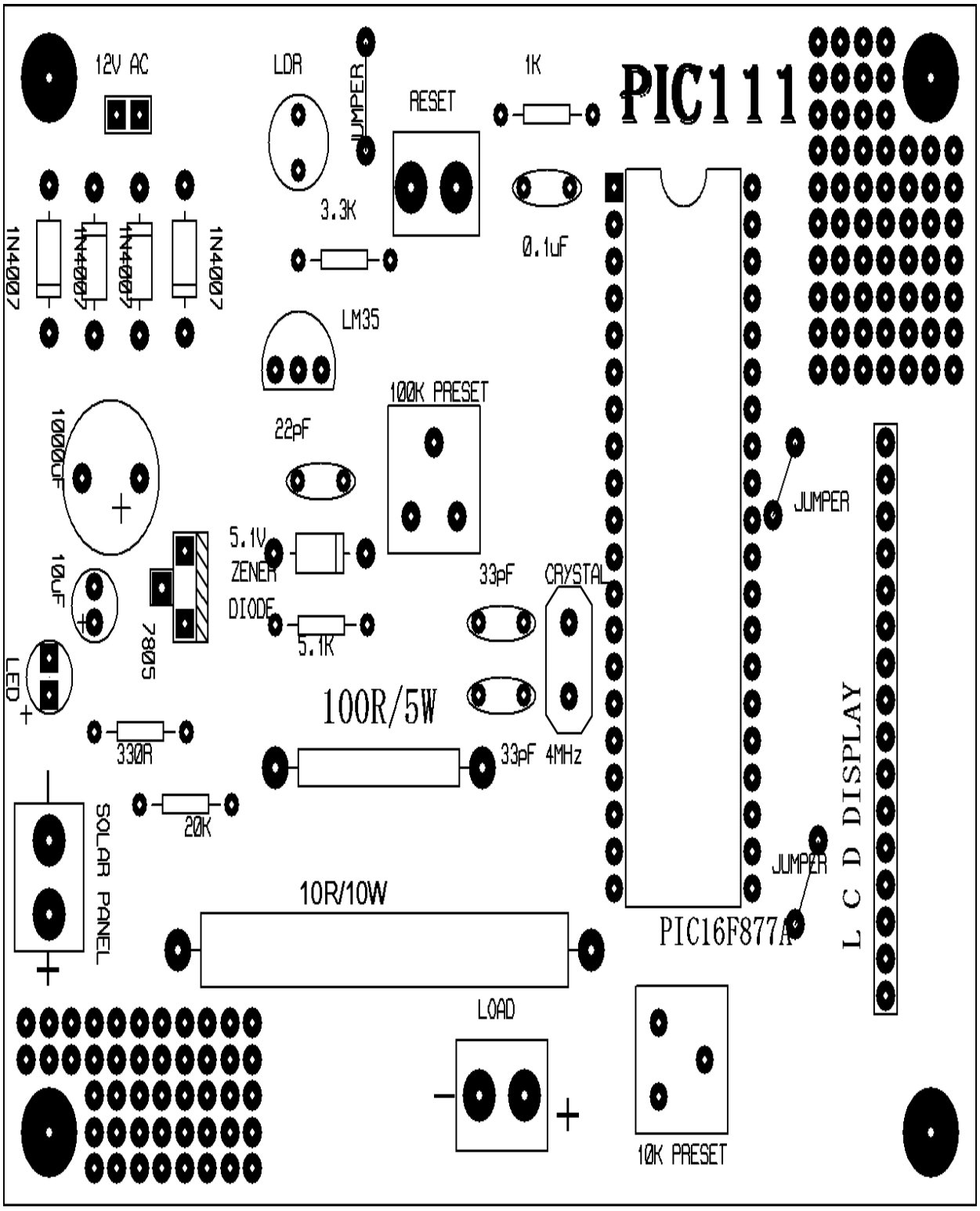
## LAYOUT DIAGRAM




## Conclusion

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