AUTOMATIC SOLAR PANEL CLEANING SYSTEM

A PROJECT REPORT

Submitted by

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In partial fulfillment for the award of the degree

Of

BACHELOR OF ENGINEERING

IN

ELECTRICAL AND ELECTRONICS ENGINEERING

LOYOLA INSTITUTE OF TECHNOLOGY,

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JUNE 2023

BONAFIDE CERTIFICATE

Certified that this project report **“AUTOMATIC SOLAR PANEL CLEANING SYSTEM”** is the bonafide work of **“S AUGUSTINE (210920105002), B DAMODARAN (210920105004), M SRUTHI (210920105009), S SURYA (210920105010)”** who carried out the project work under my supervision.

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submitted for the university examinations held on ……………

INTERNAL EXAMINER **EXTERNAL EXAMINER**

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At the outset, it is imperative to mention that this project would not have been completed without the helping hand of these noble souls. To them, we owe our gratitude, the depth of which, mere words cannot express. We avail this opportunity to thank them.

Our heartfelt thanks to our parents and friends for their constant support and encouragement to complete our project work. We thank GOD Almighty for his kind blessing and all unseen hands behind the success of our project work.

We wish to convey our sincere thanks to our beloved Founder Chairman

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ABSTRACT

The dustiest spots on Earth happen to be some of the best locations for solar energy collection. The dust that settles on solar panels from nearby pollution and traffic reduces the amount of sunlight that reaches the solar cells. Due to the presence of dust particles, the efficiency of solar panels decreases. Your solar panels' ability to generate power is affected by several factors; nevertheless, dirty panels are one of the most common and easy to clean. The consensus amongst experts is that dirty solar panels do not generate as much energy as their spotless counterparts. The panel's power output can drop by as much as 50% when dust builds up on it. To ensure optimal power output from solar panels even when deployed in dusty environments, we suggest a solar panel cleaning system. This paper proposes a solar energy monitoring system to collect and analyse solar energy characteristics for performance prediction and reliable power generation. There is an LDR sensor, a relay unit, and a brush involved in this project. The LDR sensor can tell if it's day or night outside. Dust on the sun's surface can be noticed in varying amounts, as their visibility is related to the sun's output. Infrared sensors check for dust and activate an oscillating wiper to clear it away. Here, we are keeping an eye on the pv voltage.

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ABBREVIATIONS

S .NO	ABBREVIATION	DESCRIPTION
1	DC	DIRECT CURRENT
2	PIC	PERIPHERAL INTERFACE CONTROLLER
3	MC	MICROCONTROLLER
4	IR	INFRARED SENSOR
5	LCD	LIQUID CRYSTAL DISPLAY
6	LDR	LIGHT DEPENDENT RESISTOR
7	V	VOLTAGE
8	IP	INPUT
9	OP	OUTPUT
10	I/O	INPUT /OUTPUT
11	RPM	ROTATION PER MINUTE

CHAPTER 1

INTRODUCTION

INTRODUCTION

There has been a recent uptick in the global installation of photovoltaic arrays. Each solar park has a 20-25 year lifespan, making it critical to maximise electricity generation during everyday service. In addition to ambient, climatic, component performance, and intrinsic system characteristics, the amount of energy generated by solar photovoltaic modules is correlated with the sun's available irradiance and spectrum content. Dust and other material that settles on the surface of photovoltaic (PV) panels reduces their efficiency. Using commercial detergents to clean grimy solar panels is not only inefficient, but can also damage the panels' frames and waste valuable time. Maintaining maximum efficiency requires regular cleaning of solar panels, which can be challenging for big solar panel arrays. A big ground-based solar array, up to a functional park of 22,000 panels, requires an automated cleaning system (20,000 Square meters).

In many third world countries, the generation of electricity is a crucial issue. The growth of the manufacturing and retail sectors has increased the need for power. As a result, we should all be doing more to promote the use of renewable energy sources, which generate clean energy and help us meet our overall energy needs. In the long run, this can help society cut down on harmful emissions and preserve the ozone layer for the next generation. Among them, the solar photovoltaic method is gaining popularity because of its widespread availability, low cost, simple installation, and low maintenance requirements.

The Internet of Things (IoT) is a rapidly developing technology that improves the functionality and usability of everyday objects when they are networked together using a common protocol and a cloud-based storage and processing system. Parameters as simple as pv voltage, temperature, and humidity all have an impact on the solar panel's output. Thus, a real-time solar monitoring system is crucial for boosting PV panel performance by comparison with experimental result to trigger preventative action.

CHAPTER 2

LITRATURE SURVEY

LITRATURE SURVEY

[1] Manju B et.al "Automatic Solar Panel Cleaning System" International Journal of Advances in Scientific Research and Engineering (ijasre), July - 2018

Solar power has become a source of renewable energy and solar energy application should be enhanced. The solar PV modules are generally employed in dusty environments which are the case tropical countries like India. The dust gets accumulated on the front surface of the module and blocks the incident light from the sun. It reduces the power generation capacity of the module. The power output reduces as much as by 50% if the module is not cleaned for a month. The cleaning system has been designed cleans the module by controlling the Arduino programming and remove the dust in the PV modules to improving the power efficiency.

[2] Nurul F. Zainuddin et.al "Design and Development of Smart Self-Cleaning Solar Panel System" IEEE International Conference on Automatic Control and Intelligent Systems, 29 June 2019

Solar power, being a noteworthy wellspring of sustainable and renewable energy source, is critical in satisfying the future vitality need. However, collection of fine particles, dust and water from the air above the solar panel will prevent sunlight from reaching the surface of the solar cell. This is a noteworthy issue since the light block materials present as external impedance that lower the solar based photovoltaic execution. In this study, a flexible cleaning gadget is developed, which ventures to every part of the whole length of the solar panel. The technique presented is also able to monitor the electrical power generated from the solar cells and instructions for cleaning solar cell photovoltaic surfaces can be activated when required by using Internet of Things (IOT) mobile applications. The results revealed that the external resistance could reduce the performance of the solar panel up to 22%.

[3] Javad Farrokhi Derakhshandeh et.al " A comprehensive review of automatic cleaning systems of solar panels" Sustainable Energy Technologies and Assessments 47 (2021)

This paper reviews the most recent and common cleaning systems designed and fabricated to overcome problems associated with dust accumulation problems. In general, the cleaning systems are categorized into two main groups; i) active and ii) passive. A comprehensive review of the automatic cleaning systems is conducted. The features of each system are explained, and the pros and cons are compared in detail. Leading indicators of the system, including cost, efficiency, water usage, cleaning time, and human interference, are considered when choosing an optimal cleaning system. While brushing and heliotex cleaning systems are cost-effective mechanisms, both require a human operator. On the other hand, electrostatic cleaning systems are recommended for regions where water is scarce. Furthermore, robotic cleaning systems are not recommended for counties with windy climates due to their slow operation and high costs.

[4] Amit Kumar Mondal et.al "A brief history and future aspects in automatic cleaning systems for solar photovoltaic panels" Advanced Robotics, 2015

This paper discusses a comprehensive overview of dust problem and the recent developments made on automated cleaning system for solar photovoltaic modules which give brief overview on techniques like electrical, mechanical, chemical and electrostatic. The main objective of the study is to review the literature on solar photovoltaic module automated cleaning techniques for identifying research gaps in the automated cleaning systems. The energy or efficiency produced by solar photovoltaic modules is related with the Sun's available irradiance and spectral content, as well as other factors like environmental, climatic, component performance and inherent system. These dust, dirt and bird droppings are the major reasons for the solar photovoltaic system underperformance

[5] **Athira Sivan et.al "Automatic Self Cleaning Solar Panel" International Research Journal of Engineering and Technology (IRJET) ,May 2017**

This project consists of a LDR sensor, wiper unit and sprayer. The LDR sensor is used to detect whether it is a day or night. Depending on the solar output the presence of dust on the surface of solar is detected. If the dust is detected the wiper starts to work on the surface along with the water sprayer.A some of the best places to collect solar energy are also some of the dustiest on Earth. Dust from pollution and traffic that fall on the solar panel surface prevents the sunlight from reaching the solar cells. The efficiency of solar panel gets affected in the presence of dust particles. While many factors affect how much electricity your solar panels will produce, dusty solar panels can be one of the biggest, and easiest to fix. Experts have agreed that dusty solar panels do not produce as much power as clean panels. The power output of the panel degrades up to 50% due to the dust accumulation. A solar panel cleaning system is proposed in order to make a solar panel operate at the best power generation state, while the solar panel is used in dusty environment.

[6] Milan Vaghani et.al "Automated Solar Panel Cleaning System using IoT" International Research Journal of Engineering and Technology (IRJET), April 2019

This project is developed for the betterment of the solar panel users. We providing transparency in cleaning system by using the most newly invented technology, which provide a better performance, integrity, consistency, cost-effective and scalable solution for the removal of dust and speck. The presented cleaning system provides about 32% more energy output compared to the dust accumulated solar panel. This system is control by application from whole world. Also this system reduces manpower for cleaning of solar panel. This is automatic solar panel cleaning system.

[7] Nasib Khadka et.al "Smart solar photovoltaic panel cleaning system" International Conference on Sustainable Energy and Green Technology 2019

This paper presents the design and fabrication process of a prototype that can able to clean the panel surface. The prototype of this system comprises of a cleaning robot and a cloud interface: the cleaning robot is mobile and able to clean the entire solar array back and forth, with its separately driven cleaning rotatory brush; whereas, the cloud interface is a human-machine interface featuring the distant monitoring and control of the robot. Additionally, to notify the performance of distantly placed solar farm, a sensing unit consisting of sensors was added to this system. Furthermore, to add an automatic cleaning feature, a month-long data of totally clean and dusty panel was processed with regression analysis, and the developed regression model was programmed into the sensing unit. The sensing unit added with the regression model is named as an autonomous unit, as it predicts the suitable time for cleaning action. According to the system evaluation done on a demonstration PV module, it was found that the designed system can clean dry dust accumulated over the panel's surface. Moreover, by attaching the metal rail tracks on a long solar array, the system seems to be implementable on a large scale solar farm.

CHAPTER 3

EXISTING SYSTEM

EXISTING SYSTEM

- With the old setup, solar panel cleaning was done manually. The effectiveness of solar panels degrades for many reasons, including human mistake, bird faeces, dust, and debris that accumulates on the panels' surfaces.
- Moreover, solar panels are harmed since they are not regularly cleaned. Losses in the system are also exacerbated by the fact that mechanically cleaning the solar panels causes wear and tear.
- Also, the system efficiency is dropping, therefore it's not very efficient in terms of energy use.

DISADVANTAGE

- To clean the solar panel they are using the manual operated system.
- Improper cleaning of solar panels is takes place.
- Due to bird waste and dust and dirt is accumulated on the surface of the solar panel due to which the efficiency of the solar panel is reduces.

CHAPTER 4

PROPOSED SYSTEM

PROPOSED SYSTEM

The suggested system includes a PIC microcontroller, a solar panel, a light-dependent resistor, a relay, an LCD display, and infrared (IR) technology. The PIC microcontroller is the brains of this operation. An LDR is used to determine whether day or night conditions currently exist in the atmosphere. A voltage divider and an analogue to digital converter are used to send data from the LDR and the solar panel to the microcontroller. Whereas an ADC takes an analogue voltage and converts it to a digital number proportional to its magnitude, a voltage divider is a passive linear circuit that creates an output value that is a fraction of its input voltage. An infrared (IR) sensor is integrated into the system, automating the cleaning mechanism with properly shaped wipers, whose action covers the surface of the panels throughout the wiper's sweep cycle. A motor drives the wiper in a wiper system, causing it to move horizontally across the windscreen. While the solar panel charges the energy storage device during the day, that device provides electricity to the motor at night.

The panel's voltage is measured with the help of the voltage sensors. The efficiency of a solar PV module, the microcontroller plays a crucial role in real-time monitoring and decision making.

ADVANTAGE

- Clean the solar panel and clean the dust of solar panel by using electro-mechanical shaft due to which solar panel cleaning will be done.
- This system is used for increase the efficiency of output & reduces the human effort.

4.1 BLOCK DIAGRAM

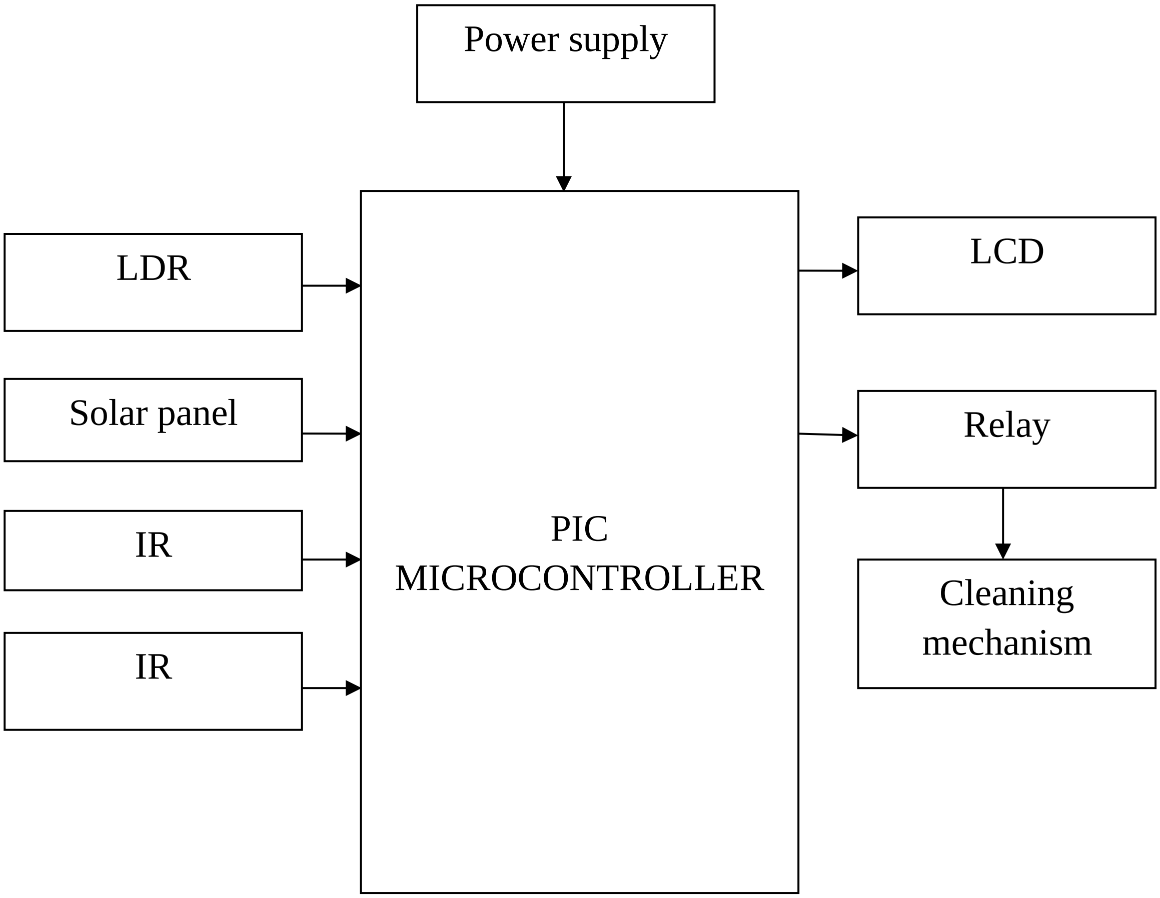

Fig. 4.1 Block diagram

4.2 HARDWARE REQUIREMENTS

- DC Motor
- IR Sensor
- PIC Microcontroller
- Voltage Divider
- Solar Panel
- Relay Board
- Power Supply
- Power Regulator
- LCD Display
- LDR Sensor
- Rack and Pinion

4.2.3 HARDWARE DISCRIPTION

4.2.3.1DC MOTOR

GENERAL DESCRIPTION

The relationship between torque vs speed and current is linear as shown left; as the load on a motor increase, Speed will decrease. The graph pictured here represents the characteristics of a typical motor. As long as the motor is used in the area of high efficiency (as represented by the shaded area) long life and good performance can be expected. If voltage in continuous applied to a motor in a locked rotor condition, the motor will heat up and fail in a relatively short time. Therefore, it is important that there is some form of protection against high temperature rises. A motor's basic rating point is slightly lower than its maximum efficiency point.

PRODUCT DESCRIPTION

A DC motor converts direct current electrical power into mechanical power. DC or direct current motor works on the principal, when a current carrying conductor is placed in a magnetic field; it experiences a torque and has a tendency to move. This is known as motoring action. When magnetic field and electric field interact, they produce a mechanical force. Thus, a DC motor can be used at a voltage lower than the rated voltage. But, below 1000 rpm, the speed becomes unstable, and the motor will not run smoothly. However, using the motor outside this range will result in high temperature rises and deterioration of motor parts.

Fig. 4.2.1.1 DC Motor

FEATURES

- Supply voltage: 5VDC
- Very reliable and low cost
- Speed: 10 rpm

4.2.1.2 IR SENSOR

GENERAL DESCRIPTION

IR LED emits infrared radiation. This radiation illuminates the surface in front of LED. Depending on reflectivity of the surface, amount of light reflected varies. This reflected light is made incident on reverse biased IR sensor. The amount of electron-hole pairs generated depends on intensity of incident IR radiation. Thus as intensity of incident ray varies, voltage across resistor will vary accordingly.

Fig. 4.2.1.2 IR Sensor

PRODUCT DESCRIPTION

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

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

FEATURES

- Operating voltage:5VDC
- Output voltage: 0 or 5VDC
- Easy to assemble and use
- Onboard detection indication
- Effective distance range of 2cm

APPLICATIONS

- Augmentative communication devices
- Car locking systems
- Computers
- Signage
- Telephones

4.2.1.3 PIC MICROCONTROLLER

The PIC microcontroller used here is 16F877A. This performs the key role of processing the received data from the sensors and transmitting them to the Li-Fi module. The advantage of microcontroller such as low power consumption and flexibility to connect other devices makes it as the best choice among other processors. The features of this microcontroller include the following.

- RISC architecture
- Operating frequency 0-20 MHz
- Power supply voltage 2.0-5.5V
- 8K ROM memory in FLASH technology
- 256 bytes EEPROM memory
- 368 bytes RAM memory
- A/D converter:
    - 14-channels
    - 10-bit resolution
- 3 independent timers/counters
- Watch-dog timer

PIC (usually pronounced as "pick") is a family of microcontrollers made by Microchip Technology, derived from the PIC1650 originally developed by General Instrument's Microelectronics Division. The name PIC initially referred to Peripheral Interface Controller and is currently expanded as Programmable

Intelligent Computer. The first parts of the family were available in 1976; by 2013 the company had shipped more than twelve billion individual parts, used in a wide variety of embedded systems.

Early models of PIC had read-only memory (ROM) or field-programmable EPROM for program storage, some with provision for erasing memory. All current models use flash memory for program storage, and newer models allow the PIC to reprogram itself. Program memory and data memory are separated. Data memory is 8-bit, 16-bit, and, in latest models, 32-bit wide. Program instructions vary in bit-count by family of PIC, and may be 12, 14, 16, or 24 bits long. The instruction set also varies by model, with more powerful chips adding instructions for digital signal processing functions.

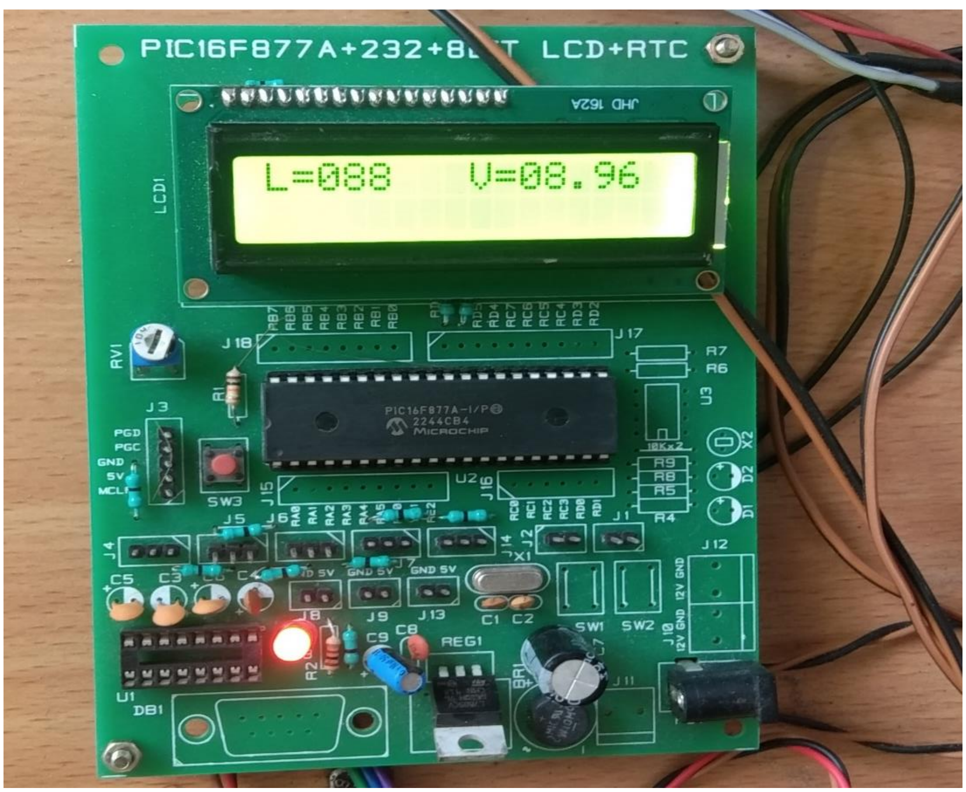

Fig. 4.2.1.3.1 The PIC microcontroller 16F877A.

The hardware capabilities of PIC devices range from 6-pin SMD, 8-pin DIP chips up to 144-pin SMD chips, with discrete I/O pins, ADC and DAC modules, and communications ports such as UART, I2C, CAN, and even USB. Low-power and high-speed variations exist for many types.

The manufacturer supplies computer software for development known as MPLAB X, assemblers and C/C++ compilers, and programmer/debugger hardware under the MPLAB and PICKit series. Third party and some open-source tools are also available. Some parts have in-circuit programming capability; low-cost development programmers are available as well as high-production programmers.

PIC devices are popular with both industrial developers and hobbyists due to their low cost, wide availability, large user base, extensive collection of application notes, and availability of low cost or free development tools, serial programming, and re-programmable flash-memory capability.

FEATURES

High-Performance RISC CPU

- Only 35 single-word instructions to learn
- All single-cycle instructions except for program branches, which are two-cycle
- Operating speed: DC – 20 MHz clock input DC – 200 ns instruction cycle
- Up to 8K x 14 words of Flash Program Memory, Up to 368 x 8 bytes of Data Memory (RAM), Up to 256 x 8 bytes of EEPROM Data Memory

- Pin out compatible to other 28-pin or 40/44-pin
- PIC16CXXX and PIC16FXXX microcontrollers

Peripheral Features

- Timer0: 8-bit timer/counter with 8-bit prescaler
- Timer1: 16-bit timer/counter with prescaler, can be incremented during Sleep via external crystal/clock
- Timer2: 8-bit timer/counter with 8-bit period register, prescaler and postscaler
  - Two Capture, Compare, PWM module
  - Capture is 16-bit, max. resolution is 12.5 ns
  - Compare is 16-bit, max. resolution is 200 ns
- PWM max. resolution is 10-bit
- Synchronous Serial Port (SSP) with SPI™ (Master mode) and I2C™ (Master/Slave)
- Universal Synchronous Asynchronous Receiver Transmitter (USART/SCI) with 9-bit address detection
- Parallel Slave Port (PSP) – 8 bits wide with external RD, WR and CS controls (40/44-pin only)
- Brown-out detection circuitry for Brown-out Reset (BOR)

Analog Features

- 10-bit, up to 8-channel Analog-to-Digital Converter (A/D)
- Brown-out Reset (BOR)
- Analog Comparator module with:
  - Two analog comparators
  - Programmable on-chip voltage reference (VREF) module
  - Programmable input multiplexing from device inputs and internal voltage reference
  - Comparator outputs are externally accessible

Special Microcontroller Features

- 100,000 erase/write cycle Enhanced Flash program memory typical
- 1,000,000 erase/write cycle Data EEPROM memory typical
- Data EEPROM Retention > 40 years
- Self-reprogrammable under software control
- In-Circuit Serial Programming™ (ICSP™) via two pins
- Single-supply 5V In-Circuit Serial Programming
- Watchdog Timer (WDT) with its own on-chip RC oscillator for reliable operation
- Programmable code protection

- Power saving Sleep mode
- Selectable oscillator options
- In-Circuit Debug (ICD) via two pins

CMOS Technology

- Low-power, high-speed Flash/EEPROM technology
- Fully static design
- Wide operating voltage range (2.0V to 5.5V)
- Commercial and Industrial temperature ranges
- Low-power consumption

Pin Diagram

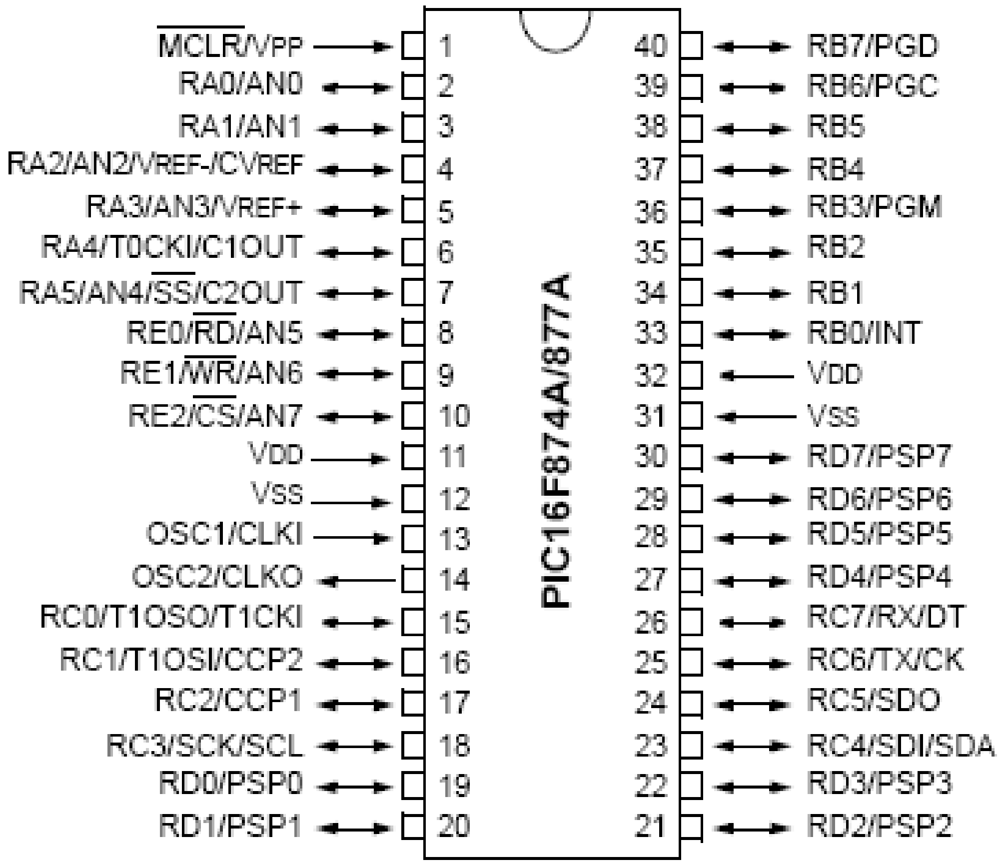

Fig. 4.2.1.3.3PIC Microcontroller Pin Diagram

DEVICE OVERVIEW:

This document contains device specific information about the following devices:

• PIC16F873A

• PIC16F874A

• PIC16F876A

• PIC16F877A

PIC16F873A/876A devices are available only in 28-pin packages, while PIC16F874A/877A devices are available in 40-pin and 44-pin packages. All devices in the PIC16F87XA family share common architecture with the following differences:

- The PIC16F873A and PIC16F874A have one-half of the total on-chip memory of the PIC16F876A and PIC16F877A
- The 28-pin devices have three I/O ports, while the 40/44-pin devices have five
- The 28-pin devices have fourteen interrupts, while the 40/44-pin devices have fifteen
- The 28-pin devices have five A/D input channels, while the 40/44-pin devices have eight
- The Parallel Slave Port is implemented only on the 40/44-pin devices

The available features are summarized in Table 1-1. Block diagrams of the PIC16F873A/876A and PIC16F874A/877A devices are provided in Figure 1-1 and Figure 1-2, respectively. The pin outs for these device families are listed in Table 1-2 and Table 1-3. Additional information may be found in the PICmicro® Mid-Range Reference Manual (DS33023), which may be obtained from your local Microchip Sales Representative or downloaded from the Microchip web site. The Reference Manual should be considered a complementary document to this data sheet and is highly recommended reading for a better understanding of the device architecture and operation of the peripheral modules.

Memory Organization

There are three memory blocks in each of the PIC16F87XA devices. The program memory and data memory have separate buses so that concurrent access can occur and is detailed in this section. The EEPROM data memory block is detailed in **Section 3.0 "Data EEPROM and Flash Program Memory"**. Additional information on device memory may be found in the PICmicro® Mid-Range MCU Family Reference Manual (DS33023).

Program Memory Organization

The PIC16F87XA devices have a 13-bit program counter capable of addressing an 8K word x 14 bit program memory space. The PIC16F876A/877A devices have 8K words x 14 bits of Flash program memory, while PIC16F873A/874A devices have 4K words x 14 bits. Accessing a location above the physically implemented address will cause a wraparound. The Reset vector is at 0000h and the interrupt vector is at 0004h.

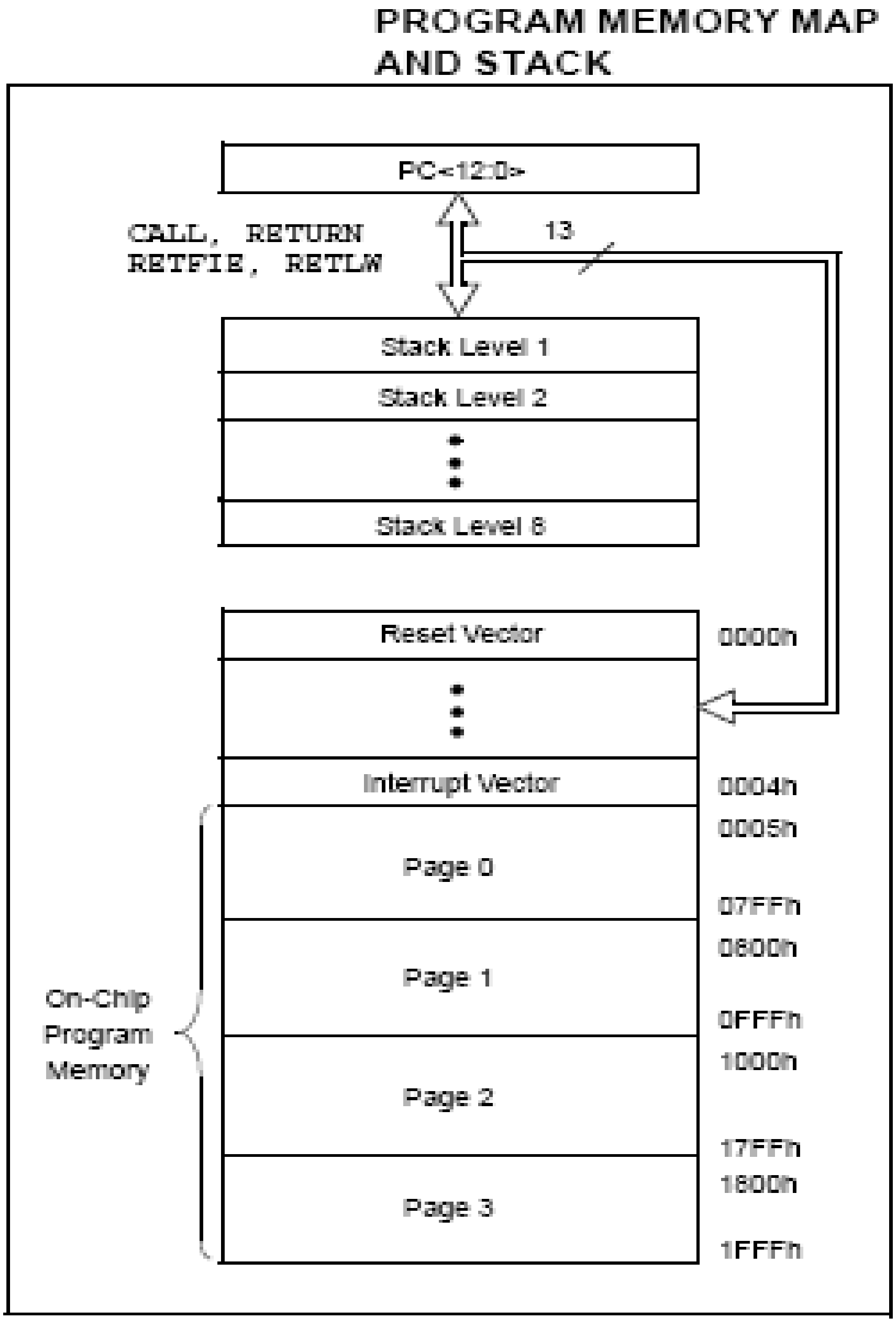

Fig. 4.2.1.3.4 Memory map of PIC Microcontroller

Data Memory Organization

The data memory is partitioned into multiple banks which contain the General-Purpose Registers and the Special Function Registers. Bits RP1 (Status<6>) and RP0 (Status<5>) are the bank select bits. Each bank extends up to 7Fh (128 bytes). The lower locations of each bank are reserved for the Special Function Registers. Above the Special Function Registers are General Purpose Registers, implemented as static RAM. All implemented banks contain Special Function Registers. Some frequently used Special Function Registers from one bank may be mirrored in another bank for code reduction and quicker access.

I/O PORTS

Some pins for these I/O ports are multiplexed with an alternate function for the peripheral features on the device. In general, when a peripheral is enabled, that pin may not be used as a general purpose I/O pin. Additional information on I/O ports may be found in the PICmicro™ Mid-Range Reference Manual (DS33023).

PORTA and the TRISA Register:

PORTA is a 6-bit wide, bidirectional port. The corresponding data direction register is TRISA. Setting a TRISA bit (= 1) will make the corresponding PORTA pin an input (i.e., put the corresponding output driver in a High-Impedance mode). Clearing a TRISA bit (= 0) will make the corresponding PORTA pin an output (i.e., put the contents of the output latch on the selected pin). Reading the PORTA register reads the status of the pins, whereas writing to it will write to the port latch. All write operations are read-modify-write operations. Therefore, a write to a port implies that the port pins are read; the value is modified and then written to the port data latch.

Pin RA4 is multiplexed with the Timer0 module clock input to become the RA4/T0CKI pin. The RA4/T0CKI pin is a Schmitt Trigger input and an open-drain output. All other PORTA pins have TTL input levels and full CMOS output drivers. Other PORTA pins are multiplexed with analog inputs and the analog VREF input for both the A/D converters and the comparators. The operation of each pin is selected by clearing/setting the appropriate control bits in the ADCON1 and/or CMCON registers. The TRISA register controls the direction of the port pins even when they are being used as analog inputs. The user must ensure the bits in the TRISA register are maintained set when using them as analog inputs.

PORTB and the TRISB Register

PORTB is an 8-bit wide, bidirectional port. The corresponding data direction register is TRISB. Setting a TRISB bit (= 1) will make the corresponding PORTB pin an input (i.e., put the corresponding output driver in a High-Impedance mode). Clearing a TRISB bit (= 0) will make the corresponding PORTB pin an output (i.e., put the contents of the output latch on the selected pin). Three pins of PORTB are multiplexed with the In-Circuit Debugger and Low-Voltage Programming function: RB3/PGM, RB6/PGC and RB7/PGD. The alternate functions of these pins are described in **"Special Features of the CPU"**. Each of the PORTB pins has a weak internal pull-up. A single control bit can turn on all the pull-ups. This is performed by clearing bit RBPU (OPTION_REG<7>). The weak pull-up is automatically turned off when the port pin is configured as an output. The pull-ups are disabled on a Power-on Reset.

This interrupt can wake the device from Sleep. The user, in the Interrupt Service Routine, can clear the interrupt in the following manner:

a) Any read or write of PORTB. This will end the mismatch condition.

b) Clear flag bit RBIF.

A mismatch condition will continue to set flag bit RBIF. Reading PORTB will end the mismatch condition and allow flag bit RBIF to be cleared. The interrupt-on-change feature is recommended for wake-up on key depression operation and operations where PORTB is only used for the interrupt-on-change feature. Polling of PORTB is not recommended while using the interrupt-on-change feature. This interrupt-on-mismatch feature, together with software configurable pull-ups on these four pins, allow easy interface to a keypad and make it possible for wake-up on key depression.

PORTC and the TRISC Register

PORTC is an 8-bit wide, bidirectional port. The corresponding data direction register is TRISC. Setting a TRISC bit (= 1) will make the corresponding PORTC pin an input (i.e., put the corresponding output driver in a High-Impedance mode). Clearing a TRISC bit (= 0) will make the corresponding PORTC pin an output (i.e., put the contents of the output latch on the selected pin). PORTC is multiplexed with several peripheral functions (Table 4-5). PORTC pins have Schmitt Trigger input buffers. When the I2C module is enabled, the PORTC<4:3> pins can be configured with normal I2C levels, or with SMBus levels, by using the CKE bit (SSPSTAT<6>).

When enabling peripheral functions, care should be taken in defining TRIS bits for each PORTC pin. Some peripherals override the TRIS bit to make a pin an output, while other peripherals override the TRIS bit to make a pin an input. Since the TRIS bit override is in effect while the peripheral is enabled, read-modify write instructions (BSF, BCF, and XORWF) with TRISC as the destination, should be avoided. The user should refer to the corresponding peripheral section for the correct TRIS bit settings.

PORTD and TRISD Registers:

PORTD is an 8-bit port with Schmitt Trigger input buffers. Each pin is individually configurable as an input or output. PORTD can be configured as an 8-bit wide microprocessor port (Parallel Slave Port) by setting control bit, PSPMODE (TRISE<4>). In this mode, the input buffers are TTL.

PORTD Functions:

Name	Bit#	Buffer Type	Function
RD0/PSP0	bit 0	ST/TTL(1)	Input/output port pin or Parallel Slave Port bit 0.
RD1/PSP1	bit 1	ST/TTL(1)	Input/output port pin or Parallel Slave Port bit 1.
RD2/PSP2	bit2	ST/TTL(1)	Input/output port pin or Parallel Slave Port bit 2.
RD3/PSP3	bit 3	ST/TTL(1)	Input/output port pin or Parallel Slave Port bit 3.
RD4/PSP4	bit 4	ST/TTL(1)	Input/output port pin or Parallel Slave Port bit 4.
RD5/PSP5	bit 5	ST/TTL(1)	Input/output port pin or Parallel Slave Port bit 5.
RD6/PSP6	bit 6	ST/TTL(1)	Input/output port pin or Parallel Slave Port bit 6.
RD7/PSP7	bit 7	ST/TTL(1)	Input/output port pin or Parallel Slave Port bit 7.

PORTE and TRISE Register:

PORTE has three pins (RE0/RD/AN5, RE1/WR/AN6 and RE2/CS/AN7) which are individually configurable as inputs or outputs. These pins have Schmitt Trigger input buffers. The PORTE pins become the I/O control inputs for the microprocessor port when bit PSPMODE (TRISE<4>) is set. In this mode, the user must make certain that the TRISE<2:0> bits are set and that the pins are configured as digital inputs. Also, ensure that ADCON1 is configured for digital I/O. In this mode, the input buffers are TTL.

Register 4-1 shows the TRISE register which also controls the Parallel Slave Port operation. PORTE pins are multiplexed with analog inputs. When selected for analog input, these pins will read as ‘0’s. TRISE controls the direction of the RE pins, even when they are being used as analog inputs. The user must make sure to keep the pins configured as inputs when using them as analog inputs.

4.2.1.4 VOLTAGE DIVIDER

In electronics, a voltage divider (also known as a potential divider) is a passive linear circuit that produces an output voltage (Vout) that is a fraction of its input voltage (Vin). Voltage division is the result of distributing the input voltage among the components of the divider. A simple example of a voltage divider is two resistors connected in series, with the input voltage applied across the resistor pair and the output voltage emerging from the connection between them.

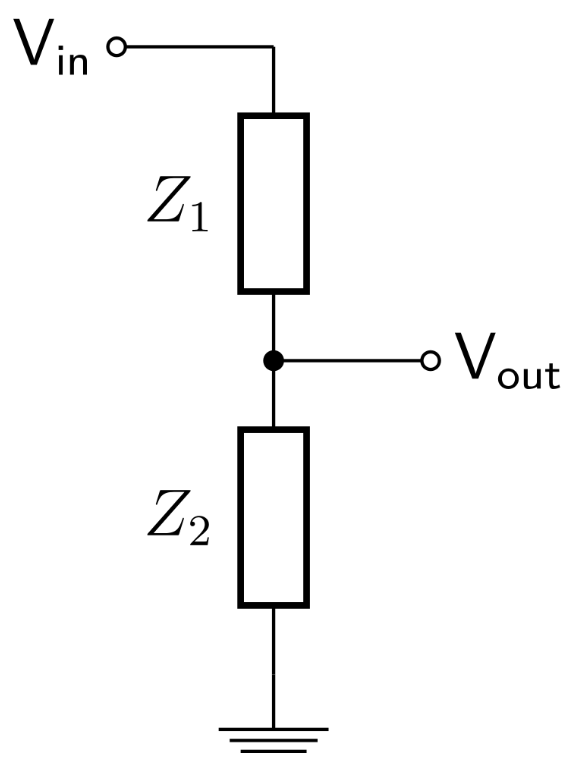

Fig. 4.2.1.4.1 circuit diagram of voltage divider

Resistor voltage dividers are commonly used to create reference voltages, or to reduce the magnitude of a voltage so it can be measured, and may also be used as signal attenuators at low frequencies. For direct current and relatively low frequencies, a voltage divider may be sufficiently accurate if made only of resistors; where frequency response over a wide range is required (such as in an oscilloscope probe), a voltage divider may have capacitive elements added to compensate load capacitance. In electric power transmission, a capacitive voltage divider is used for measurement of high voltage.

A voltage divider referenced to ground is created by connecting two electrical impedances in series, as shown in Figure 1. The input voltage is applied across the series impedances Z1 and Z2 and the output is the voltage across Z2. Z1 and Z2 may be composed of any combination of elements such as resistors, inductors and capacitors.

If the current in the output wire is zero then the relationship between the input voltage, Vin, and the output voltage, Vout, is:

$$V_{\text{out}} = \frac{Z_2}{Z_1 + Z_2} \cdot V_{\text{in}}$$

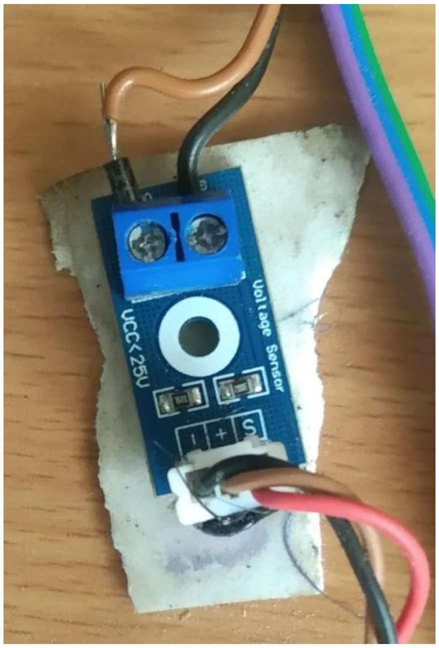

Fig. 4.2.1.4.2 voltage divider

4.2.1.5 SOLAR PANEL

DEFINITION

Solar panels are those devices which are used to absorb the sun's rays and convert them into electricity or heat.

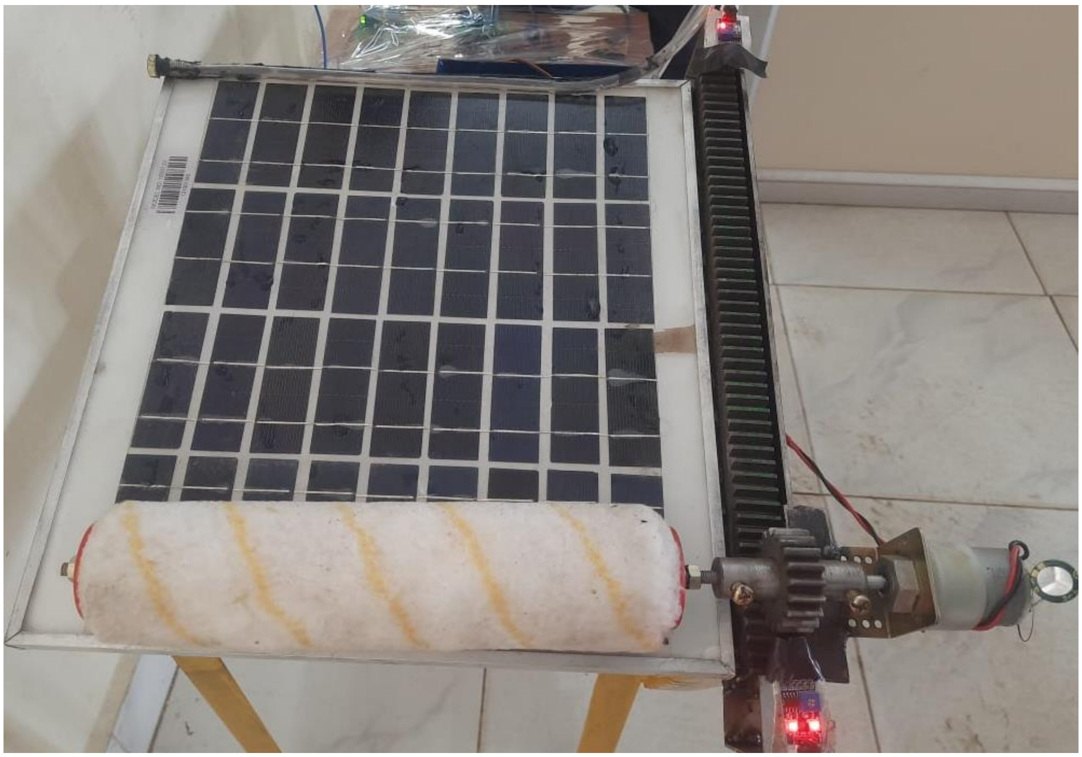

Fig. 4.2.1.4.2 Solar Panels

DESCRIPTION

A solar panel is actually a collection of solar (or photovoltaic) cells, which can be used to generate electricity through photovoltaic effect. These cells are arranged in a grid-like pattern on the surface of solar panels.

Thus, it may also be described as a set of photovoltaic modules, mounted on a structure supporting it. A photovoltaic (PV) module is a packaged and connected assembly of 6×10 solar cells.

When it comes to wear-and-tear, these panels are very hardy. Solar panels wear out extremely slow. In a year, their effectiveness decreases only about one to two per cent (at times, even lesser).

Most solar panels are made up using crystalline silicon solar cells.

Installation of solar panels in homes helps in combating the harmful emissions of greenhouse gases and thus helps reduce global warming. Solar panels do not lead to any form of pollution and are clean. They also decrease our reliance on fossil fuels (which are limited) and traditional power sources.

These days, solar panels are used in wide-ranging electronic equipments like calculators, which work as long as sunlight is available.

However, the only major drawback of solar panels is that they are quite costly. Also, solar panels are installed outdoors as they need sunlight to get charged.

FEATURES

- Maximum Power Watt - 5
- Production Tolerance - ±10%
- Maximum Power voltage V - 12V
- Maximum Power current A - 0.56
- Open circuit voltage V - 21.6
- Short circuit current A - 0.59
- Cells thickness - 0.18mm±20μm

APPLICATIONS

- Standalone PV systems
- Solar planes
- Solar vehicles
- Solar-pumped lasers

4.2.1.6 RELAY BOARD

GENERAL DESCRIPTION

Relays are simple switches which are operated both electrically and mechanically. Relays consist of an electromagnet and also a set of contacts. The switching mechanism is carried out with the help of the electromagnet. The main operation of a relay comes in places where only a low-power signal can be used to control a circuit. It is also used in places where only one signal can be used to control a lot of circuits. They were used to switch the signal coming from one source to another destination. The high end applications of relays require high power to be driven by electric motors and so on. Such relays are called contactors.

Fig. 4.2.1.6 Relay Board

PRODUCT DESCRIPTION

A relay is an electromechanical switch which is activated by an electric current. A four relay board arrangement contains driver circuit, power supply circuit and isolation circuit. A relay is assembled with that circuit. The driver circuit contains transistors for switching operations. The transistor is use for switching the relay. An isolation circuit prevents reverse voltage from the relay which protects the controller and transistor from damage. The input pulse for switching the transistor is given from the microcontroller unit. It is used for switching of a four device.

FEATURES

- Input voltage: 12VDC
- Driver unit: ULN2003A
- Isolation unit: In4007
- Fast switching
- Motor forward and reverse operation

APPLICATIONS

- Ac load Switching applications
- Dc load Switching applications
- Motor switching applications

4.2.1.7 POWER SUPPLY

- **Lead-acid battery**

A battery is a device that stores electric power in the form of chemical energy. When necessary, the energy is again released as electric power for DC consumers such as lighting and starter motors. A battery consists of several galvanic cells with a voltage of 2 volt each. For a 12-volt battery, six cells are linked in series and fitted inside a single casing.

To achieve 24 volt, two 12-volt batteries are linked in series. Each cell has positive oxidised lead plates and negative lead metal plates, and has an electrolyte consisting of water and sulphuric acid. During discharging, the lead oxide on the lead plates is converted into lead. The acid content decreases because sulphuric acid is required for this process.

Fig. 4.2.1.7.1 Power Supply

4.2.1.8 POWER REGULATOR

DEFINITION

A power supply (sometimes known as a power supply unit or PSU) is a device or system that supplies electrical or other types of energy to an output load or group of loads. The term is most commonly applied to electrical energy supplies, less often to mechanical ones, and rarely to others.

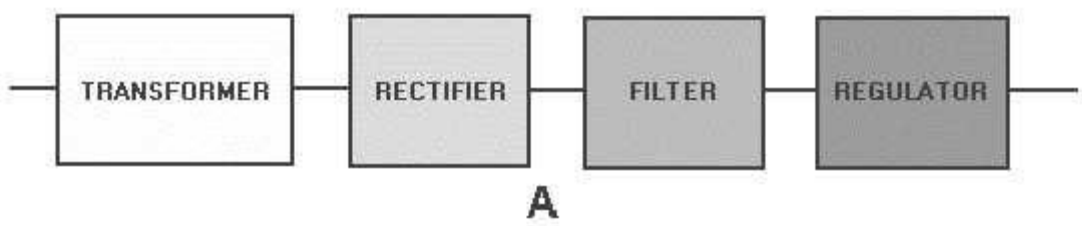

Fig. 4.2.1.8.1 Block Diagram of a Basic Power Regulator

The transformer steps up or steps down the input line voltage and isolates the power supply from the power line. The RECTIFIER section converts the alternating current input signal to a pulsating direct current. However, as you proceed in this chapter you will learn that pulsating dc is not desirable. For this reason a FILTER section is used to convert pulsating dc to a purer, more desirable form of dc voltage.

The final section, the REGULATOR, does just what the name implies. It maintains the output of the power supply at a constant level in spite of large changes in load current or input line voltages. Now that you know what each section does, let's trace an ac signal through the power supply. At this point you need to see how this signal is altered within each section of the power supply. Later on in the chapter you will see how these changes take place. In view B of figure 4-1, an input signal of 115 volts ac is applied to the primary of the transformer. The transformer is a stepup transformer with a turns ratio of 1:3. You can calculate the output for this transformer by multiplying the input voltage by the ratio of turns in the primary to the ratio of turns in the secondary; therefore, 115 volts ac ´ 3 = 345 volts ac (peak-to- peak) at the output. Because each diode in the rectifier section conducts for 180 degrees of the 360-degree input, the output of the rectifier will be one-half, or approximately 173 volts of pulsating dc. The filter section, a network of resistors, capacitors, or inductors, controls the rise and fall time of the varying signal; consequently, the signal remains at a more constant dc level. You will see the filter process more clearly in the discussion of the actual filter circuits. The output of the filter is a signal of 110 volts dc, with ac ripple riding on the dc. The reason for the lower voltage (average voltage) will be explained later in this chapter. The regulator maintains its output at a constant 110-volt dc level, which is used by the electronic equipment (more commonly called the load).

Simple 5V power supply for digital circuits

- Brief description of operation: Gives out well regulated +5V output, output current capability of 100 mA
- Circuit protection: Built-in overheating protection shuts down output when regulator IC gets too hot
- Circuit complexity: Very simple and easy to build
- Circuit performance: Very stable +5V output voltage, reliable operation
- Availability of components: Easy to get, uses only very common basic components
- Design testing: Based on datasheet example circuit, I have used this circuit successfully as part of many electronics projects

- Applications: Part of electronics devices, small laboratory power supply
- Power supply voltage: Unregulated DC 8-18V power supply
- Power supply current: Needed output current + 5 mA
- Component costs: Few dollars for the electronics components + the input transformer cost

CIRCUIT DESCRIPTION

This circuit is a small +5V power supply, which is useful when experimenting with digital electronics. Small inexpensive wall transformers with variable output voltage are available from any electronics shop and supermarket. Those transformers are easily available, but usually their voltage regulation is very poor, which makes then not very usable for digital circuit experimenter unless a better regulation can be achieved in some way. The following circuit is the answer to the problem.

This circuit can give +5V output at about 150 mA current, but it can be increased to 1 A when good cooling is added to 7805 regulator chip. The circuit has over overload and therminal protection.

Circuit diagram of the power supply

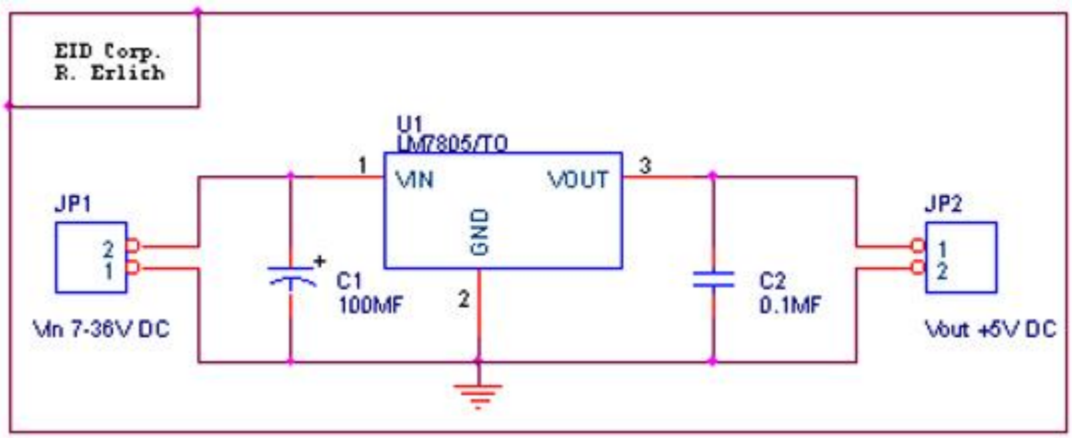

Fig. 4.2.1.8.2 Circuit Diagram of a Basic Power Regulator

The capacitors must have enough high voltage rating to safely handle the input voltage feed to circuit. The circuit is very easy to build for example into a piece of Vero board.

Pinout of the 7805 regulator IC

- Unregulated voltage in
- Ground
- Regulated voltage out

Component list

- 7805 regulator IC
- 100 uF electrolytic capacitor, at least 25V voltage rating
- 10 uF electrolytic capacitor, at least 6V voltage rating
- 100 nF ceramic or polyester capacitor

Fig. 4.2.1.8.3 Power Regulator

More output current

If you need more than 150 mA of output current, you can update the output current up to 1A doing the following modifications:

- Change the transformer from where you take the power to the circuit to a model which can give as much current as you need from output
- Put a heat sink to the 7805 regulator (so big that it does not overheat because of the extra losses in the regulator)

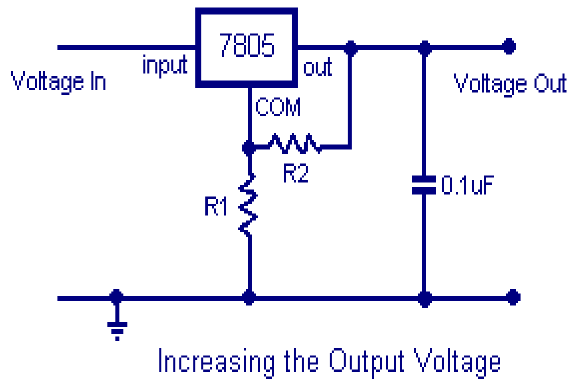

Fig. 4.2.1.8.4 Circuit Diagram of 7805 Regulator

Other output voltages

If you need other voltages than +5V, you can modify the circuit by replacing the 7805 chips with another regulator with different output voltage from regulator 78xx chip family. The last numbers in the chip code tells the output voltage. Remember that the input voltage must be at least 3V greater than regulator output voltage to otherwise the regulator does not work well.

4.2.1.9 (16×2) LCD DISPLAY

GENERAL DESCRIPTION

LCD stands for liquid crystal display. They come in many sizes 8x1 , 8x2 , 10x2 , 16x1 , 16x2 , 16x4 , 20x2 , 20x4 ,24x2 , 30x2 , 32x2 , 40x2 etc . Many multinational companies like Philips Hitachi Panasonic make their own special kind of LCD'S to be used in their products. All the LCD'S performs the same functions (display characters numbers special characters ASCII characters etc).Their programming is also same and they all have same 14 pins (0-13) or 16 pins (0 to 15). Alphanumeric displays are used in a wide range of applications, including palmtop computers, word processors, photocopiers, point of sale terminals, medical instruments, cellular phones, etc.

PRODUCT DESCRIPTION

This is an LCD Display designed for E-blocks. It is a 16 character, 2-line alphanumeric LCD display connected to a single 9-way D-type connector. This allows the device to be connected to most E-Block I/O ports. The LCD display requires data in a serial format, which is detailed in the user guide below. The display also requires a 5V power supply. Please take care not to exceed 5V, as this will cause damage to the device. The 5V is best generated from the E-blocks Multi programmer or a 5V fixed regulated power supply.

The 16 x 2 intelligent alphanumeric dot matrix displays is capable of displaying 224 different characters and symbols. A full list of the characters and symbols is printed on pages 7/8 (note these symbols can vary between brand of LCD used). This booklet provides all the technical specifications for connecting the unit, which requires a single power supply (+5V).

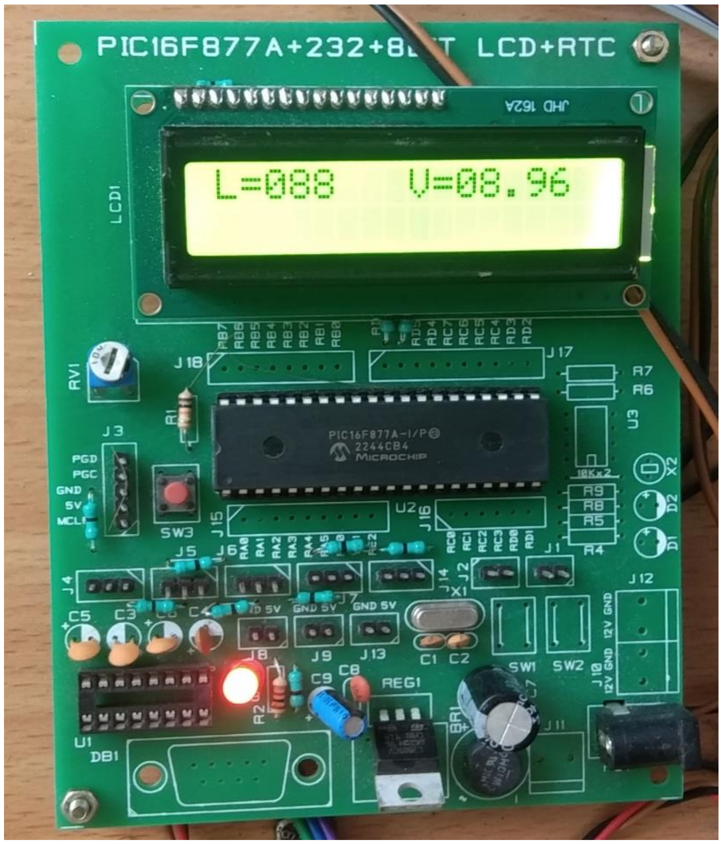

Fig. 4.2.1.9 16 X 2 LCD Display

FEATURES

- Input voltage: 5v
- E-blocks compatible
- Low cost
- Compatible with most I/O ports in the E-Block range
- Ease to develop programming code using Flow code

4.2.1.10 LDR SENSOR

GENERAL DESCRIPTION

An **LDR sensor (Light Dependent Resistor)** is a device that is used to detect light. It has a (variable) resistance that changes with the light intensity that falls upon it. This allows them to be used in light sensing circuits.

They are used in many consumer products to determine the intensity of light.An LDR or light dependent resistor is also known as a photoresistor, photocell, photoconductor.

It is one type of resistor whose resistance varies depending on the amount of light falling on its surface. When the light falls on the resistor, the resistance changes. To sense the presence of light these resistors are often used.

These resistors have many functions and resistances.For instance, when the LDR is in darkness, then it can be used to turn ON the light or to turn OFF the light when it is in the light.

WORKING OF LDR

The working principle of an LDR sensor is fascinating. Also known as a Light Dependent Resistor, it operates based on the variation in light intensity that falls on its surface. When exposed to light, the resistance of the LDR decreases, allowing current to flow through it.This change in resistance is utilized by electronic circuits to determine the light levels in a given environment. The sensor's sensitivity can be adjusted by varying factors such as material composition and size.

LDR sensors are commonly used in various applications including street lights, camera exposure control, and automatic night lights. By detecting changes in ambient light conditions, they help automate processes that rely on light detection.

LDR PINOUT

The pinout typically consists of two pins: one for power (Vcc) and another for ground (GND). These pins provide the necessary voltage for the sensor to function effectively.

The **bigger** one wire is ***+ve*** of LDR and the other is ***-ve***.

SPECIFICATIONS OF LDR

When it comes to the specifications of an LDR sensor, there are key factors to consider. The resistance range is crucial, typically ranging from a few hundred ohms in bright light to several megaohms in darkness.

The spectral response indicates the sensitivity of the sensor to different wavelengths of light, with variations depending on the materials used in its construction.

Moreover, the rise and fall time of an LDR sensor determines how quickly it can adjust to changes in light intensity. This parameter is significant for applications requiring fast response times.

Additionally, the power consumption of an LDR sensor should be taken into account, especially for battery-operated devices where energy efficiency is vital.

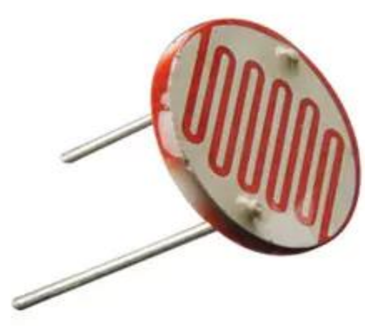
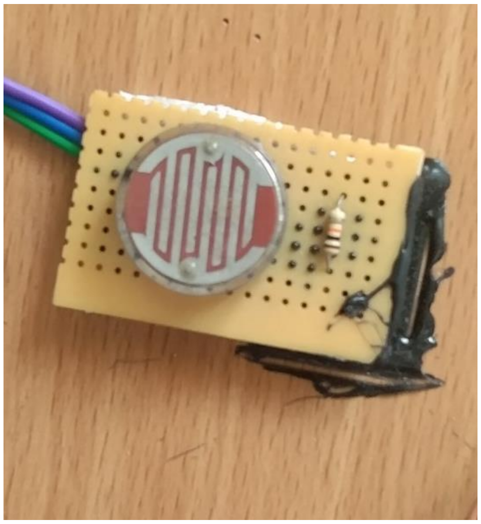

Fig. 4.2.1.10 LDR Sensor

4.2.1.11 RACK AND PINION

GENERAL DESCRIPTION

A **rack and pinion** is a type of linear actuator that comprises a circular gear (the *pinion*) engaging a linear gear (the *rack*). Together, they convert between rotational motion and linear motion. Rotating the pinion causes the rack to be driven in a line. Conversely, moving the rack linearly will cause the pinion to rotate. A rack-and-pinion drive can use both straight and helical gears.

Though some suggest helical gears are quieter in operation, no hard evidence supports this theory. Helical racks, while being more affordable, have proven to increase side torque on the datums, increasing operating temperature leading to premature wear. Straight racks require a lower driving force and offer increased torque and speed per fraction of gear ratio which allows lower operating temperature and lessens viscal friction and energy use. The maximum force that can be transmitted in a rack-and-pinion mechanism is determined by the torque on the pinion and its size, or, conversely, by the force on the rack and the size of the pinion.

Fig. 4.2.1.11 Rack and Pinion

4.2.1.12 WATER PUMP

GENERAL DESCRIPTION

This is a low cost mini submersible type water pump that works on 3-6V DC. It is extremely simple and easy to use. Just immerse the pump in water, connect a suitable pipe to the outlet and power the motor with 3-6V to start pumping water. Great for building science projects, fire-extinguishers, fire fighting robots, fountains, waterfalls, plant watering systems etc.

This motor is small, compact and light. It can be controlled from a micro controller/Arduino using our DC Motor Drivers or one of our Relay Boards. You may use our 5V SMPS Power Supply Adapter to run this pump. You may also use our 6V Solar Panel to run the pump with appropriate a 6V voltage regulator.

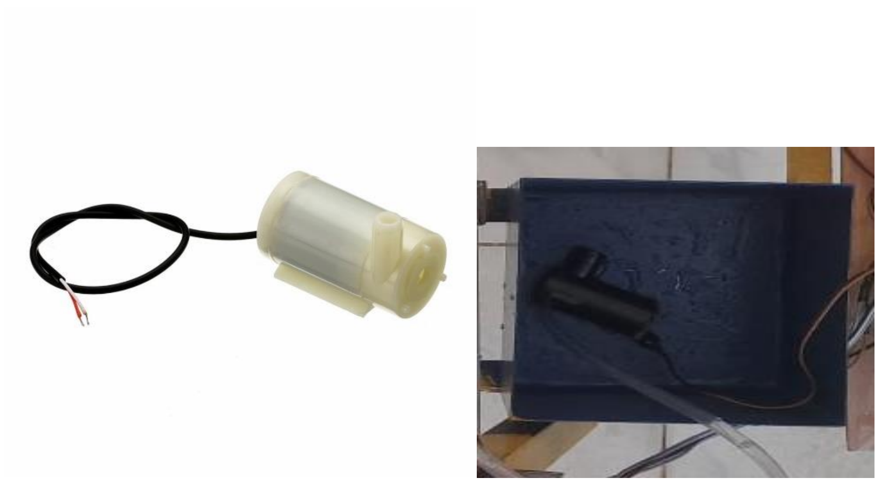

Fig. 4.2.1.12 Submersible type Water Pump

FEATURES

- Operating DC Voltage: 2.5-6V
- Maximum Water lift height: 40-110cm / 15.75"-43.4"
- Flow rate: 80-120L/H
- Outer Diameter of Water Outlet: 7.5mm / 0.3"
- Inside Diameter of Water Outlet: 5mm / 0.2"
- Pump Diameter: Approx. 24mm / 0.95"
- Pump Length: Approx. 45mm / 1.8"
- Pump Height: Approx. 30mm / 1.2"
- Wire Length: ~13mm cm

APPLICATIONS

- Great for building science projects, fire-extinguishers, fire fighting robots, fountains, waterfalls, plant watering systems etc.
- Controlled fountain water flow
- Controlled Garden watering systems
- Hydroponic Systems
- Fresh water intake or exhaust systems for fish aquqriums

4.2.1.12 WATER TANK

- Water Tank is used for storing the water ,which is used for cleaning the solar panel.

Fig. 4.2.1.12 Water Tank

4.2.1.12 ROTATING BRUSH

- Rotating brush is of various type from fiber to cloth .we have decided to go with cloth type rotating brush for better cleaning and it’s efficiency is high.

Fig. 4.2.1.12 Rotating Brush

4.3 SOFTWARE REQUIREMENTS

- MPLAB-IDE.
- EMBEDDED C.

4.3.1 SOFTWARE DESCRIPTION

4.3.1.1 MP LAB

MPLAB is a proprietary freeware integrated development environment for the development of embedded applications on PIC and dsPIC microcontrollers, and is developed by Microchip Technology. MPLAB and MPLAB X support project management, code editing, debugging and programming of Microchip 8-bit PIC and AVR (including ATMEGA) microcontrollers, 16-bit PIC24 and dsPIC microcontrollers, as well as 32-bit SAM (ARM) and PIC32 (MIPS) microcontrollers.

MPLAB is designed to work with MPLAB-certified devices such as the MPLAB ICD 3 and MPLAB REAL ICE, for programming and debugging PIC microcontrollers using a personal computer. PICKit programmers are also supported by MPLAB.

MPLAB X supports automatic code generation with the MPLAB Code Configurator and the MPLAB Harmony Configurator plugins.

Early models of PIC had read-only memory (ROM) or field-programmable EPROM for program storage, some with provision for erasing memory. All current models use flash memory for program storage, and newer models allow the PIC to reprogram itself. Program memory and data memory are separated. Data memory is

8-bit, 16-bit, and, in latest models, 32-bit wide. Program instructions vary in bit-count by family of PIC, and may be 12, 14, 16, or 24 bits long. The instruction set also varies by model, with more powerful chips adding instructions for digital signal processing functions.

The hardware capabilities of PIC devices range from 6-pin SMD, 8-pin DIP chips up to 144-pin SMD chips, with discrete I/O pins, ADC and DAC modules, and communications ports such as UART, I2C, CAN, and even USB. Low-power and high-speed variations exist for many types.

The manufacturer supplies computer software for development known as MPLAB X, assemblers and C/C++ compilers, and programmer/debugger hardware under the MPLAB and PICKit series. Third party and some open-source tools are also available. Some parts have in-circuit programming capability; low-cost development programmers are available as well as high-production programmers.

PIC devices are popular with both industrial developers and hobbyists due to their low cost, wide availability, large user base, extensive collection of application notes, availability of low cost or free development tools, serial programming, and re-programmable Flash-memory capability.

4.3.1.2 EMBEDDED C

Embedded C is a set of language extensions for the C programming language by the C Standards Committee to address commonality issues that exist between C extensions for different embedded systems.

Historically, embedded C programming requires nonstandard extensions to the C language in order to support exotic features such as fixed-point arithmetic, multiple distinct memory banks, and basic I/O operations. In 2008, the C Standards Committee extended the C language to address these issues by providing a common standard for all implementations to adhere to. It includes a number of features not available in normal C, such as fixed-point arithmetic, named address spaces and basic I/O hardware addressing. Embedded C uses most of the syntax and semantics of standard C, e.g., main() function, variable definition, data type declaration, conditional statements (if, switch case), loops (while, for), functions, arrays and strings, structures and union, bit operations, macros, etc

4.3.1.2 OPERATION CODE

```
#include<pic.h>

#include<htc.h>



void UART_INIT();

void uart_sendstring(unsigned char *str);

void uart_sendchar(unsigned char a);

char UART_getchar();


void Delay1();

void delay();

void Delay2();



#define lcd PORTB

#define rs RD6

#define en RD7
```

```
#define ir1 RD0

#define ir2 RD1

#define relay1 RC0

#define relay2 RC1

#define relay3 RC2

#define relay4 RC3



void lcd_data(unsigned char a);

void lcd_com(unsigned char a);

void lcd_str(unsigned char *a);

void lcd_init();



void ADC_Init();

unsigned int ADC_Read(unsigned char channel);

void val(unsigned int re);

void val1(unsigned int re);

void val2(unsigned int re);
```

```
void Delay(unsigned int s)

{



for(i=0;i<s;i++)

for(j=0;j<10555;j++);

}

void Delay1()

{



for(i=0;i<20;i++)

for(j=0;j<1075;j++);

}

void Delay2()

{



for(i=0;i<50000;i++);

}

void main()
```

```
{
TRISB=0X00;
PORTB=0X00;
TRISC=0x80;
PORTC=0X00;
TRISD=0X03;
PORTD=0X00;
UART_INIT();
lcd_init();
ADC_Init();
lcd_com(0x80);
lcd_str("    WELCOME   ");
__delay_ms(3000);
lcd_com(0x01);
lcd_com(0x80);
lcd_str("  SOLAR PANEL     ");
lcd_com(0xC0);
lcd_str(" CLEANING ROBOT   ");
__delay_ms(1000);
```

```
lcd_com(0x01);
lcd_com(0x80);

while(1)
{
n1=ADC_Read(0);
n2=ADC_Read(1);
n3=ADC_Read(3);
n4=ADC_Read(2);

n2=ADC_Read(1);
lcd_com(0x80);
lcd_str("L=");
n2=n2*0.0977;
val(n2);
__delay_ms(500);

n1=ADC_Read(0);
lcd_com(0x88);
```

```
lcd_str("V=");

n1=n1*1.466;

val2(n1);



n3=ADC_Read(3);

lcd_com(0xC0);

lcd_str("T=");

n3=n3-30;

val(n3);

__delay_ms(500);



n4=ADC_Read(2);

lcd_com(0xC8);

lcd_str("H=");

n4=n4*0.0977;

val(n4);

__delay_ms(500);
```

```
if(n2<20)

{

if (ir1==0)

{

lcd_com(0xCE);

lcd_str("UP");

relay1=1;

relay2=0;

relay3=1;

relay4=0;

__delay_ms(1100);

}


if (ir2==0)

{

lcd_com(0xCE);

lcd_str("DOWN");

relay1=0;
```

```
relay2=1;
relay3=1;
relay4=0;
__delay_ms(1100);
}
}

else
{
relay1=0;
relay2=0;
relay3=0;
relay4=0;
}

}
}
```

```
void UART_INIT()
{
TXSTA=0X24;
RCSTA=0X90;
TXREG=0X00;
RCREG=0X00;
SPBRG=0X81;


}


void uart_sendstring(unsigned char *str)
{
while(*str)
{
uart_sendchar(*str++);
for(i=0;i<2000;i++);
}
```

```
}

void uart_sendchar(unsigned char a)
{
while(!TXIF);
TXREG=a;
}

char UART_getchar()
{
while(RCIF == 0);
   return RCREG;
}

void lcd_init()
{
lcd_com(0x38);
lcd_com(0x0c);
```

```
lcd_com(0x06);
lcd_com(0x80);
lcd_com(0x01);
}

void lcd_com(unsigned char com)
{
lcd=com;
rs=0;
en=1;
delay();
en=0;
delay();
}
void lcd_data(unsigned char dat)
{
lcd=dat;
rs=1;
en=1;
```

```
delay();

en=0;

delay();

}

void lcd_str(unsigned char *a)

{

while(*a)

{

lcd_data(*a++);

}

}

void delay()

{

unsigned char i;

for(i=0;i<255;i++);

}


void ADC_Init()

{
```

```
  ADCON0 = 0x41;
  ADCON1 = 0xC0;


}
unsigned int ADC_Read(unsigned char channel)
{
  if(channel > 7)
  return 0;
  ADCON0 &= 0xC5;
  ADCON0 |= channel<<3;
  __delay_ms(10);
  GO_nDONE = 1;
  while(GO_nDONE);
  return ((ADRESH<<8)+ADRESL);


}



void val(unsigned int re)
```

```
{
delay(200);
d1=(re/1000);
d2=((re-d1*1000)/100);
d3=((re-(d1*1000+d2*100))/10);
d4=(re-(d1*1000+d2*100+d3*10));
lcd_data(d2+0x30);
lcd_data(d3+0x30);
lcd_data(d4+0x30);
delay(50);
}

void val2(unsigned int re)
{
delay(200);
d1=(re/1000);
d2=((re-d1*1000)/100);
d3=((re-(d1*1000+d2*100))/10);
d4=(re-(d1*1000+d2*100+d3*10));
```

```
lcd_data(d1+0x30);

lcd_data(d2+0x30);

lcd_data('.');

lcd_data(d3+0x30);

lcd_data(d4+0x30);

delay(50);

}


void val1(unsigned int re)

{

delay(200);

d1=(re/1000);

d2=((re-d1*1000)/100);

d3=((re-(d1*1000+d2*100))/10);

d4=(re-(d1*1000+d2*100+d3*10));


uart_sendchar(d1+0x30);

uart_sendchar(d2+0x30);

uart_sendchar('.');
```

```
uart_sendchar(d3+0x30);

uart_sendchar(d4+0x30);

delay(50);

}
```

CHAPTER 5

OUTPUT RESULT

OUTPUT RESULT

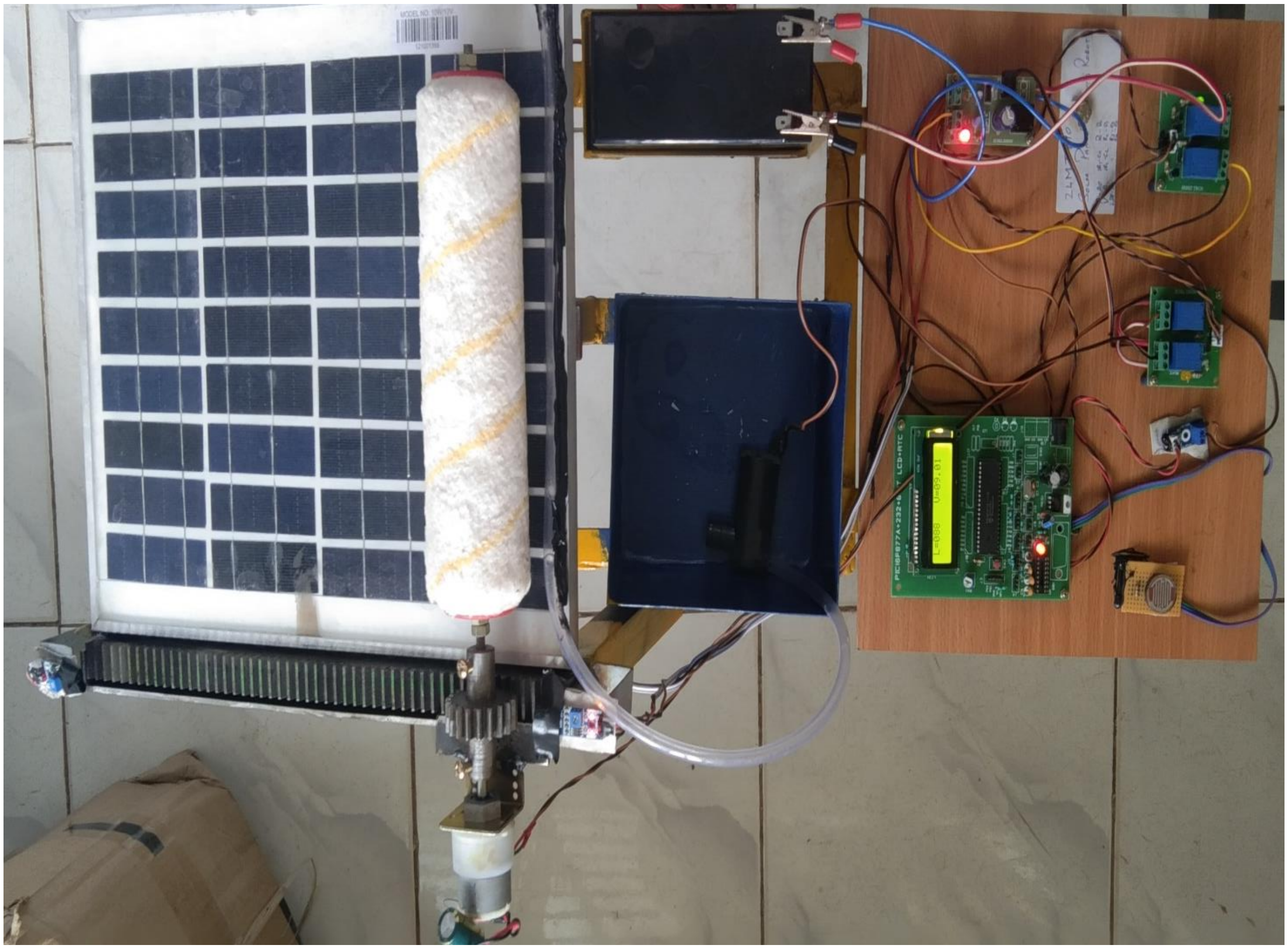

Fig.5.1 AUTOMATIC SOLAR PANEL CLEANING SYSTEM

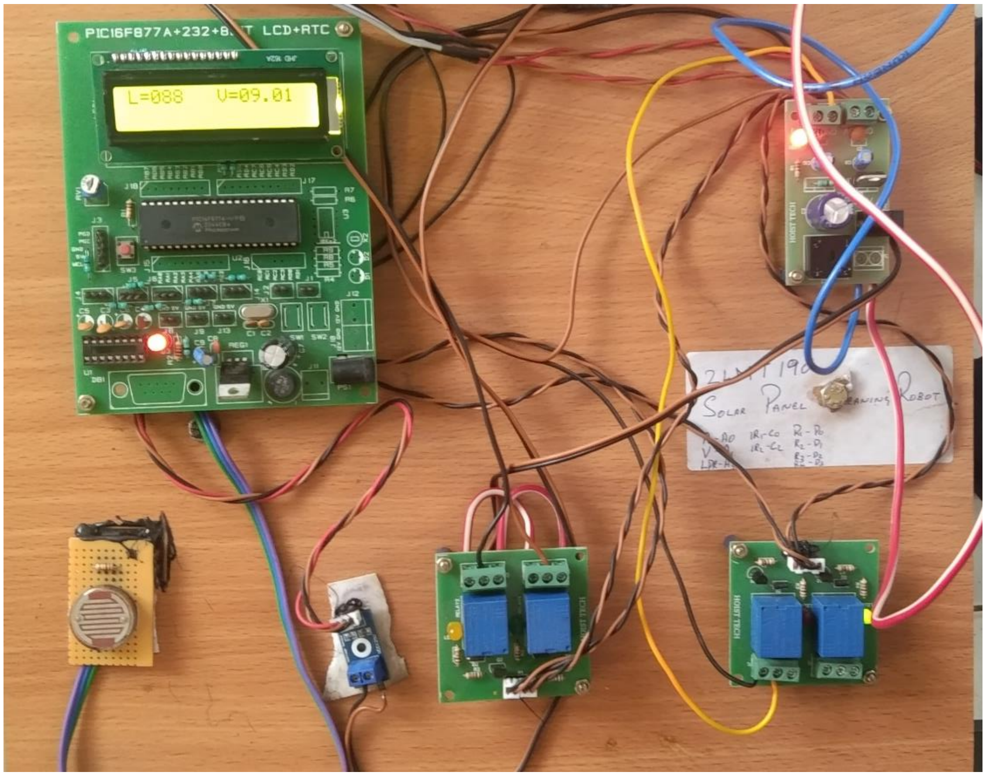

Fig.5.2 Mother Board of Automatic Solar Panel Cleaning System

CHAPTER 6

CONCLUSION

CONCLUSION

Solar power is an immense source of directly useable energy and ultimately creates other energy resources: biomass, wind, hydropower and wave energy.The result shows that the developed solar panel cleaning system is able to clean the panel effectively and increase back the output current as well as the maximum power of the panel by 50%, after the dust on the PV panel is cleaned. This paper proposes a solar energy monitoring system to collect and analyse solar energy characteristics for performance prediction and reliable power generation. There is an LDR sensor, a relay unit, and a brush involved in this project. The LDR sensor can tell if it's day or night outside. Dust on the sun's surface can be noticed in varying amounts, as their visibility is related to the sun's output. Infrared sensors check for dust and activate an oscillating wiper to clear it away.

REFERENCE

1. World Energy Outlook 2019, IEA, Paris, France, 2019.
2. Key World Energy Statistics, IEA, Paris, France, 2019.
3. Renewable Energy Options for the Industry Sector, IRENA, Abu Dhabi, United Arab Emirates, 2015.
4. Future of Solar Photovoltaic: Deployment, Investment, Technology, Grid Integration and Socio-Economic Aspects, IRENA, Abu Dhabi, United Arab Emirates, 2019.
5. (2020). The World's Biggest Solar Power Plant. [Online].
6. A. K. Mondal and K. Bansal, ''A brief history and future aspects in automatic cleaning systems for solar photovoltaic panels,'' Adv. Robot., vol. 29, no. 8, pp. 515–524, Apr. 2015.
7. M. R. Maghami, H. Hizam, C. Gomes, M. A. Radzi, M. I. Rezadad, and S. Hajighorbani, ''Power loss due to soiling on solar panel: A review,'' Renew. Sustain. Energy Rev., vol. 59, pp. 1307–1316, Jun. 2016.
8. J. R. Caron and B. Littmann, ''Direct monitoring of energy lost due to soiling on first solar modules in california,'' IEEE J. Photovolt., vol. 3, no. 1, pp. 336–340, Jan. 2013.
9. F. A. Mejia and J. Kleissl, ''Soiling losses for solar photovoltaic systems in california,'' Sol. Energy, vol. 95, pp. 357–363, Sep. 2013.
10. F. Mejia, J. Kleissl, and J. L. Bosch, ''The effect of dust on solar photovoltaic systems,'' Energy Procedia, vol. 49, pp. 2370–2376, Oct. 2014.
11. B. R. Paudyal and S. R. Shakya, ''Dust accumulation effects on efficiency of solar PV modules for off grid purpose: A case study of kathmandu,'' Sol. Energy, vol. 135, pp. 103–110, Oct. 2016.

12. D. M. Tobnaghi and D. Naderi, ‘‘The effect of solar radiation and temperature on solar cells performance,’’ Extensive J. Appl. Sci., vol. 3, no. 2, pp. 39–43, 2015.
13. S. Sargunanathan, A. Elango, and S. T. Mohideen, ‘‘Performance enhancement of solar photovoltaic cells using effective cooling methods: A review,’’ Renew. Sustain. Energy Rev., vol. 64, pp. 382–393, Oct. 2016.
14. O. Dupré, R. Vaillon, and M. A. Green, ‘‘Physics of the temperature coefficients of solar cells,’’ Sol. energy Mater. Sol. cells, vol. 140, pp. 92–100, 2015.
15. T. Salmi, M. Bouzguenda, A. Gastli, and A. Masmoudi, ‘‘Matlab/simulink based modeling of photovoltaic cell,’’ Int. J. Renew. Energy Res., vol. 2, no. 2, pp. 213–218, 2012.
16. Y. Jiang, J. A. A. Qahouq, and I. Batarseh, ‘‘Improved solar PV cell MATLAB simulation model and comparison,’’ in Proc. IEEE Int. Symp. Circuits Syst., May 2010, pp. 2770–2773.
17. V. J. Fesharaki, M. Dehghani, J. J. Fesharaki, and H. Tavasoli, ‘‘The effect of temperature on photovoltaic cell efficiency,’’ in Proc. 1st Int. Conf. Emerg. Trends Energy Conservation, Tehran, Iran, 2011, pp. 20–21.
18. M. K. Panjwani and G. B. Narejo, ‘‘Effect of humidity on the efficiency of solar cell (photovoltaic),’’ Int. J. Eng. Res. Gen. Sci., vol. 2, no. 4, pp. 499–503, 2014.
19. S. Mekhilef, R. Saidur, and M. Kamalisarvestani, ‘‘Effect of dust, humidity and air velocity on efficiency of photovoltaic cells,’’ Renew. Sustain. Energy Rev., vol. 16, no. 5, pp. 2920–2925, Jun. 2012.
20. H. A. Kazem and M. T. Chaichan, ‘‘Effect of humidity on photovoltaic performance based on experimental study,’’ Int. J. Appl. Eng. Res., vol. 10, no. 23, pp. 43572–43577, 2015.