ELECTRICITY POWER THEFT DETECTION

Submitted in partial fulfillment of the Degree of
Bachelor of Technology

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WAKNAGHAT

CERTIFICATE

This is to certify that the work titled "**Microcontroller Based Power Theft Identification"** submitted by "**Ankit Malhotra and Neha Joshi"** in partial fulfillment for the award of the degree of bachelor of technology in Electronics and Communication from **Jaypee University of Information Technology, Waknaghat** has been carried out under my supervision. This work has not been submitted partially or wholly to any other university or institute for award of this or any other degree or diploma.

Mr. Munish Sood
(Sr. lecturer)

ACKNOWLEDGEMENT

We take this opportunity as a privilege to thank all the individuals without whom this project could not be completed in appropriate time. We gratefully acknowledge the Management and the Administration of Jaypee University of Information Technology for providing us the opportunity and hence the environment to complete the project.

For providing us with the right path and optimum guidance we are thankful to our project guide **Mr. Munish sood.** He has been really helpful, motivational and instrumental while providing his support behind various complexities. We would also like to thank **Mr. Parmod Kumar** and **Mr. Mohan Sharma** for providing us with hardware requirements as per our need.

Date :

Ankit Malhotra

Neha Joshi

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ABSTRACT

Science and technology with all its miraculous advancements has fascinated human life to a great extent that imagining a world without these innovations is hardly possible. While technology is on the raising slope, we should also note the increasing immoral activities. With a technical view, "Power Theft" is a non-ignorable crime that is highly prevalent, and at the same time it directly affects the economy of a nation.

Detecting and eradicating such crimes with the assistance of the developing scientific field is the "Need of the Hour". With these views was this project is conceived and designed. Our project provides a complete and comprehensive tool to prevent power theft which is very simple to understand and easy to implement. It includes four sections - transmitting, receiving, counter display and processing sections. A microcontroller is configured which detects the theft and an alarm is blown.

We have used embedded systems, which is a combination of software, hardware and additional mechanical parts that together forms a component of a larger system, to perform a specific function. It's a technology, characterized by high reliability, restricted memory footprint and real time operation associated with a narrowly defined group of functions. Automation has made the art of living comfortable and easy. Embedded systems have made the process of automation a most successful one. Here, we have focused on automotive, an area of embedded controllers, in which we have dealt with the Power theft identification. The microcontroller chip is preprogrammed to perform a dedicated or a narrow range of functions as a part of a larger system, usually with minimal end user or operator intervention. Our project throws light on automated monitoring of theft identification, an application of embedded system.

CHAPTER-1

AN INSIGHT INTO THE WORLD OF ELECTRICTY THEFT

1.1 INTRODUCTION

"TODAY'S TECHNICIANS ARE SO FOCUSSED ON THE TREES OF TECHNOLOGICALCHANGE THAT THEY FAIL TO SEE THE FOREST; THE UNDERLYING ECONOMICFORCES THAT DETERMINE SUCCESS AND FAILURE…"

"TECHNOLOGY CHANGES, ECONOMY LAWS DO NOT"

Electricity is the modern man's most convenient and useful form of energy without which the present social infrastructure would not be feasible. The increase in per capita production is the reflection of the increase in the living standard of people. When importance of electricity is on the increasing side, then how much should theft of this energy or illegal consumption of power from the transmission lines be averted? Power theft has become a great challenge to the electricity board. The dailies report that Electricity Board suffers a total loss of 8 percent in revenue due to power theft every year, which has to be controlled. Our project identifies the Power theft and indicates it to the Electricity board.

DESCRIPTION OF OUR IMPLEMENTATION IDEAS:

The disc revolutions of the energy meter are sensed by photo diode, which are given to comparator (LM-324) that suitably controls them and gives them as input to microcontroller. This happens on both the distribution and the consumer end. Input. A count is also displayed on the seven-segment display showing the disc rotation with respect to load. The microcontroller performs the functions of indication and identification. Pin details, features, connections and software employed for microcontroller are described in detail.

1.2 MODES OF THEFT

It has been seen that there are 4 common methods of power theft as given below :-

- Bogus seals and tampering of seals.
- Meter tampering, meter tilting, meter interface and meter bypassing.
- Changing connection.
- Direct tapping from line.

Due to introduction of modern electronic metering equipment's, power thieves are utilizing more technological methods. Recent cases of power theft discovered by British inspectors included customers tunneling out to roadside mains cables and splicing into the supply, a garage taking its night time power supply from the nearest lamp post and domestic customers drilling holes into meter boxes and attempting to stop the counter wheels from turning. Another method of Power theft is by keeping a strong magnet in front of the disc in the energy meter and thus arresting the rotation of the disc, connecting the load directly to the power line bypassing the energy meter. But, it can be avoided easily by providing a non-magnetic enclosure.

1.3 MODERN DETECTING TOOLS

There are many modern tools that assist in power theft identification. Some of them are: -

- Tamper proof seals and labels.
- Meter leaders.
- Tamper resistant screws / locks.
- Check meter and remote meter readers.
- Tamper alarms and sensors

This project undertakes the Check meter and remote meter readers for power theft identification. In our case, the consumption recurred by the check meter is compared with the revenue meters consumption. If there is a difference, then it indicates either there is a theft or revenue meter malfunction. The check meter can also be used to monitor the energy used on the secondary of a distribution transformer serving several customer and compared to the sum of all the meter usage. Besides spotting out the line where power theft is suspected to occur, it also detects the amount of energy stolen. Compact size, lightweight for quick and high accuracy make the system more effective.

1.4 LIST OF COMPONENTS USED:

S.NO	NAME	QUANTITY	COLOUR	PINS
1	Microcontroller AT 89s52	2		40
2	Comparator LM-324	2		14
3	Photo-Diode	2		2
4	Crystal Oscillator	2	Silver	-
5	IC Base	2	Black	-
6	Diode	4		-
7	LED	5	White, Green	2
8	SIP resistor	2	Black	9
9	LCD			
10	Voltage Regulator LM7805	2	Black	3
11	33 pico Farad capacitor	4	Skin	-
12	Resistor	7	Brown-Black-Red-Gold	-
13	Resistor	2	Green-Blue-Orange-Gold	-
14	Resistor	2	Brown-Black-Orange-Gold	-
15	Reset Switch	2	Black and Red	-
16	10 mico Farad capacitor	2	Blue	-
17	220 micro Farad capacitor	1	Blue	

1.5 BLOCK DIAGRAM:

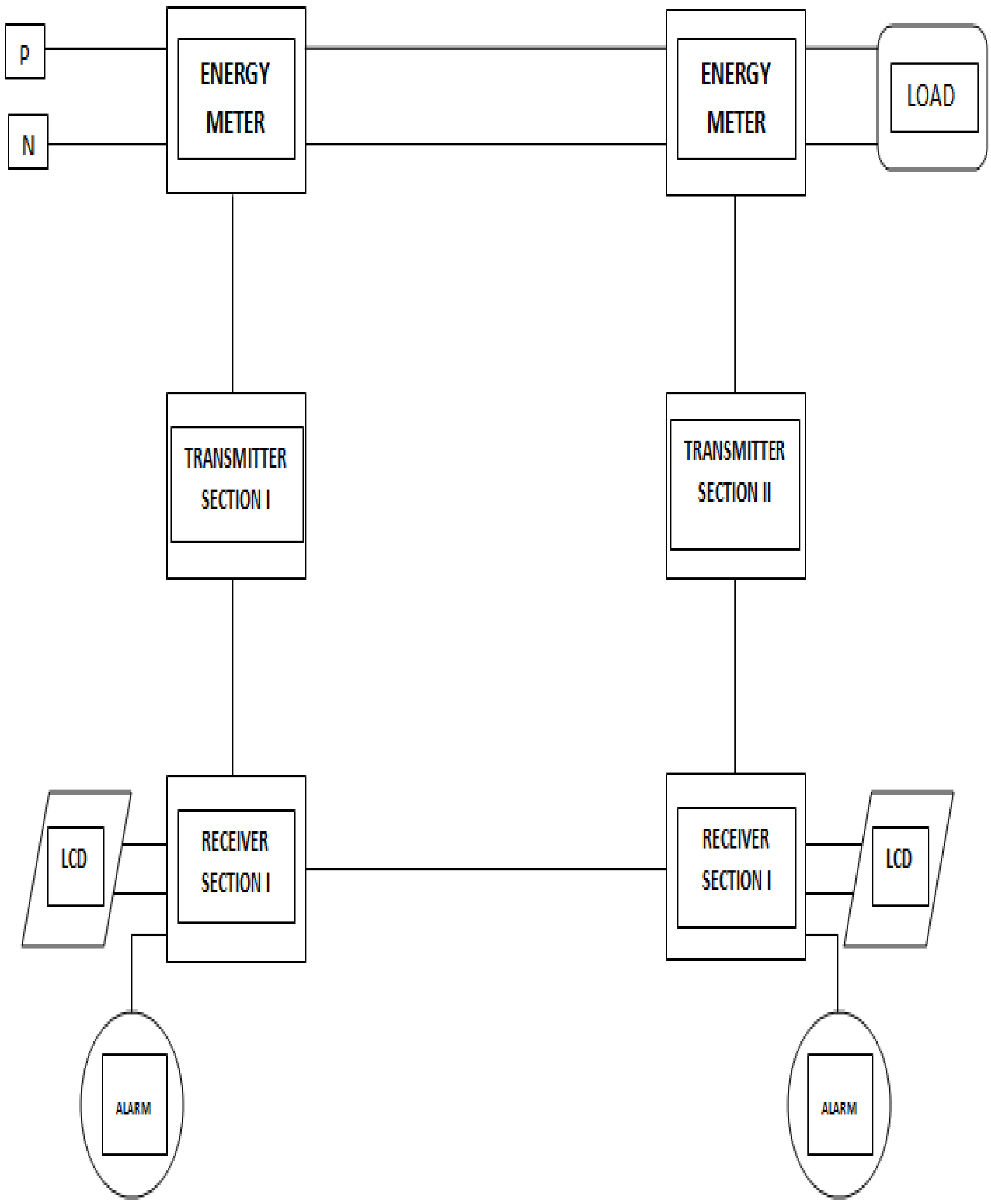

Fig 1.1 Block Diagram of our implementation of Electricity Theft Detection

CHAPTER-2

HARDWARE DESCRIPTION

The project main parts:

- Microcontroller 89c52
- Transmitter Section
- Receiver
- Mechanical Assembly
- Relay
- Step Down Transformer
- LCD or LED

2.1 8051 CONTROLLER FAMILY

INTRODUCTION:

A microcontroller is a kind of miniature computer that you can find in all kinds of gizmos. Some examples of common, everyday products that have microcontroller's built-in are shown in Figure 2.2. If it has buttons and a digital display, chances are it also has a programmable microcontroller brain. Figure 2.1; show everyday examples of devices that contain microcontrollers. Let us make a list and figure out how many devices we use in a microcontroller in our daily routine. For instance: if our clock radio goes off, and we hit the snooze button time and again then we are encountering a microcontroller. Heating up some food on the microwave oven and making a call on the cell phone also involves operating microcontrollers. That's just the beginning: Here are few more examples: operating AC with a handheld remote, playing with an XBO 360 (handheld video game),

Fig 2.1 Devices using Microcontrollers

using a calculator, and checking your digital wristwatch. All those devices have microcontroller inside them that interact with us.

Atmel 89c52 microcontroller module shown in Figure 2.2 has a microcontroller built onto it. It's the black chip with lettering on it that reads "Atmel 89c52". The rest of the components on the microcontroller module are also found in the consumer appliances we use everyday. Altogether, they are aptly called the Embedded Computer System. This name is almost always shortened to just "Embedded System". Frequently, such modules are commonly just called "Microcontrollers".

2.2 INSIDE THE MICROCONTROLLER

Block Diagram

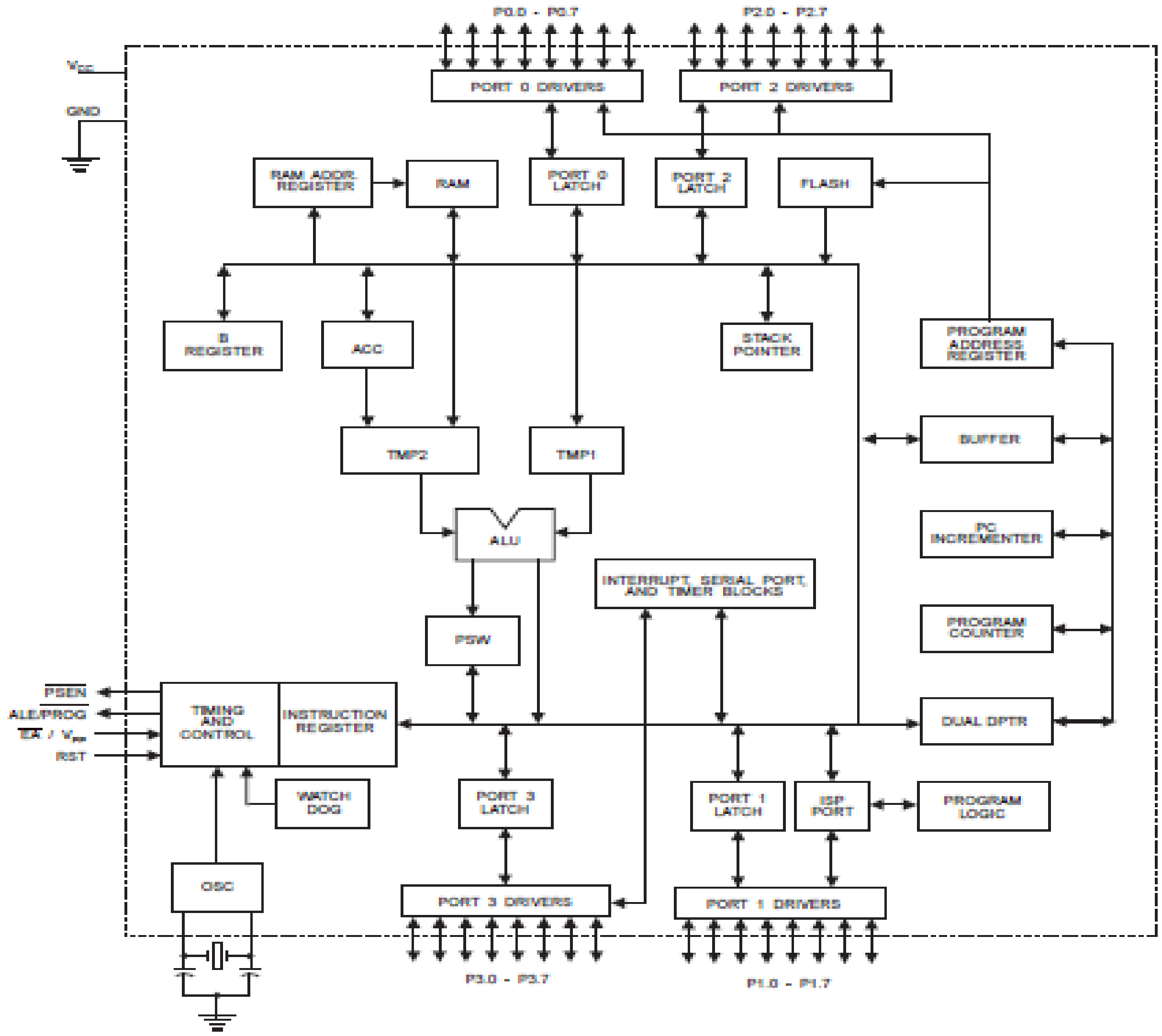

Fig 2.2 Atmel 89c52 microcontroller module (Internal Structure)

2.3 TYPES OF MICROCONTROLLER

INTEL 8051 AND IT'S FAMILY

In 1981, Intel Corporation introduced an 8-bit microcontroller called 8051. The Intel 8051 became widely popular and allowed other companies to produce any flavor of 8051 but with condition that code remains compatible with 8051. Other two members of the family are 8052 and 8031.

Some other producing members of the 8051 family are:

1. Intel
2. Atmel
3. Dallas semiconductors
4. Phillips/Signetics
5. Siemens

PIC MICROCONTROLLER (Microchip Technology)

PIC is a family of Harvard architecture microcontrollers made by Microchip Technology, derived from the PIC1640 originally developed by General Instrument's Microelectronics Division. The name PIC initially was referred to as "**Peripheral Interface Controller**".

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

2.4 89c52 PIN DIAGRAM

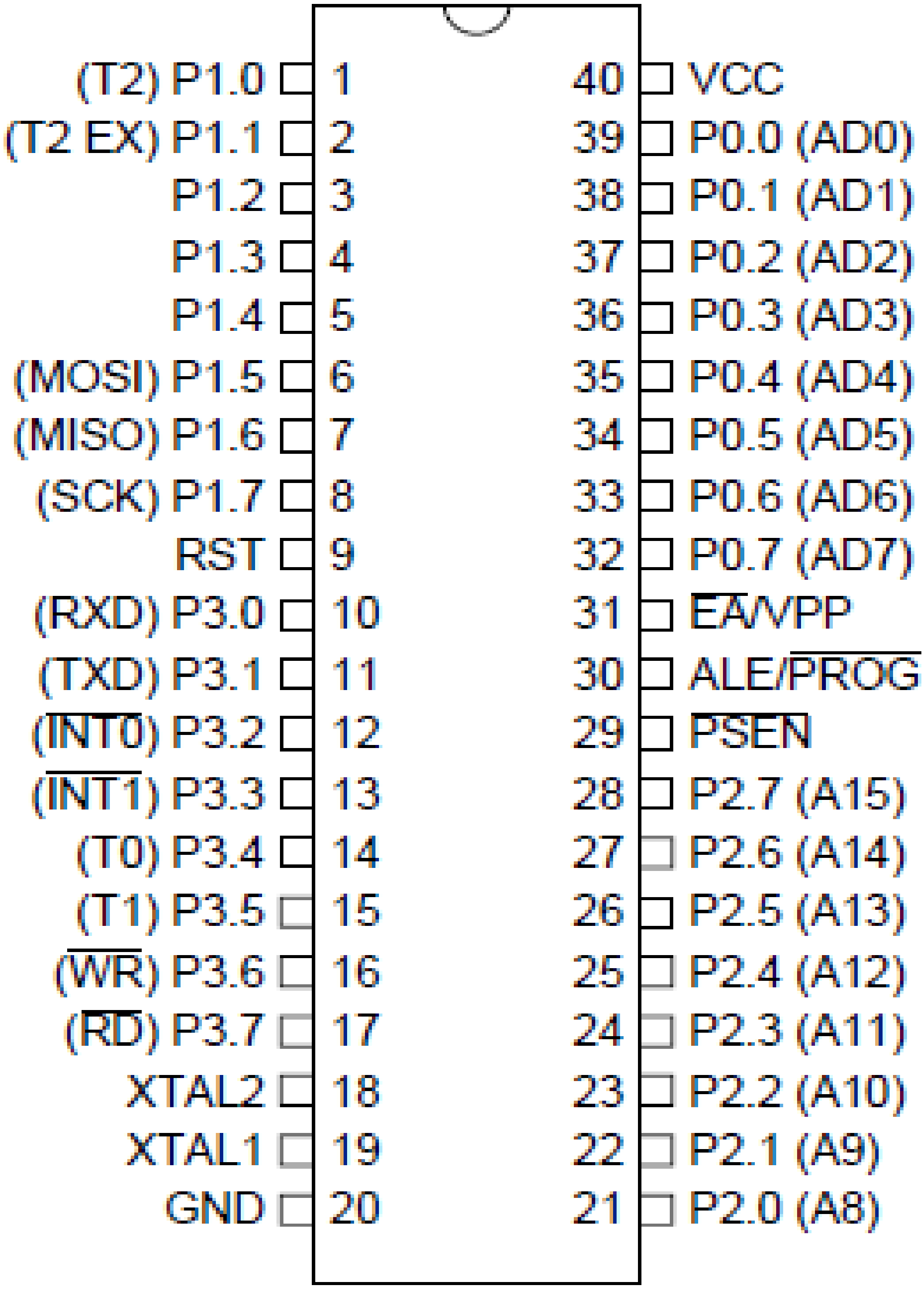

Fig 2.3 AT 89c53 Pin Diagram

2.5 PIN DESCRIPTION:

1. **VCC:** Supply voltage.

2. **GND:** Ground.

3. **Port 1:** Port 1 is a bidirectional I/O port. Port pins P1.2 to P1.7 provide internal pull-ups. P1.0 and P1.1 require external pull-ups. P1.0 and P1.1 also serve as the positive input (A1N0) and the negative input (A1N1), respectively, of the on-chip precision analog comparator. The Port 1 output buffers can sink 20 mA and can drive LED displays directly. When 1s are written to Port 1 pins, they can be used as inputs. When pins P1.2 to P1.7 are used as inputs and are externally pulled low, they will source current (IIL) because of the internal pull-ups. Port-1 also receives code data during flash programming and verification.

PORT PIN	ALTERNATE FUNCTIONS
P1.5	MOSI (Master data output, slave data input pin for ISP channel)
P1.6	MISO (Master data input, slave data output pin for ISP channel)
P1.7	SCK (Master clock output, slave clock input pin for ISP channel)

Fig 2.4 AT 89c53 Pin Description

4. **Port 3:** Port 3 pins P3.0 to P3.5, P3.6 are seven bidirectional pins with internal pull-ups. P3.6 is hard-wired as an input to the output of the on-chip comparator and is not accessible as a general purpose I/O pin. The Port 3 output buffers can sink 20 mA. When 1s are written to Port 3 pins they are pulled high by internal pull-ups. As inputs,

Port 3 pins that are externally being pulled by source current (IIL) because of pull-ups. Port 3 also serves the various special features of AT89S2051/S4051 as listed below: Port 3 also receives some control signals for Flash Programming and Verification.

5. **RST:** Reset input. Holding the RST pin high for two machine cycles while the machine is running resets the device. Each machine cycle takes 6 clock cycles.

6. **XTAL1:** Input to the inverting amplifier and input to the internal clock operating circuit.

7. **XTAL2:** Output from the inverting amplifier.

Characteristics:

XTAL1 and XTAL2 are the input and output, respectively, of an inverting amplifier which can be configured for use as an on-chip. Either a quartz crystal or ceramic resonator may be used. To drive the device from an external clock source, XTAL2 should be left unconnected while XTAL1 is on. There are no requirements on the duty cycle of the external clock signal, since the input to the internal clocking circuitry is through a divide by without flip-flop, but minimum and maximum voltage high and low specific time specifications.

2.6 PHOTO DIODE

A **photodiode** is a type of photo detector capable of converting light into either current or voltage, depending upon the mode of operation. Photodiodes are similar to regular semiconductor diodes except that they may be either exposed (to detect vacuum UV or X-rays) or packaged with a window or optical fiber connection to allow light to reach the sensitive part of the device. Many diodes designed for use specifically as a photodiode will also use a PIN junction rather than the typical PN junction.

Fig 2.5 Photo Diode

Principle of Operation

A photodiode is a p-n junction or PIN structure. When a photon of sufficient energy strikes the diode, it creates an electron-hole pair. This mechanism is also known as the inner photoelectric effect. If the absorption occurs in the junction's depletion region, or one diffusion length away from it, these carriers are swept from the junction by the built-in electric field of the depletion region. Thus holes move toward the anode, and electrons toward the cathode, and a photocurrent is produced. The total current through the photodiode is the sum of the dark current (current that is generated in the absence of light) and the photocurrent, so the dark current must be minimized to maximize the sensitivity of the device.

Photovoltaic mode

When used in zero bias or *photovoltaic mode*, the flow of photocurrent out of the device is restricted and a voltage builds up. This mode exploits the photovoltaic effect, which is the basis for solar cells – a traditional solar cell is just a large area photodiode.

Photoconductive mode

In this mode the diode is often reverse biased (with the cathode driven positive with respect to the anode). This reduces the response time because the additional reverse bias increases the width of the depletion layer, which decreases the junction's capacitance. The reverse bias also increases the dark current without much change in the photocurrent. For a given spectral distribution, the photocurrent is linearly proportional to the illuminance (and to the irradiance).

Although this mode is faster, the photoconductive mode tends to exhibit more electronic noise. The leakage current of a good PIN diode is so low (<1 nA) that the Nyquist-noise of the load resistance in a typical circuit often dominates.

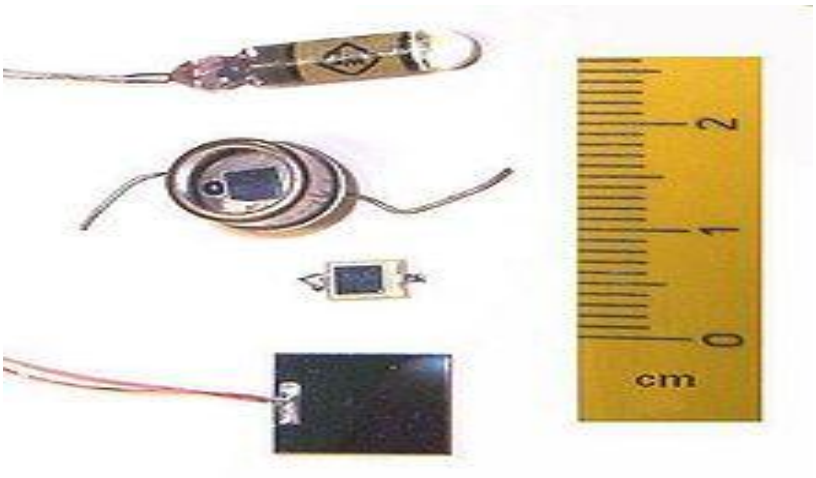

Fig 2.6 Photo Diode

2.7 LM-324

The LM124 series consists of four independent, high gain, internally frequency compensated operational amplifiers which were designed specifically to operate from a single power supply over a wide range of voltages. Operation from Split power supplies is also possible and the low power supply current drain is independent of the magnitude of the power supply voltage. Application areas include transducer amplifiers, DC gain blocks and all the conventional op amp circuits, which now can be more easily implemented in single power supply systems. For example, the LM124 series can be directly operated off of the standard +5V power supply voltage, which is used in digital systems and will easily provide the required interface electronics without requiring the additional ±15Vpower supplies.

Unique Characteristics

- In the linear mode the input common-mode voltage range includes ground and the output voltage can also swing to ground, even though operated from only a single power supply voltage.
- The unity gain cross frequency is temperature compensated.
- The input bias current is also temperature compensated

Advantages

- Eliminates need for dual supplies
- Four internally compensated op amps in a single package
- Allows directly sensing near GND and VOUT also goes to GND
- Compatible with all forms of logic
- Power drain suitable for battery operation

Features

- Internally frequency compensated for unity gain
- Large DC voltage gain 100 dB

- Wide bandwidth (unity gain) 1 MHz(temperature compensated)
- Wide power supply range:
  Single supply 3V to 32V
  Dual supplies ±1.5V to ±16V
- Very low supply current drain (700 µA) — essentially independent of supply voltage
- Low input biasing current 45 nA(temperature compensated)
- Low input offset voltage 2 mV and offset current: 5 nA
- Input common-mode voltage range includes ground
- Differential input voltage range equal to the power supply voltage
- Large output voltage swing 0V to V+ − 1.5V

2.8 CRYSTAL OSSCILLATOR

Fig 2.7 Crystal Oscillator

A crystal oscillator is an electronic oscillator circuit that uses the mechanical resonance of a vibrating crystal of piezoelectric material to create an electrical signal with a very precise frequency. This frequency is commonly used to keep track of time (as in quartz wristwatches), to provide a stable clock signal for digital integrated circuits, and to stabilize frequencies for radio transmitters and receivers. The most common type of piezoelectric resonator used is the quartz crystal, so oscillator circuits incorporating them became known as crystal oscillators, but other piezoelectric materials including polycrystalline ceramics are used in similar circuits. Quartz crystals are manufactured for frequencies from a few tens of kilohertz to tens of megahertz. More than two billion crystals are manufactured annually. Most are used for consumer devices such as wristwatches, clocks, radios, computers, and cellphones. Quartz crystals are also found inside test and measurement equipment, such as counters, signal generators, and oscilloscopes.

2.9 IC BASE

Fig 2.8 IC Base

Using an IC base saves the IC from burning due to overheat if IC is soldered directly. Also, changing an IC becomes very easy if the IC gets damaged due to some reason and once the IC- base is soldered, the IC can be easily taken out and fitted back ‘n’ number of times. Before soldering the IC-Base it should be checked that all the pins have successfully pierced the holes of the PCB and appeared on back side because sometimes the some pins are not able to pierce and get damaged in the process. The IC-Base should be carefully installed upright according to circuit, but if it gets soldered oppositely by mistake then there is no need to de-solder the IC-Base, rather the IC should be fitted in the base keeping in mind the orientation of the circuit.

2.10 DIODE

Fig 2.9 1N-4148 Diode

A diode is a semiconductor device, which allows current to flow through it in only one direction. Although a transistor is also a semiconductor device, it does not operate the way a diode does. A diode is specifically made to allow current to flow through it in only one direction.

Some ways in which the diode can be used are listed here.

A diode can be used as a rectifier that converts AC (Alternating Current) to DC (Direct Current) for a power supply device.

What is a Diode and how to work?

A diode is the simplest sort of semiconductor device. Broadly speaking, a semiconductor is a material with a varying ability to conduct electrical current. Most semiconductors are made of a poor conductor that has had impurities (atoms of another material) added to it. The process of adding impurities is called doping.

In the case of LEDs, the conductor material is typically aluminum-gallium-arsenide .In pure aluminum-gallium-arsenide; all of the atoms bond perfectly to their neighbors, leaving no free electrons (negatively-charged particles) to conduct electric current. In doped material, additional atoms change the balance, either adding free electrons or creating holes where electrons can go. Either of these additions makes the material more conductive.

A semiconductor with extra electrons is called N-type material, since it has extra negatively charged particles. In N-type material, free electrons move from a negatively charged area to a positively charged area.

A semiconductor with extra holes is called P-type material, since it effectively has extra positively charged particles. Electrons can jump from hole to hole, moving from a negatively charged area to a positively charged area. As a result, the holes themselves appear to move from a positively charged area to a negatively charged area.

A diode comprises a section of N-type material bonded to a section of P-type material, with electrodes on each end. This arrangement conducts electricity in only one direction. When no voltage is applied to the diode, electrons from the N-type material fill holes from the P-type material along the junction between the layers, forming a depletion zone. In a depletion zone, the semiconductor material is returned to its original insulating state -- all of the holes are filled, so there are no free electrons or empty spaces for electrons, and charge can't flow.

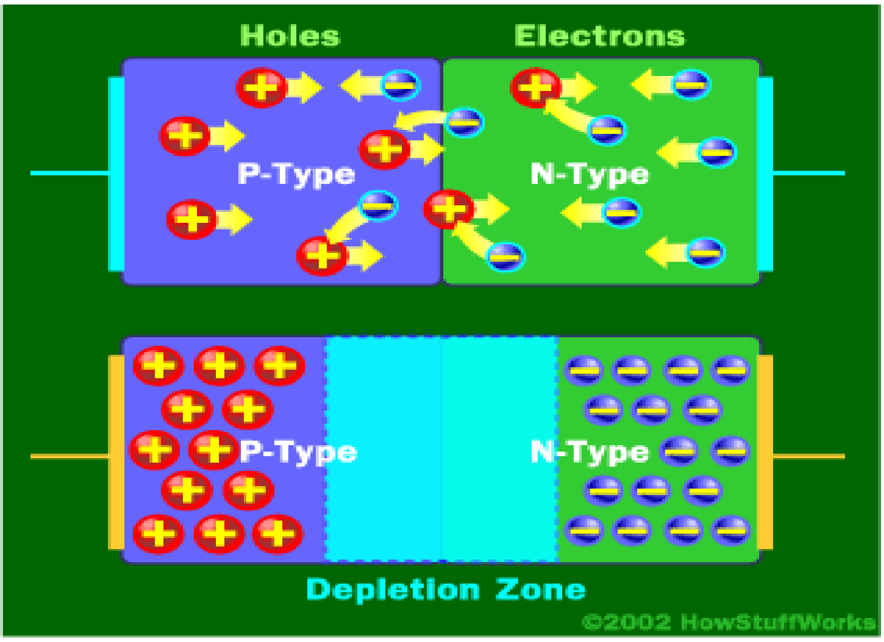

Fig 2.10 Diffusion of holes and electrons

At the junction, free electrons from the N-type material fill holes from the P-type material. This creates an insulating layer in the middle of the diode called the depletion zone. To get rid of the depletion zone, you have to get electrons moving from the N-type area to the P-type area and holes moving in the reverse direction. To do this, you connect the N-type side of the diode to the negative end of a circuit and the P-type side to the positive end. The free electrons in the N-type material are repelled by the negative electrode and drawn to the positive electrode. The holes in the P-type material move the other way. When the voltage difference between the electrodes is high enough, the electrons in the depletion zone are boosted out of their holes and begin moving freely again. The depletion zone disappears, and charge moves across the diode.

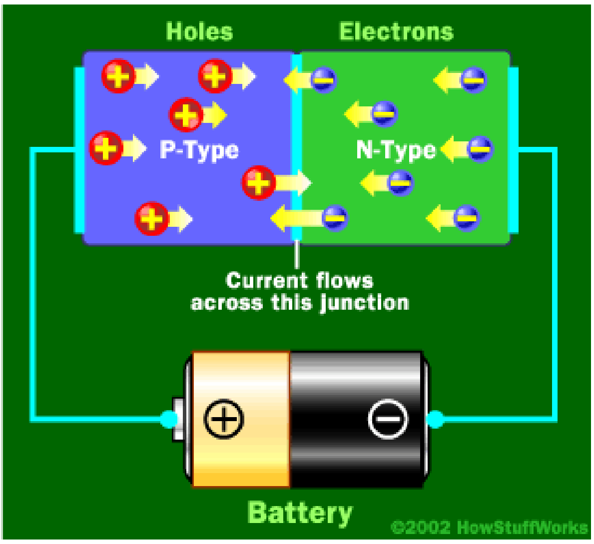

Fig 2.11 Diode connected with an external source

When the negative end of the circuit is hooked up to the N-type layer and the positive end is hooked up to P-type layer, electrons and holes start moving and the depletion zone disappears. If you try to run current the other way, with the P-type side connected to the negative end of the circuit and the N-type side connected to the positive end, current will not flow. The negative electrons in the N-type material are attracted to the positive electrode. The positive holes in the P-type material are attracted to the negative electrode. No current flows across the junction because the holes and the electrons are each moving in the wrong direction. The depletion zone increases. (See How Semiconductors Work for more information on the entire process.)

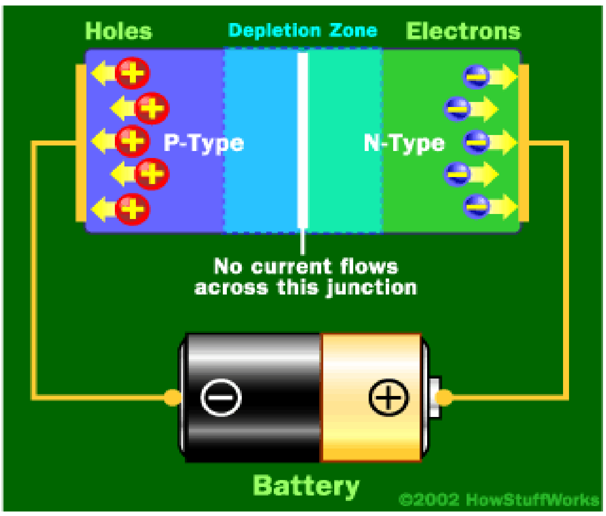

Fig 2.12 Formation of Depletion Layer

When the positive end of the circuit is hooked up to the N-type layer and the negative end is hooked up to the P-type layer, free electrons collect on one end of the diode and holes collect on the other. The depletion zone gets bigger.

The interaction between electrons and holes in this setup has an interesting side effect -- it generates light! In the next section, we'll find out exactly why this is.

2.11 LED

Fig 2.13 Light emitting Diode

What is LED?

Light emitting diodes, commonly called LEDs, are real unsung heroes in the electronics world. They do dozens of different jobs and are found in all kinds of devices. Among other things, they form the numbers on digital clocks, transmit information from remote controls, light up watches and tell you when your appliances are turned on. Collected together, they can form images on a jumbo television screen or illuminate a traffic light.

Basically, LEDs are just tiny light bulbs that fit easily into an electrical circuit. But unlike ordinary incandescent bulbs, they don't have a filament that will burn out, and they don't get especially hot. Solely the movement of electrons in a semiconductor material illuminates them, and they last just as long as a standard transistor.

How Can a Diode Produce Light?

Light is a form of energy that can be released by an atom. It is made up of many small particle-like packets that have energy and momentum but no mass. These particles, called photons, are the most basic units of light.

Photons are released as a result of moving electrons. In an atom, electrons move in orbitals around the nucleus. Electrons in different orbitals have different amounts of energy. Generally speaking, electrons with greater energy move in orbitals farther away from the nucleus.

For an electron to jump from a lower orbital to a higher orbital, something has to boost its energy level. Conversely, an electron releases energy when it drops from a higher orbital to a lower one. This energy is released in the form of a photon. A greater energy drop releases a higher-energy photon, which is characterized by a higher frequency.

As we saw in the last section, free electrons moving across a diode can fall into empty holes from the P-type layer. This involves a drop from the conduction band to a lower orbital, so the electrons release energy in the form of photons. This happens in any diode, but you can only see the photons when the diode is composed of certain material. The atoms in a standard silicon diode, for example, are arranged in such a way that the electron drops a relatively short distance. As a result, the photon's frequency is so low that it is invisible to the human eye -- it is in the infrared portion of the light spectrum. This isn't necessarily a bad thing, of course: Infrared LEDs are ideal for remote controls, among other things.

Visible light-emitting diodes (VLEDs), such as the ones that light up numbers in a digital clock, are made of materials characterized by a wider gap between the conduction band and the lower orbitals. The size of the gap determines the frequency of the photon -- in other words, it determines the color of the light.

While all diodes release light, most don't do it very effectively. In an ordinary diode, the semiconductor material itself ends up absorbing a lot of the light energy. LEDs are specially constructed to release a large number of photons outward. Additionally, they are housed in a plastic bulb that concentrates the light in a particular direction. As you can see in the diagram, most of the light from the diode bounces off the sides of the bulb, traveling on through the rounded end.

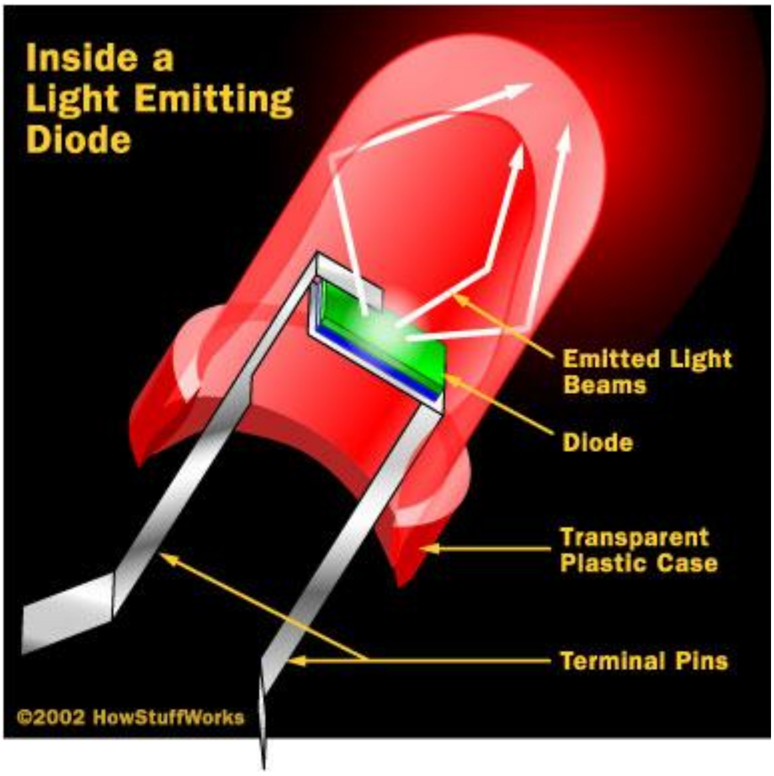

Fig 2.14 Inside an LED

LEDs have several advantages over conventional incandescent lamps. For one thing, they don't have a filament that will burn out, so they last much longer. Additionally, their small plastic bulb makes them a lot more durable. They also fit more easily into modern electronic circuits.

But the main advantage is efficiency. In conventional incandescent bulbs, the light-production process involves generating a lot of heat (the filament must be warmed). This is completely wasted energy, unless you're using the lamp as a heater, because a huge portion of the available electricity isn't going toward producing visible light. LEDs generate very little heat, relatively speaking. A much higher percentage of the electrical power is going directly to generating light, which cuts down on the electricity demands considerably.

Up until recently, LEDs were too expensive to use for most lighting applications because they're built around advanced semiconductor material. The price of semiconductor devices has plummeted over the past decade, however, making LEDs a more cost-effective lighting option for a wide range of situations. While they may be more expensive than incandescent lights up front, their lower cost in the long run can make them a better buy. In the future, they will play an even bigger role in the world of technology.

2.12 SIP RESISTOR

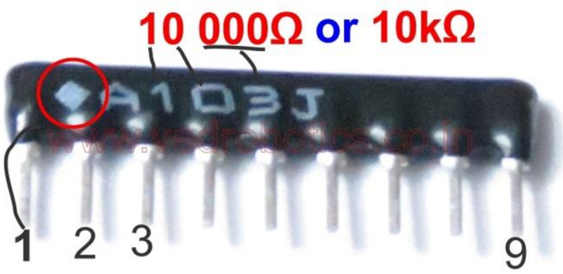

Fig 2.15 Pull Up Resistor or SIP resistor

SIP means 'single in-line package', so it is a pack of several resistors, often with one end common. The connections are a series of pins like one side of a DIP (dual in-line package) as often seen in integrated circuits. The resistors may be used for a variety of purposes, like bus terminators, resistor ladder networks, pull-ups or pull-downs, but usually in microcontroller boards.

2.13 VOLTAGE REGULATOR

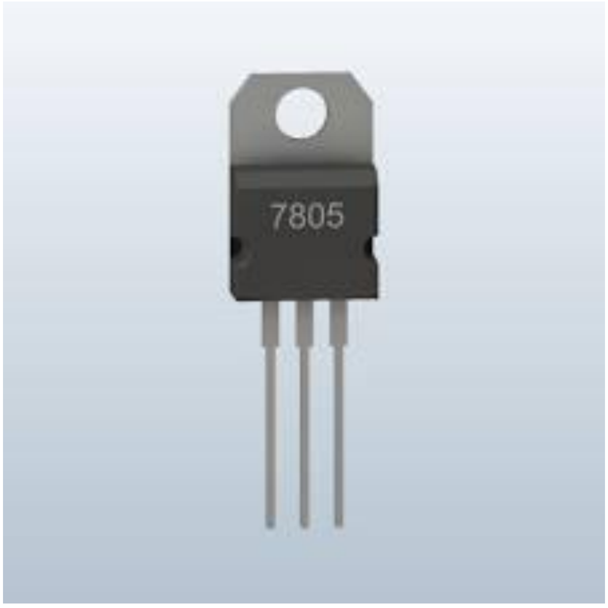

Fig 2.16 LM-7805 Voltage Regulator

A LM7805 Voltage Regulator is a voltage regulator that outputs +5 volts. An easy way to remember the voltage output by a LM78XX series of voltage regulators is the last two digits of the number. A LM7805 ends with "05"; thus, it outputs 5 volts. The "78" part is just the convention that the chipmakers use to denote the series of regulators that output positive voltage. The other series of regulators, the LM79XX, is the series that outputs negative voltage. So:

LM78XX: Voltage regulators that output positive voltage, "XX"=voltage output.

LM79XX: Voltage regulators that output negative voltage, "XX"=voltage output

The LM7805, like most other regulators, is a three-pin IC.

Pin 1 (Input Pin): The Input pin is the pin that accepts the incoming DC voltage, which the voltage regulator will eventually regulate down to 5 volts.

Pin 2 (Ground): Ground pin establishes the ground for the regulator.

Pin 3 (Output Pin): The Output pin is the regulated 5 volts DC.

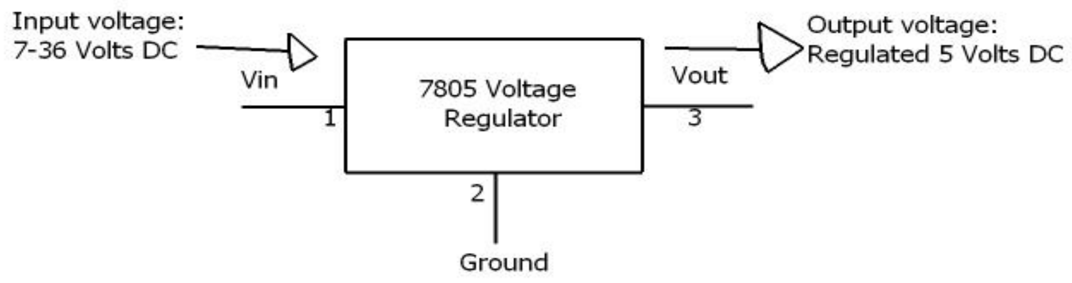

Fig 2.17 Voltage Regulator (Block Diagram)

Be advised, though, that though this voltage regulator can accept an input voltage of 36 volts, it is recommended to limit the voltage to 2-3 volts higher than the output regulated voltage. For a 5-volt regulator, no more than 8 volts should be applied as the input voltage. The difference between the input and output voltage appears as heat. The greater the difference between the input and output voltage, the more heat is generated. If too much heat is generated, through high input voltage, the regulator can overheat. If the regulator does not have a heat sink to dissipate this heat, it can be destroyed and malfunction. So the two options are, design your circuit so that the input voltage going into the regulator is limited to 2-3 volts above the output regulated voltage or place a heat sink in your circuit to dissipate the created heat.

Key Features

- Output current up to 1.5 A
- Output voltages of 5; 6; 8; 8.5; 9; 12; 15; 18; 24 V
- Thermal overload protection
- Short circuit protection
- Output transition SOA protection
- 2 % output voltage tolerance (A version)
- Guaranteed in extended temperature range (A version)

CHAPTER-3

ENERGY METER

3.1 INTRODUCTION

An electric meter or energy meter is a device that measures the amount of electrical energy supplied to or produced by a residence, business or machine. Electricity is a clean, convenient
Way to deliver energy. The electricity meter is how electricity providers measure billable services. The most common type of meter measures kilowatt-hours. When used in electricity retailing, the utilities record the values measured by these meters to generate an invoice for the electricity. They may also record other variables including the time when electricity was used.

Since it is expensive to store large amounts of electricity, it must usually be generated, as it is needed. More electricity requires more generators, and so providers want consumers to avoid causing peaks in consumption. Electricity meters have therefore been devised that encourage users to shift their consumption of power away from peak times, such as mid afternoon, when many buildings turn on air conditioners .For these applications, meters measure demand, the maximum use of power in some interval. In some areas, the meters charge more money at certain times of the day to reduce use. Also in some areas meters have relays to turn off non-essential equipment. Providers are also concerned about efficient use of their distribution network. So, they try to maximize the delivery of billable power. This includes methods to reduce tampering with meters.

Also the network has to be upgraded with thicker wires, larger transformers or more generators if the parts of it become too hot from excessive currents. The currents can be caused either by real power, in which the waves of voltages and currents coincide, or apparent power in which waves of currents and voltages do not overlap, and so cannot deliver power

Since the providers can only collect money for real power, they try to maximize the amount of real power delivered by their networks. Therefore the distribution networks always incorporate electricity meters that measure apparent power, usually by displaying or recording power factors or volt-amp-reactive-hours. Many industrial power meters can measure volt-amp-reactive hours

Unit of Measurement

Panel-mounted solid-state electricity meter, connected to a 2MVa electricity substation. Remote current and voltage sensors can be read and programmed remotely by modem and locally by infrared. The circle with the two dots is the infrared port. Tamper-evident seals can be seen. The most common unit of measurement on the electricity meter is kilowatt-hour, which is equal to the amount of energy used by load of one kilowatt over a period of one hour, or 3,600,000 joules. Some electricity companies use the SI mega joule instead. Demand is normally measured in watts, but averaged over a period, most often a quarter or half-hour.

Reactive power is measured in “ volt-amperes reactive”, (varh) in killovar-hours. A “lagging” or inductive load, such as a motor, will have negative reactive power. A “leading” or capacitive load will have positive reactive power.

Volt-amperes measures all power passed through a distribution network, including reactive and actual. This is equal to the product of root-mean-square volts and amperes. Distortion of the electric current by loads is measured in several ways. Power factor is the ratio of resistive (or real power) to volt-amperes. A capacitive load has a leading power factor, and an inductive load has a lagging power factor. A purely resistive load (such as a filament lamp, heater or kettle) exhibits a power factor of 1. Current harmonics are measure of distortion of the waveform. For example, electronic loads such as computer power supplies draw their current at voltage peak to fill their internal storage elements. This can lead to a significant voltage drop near the supply voltage peak, which shows as a flattening of the voltage waveform. This flattening causes odd harmonics, which are not permissible if they exceed specific limits, as they are not wasteful, but they may interfere with the operation of other equipment. Harmonic emissions are mandate d by law in EU and other countries to fall with in specified limits.

Other units of measurement

In addition to metering based on the amount of energy used, other types of metering are available. Meters that measured the amount of charge (coulombs) used, known as ampere-hour meters, which were used in early days of electrification. These were dependent upon the supply voltage remaining constant for accurate measurement of energy usage, which wasnot a likely circumstance with most supplies.

3.2 TYPES OF METERS

The Mechanism of electromechanical induction meter includes

1. Voltage coil - many turns of fine wired encased in plastic, connected in parallel with load.
2. Current coil - three turns of thick wire, connected in series with load.
3. Stato - concentrates and confines magnetic field.
4. Aluminum rotor disc
5. Rotor break magnets
6. Spindle with worm gear
7. Display dials- notes that 1/10, 10 and 1000 dials rotate clockwise while the 1,100 and 10,000 rotate counter clockwise.

Modern electricity meters operate by continuously measuring the instantaneous voltage and current and finding the product of these to give instantaneous electrical power which is then integrated against time to give energy used (joules, kilowatt-hours etc.). The meters fall in to two basic categories

Electromechanical Meters

Fig 3.1 Electromechanical Meter

It is a device that measures the amount of energy consumed by an electrically operated device.

The key point: metering is based on the product of two electrical entities current “I” and voltage “V”; power is the product of these two entities, V and I. Energy is calculated integrating over time (that is adding together time after time) the V*I products. This mechanical electricity meter has every other dial-rotating counter clock-wise; the most common type of electricity meter is the Thomson or electromechanical induction watt-hour meter, invented by Elihu Thomson in 1888.

Electromechanical technology

The electromechanical induction meter operates by counting the revolutions of an aluminum disc, which is made to rotate at a speed proportional to the energy usage. It consumes a small amount of power, typically around 2 watts.

Two coils act upon the metallic disc. One coil is connected in such a way that it produces a magnetic flux in proportion to the voltage and the other produces in proportion to the current. The field of the voltage coil is delayed by 90 degrees using a lag coil. This produces eddy currents in the disc and the effect is such that a force is exerted on the disc in proportion to the product of instantaneous current or voltage. A permanent magnet exerts an opposing force proportional to the product of instantaneous current and voltage. A permanent voltage exerts an opposing force proportional to the power being used. The disc drives a register mechanism, which integrates the speed of the disc over time by counting revolutions, much like the odometer we have in our car, in order to render a measurement of the total energy used over a period of time.

Reading electromechanical meters

Three-phase electromechanical induction meter, metering 100A 230/400 V supply. Horizontal aluminum disc is visible in center of the meter. The disc is supported by a spindle, which has a worm gear, which drives the register. The register is a series of dials, which record the amount of energy used. The dials may be of the cyclometer type, an odometer-like display that is easy to read where for each dial a single digit is shown through a window in the face of the meter, or of the pointer type where a pointer indicates each digit. With the dial pointer type, adjacent pointers generally rotate in opposite directions due to the gearing mechanism. The amount of energy represented by one revolution of the disc is denoted by the symbol Kh that is given in units of watt-hours per revolution. The value 7.2 is commonly seen. Using the value of Kh one can determine their power consumption at any given time by timing the disc with a stopwatch. For example, if Kh = 7.2 as above, and one revolution took place in 14.4 seconds, the power is 1800 watts. This method can be used to determine the power consumption of household devices by switching them on one by one.

Most domestic electricity meters must be read manually, whether by a representative of the power company or by the customer. Where the customer reads the meter, the reading may be supplied to the power company by telephone or post over the Internet. The electricity company will normally require a visit by a company representative at least annually in order to verify customer-supplied readings and to make a basic safety check of the meter.

Electromechanical Accuracy

In an induction type meter, creep is a phenomenon that can adversely affect accuracy that occurs when the meter disc rotates continuously with potential applied and the load terminals open circuited. A test for error due to creep is called a creep test.Two standards govern meter accuracy, ANSI C12.20 for North America and IEC 62053

Solid State Meters

Some newer electricity meters are solid state and display the power used on an LCD, while newer electronic meters can be read automatically. In addition to measure the electricity used, solid state meters can also record other parameters of the load and supply such as maximum demand, power factor and reactive power used etc. They can also include electronic clock mechanisms to compute a value, rather than the amount of electricity consumed, with the pricing varying by time of the day, day of the week and seasonally

Fig 3.2 Solid state Meter

Solid State technology

Most solid-state meters use a current transformer to measure the current. This means that the main current carrying conductors need not pass through the meter itself

And so on the meter can be located remotely from the main current carrying conductors, which is particular advantage in large-power installations. It is also possible to use remote current transformers with electromechanical meters though this is less common.

Communication technologies

Remote meter reading is a practical example of telemetry. It saves the cost of a human reader and the resulting mistakes, but it also allows more measurements, and remote provisioning. Many smart meters now include a switch to interrupt or restore service.

Historically, routing meters could report their power information, using a pair of contact closures attached to a KYZ line. In a KYZ interface, the Y and Z wires are switch contacts, shorted to k for half of a rotor's circumference. To measure the rotor direction, the z signal is offset by 90 degree from the Y. When the rotor rotates in the opposite direction, showing export of power, the sequence reverses. The time between pulses measure the demand. The number of pulses is total power usage

KYZ outputs were historically attached to "totalizer relays "feeding a "totalizer" so that many meters could be read all at once in one place. KYZ outputs are also the classic way of attaching electric meters to programmable logic controllers, HVACs or other control systems. Some modern meters also supply a contact closure that warns when the meter detects a demand near a higher tariff.

Some meters have an open collector output that gives 32-100ms pulses for a constant amount of used electrical energy. That usually counts 1000-10000 pulses per kWh. Output is limited to max 27 V DC and 27mA DC. The output usually follows the DIN 43864 standard.

Often, meters designed for semi-automated reading have a serial port on that which communicates by infrared LED through the faceplate of the meter. In some apartment buildings, a similar protocol are used, but in a wired bus using a serial current loop to connect all the meters to a single plug. The plug is often near the mailboxes. In the European Union, the most common infrared and protocol is "FLAG", a simplified subset of mode C of IEC 61107. In the United States and Canada, the favored infrared

Protocol is ANSI C12.18. Some industrial meters use a protocol for programmable logic controllers (Modbus).

The most modern protocol proposed for this purpose is DLM/COSEM, which can operate over any medium, including serial ports. The data can be transmitted by Zigbee, Wi-Fi, and telephone lines or over the power lines themselves. Some meters can be read over the Internet.

Automatic reading

AMR (Automatic Meter Reading) and RMR (Remote Meter Reading) describe various systems that allow meters to be checked with out the need to send a meter read out. This can be effectively achieved using off-site metering, that is an electronic meter placed at the junction point where all the connections originate, inaccessible to the end-user, and it relays the readings via the AMR technology to the utility.

3.3 INTERFACING OF METER WITH AT 89c52

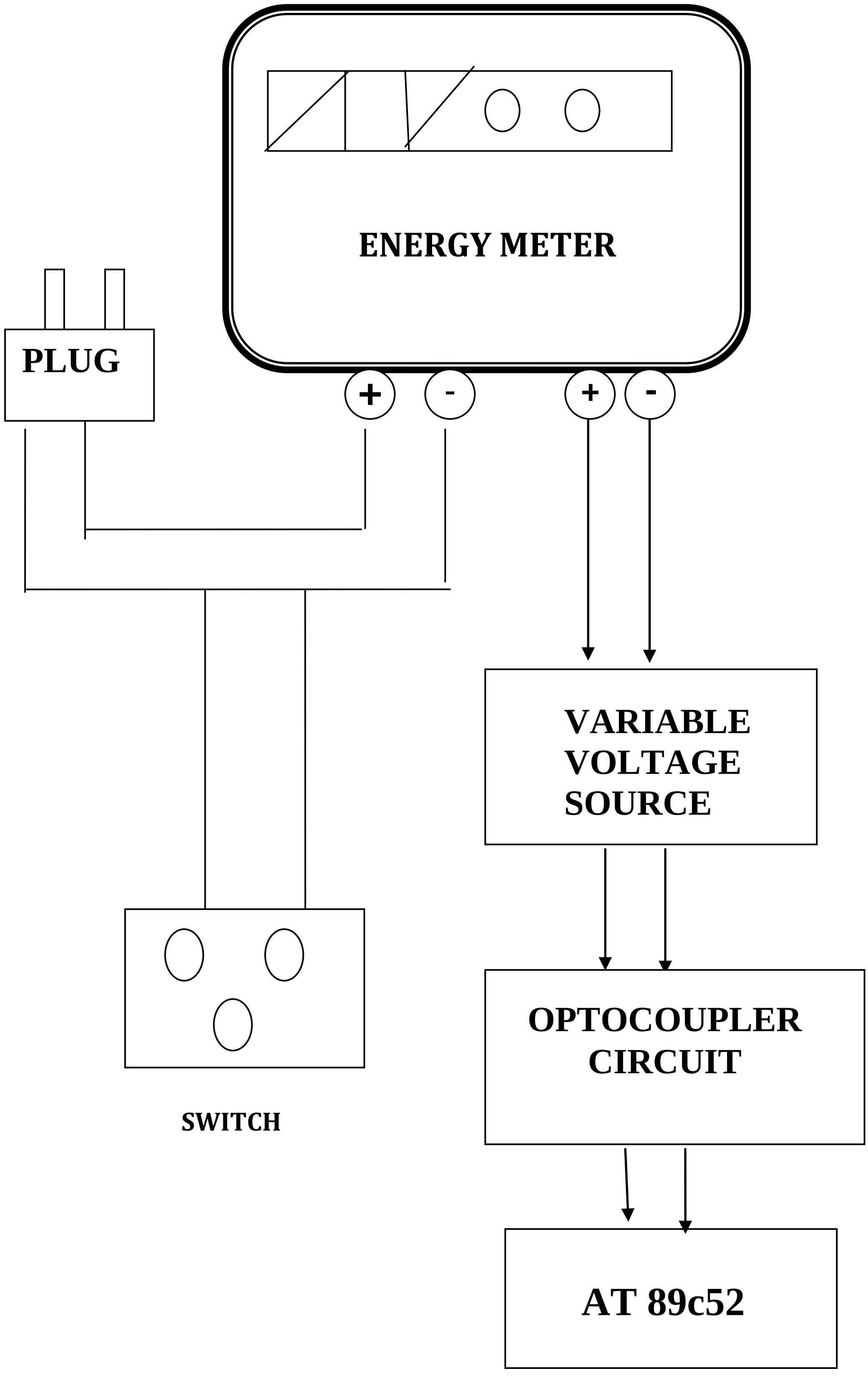

Fig 3.3 Interfacing Block Diagram

CHAPTER – 4

POWER THEFT DETECTION

The power theft is identified comparing the readings evaluated from the check meter at the distribution frame and the revenue meter at the consumer end.

4.1 SENSING THE CONTROL SIGNAL

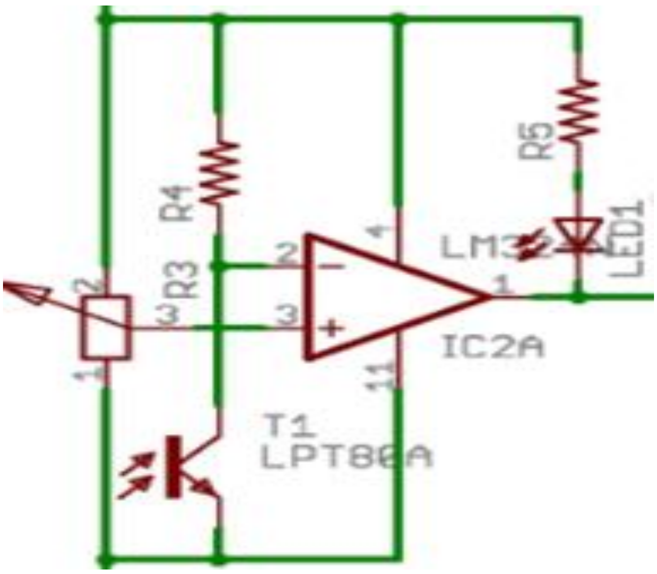

Fig 4.1 Circuit Diagram

The circuit above shows the generation of control signals from both the revenue and the check meter by employing a photo diode. Photo diode senses the blinking of the led on both the check and the revenue meter and gives it as an input to the comparator circuit that employs the use of LM-324 which contains 4 op-amp’s which are used for providing sufficient gain to distinguish the blinking condition from the non-blinking and thereby generating a pulse which is fed as a control signal to our micro controller.

4.2 AC to DC CONVETER

The circuit below shows how microcontroller is provided with the supply voltage to switch it ON. The 220-v AC supply from the switch is input to a step down transformer, which scales it down to 9v which is further regulated by voltage regulator (IC-7805) that gives output DC of 5v which is fed as input to our microcontroller.

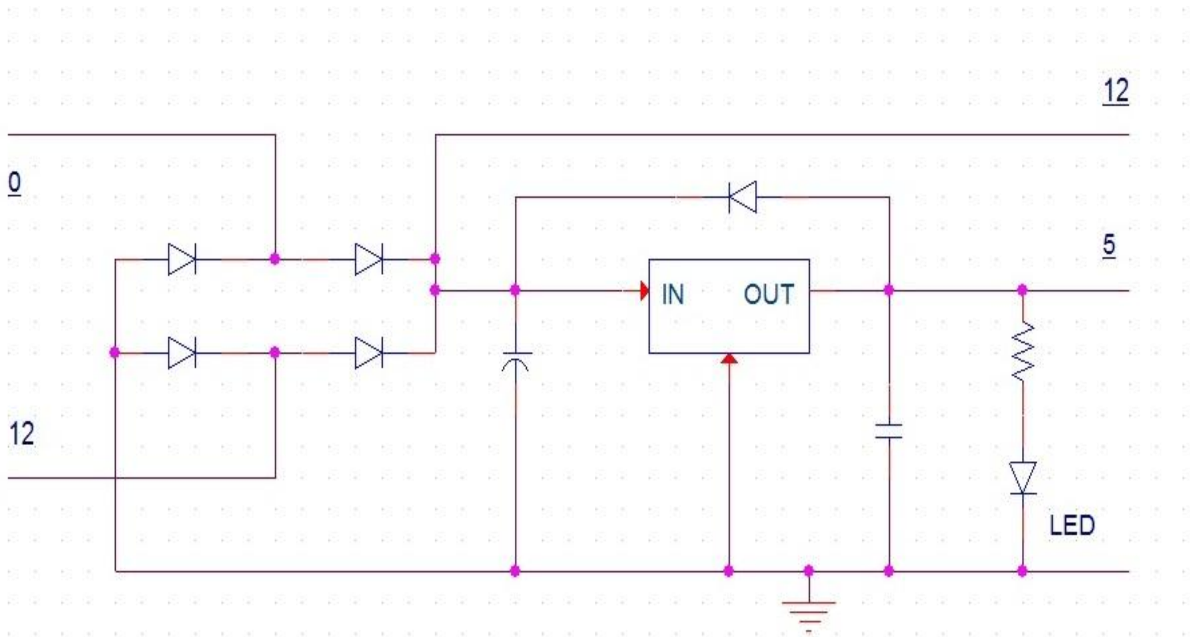

Fig 4.2 ADC CONVERTOR CIRCUIT

4.3 CIRCUIT DIAGRAM

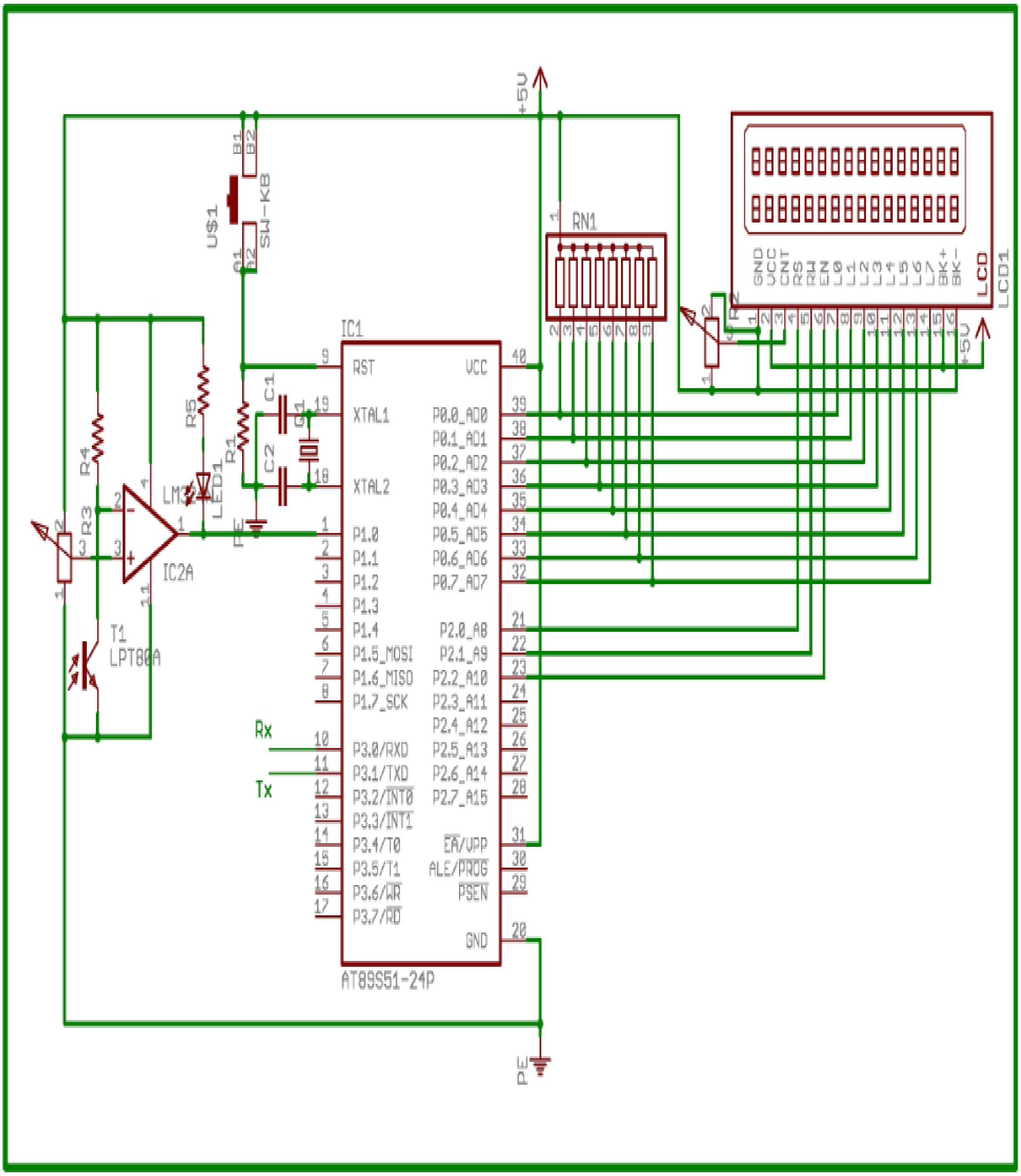

Fig4.3 Interfacing Block Diagram

CHAPTER – 5

LCD INTERFACING

A liquid crystal display (LCD) is an electro-optical amplitude modulator realized as a thin, flat display device made up of any number of color or monochrome pixels arrayed in front of a light source or reflector. It is often utilized in battery-powered electronic devices because it uses very small amounts of electric power.

5.1 PIN DESCRIPTION

The most commonly used LCDs found in the market today are 1 Line, 2 Line or 4 Line LCDs which have only 1 controller and support at most of 80 characters, whereas LCDs supporting more than 80 characters make use of 2 HD44780 controllers.

Most LCDs with 1 controller has 14 pins and LCDs with 2 controllers has 16 Pins (two pins are extra in both for back-light LED connections). Pin description is shown in the table below.

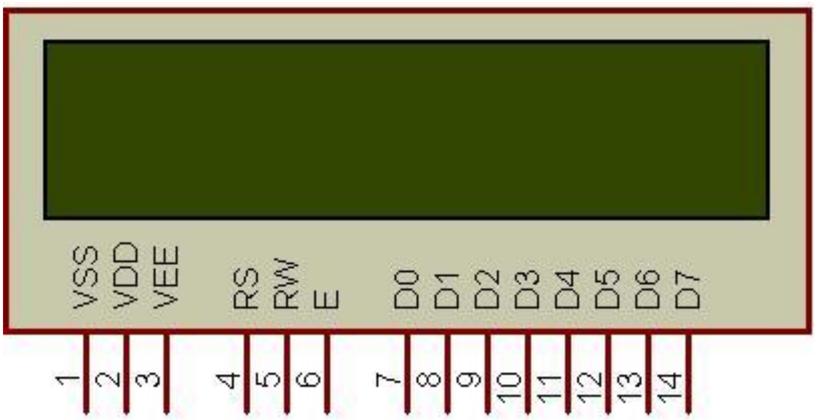

Fig 5.1 Liquid Crystal Display (Pin Diagram)

Pin no.	Name	Pin Description
1	V_{SS}	Power supply (gnd)
2	V_{CC}	Power supply (+5 volts)
3	V_{EE}	Contrast adjust
4	RS	0 = Instruction input 1 = Data input
5	R/W	0 = Write to LCD module 1 = Read from LCD module
6	EN	Enable signal
7	D_0	Data Bus line 0 (LSB)
8	D_1	Data Bus line 1
9	D_2	Data Bus line 2
10	D_3	Data Bus line 3
11	D_4	Data Bus line 4
12	D_5	Data Bus line 5
13	D_6	Data Bus line 6
14	D_7	Data Bus line 7 (MSB)

Fig 5.2 Table with Pin Description of LCD

Important factors to consider when evaluating an LCD:

- **Resolution:** The horizontal and vertical size expressed in pixels (e.g., 1024X768), unlike monochrome CRT monitors; LCD monitors have a native-supported resolution for display effect.
- **Dot Pitch:** The distance between the centers of two adjacent pixels. The smaller the dot pitch size, the less granularity is present, resulting in the sharper image. Dot pitch may be the same both vertically and horizontally, or different (less common).
- **Viewable Size:** The size of an LCD panel measured on the diagonal (more specifically known as active display area).
- **Response Time:** The least or the minimum time necessary to change a pixel's color or brightness. Response time is also divided into rise and fall time. For LCD monitors, this is measure in btb (black to black) or gtg (gray to gray). These different types of measurements make comparison difficult.

Input ports: (e.g., DVI, VGA, LVDS, Display Port, or even S-Video and HDMI).

Fig 5.3 An LCD device

Features

1. 16 Characters x 2 Lines
2. 5 x 7 Dot Matrix Character + Cursor
3. HD44780 Equivalent LCD Controller/drive Built-In
4. 4-bit or 8-bit MPU Interface
5. Uses HD44780 Controller
6. Works with almost any microcontroller
7. Low cost

5.2 INTERFACING

Liquid Crystal Display also called, as LCD is very helpful in providing user interface as well as for debugging purpose. These LCDs are very simple to interface with the controller as well as are cost effective.

The most commonly used ALPHANUMERIC displays are 1X16 (Single Line & 16 characters), 2X16 (Double Line & 16 characters per Line) & 4X20 (four lines & Twenty characters per line).

The LCD requires 3 control lines (RS, R/W & EN) & 8(or 4) data lines. The number on data lines depends on the mode of operation. If operated in 8-bit mode then 8 data lines +3 control lines i.e. total 11 lines are required. And if operated in 4-bit mode then 4 data lines + 3 control lines i.e. 7 lines are required. How do we decide which mode to use? It is simple! If you have sufficient data lines then we can use the 8 bit mode & if there is a time constraint that is display should be faster then we have to use the 8-bit mode because basically 8-bit mode takes twice as much time a compared to 8-bit mode.

When RS is low (0), the data is to be treated as a command. When RS is high (1), the data being sent is considered as text data, which should be displayed on the screen. When R/W is low (0), the information on the information on the data bus is being written to the LCD. When RW is high (1), the program is effectively reading from the LCD. Most of the times there is no need to read from the LCD so this line can directly be connected to GND thus saving one controller line.

The enable pin (EN) is used to latch the data present on the data pins. A HIGH-LOW signal is required to latch the data. The LCD interprets and executes our command at the instant the EN line is brought low. If you never bring EN low, your instruction will never be executed.

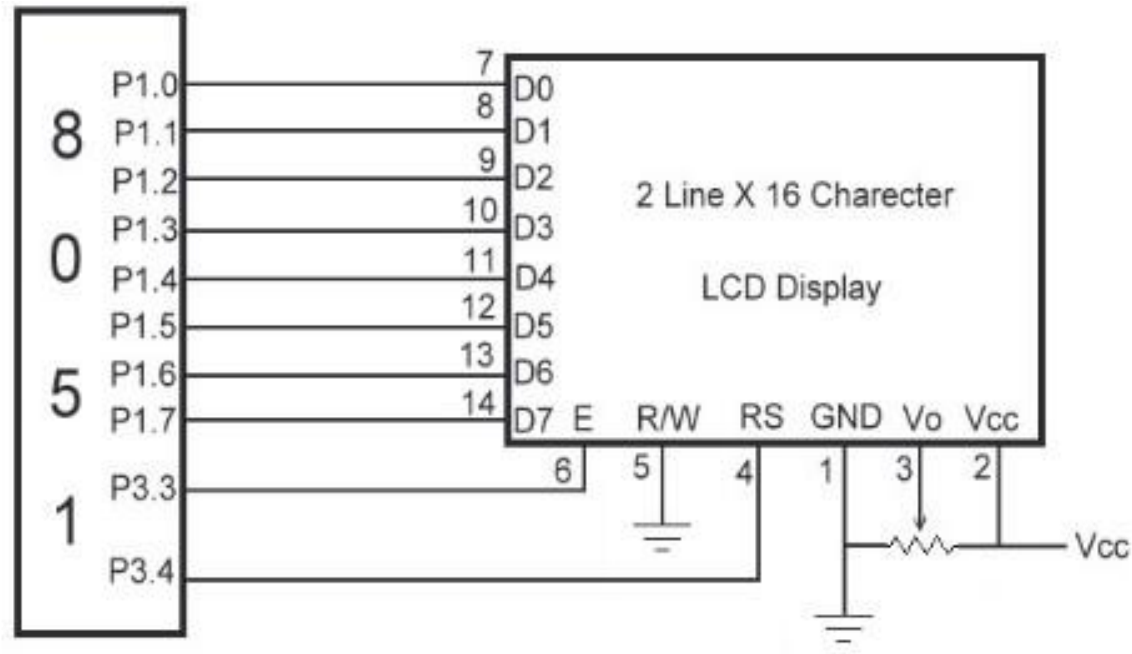

Fig 5.4 LCD Interfacing with microcontroller of 8051 family

When R/W is low (0), the information on the data bus is being written to the LCD. When RW is high (1), the program is effectively reading from the LCD.

CONCLUSION

This project is designed for industrial purpose, but it can be extended to domestic purposes also. It gives a big hand to vigilance squad to control theft quickly and easily. With its usage, the crime of stealing power may be brought to an end and thereby a new bloom may be expected in the economy of our motherland. The prime limitation of the system in the present form is the distance coverage. To overcome this when applied in a large scale, repeaters can be employed.

At present we have successfully implemented the entire algorithm with one consumer but in future we are willing to implement the same using a multiple user database. Employing an integrator to add all the readings from the various consumers and then comparing it with the reading from the transmitting end can achieve this. Distance coverage is an important limitation which can be overcome by providing the repeaters at regular intervals when applied in a large scale.

We also wish to improvise the algorithm such that we can be able to figure out where exactly is the electricity theft being held and not just indicate the line in which electricity theft is being held.

At the end we would like to say:

"*An investment in knowledge pays the best interests.*"

-Benjamin Franklin

REFERENCES:

1. ELECTRICAL POWER THEFT DETECTION AND WIRELESS METER READING Sagar Patil1 Gopal Pawaskar Kirtikumar Patil3 Final year B.Tech Student, Dept. of Electrical Engineering, Walchand College of Engineering, Sangli, Maharashtra, India
2. http://www.slideshare.net/biswajitcet13/wireless-power-theft-monitoring//
3. MITSUBISHI ELECTRIC RESEARCH LABORATORIS NEWSLETTERS
4. http://www.merl.com
5. http://electronics.stackexchange.com/questions/74561/can-power-theft-on-a-large-scale-be-stopped
6. Sooxma technologies Power theft Detection System Technology information Charts.
7. Smart Meter Data Analysis for Power Theft
   Detection Nikovski, D.; Wang, Z.; Esenther, A.; Sun, H.; Sugiura, K.; Muso, T.; Tsuru, K.TR2013-065 July 2013.