WIRELESS ENERGY METER

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Under the Supervision of

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May-2011

Submitted in partial fulfillment of the Degree of

Bachelor of Technology

DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

JAYPEE UNIVERSITY OF INFORMATION TECHNOLOGY,

WAKNAGHAT

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CERTIFICATE

This is to certify that the work titled "**Wireless Energy Meter**" submitted by "**Tushar Chopra, Sumanyu Mahajan and Udit Mahajan**" in partial fulfillment for the award of degree of B.Tech, of 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 the award of this or any other degree or diploma.

Signature of Supervisor ....

Name of Supervisor Mr. Vikas Hastir

Designation Lecturer

Date:

Acknowledgement

It has been a wonderful and intellectually stimulating experience working on the "**Wireless Energy Meter**". Taking energy consumption readings from individual houses in a locality would be really convenient if the person does not have to go to all houses separately. Instead he can just get the readings of all the houses in a locality wirelessly sitting at a particular place.

We wish to express our earnest gratitude to **Mr. Vikas Hastir** for providing us invaluable guidance, suggestions and providing us with the finest details of the subject, which allowed us to present our project in the final form.

We gratefully acknowledge all the staff members of Electronics and Communication Engineering Department of Jaypee University of Information Technology, Waknaghat, for providing us with all the facilities required for the completion of our project.

We would like to thank **Dhirendra Kumar Singh** for letting us work in the electrical lab and providing us with certain basic hardware requirements as per need.

Tushar Chopra ....

Sumanyu Mahajan ....

Udit Mahajan ....

Date: 24th May '11

Abstract

This is a single Micro controller based Digital energy meter system which can be used to perform the following functions:

(1) To calculate and calibrate the power consumption of a number of consumers through wireless network.

(2) To transmit the readings to the department through wireless network .

Hence, it is named as WIRELESS MULTIPLEXED ENERGY METER SYSTEM . This multiplexed energy meter is used to install in the electrical pole or in the Pillar-box to read the current consumed by the group of consumers.

This system uses a network of wireless energy meters to monitor energy usage throughout large multi-story buildings, public sectors, and automatically relay the readings by radio signal to a central data server. Providing time-stamped, interval-based consumption data and coincident demand readings accurate to the main server computer, wireless energy metering system lowers overall installed costs by avoiding the need to lay communications wire and the associated conduit throughout a facility.

We can also detect power theft easily at a particular location. As the usage can be monitored from time to time, so we can keep a check on energy usage. If the readings show an unexpected increase then it can be assessed that there is some wrongdoing going on.

Tushar Chopra ....

Sumanyu Mahajan ....

Udit Mahajan ....

Supervisor: Mr. Vikas Hastir

Signature ....

Date: 24th May'11

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CHAPTER 1

1.1 INTRODUCTION

This single Micro controller based Digital energy meter system can:

(1) Calibrate the power consumption of many number of consumers through wireless network

(2) Transmit to the department through wireless network .

So it is named as WIRELESS MULTIPLEXED ENERGY METER SYSTEM . This multiplexed energy meter is used to install in the electrical pole or in the Pillar-box to read the current consumed by the group of consumers.

This system uses a network of wireless energy meters to monitor energy usage throughout large multi-story buildings, public sectors, and automatically relay the readings by radio signal to a central data server. Providing time-stamped, interval-based consumption data and coincident demand readings accurate to the main server computer, wireless energy metering system lowers overall installed costs by avoiding the need to lay communications wire and the associated conduit throughout a facility.

BASIC IDEA:

We can find the power theft easily at particular location. This system of monitoring the collecting of consumed readings and controlling the power supplies of consumers and Grid controls are equipped with any type of Latest Technology during the period of implementing this project

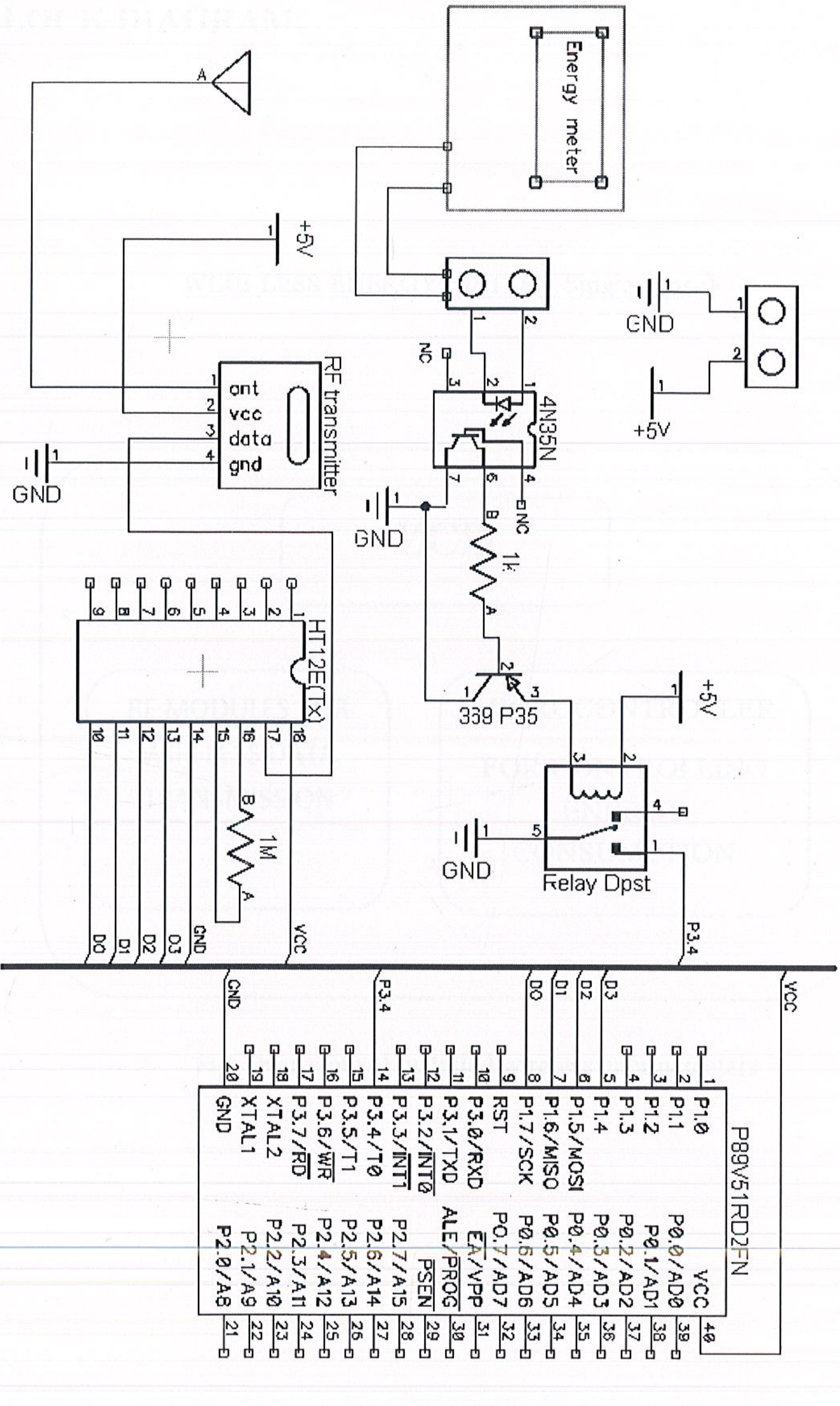
FEATURES:

1. Wireless metering devices small enough to attach to almost any existing enclosure
2. Easy-to-use, split-core current transformers for non-intrusive current measurement
3. A PC-based gateway that gathers, aggregates and logs all meter data
4. No need of many Assessors to go to every house to collect the electrical power readings consumed by the consumer. Using a dedicated wireless network we just need a single receiver to get reading of all homes in particular radius (about 200m)
5. Provide real time consumption of electricity
6. We can also use mobile phone network or telephone line network we can read the electrical energy consumed by the group of consumers.

LIST OF COMPONENTS USED:

S.NO	Name	Quantity	Colour	Pins
1.	Microcontroller 8051	1	Black	40
2.	Resistance 330 ohm	10	Orange-orange-brown	2
3.	Designed PCB	1		-
4.	LED	1	Red	-
5.	IC Base (16,40 pin)	3	Black	-
6.	Liquid Crystal Display(LCD)	2	Black	-
7.	LCD DRIVER IC	2	Black	16
8.	Battery (9v) + Connector	1		-
9.	Step down transformer (9-0-9)	1		-
10.	Diode (1 amp.)	1	Black	4
11.	Voltage regulator 7805	1	Black	3
12.	10 microfarad capacitor	2		-
13.	33 picofarad capacitor	2		2
14.	Crystal 11.0592 Mhz	1		2
15.	Sip resistance (10 k ohm)	1	Black	9
16.	General purpose PCB	1		
17.	Connectors	10	-	-

1.3 CIRCUIT DIAGRAM:



1.4 BLOCK DIAGRAM:

WIRE-LESS ENERGY METER (Single Phase)

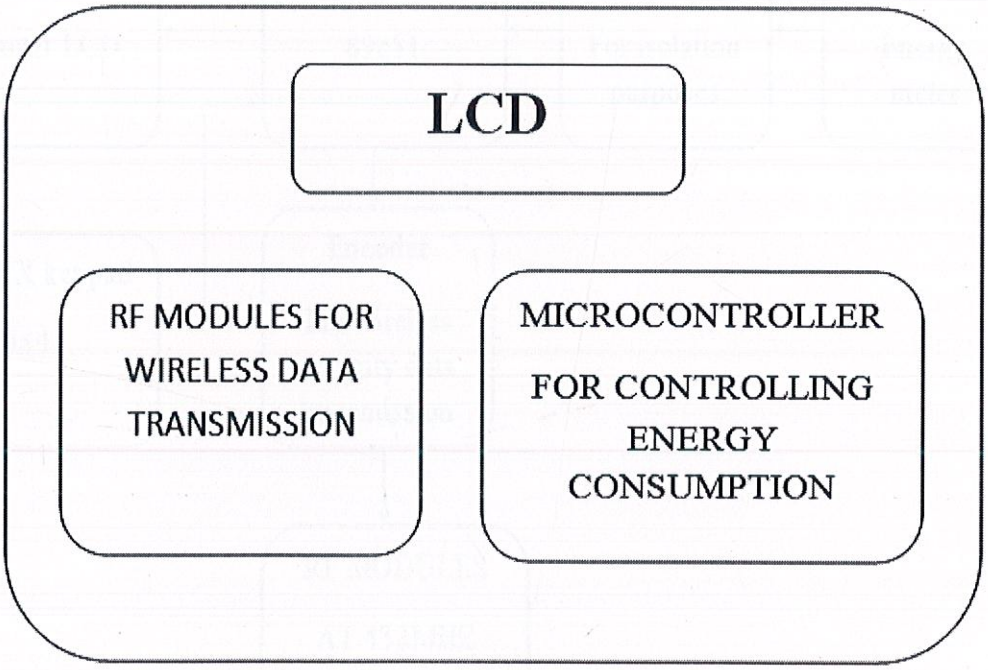
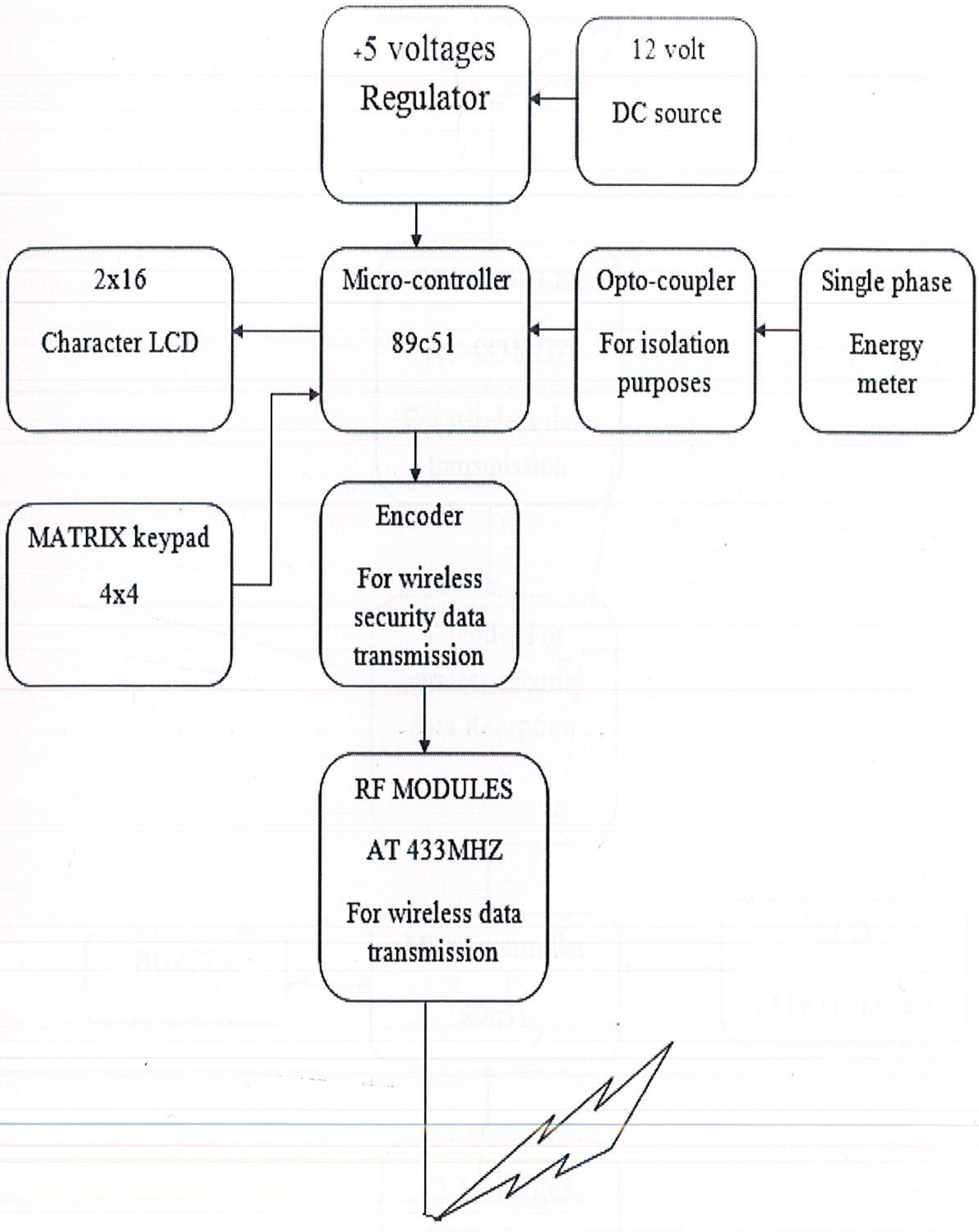


Fig: Over view of installed wireless energy meters

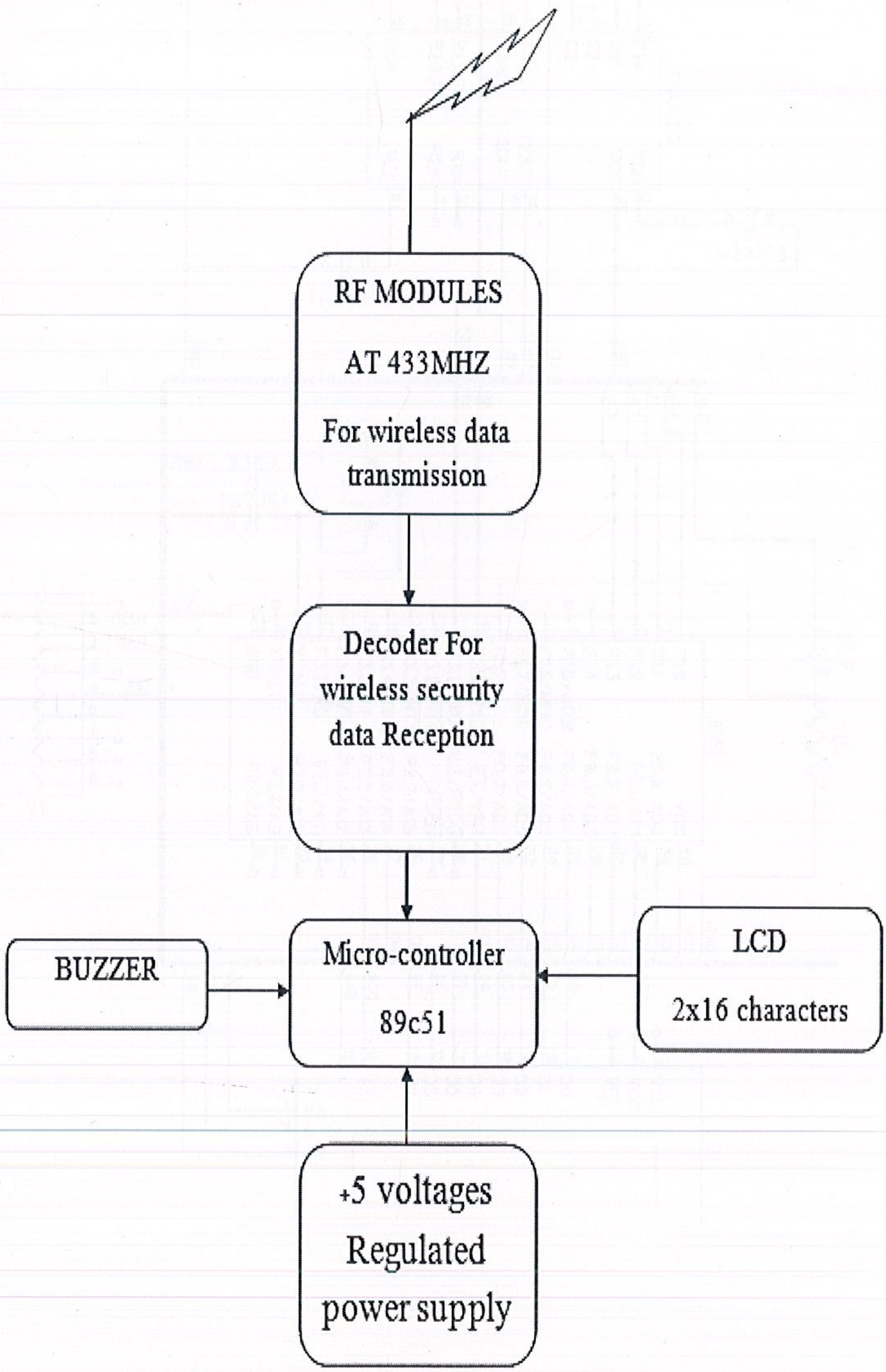
TRANSMITTER PART OF ENERGY METER



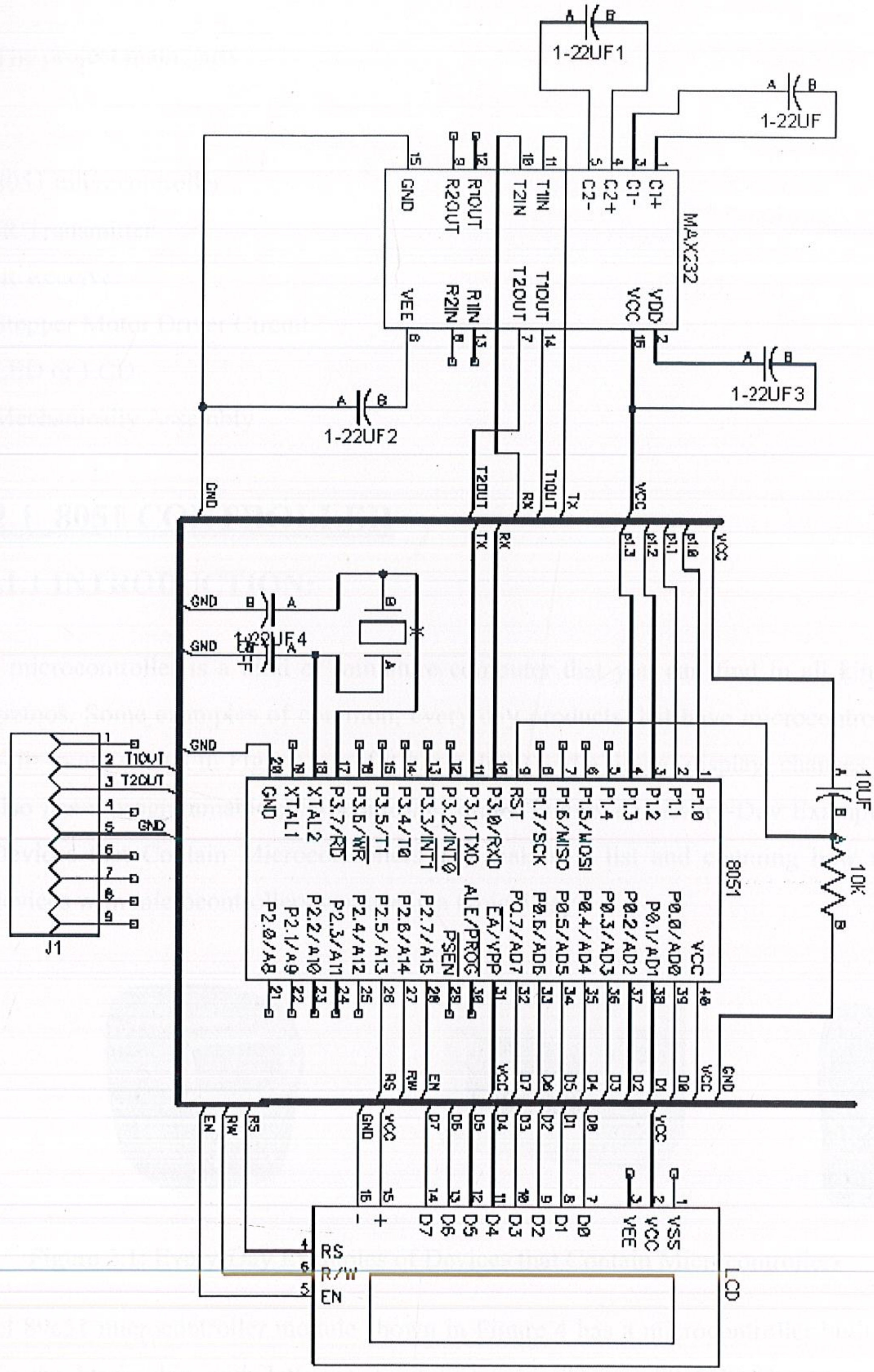
Transmitting Antenna

RECIEVER PART OF ENERGY METER

RECEIVING ANTENNA



Micrcontroller+LCD+ISP programmer circuit



CHAPTER-2 HARDWARE DESCRIPTION

The project main parts:

- 8051 microcontroller
- IR Transmitter
- IR Receiver
- Stepper Motor Driver Circuit
- LED or LCD
- Mechanically Assembly

2.1 8051 CONTROLLER

2.1.1 INTRODUCTION:

A microcontroller is a kind of miniature computer that you can find in all kinds of gizmos. Some examples of common, every-day products that have microcontroller's built-in are shown in Figure 2.1. If it has buttons and a digital display, chances are it also has a programmable microcontroller brain. Figure 2.1. Every-Day Examples of Devices that Contain Microcontrollers Try making a list and counting how many devices with microcontrollers you use in a typical day.

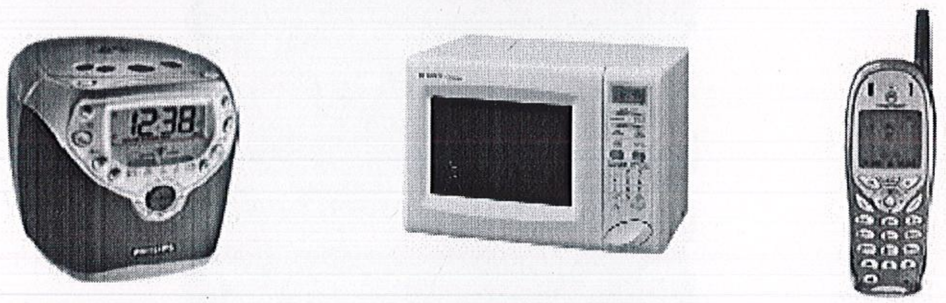


Figure 2.1: Every-Day Examples of Devices that Contain Microcontrollers

Atmel 89c51 microcontroller module shown in Figure 4 has a microcontroller built onto it. It's the black chip with lettering on it that reads "Atmel 89c51". The rest of the components on the microcontroller module are also found in consumer appliances you use every day. All together, they are correctly called an embedded computer system. This name is almost always shortened to just "embedded system". Frequently, such modules are commonly just called "microcontrollers."

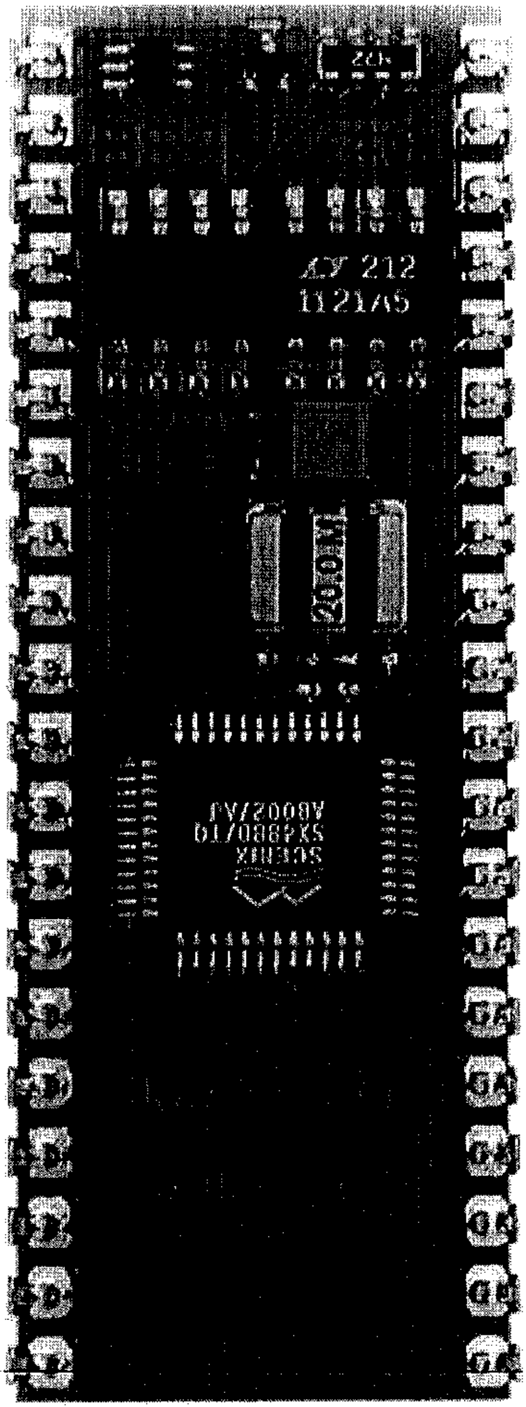


Fig 2.3: 40 Pins Atmel 89c51 microcontroller module

(Internal structure)

2.2 TYPES OF MICROCONTROLLER

2.2.1 INTEL 8051 AND ITS FAMILY

In 1981, Intel Corporation introduces 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 in 8051 family of microcontroller are 8052 & 8031

Some other companies producing member of 8051 family are:

1. Intel
2. Atmel
3. Dallas Semiconductors
4. Philips/ Signetics
5. Siemens

2.2.2 PIC MICROCONTROLLER (Microchip Technology)

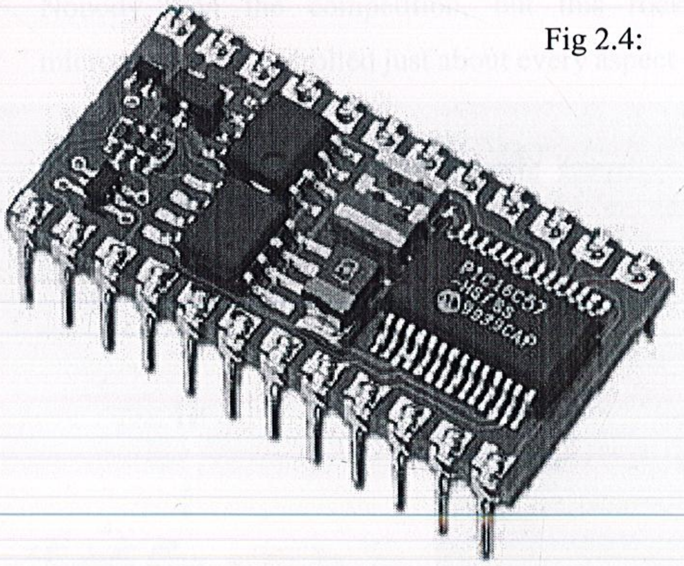


Fig 2.4: "The BASIC Stamp® 2 Microcontroller Module *BASIC Stamp 2 Modules are the most Popular Microcontrollers made By Parallax, Inc.*

2.3 AMAZING INVENTIONS WITH MICROCONTROLLERS:-

1. Consumer appliances aren't the only things that contain microcontrollers. Robots, machinery, aerospace designs and other high-tech devices are also built with microcontrollers. Robots have been designed to do everything from helping students learn more about microcontrollers, to moving the lawn, to solving complex mechanical problems. Figure1-4 shows two example robots.

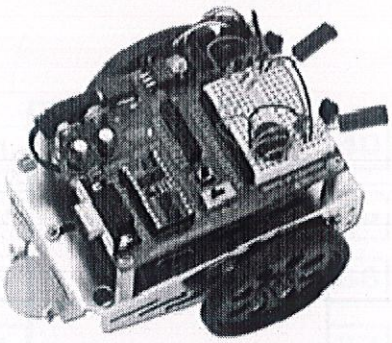


Fig 2.5: Applications of microcontroller

2. Microcontrollers are also used in scientific, high technology, and aerospace projects. The weather station shown on the left of Figure 1-7 is used to collect environmental data related to coral reef decay. The Atmel 89c51 microcontroller inside it gathers this data from a variety of sensors and stores it for later retrieval by scientists. The submarine in the center is an undersea exploration vehicle, and its thrusters, cameras and lights are all controlled by Atmel 89c51 microcontroller. The rocket shown on the right is one that was part of a competition to launch a privately owned rocket into space. Nobody won the competition, but this rocket almost made it! Atmel 89c51 microcontroller controlled just about every aspect of the launch sequence.

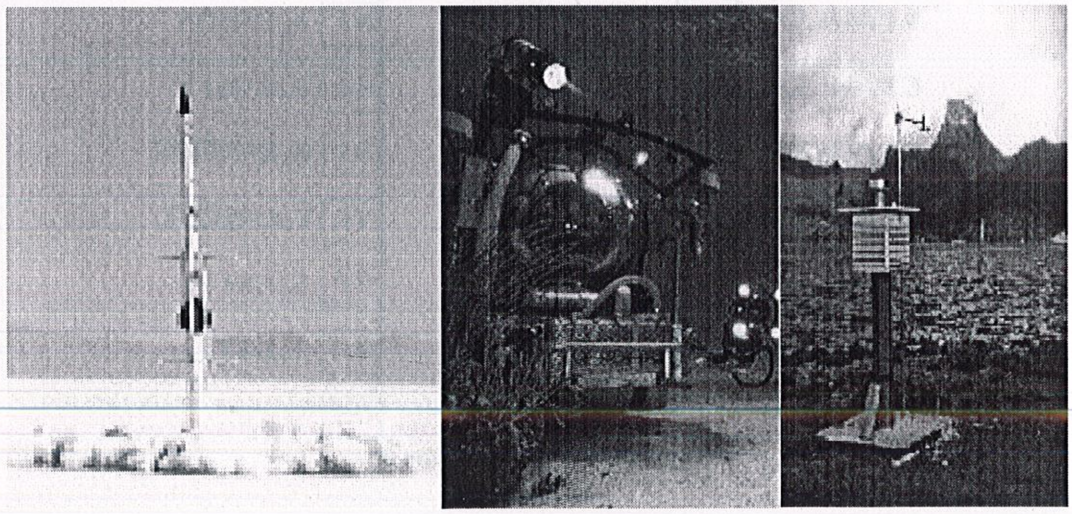


Figure 2.6: High-tech and Aerospace Microcontroller Examples *Ecological data collection by EME Systems (left), undersea research by Harbor Branch Institute*

2.4 8051 PIN DIAGRAM

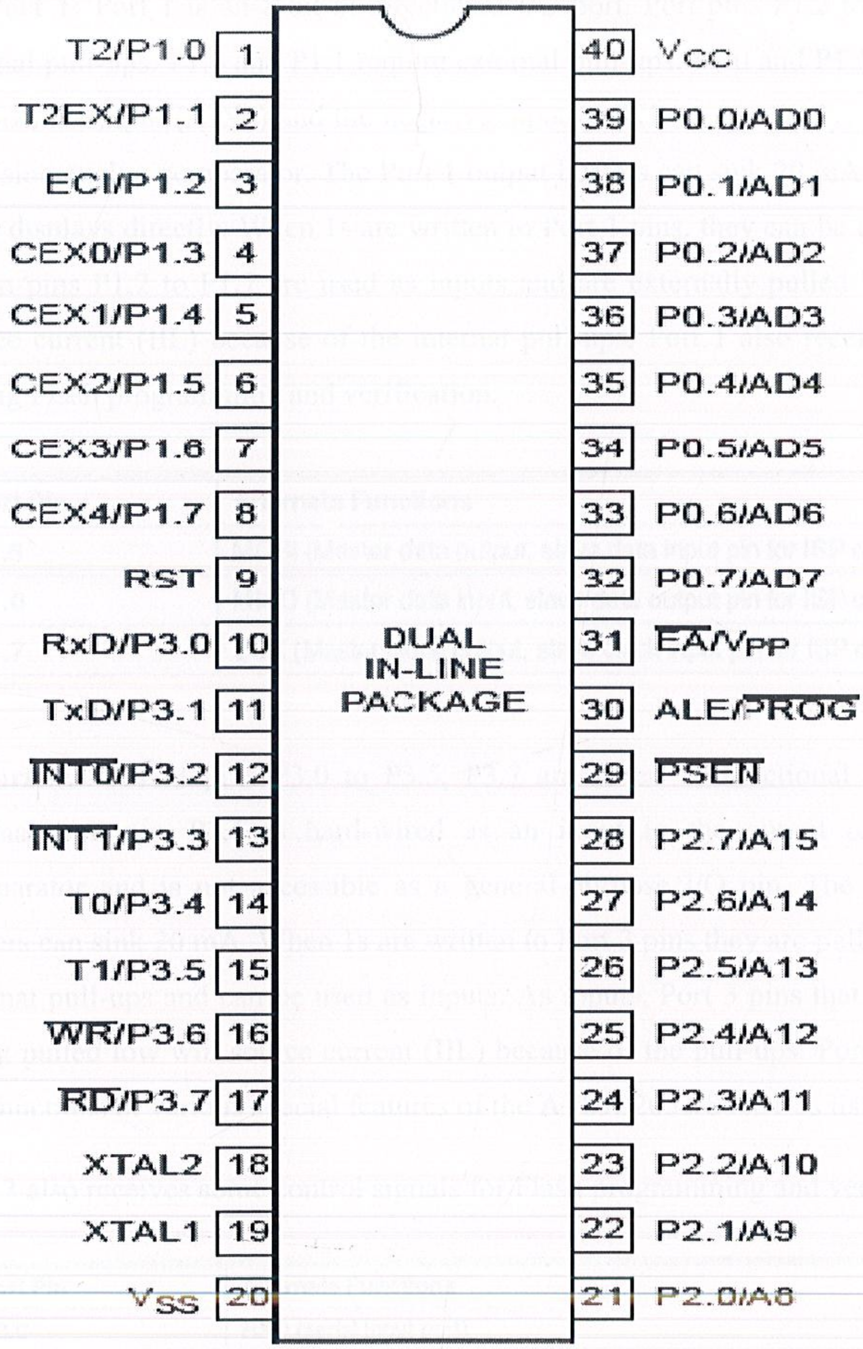


Fig 2.8: Pin Description

2.6 Pin Description:

1.)VCC: Supply voltage.

2.)GND: Ground.

3.) Port 1: Port 1 is an 8-bit bi-directional 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 (AIN0) and the negative input (AIN1), 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)

4.)Port 3: Port 3 pins P3.0 to P3.5, P3.7 are seven bi-directional I/O 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 the internal pull-ups and can be used as inputs. As inputs, Port 3 pins that are externally being pulled low will source current (IIL) because of the pull-ups. Port 3 also serves the functions of various special features of the AT89S2051/S4051 as listed below:

Port 3 also receives some control signals for Flash programming and verification.

Port Pin	Alternate Functions
P3.0	RXD (serial input port)
P3.1	TXD (serial output port)
P3.2	$\overline{\text{INT0}}$ (external interrupt 0)
P3.3	$\overline{\text{INT1}}$ (external interrupt 1)
P3.4	T0 (timer 0 external input)
P3.5	T1 (timer 1 external input)/ PWM output

5.) RST:

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

6.) XTAL1:

Input to the inverting amplifier and input to the internal clock operating circuit.

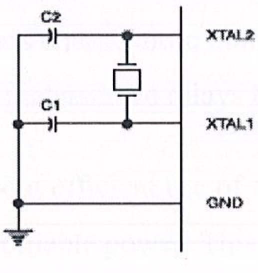
7.) XTAL2:

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 . 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-two flip-flop, but minimum and maximum voltage high and low time specifications

(fig 9.1) Connections



Note: C1, C2 = 30 pF ± 10 pF for Crystals
= 40 pF ± 10 pF for Ceramic Resonators

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 the 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 midafternoon, when many buildings turn on air-conditioning.

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 day, to reduce use. Also, in some areas meters have relays to turn off nonessential 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 the meters.

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

Since providers can only collect money for real power, they try to maximize the amount of real power delivered by their networks. Therefore, 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.

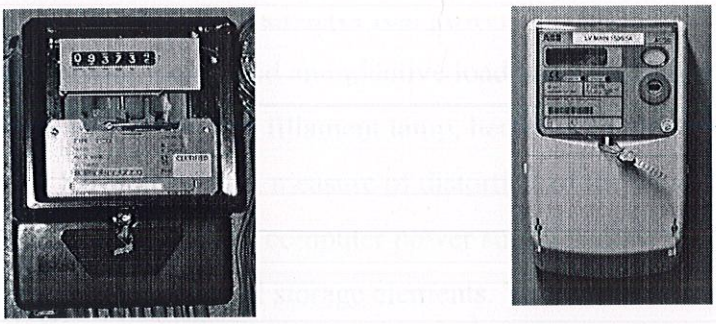


Fig.: Energy Meter used for residential purposes

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 infra-red. The circle with two dots is the infra-red port. Tamper-evident seals can be seen.

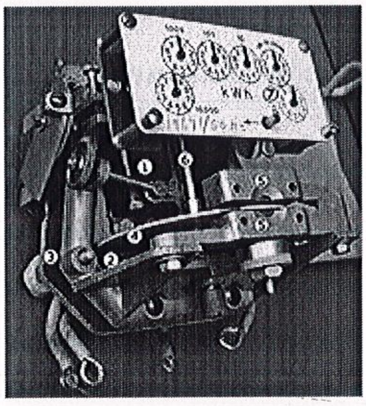
The most common unit of measurement on the electricity meter is the kilowatt hour, which is equal to the amount of energy used by a load of one kilowatt over a period of one hour, or 3,600,000 joules. Some electricity companies use the SI mega joule instead.

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 kilovar-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 fillament lamp, heater or kettle) exhibits a power factor of 1. Current harmonics are a measure of distortion of the wave form. For example, electronic loads such as computer power supplies draw their current at the 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 only wasteful, but may interfere with the operation of other equipment. Harmonic emissions are mandated by law in EU and other countries to fall within specified limits.

Types of meters

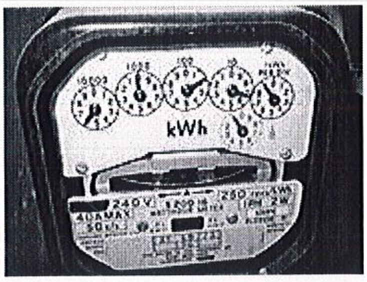


Mechanism of electromechanical induction meter. (1) - Voltage coil - many turns of fine wire encased in plastic, connected in parallel with load. (2) - Current coil - three turns of thick wire, connected in series with load. (3) - Stator - concentrates and confines magnetic field. (4) - Aluminum rotor disc. (5) - rotor brake magnets. (6) -

spindle with worm gear. (7) - display dials - note that the 1/10, 10 and 1000 dials rotate clockwise while the 1, 100 and 10000 dials rotate counter-clockwise.

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

Electromechanical meters



This mechanical electricity meter has every other dial rotating counter-clockwise.

The most common type of electricity meter is the Thomson or electromechanical induction watt-hour meter, invented by Elihu Thomson in 1888.[2][3]

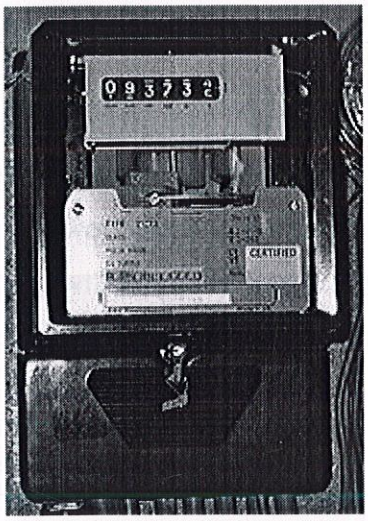
Electromechanical technology

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

The metallic disc is acted upon by two coils. One coil is connected in such a way that it produces a magnetic flux in proportion to the voltage and the other produces a magnetic flux in proportion to the current. The field of the voltage coil is delayed by 90 degrees using a lag coil.[4] 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 the instantaneous current and voltage. A permanent magnet exerts an opposing force proportional to the speed of rotation of the disc. The equilibrium between these two opposing forces results in the disc rotating at a speed 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 in a car, in order to render a measurement of the total energy used over a period of time.

The type of meter described above is used on a single-phase AC supply. Different phase configurations use additional voltage and current coils.

Reading electromechanical meters



Three-phase electromechanical induction meter, metering 100 A 230/400 V supply. Horizontal aluminum rotor disc is visible in center of meter

The aluminum 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. It should be noted that 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* which 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. If the time in seconds taken by the disc to complete one revolution is *t*, then the power in watts is

$$P = \frac{3600 \cdot Kh}{t}$$

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, post or 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.

Communication technologies

Remote meter reading is a practical example of telemetry. It saves the cost of a human meter 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, rotating meters could report their power information remotely, 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 degrees from the Y. When the rotor rotates in the opposite direction, showing export of power, the sequence reverses. The time between pulses measures 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 32-100 ms pulses for a constant amount of used electrical energy. Usually 1000-10000 pulses per kWh. Output is limited to max 27 V DC and 27 mA DC. The output usually follows the DIN 43864 standard.

Often, meters designed for semi-automated reading have a serial port on that communicates by infrared LED through the faceplate of the meter. In some apartment buildings, a similar protocol is 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 U.S. and Canada, the favoured 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, WiFi, telephone lines or over the power lines themselves. Some meters can be read over the internet.

INTERFACING ENERGY METER WITH 8051:

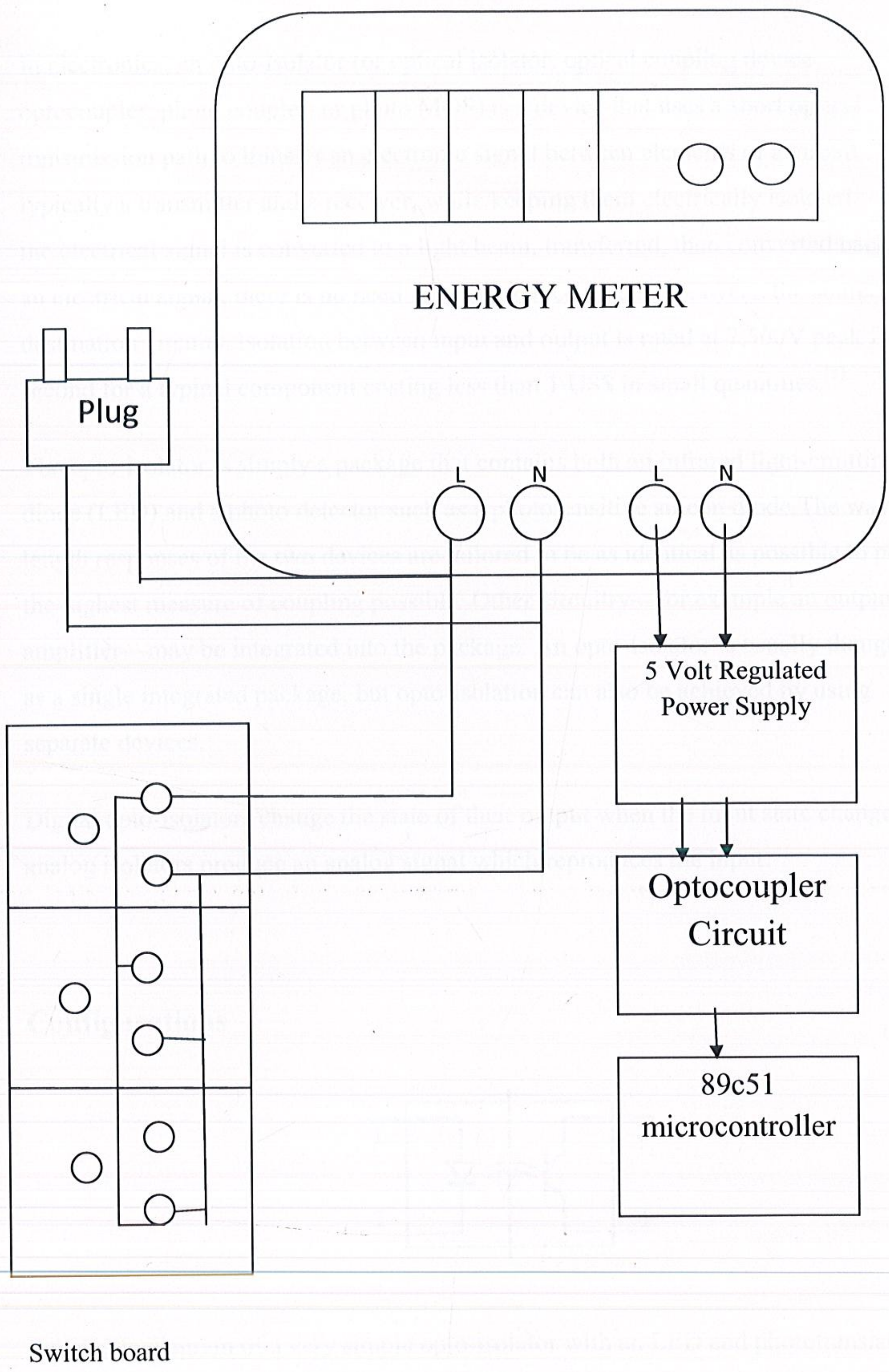


Fig 3.1: Energy meter interfacing

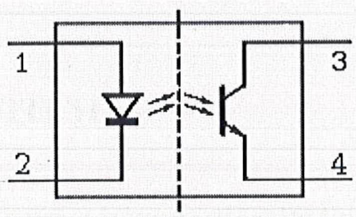
1.OPTO-ISOLATOR or OPTO-COUPLER

In electronics, an opto-isolator (or optical isolator, optical coupling device, optocoupler, photo coupler, or photo MOS) is a device that uses a short optical transmission path to transfer an electronic signal between elements of a circuit, typically a transmitter and a receiver, while keeping them electrically isolated—since the electrical signal is converted to a light beam, transferred, then converted back to an electrical signal, there is no need for electrical connection between the source and destination circuits. Isolation between input and output is rated at 7,500V peak for 1 second for a typical component costing less than 1 US$ in small quantities.[1]

The opto-isolator is simply a package that contains both an infrared light-emitting diode (LED) and a photo detector such as a photosensitive silicon diode.The wave-length responses of the two devices are tailored to be as identical as possible to permit the highest measure of coupling possible. Other circuitry—for example an output amplifier—may be integrated into the package. An opto-isolator is usually thought of as a single integrated package, but opto-isolation can also be achieved by using separate devices.

Digital opto-isolators change the state of their output when the input state changes; analog isolators produce an analog signal which reproduces the input.

Configurations



Schematic diagram of a very simple opto-isolator with an LED and phototransistor. The dashed line represents the isolation barrier, over which there is no electrical contact.

A common implementation is a LED and a phototransistor in a light-tight housing to exclude ambient light and without common electrical connection, positioned so that light from the LED will impinge on the photodetector. When an electrical signal is applied to the input of the opto-isolator, its LED lights and illuminates the photodetector, producing a corresponding electrical signal in the output circuit. Unlike a transformer the opto-isolator allows DC coupling and can provide any desired degree of electrical isolation and protection from serious overvoltage conditions in one circuit affecting the other.

With a photodiode as the detector, the output current is proportional to the intensity of incident light supplied by the emitter. The diode can be used in a photovoltaic mode or a photoconductive mode. In photovoltaic mode, the diode acts as a current source in parallel with a forward-biased diode. The output current and voltage are dependent on the load impedance and light intensity. In photoconductive mode, the diode is connected to a supply voltage, and the magnitude of the current conducted is directly proportional to the intensity of light. This optocoupler type is significantly faster than photo transistor type, but the transmission ratio is very low; it is common to integrate an output amplifier circuit into the same package.

The optical path may be air or a dielectric waveguide. When high noise immunity is required an optical conductive shield can be integrated into the optical path. The transmitting and receiving elements of an optical isolator may be contained within a single compact module, for mounting, for example, on a circuit board; in this case, the module is often called an optoisolator or opto-isolator

2. TRANSISTOR AS SWITCH

Because a transistor's collector current is proportionally limited by its base current, it can be used as a sort of current-controlled switch. A relatively small flow of electrons sent through the base of the transistor has the ability to exert control over a much larger flow of electrons through the collector.

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Suppose we had a lamp that we wanted to turn on and off with a switch. Such a circuit would be extremely simple as in Figure below(a).

For the sake of illustration, let's insert a transistor in place of the switch to show how it can control the flow of electrons through the lamp. Remember that the controlled current through a transistor must go between collector and emitter. Since it is the current through the lamp that we want to control, we must position the collector and emitter of our transistor where the two contacts of the switch were. We must also make sure that the lamp's current will move *against* the direction of the emitter arrow symbol to ensure that the transistor's junction bias will be correct as in Figure below(b).

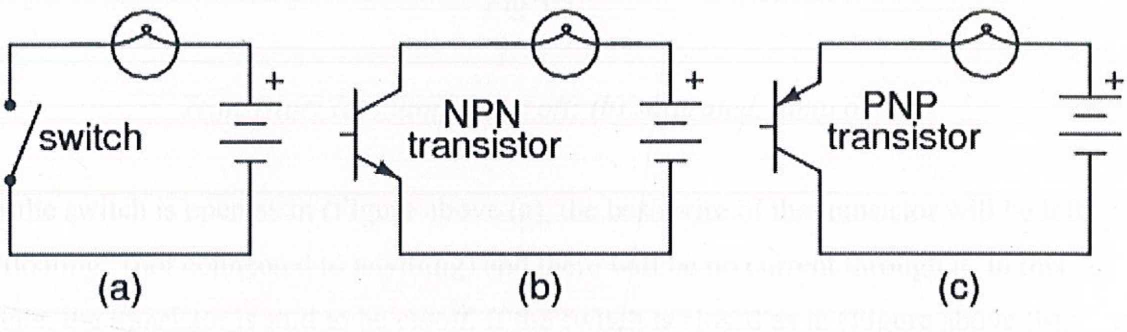


Fig 3.2

(a) mechanical switch, (b) NPN transistor switch, (c) PNP transistor switch.

A PNP transistor could also have been chosen for the job. Its application is shown in Figure above(c).

The choice between NPN and PNP is really arbitrary. All that matters is that the proper current directions are maintained for the sake of correct junction biasing (electron flow going *against* the transistor symbol's arrow).

Going back to the NPN transistor in our example circuit, we are faced with the need to add something more so that we can have base current. Without a connection to the base wire of the transistor, base current will be zero, and the transistor cannot turn on, resulting in a lamp that is always off. Remember that for an NPN transistor, base current must consist of electrons flowing from emitter to base (against the emitter arrow symbol, just like the lamp current). Perhaps the simplest thing to do would be to connect a switch between the base and collector wires of the transistor as in Figure below (a).

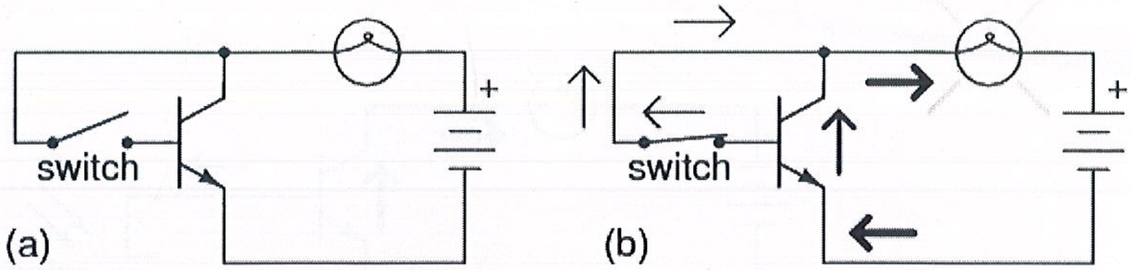


Fig 3.3

Transistor: (a) cutoff, lamp off; (b) saturated, lamp on.

If the switch is open as in (Figure above (a), the base wire of the transistor will be left "floating" (not connected to anything) and there will be no current through it. In this state, the transistor is said to be *cutoff*. If the switch is closed as in (Figure above (b), however, electrons will be able to flow from the emitter through to the base of the transistor, through the switch and up to the left side of the lamp, back to the positive side of the battery. This base current will enable a much larger flow of electrons from the emitter through to the collector, thus lighting up the lamp. In this state of maximum circuit current, the transistor is said to be *saturated*.

Of course, it may seem pointless to use a transistor in this capacity to control the lamp. After all, we're still using a switch in the circuit, aren't we? If we're still using a switch to control the lamp -- if only indirectly -- then what's the point of having a transistor to control the current? Why not just go back to our original circuit and use the switch directly to control the lamp current?

Two points can be made here, actually. First is the fact that when used in this manner, the switch contacts need only handle what little base current is necessary to turn the transistor on; the transistor itself handles most of the lamp's current. This may be an important advantage if the switch has a low current rating: a small switch may be used to control a relatively high-current load. More important, the current-controlling behavior of the transistor enables us to use something completely different to turn the lamp on or off. Consider Figure below, where a pair of solar cells provides 1 V to overcome the 0.7 V_{BE} of the transistor to cause base current flow, which in turn controls the lamp.

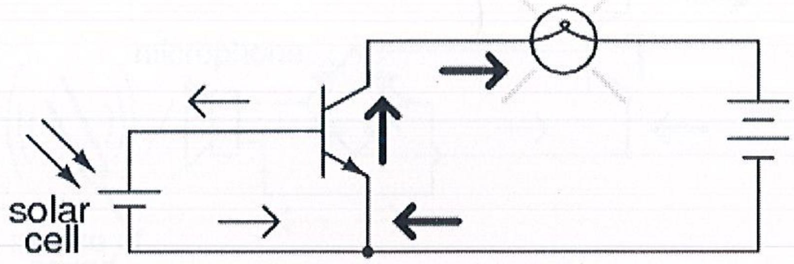
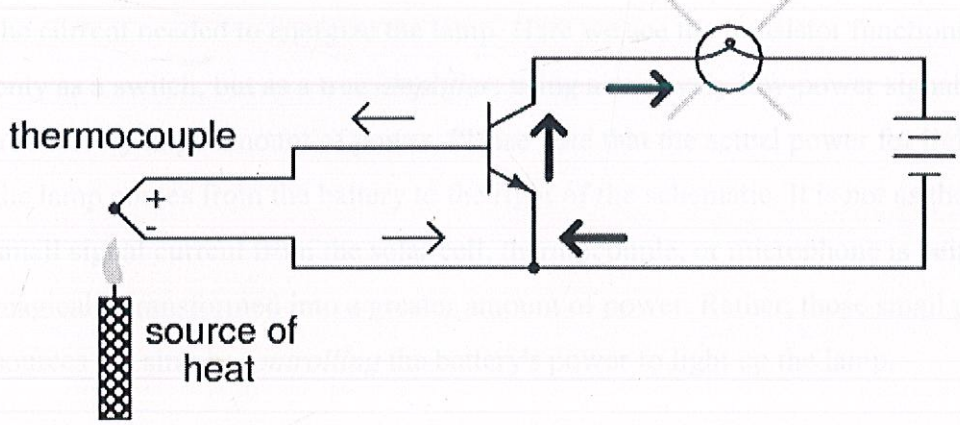


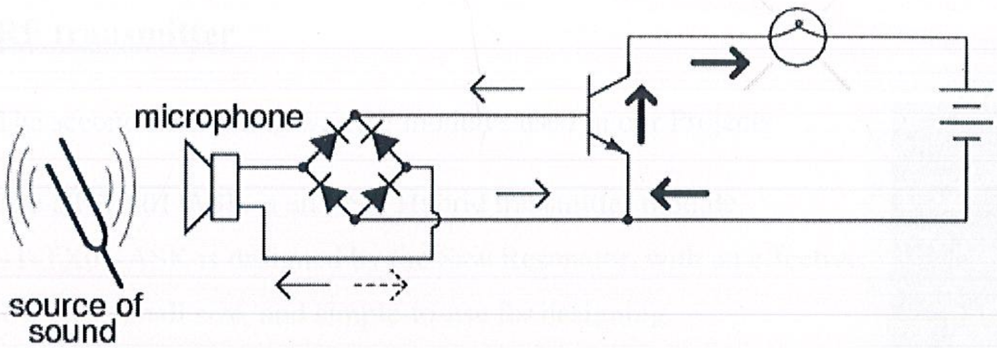
Fig 3.4:Solar cell serves as light sensor.

Or, we could use a thermocouple (many connected in series) to provide the necessary base current to turn the transistor on in Figure below.



A single thermocouple provides 10s of mV. Many in series could produce in excess of the 0.7 V transistor V_{BE} to cause base current flow and consequent collector current to the lamp.

Even a microphone (Figure below) with enough voltage and current (from an amplifier) output could turn the transistor on, provided its output is rectified from AC to DC so that the emitter-base PN junction within the transistor will always be forward-biased:



Amplified microphone signal is rectified to DC bias the base of the transistor providing a larger collector current.

The point should be quite apparent by now: *any* sufficient source of DC current may be used to turn the transistor on, and that source of current only need be a fraction of the current needed to energize the lamp. Here we see the transistor functioning not only as a switch, but as a true *amplifier*: using a relatively low-power signal to *control* a relatively large amount of power. Please note that the actual power for lighting up the lamp comes from the battery to the right of the schematic. It is not as though the small signal current from the solar cell, thermocouple, or microphone is being magically transformed into a greater amount of power. Rather, those small power sources are simply *controlling* the battery's power to light up the lamp.

Chapter 4: RF Data Transmission

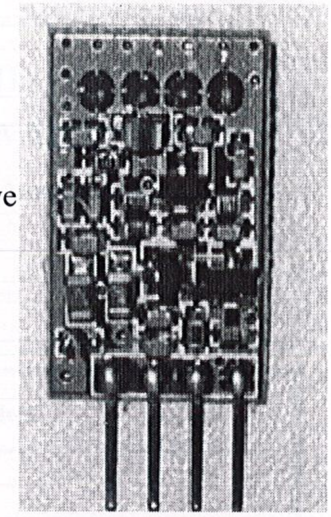
4.1 Introduction:

2. RF MODULES

RF transmitter

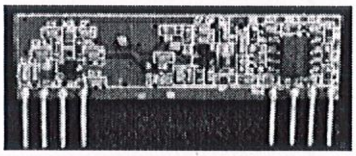
The second Main thing was RF modules used in our Projects

The ST-TX01-ASK is an ASK Hybrid transmitter module.
ST-TX01-ASK is designed by the Saw Resonator, with an effective low cost, small size, and simple-to-use for designing.
Frequency Range:315 / 433.92 MHZ.
Supply Voltage: 3~12V.
Output Power: 4~16dBm
Circuit Shape: Saw



ST-TX01-ASK (Saw Type)

RF receiver



ST-RX02-ASK receiver

The ST-RX02-ASK is an ASK Hybrid receiver module.
A effective low cost solution for using at 315/433.92 MHZ.

The circuit shape of ST-RX02-ASK is L/C.
Receiver Frequency: 315 / 433.92 MHZ
Typical sensitivity: -105dBm
Supply Current: 3.5mA
IF Frequency: 1MHz

3. Encoder HT12E

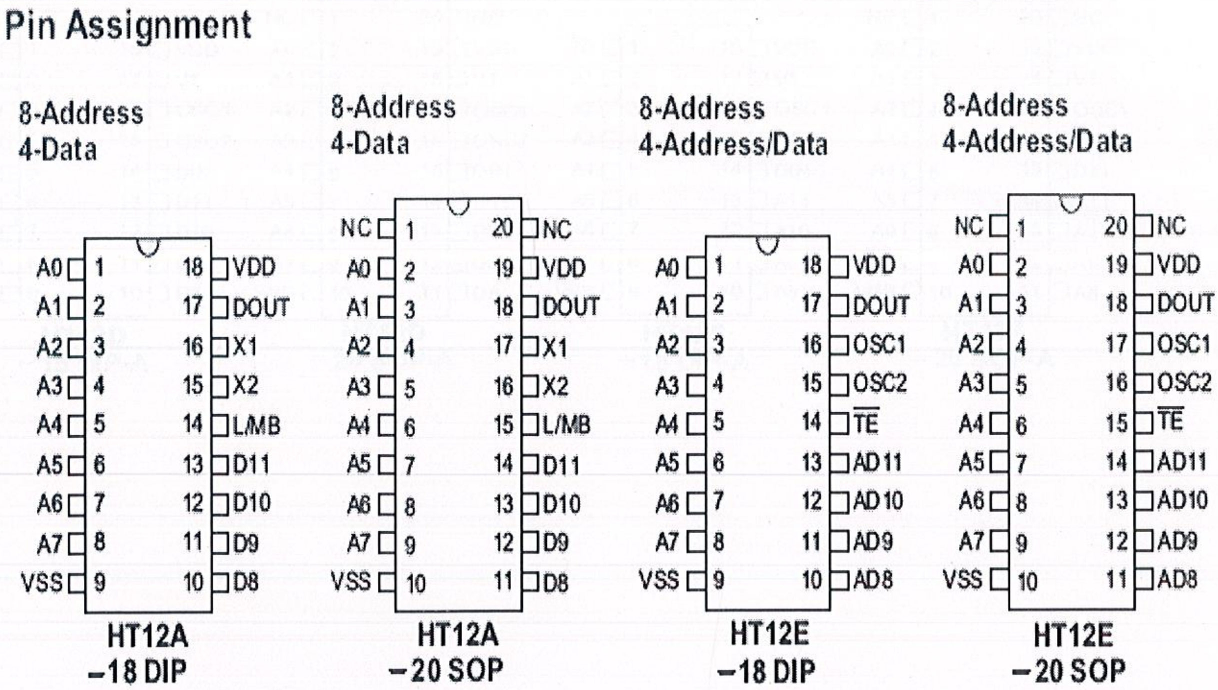
General Description

The 212 encoders are a series of CMOS LSIs for remote control system applications. They are capable of encoding information which consists of N address bits and 12N data bits. Each address/data input can be set to one of the two logic states. The programmed addresses/data are transmitted together with the header bits via an RF or an infrared transmission medium upon receipt of a trigger signal. The capability to select a TE trigger on the HT12E or a DATA trigger on the HT12A further enhances the application flexibility of the 212 series of encoders. The HT12A additionally provides a 38kHz carrier for infrared systems.

Pin Description

<table>
<tr><th>Pin Name</th><th>I/O</th><th>Internal Connection</th><th>Description</th></tr>
<tr><td rowspan="2">A0~A7</td><td rowspan="2">I</td><td>CMOS IN Pull-high (HT12A)</td><td rowspan="2">Input pins for address A0~A7 setting
These pins can be externally set to VSS or left open</td></tr>
<tr><td>NMOS TRANSMISSION GATE PROTECTION DIODE (HT12E)</td></tr>
<tr><td>AD8~AD11</td><td>I</td><td>NMOS TRANSMISSION GATE PROTECTION DIODE (HT12E)</td><td>Input pins for address/data AD8~AD11 setting
These pins can be externally set to VSS or left open</td></tr>
<tr><td>D8~D11</td><td>I</td><td>CMOS IN Pull-high</td><td>Input pins for data D8~D11 setting and transmission enable, active low
These pins should be externally set to VSS or left open (see Note)</td></tr>
<tr><td>DOUT</td><td>O</td><td>CMOS OUT</td><td>Encoder data serial transmission output</td></tr>
<tr><td>L/MB</td><td>I</td><td>CMOS IN Pull-high</td><td>Latch/Momentary transmission format selection pin:
Latch: Floating or VDD
Momentary: VSS</td></tr>
</table>

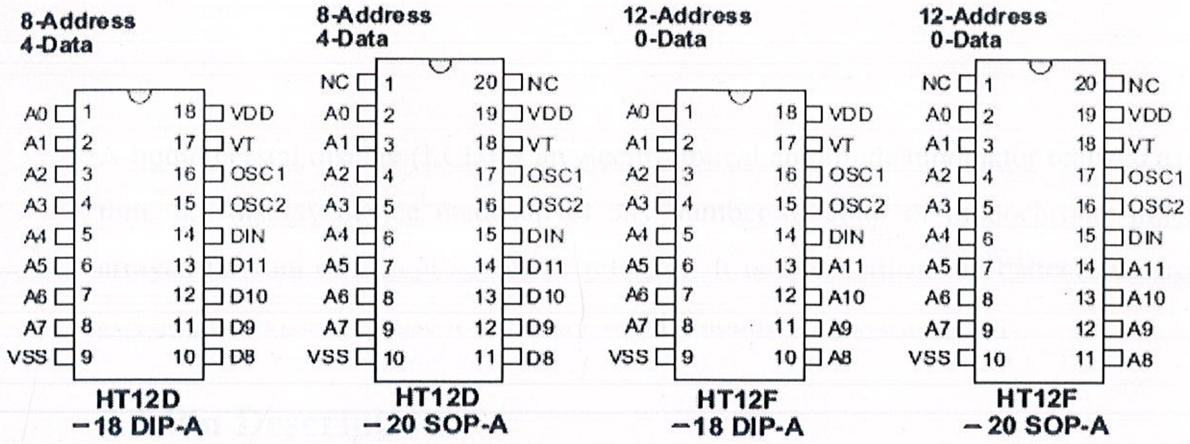
4. DECODER HT12D



General Description

The 212 decoders are a series of CMOS LSIs for remote control system applications. They are paired with Holteks 212 series of encoders (refer to the encoder/decoder cross reference table). For proper operation, a pair of encoder/decoder with the same number of addresses and data format should be chosen. The decoders receive serial addresses and data from a programmed 212 series of encoders that are transmitted by a carrier using an RF or an IR transmission medium. They compare the serial input data three times continuously with their local addresses. If no error or unmatched codes are found, the input data codes are decoded and then transferred to the output pins. The VT pin also goes high to indicate a valid transmission. The 212 series of decoders are capable of decoding informations that consist of N bits of address and 12_N bits of data. Of this series, the HT12D is arranged to provide 8 address bits and 4 data bits, and HT12F is used to decode 12 bits of address information.

Pin Assignment



Pin Description

Pin Name	I/O	Internal Connection	Description
A0~A11 (HT12F)	I	NMOS Transmission Gate	Input pins for address A0~A11 setting These pins can be externally set to VSS or left open.
A0~A7 (HT12D)	I	NMOS Transmission Gate	Input pins for address A0~A7 setting These pins can be externally set to VSS or left open.
D8~D11 (HT12D)	O	CMOS OUT	Output data pins, power-on state is low.
DIN	I	CMOS IN	Serial data input pin
VT	O	CMOS OUT	Valid transmission, active high
OSC1	I	Oscillator	Oscillator input pin
OSC2	O	Oscillator	Oscillator output pin
VSS	—	—	Negative power supply, ground
VDD	—	—	Positive power supply

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 characheres, 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 controller has 16 Pins (two pins are extra in both for back-light LED connections). Pin description is shown in the table below.

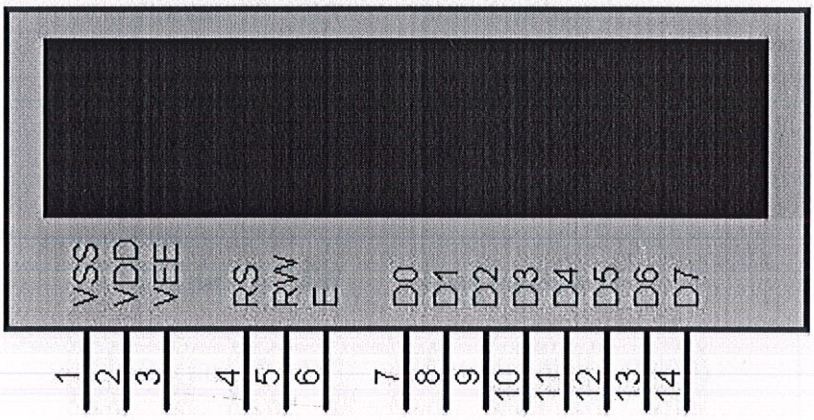


Figure 5.1: Character LCD type HD44780 Pin diagram

Pin No.	Name	Description
Pin no. 1	**VSS**	Power supply (GND)
Pin no. 2	**VCC**	Power supply (+5V)
Pin no. 3	**VEE**	Contrast adjust
Pin no. 4	**RS**	0 = Instruction input 1 = Data input
Pin no. 5	**R/W**	0 = Write to LCD module 1 = Read from LCD module
Pin no. 6	**EN**	Enable signal
Pin no. 7	**D0**	Data bus line 0 (LSB)
Pin no. 8	**D1**	Data bus line 1
Pin no. 9	**D2**	Data bus line 2
Pin no. 10	**D3**	Data bus line 3
Pin no. 11	**D4**	Data bus line 4
Pin no. 12	**D5**	Data bus line 5
Pin no. 13	**D6**	Data bus line 6
Pin no. 14	**D7**	Data bus line 7 (MSB)

Table 5.2: Character LCD pins with 1 Controller

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 best 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 a 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 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 measured 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).

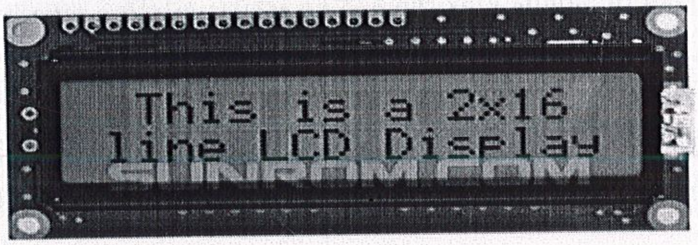


Fig 5.3: LCD Display

Features:-

1.16 Characters x 2 Lines

2. 5x7 Dot Matrix Character + Cursor

3. HD44780 Equivalent LCD Controller/driver 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 LCD's 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 character 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? Its simple if you have sufficient data lines you can go for 8 bit mode & if there is a time constrain i.e. display should be faster then we have to use 8-bit mode because basically 4-bit mode takes twice as more time as 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 data bus is being written to the LCD. When RW is high (1), the program is effectively reading from the LCD. Most of the

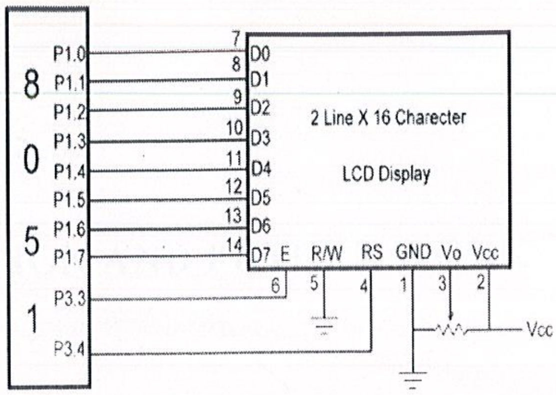


Fig 5.4: LCD interfacing

times there is no need to read from the LCD so this line can directly be connected to Gnd thus saving one controller line.

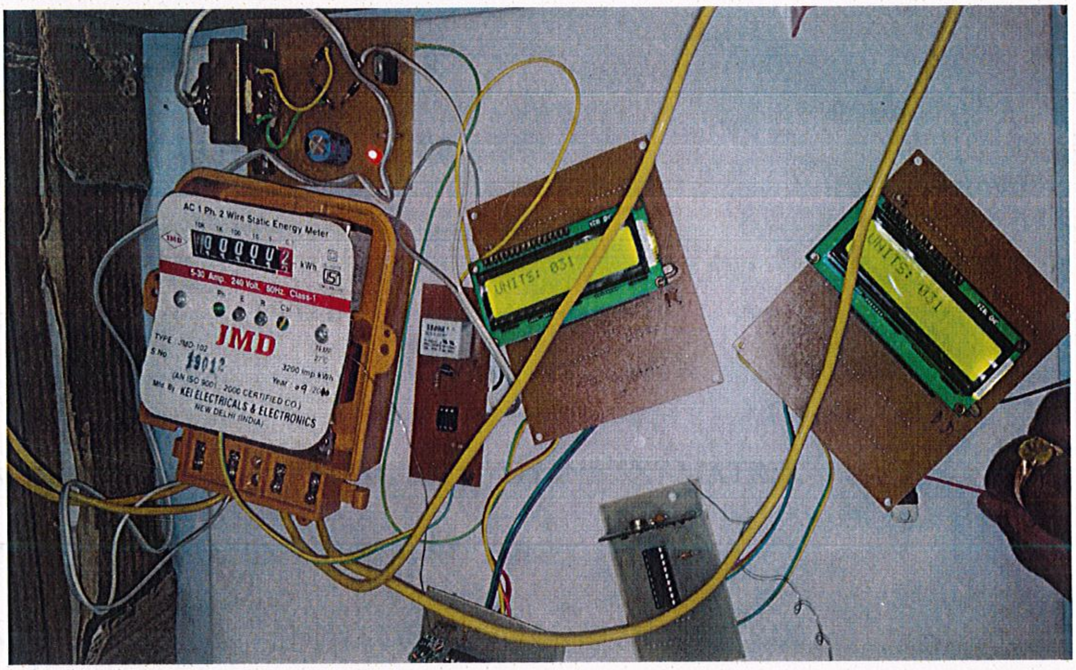
The EN pin is used to latch the data present on the data pins. A HIGH - LOW signal is required to latch the data. The LCD interprets and executes our command at the instant the EN line is brought low. If you never bring EN low, your instruction will never be executed.

CHAPTER-7

CONCLUSION AND FUTURE WORK

7.1 Result

After complete designing of our project we were able to have reading of load and successfully transmit it to the receiver via RF modules.Also,we found that receiver can have readings of more than 1 transmitter.



7.2 Future scope

Various future scopes of this project are:-

1. If monitored regularly electricity theft can be easily detected.
2. Mobile services can also be connected that sends the daily usage of electricity via sms.
3. The receiver can have more than one transmitter with each transmitter having its own address.

APPENDIX A

CODE

TRANSMITTER:-

```
;--------------------------------------------------

;LCD DATA PINS TO P0

;RF AT P1

;R3,R4,R5 --- DELAY REGISTER

;INPUT AT P3.4 FOR COUNTER0

;--------------------------------------------------

;-----------------------LCD INITIALIZE---------------

ORG 0000H

MOV A,#38H          ;INITIALISE TWO LINE 5X7 MATRIX

ACALL COMMAND       ;SUB ROUTINE

MOV A,#38H          ;INITIALISE TWO LINE 5X7 MATRIX

ACALL COMMAND       ;SUB ROUTINE

MOV A,#0CH          ;DISPLAY ON,

ACALL COMMAND       ;SUB ROUTINE

MOV A,#01H          ;CLEAR LCD

ACALL COMMAND       ;SUB ROUTINE

MOV A,#6H           ;INCREMENT CURSOR RIGHT

ACALL COMMAND       ;COMMAND SUBROUTINE

MOV A,#80H          ;SHIFT CURSOR TO 1ST LINE
```

```
ACALL COMMAND        ;COMMAND SUBROUTINE
MOV A,#38H           ;INITIALISE TWO LINE 5X7 MATRIX
ACALL COMMAND        ;SUB ROUTINE
MOV A,#38H           ;INITIALISE TWO LINE 5X7 MATRIX
ACALL COMMAND        ;SUB ROUTINE
MOV A,#0CH           ;DISPLAY ON,
ACALL COMMAND        ;SUB ROUTINE
MOV A,#01H           ;CLEAR LCD
ACALL COMMAND        ;SUB ROUTINE
MOV A,#6H            ;INCREMENT CURSOR RIGHT
ACALL COMMAND        ;COMMAND SUBROUTINE
MOV A,#80H           ;SHIFT CURSOR TO 1ST LINE
ACALL COMMAND        ;COMMAND SUBROUTINE
;--------------------[ WIRELESS ENERGY METER SYSTEM]----------------------------
MOV A, #'W'
ACALL DATA1          ; SUBROUTINE
MOV A, #'I'
ACALL DATA1          ; SUBROUTINE
MOV A, #'R'
ACALL DATA1          ; SUBROUTINE
MOV A, #'E'
ACALL DATA1          ; SUBROUTINE
MOV A, #'L'
```

```
ACALL DATA1          ; SUBROUTINE
MOV A, #'E'
ACALL DATA1          ; SUBROUTINE
MOV A, #'S'
ACALL DATA1          ; SUBROUTINE
MOV A, #'S'
ACALL DATA1          ; SUBROUTINE
MOV A,#89H          ;SHIFT CURSOR TO 1ST LINE
ACALL COMMAND          ;COMMAND SUBROUTINE
MOV A, #'E'
ACALL DATA1          ; SUBROUTINE
MOV A, #'N'
ACALL DATA1          ; SUBROUTINE
MOV A, #'E'
ACALL DATA1          ; SUBROUTINE
MOV A, #'R'
ACALL DATA1          ; SUBROUTINE
MOV A, #'G'
ACALL DATA1          ; SUBROUTINE
MOV A, #'Y'
ACALL DATA1          ; SUBROUTINE
MOV A,#0C0H          ;SHIFT CURSOR TO 2ND LINE
ACALL COMMAND          ;COMMAND SUBROUTINE
```

```
MOV A, #'M'
ACALL DATA1          ; SUBROUTINE
MOV A, #'E'
ACALL DATA1          ; SUBROUTINE
MOV A, #'T'
ACALL DATA1          ; SUBROUTINE
MOV A, #'E'
ACALL DATA1          ; SUBROUTINE
MOV A, #'R'
ACALL DATA1          ; SUBROUTINE
ACALL DELAY2
ACALL DELAY2
ACALL DELAY2
MOV A, #'.'
ACALL DATA1
ACALL DELAY2
ACALL DELAY2
ACALL DELAY2
MOV A, #'.'
ACALL DATA1
ACALL DELAY2
ACALL DELAY2
ACALL DELAY2
```

```
MOV A, #'.'
ACALL DATA1

MOV A,#01H          ;CLEAR LCD
ACALL COMMAND           ;SUB ROUTINE
MOV A,#80H          ;SHIFT CURSOR TO 1ST LINE
ACALL COMMAND

MOV A, #'U'
ACALL DATA1             ; SUBROUTINE
MOV A, #'N'
ACALL DATA1             ; SUBROUTINE
MOV A, #'I'
ACALL DATA1             ; SUBROUTINE
MOV A, #'T'
ACALL DATA1             ; SUBROUTINE
MOV A, #'S'
ACALL DATA1             ; SUBROUTINE
MOV A, #':'
ACALL DATA1             ; SUBROUTINE
;---------------------------------------------------
MOV R6,#09H                  ; AS COUNTER
LOP:
```

```
SETB P3.4
JOKER:JB P3.4,JOKER
        INC R6
 MOV A,#87H          ;SHIFT CURSOR TO 1ST LINE
 ACALL COMMAND        ;COMMAND SUBROUTINE
;-----------------------------HEX TO BCD----------------
        MOV A,R6
        MOV B,#10D
        DIV AB
        MOV R2,B              ; 0NE
        MOV B,#10D
        DIV AB
        MOV R1,B         ; TENS
        MOV R0,A              ;HUNDRED

;-------------------------------------------------------------
MOV P1,#0AH  ;PUT DATA 0000 0001 WE ONLY RECIEVE LOWER BITS
MOV P1,#0AH  ;PUT DATA 0000 0001 WE ONLY RECIEVE LOWER BITS
MOV P1,#0AH  ;PUT DATA 0000 0001 WE ONLY RECIEVE LOWER BITS
MOV P1,#0AH  ;PUT DATA 0000 0001 WE ONLY RECIEVE LOWER BITS
ACALL DELAY2
MOV P1,R0 ;PUT DATA 0000 0001 WE ONLY RECIEVE LOWER BITS
```

```
MOV P1,R0 ;PUT DATA 0000 0001 WE ONLY RECIEVE LOWER BITS
          ; RF MODULES

MOV A,R0

ADD A,#30H
                              ; BCD TO ASCII CONVERSION

ACALL DATA1

ACALL DELAY2


MOV P1,R1  ;PUT DATA 0000 0001 WE ONLY RECIEVE LOWER BITS

MOV P1,R1  ;PUT DATA 0000 0001 WE ONLY RECIEVE LOWER BITS

ACALL DELAY2

MOV A,R1

ADD A,#30H

ACALL DATA1

MOV P1,R2  ;PUT DATA 0000 0001 WE ONLY RECIEVE LOWER BITS

MOV P1,R2  ;PUT DATA 0000 0001 WE ONLY RECIEVE LOWER BITS

ACALL DELAY2

MOV A,R2

ADD A,#30H

ACALL DATA1

ACALL DELAY


SJMP LOP
```

```
DELAY1:
    MOV R4,#100D
H11:  MOV R5,#50D
H21:   DJNZ R5,H21
    DJNZ R4,H11
      RET
COMMAND:
MOV P0,A
CLR P2.5
CLR P2.6
SETB P2.7
CLR P2.7
ACALL DELAY1
RET
DATA1:
MOV P0,A
SETB P2.5
CLR P2.6
SETB P2.7
CLR P2.7
ACALL DELAY1
RET
DELAY2:
```

```
    MOV R4,#2D
H3:  MOV R5,#255D
H1:  MOV R3,#255D
H2:  DJNZ R3,H2
     DJNZ R5,H1
     DJNZ R4,H3
     RET
DELAY:
     MOV R5,#30D
H13: MOV R4,#45D
H23: DJNZ R4,H23
     DJNZ R5,H13
     RET
END
```

RECIEVER :-

```
;METER AT P1.0

;R3,R4,R5 --- DELAY REGISTER

;INPUT AT P3.4 FOR COUNTER0

;-----------------------------------------------------

ORG 0000H

 MOV A,#38H          ;INITIALISE TWO LINE 5X7 MATRIX

ACALL COMMAND        ;SUB ROUTINE

MOV A,#38H           ;INITIALISE TWO LINE 5X7 MATRIX

ACALL COMMAND        ;SUB ROUTINE

MOV A,#0CH           ;DISPLAY ON,CURSOR BLINKING

ACALL COMMAND        ;SUB ROUTINE

MOV A,#01H           ;CLEAR LCD

ACALL COMMAND        ;SUB ROUTINE

MOV A,#6H            ;INCREMENT CURSOR RIGHT

ACALL COMMAND        ;COMMAND SUBROUTINE

MOV A,#80H           ;INCREMENT CURSOR RIGHT

ACALL COMMAND        ;COMMAND SUBROUTINE

MOV A, #'U'

ACALL DATA1          ; SUBROUTINE

MOV A, #'N'

ACALL DATA1
```

```
MOV A, #'I'

ACALL DATA1            ; SUBROUTINE

MOV A, #'T'

ACALL DATA1              ; SUBROUTINE

MOV A, #'S'

ACALL DATA1            ; SUBROUTINE

MOV A, #''

ACALL DATA1


LOP

MOV A,#87H             ;SHIFT CURSOR TO 7TH POS.

ACALL COMMAND          ;COMMAND SUBROUTINE

OYE

MOV A,P1

ANL A,#00001111B

CJNE A,#0AH ,OYE

ACALL DELAY2

HI

MOV A,P1        ;GET DATA

CJNE A,#0AH,HO

SJMP HI

HO

MOV 40H,A
```

```
ANL A,#00001111B

MOV B,A

MOV A,B

ADD A,#30H

ACALL DATA1           ;LCD DISPLAY

HI2

MOV A,P1     ;GET DATA

CJNE A,#0AH,IN

SJMP HI2

IN

BACK

MOV A,P1

MOV A,P1

MOV 41H,A

CJNE A,40H,NEXT

SJMP BACK

NEXT

ANL A,#00001111B

MOV B,A

MOV A,B

ADD A,#30H

ACALL DATA1

HI3
```

```
MOV A,P1      ;GET DATA
MOV A,P1
CJNE A,#0AH,HO3
SJMP HI3
HO3
BACK2
MOV A,P1
MOV A,P1
MOV A,P1
MOV 42H,A
CJNE A,41H,NEXT2
SJMP BACK2
NEXT2
ANL A,#00001111B
MOV B,A
MOV A,B
ADD A,#30H
ACALL DATA1
LJMP LOP
DELAY1
      MOV R4,#40D
H11  MOV R5,#50D
H21   DJNZ R5,H21
```

```
    DJNZ R4,H11
     RET
COMMAND
MOV P0,A
CLR P2.5
CLR P2.6
SETB P2.7
CLR P2.7
ACALL DELAY1
RET

DATA1
MOV P0,A
SETB P2.5
CLR P2.6
SETB P2.7
CLR P2.7
ACALL DELAY1
RET
DELAY2
    MOV R4,#3D
H3  MOV R5,#255D
H1  MOV R3,#255D
```

```
H2  DJNZ R3,H2
    DJNZ R5,H1
    DJNZ R4,H3
    RET
DELAY
    MOV R5,#30D
H13 MOV R4,#45D
H23 DJNZ R4,H23
    DJNZ R5,H13
    RET
END
```

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