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Higher Diploma in Electrical and electronic Engineering

Final Year Project

MICROCONTROLLER BASED POWER THEFT IDENTIFIER

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ORGANIZATION OF THE THESIS

In view of the proposed thesis work explanation of theoretical aspects and algorithms used in this work are presented as per the sequence described below.

Table of Contents

Chapter1: Describes a brief review of the objectives and Aim of the project.

Chapter2: Discusses the introduction of embedded systems and specifications and design of embedded systems in detail.

Chapter3: Describes the Block diagram of the project and its description. The construction and description of various modules used for the application are described in detail.

Chapter4: Explains the Software tools required for the project,

Chapter5: Working procedure and schematic diagram of the hardware.

Chapter6: Overall conclusions of this project along with working procedure are given.

Acknowledgments

We would like to thank our parents and Governments for sending us to this University. We would also like to express our sincere gratitude to our supervisor **Mr. Rakibul Hasan Sagor** Assistant Professor for all his help and guidance during the course of this project.

Chapter 1

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.

This project is designed to find out such power theft in the normal distribution lines. Even though there are certain practical problems in implementing this kind of systems in future there is a scope for development of these types of systems. This project is using the principle of the differential protection scheme for the identification of the power theft. The differential protection scheme consists of two CTs (current transformers) connected at both the terminals of the load. If there is no fault in the load then the secondary currents of both the CTs will be same. Using the same principle one CT is connected at the starting end of the distributor and the remaining other CT is connected to the different loads which are legal. If there is no power theft in the line then the vector sum of all the CT's which are connected to the load will be equal to the current in the main ct. if there is a difference then we can make out that it should either be the power theft or a fault in the line.

This consists of the following components:

1) <u>5V dc generation unit:</u> This unit will give 5v dc from the 230v ac, which is used as the internal supply voltage in the circuit.

2) <u>Measuring circuit:</u> This section is built with op amps this will get the data from the entire CT and make the vector sum of the entire CT. All the mathematical operation is performed in this section by using OP Amps.

1.1 INTRODUCTION

Generation, transmission and distribution of electrical energy involve many losses. Whereas, losses implicated in generation can be technically defined, but transmission and distribution losses cannot be precisely quantified with the sending end information. Overall technical losses occur naturally and are caused because of power dissipation in transmission lines, transformers, and other power system components. Technical losses in T&D are computed with the information about total load and the total energy billed .Total loss cannot be precisely computed, but can be estimated from the difference between the total energy supplied to the customers and the total energy billed, losses are caused by the factors external to the power system. Nowadays power theft is happening in most of the countries. This cause's major crisis for the government and it tends to increase the demand also.

In these days when generation of power is not met up to the need of men, there is large number of power thefts from domestic and industrial supply lines. This Project is to limit such thefts, by letting the Electricity Board to know the theft. By this project, we introduce a new system of power connection, i.e., instead of driving the power straight away from the transformer, we drive it through a current transformer which is monitored by a Microcontroller. The embedded system is in contact with the Electricity Board through wires. Hence when large amount of load is pulled up by a particular household connection, the EB is kept known about this and it could cut the power supply to that particular House On receiving this particular signal, the controller cuts off the connection of current transformer disabling to pull load from the transformer line. When the load of the transformer exceeds, even when all the houses under it were using exact amount of supply allotted to them, the EB (Electricity Board) can monitor the theft directly from the transformer line and cut off the transformer supply entirely to catch the convicted behind the theft. Thus, this project helps the Electricity Board to trace out the power thefts and block them instantly.

1.2 BACKGROUND OF THE PROJECT

The software application and the hardware implementation help the microcontroller (ATMEGA 2560) to monitor all the parameters continuously and display it on the LCD. The system is totally designed using embedded systems technology. AT 2560 is the microcontroller and forms the heart of the system.

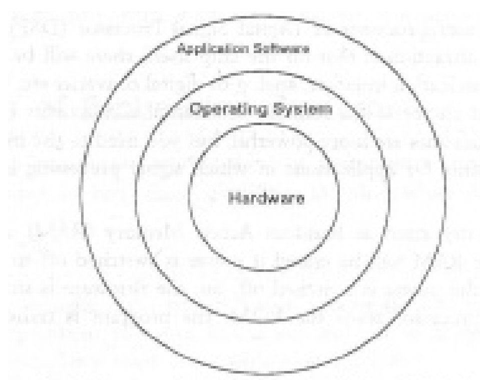
The Controlling unit has an application program to allow the microcontroller read the incoming data through the current transformers and change the status of the load accordingly. The performance of the design is maintained by controlling unit. AT2560 continuously receives the data from the transformers, after processing in the ADC section, the data is displayed on the LCD. Based on this information AT2560 controls the loads.

CHAPTER 2

INTRODUCTION TO EMBEDDED SYSTEMS

Every embedded system consists of custom-built hardware built around a Central Processing Unit (CPU). This hardware also contains memory chips onto which the software is loaded. The software residing on the memory chip is also called the 'firmware'. The embedded system architecture can be represented as a layered architecture as shown in Fig.

The operating system runs above the hardware, and the application software runs above the operating system. The same architecture is applicable to any computer including a desktop



: Layered Architecture of an Embedded Syste

computer. However, there are significant differences. It is not compulsory to have an operating system in every embedded system. For small appliances such as remote control units, air conditioners, toys etc., there is no need *for* an operating system and you can write only the software specific to that application. For applications involving complex processing, it is advisable to have an operating system. In such a case, you need to integrate the application software with the operating system and then transfer the entire software on to the memory chip. Once the software is transferred to the memory chip, the software will continue to run *for* a long time you don't need to reload new software.

Now, let us see the details of the various building blocks of the hardware of an embedded system. As shown in Fig. the building blocks are;

· Central Processing Unit (CPU)

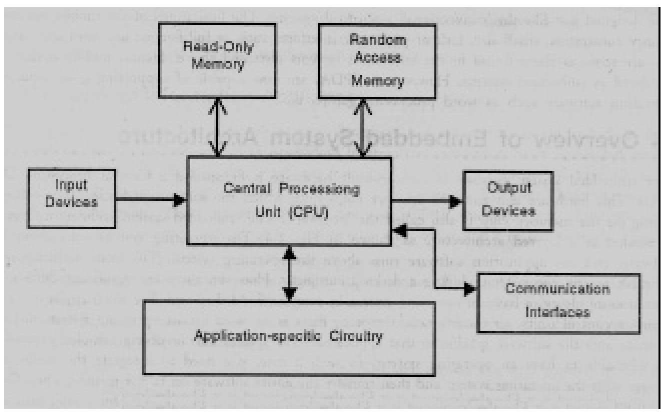
· Memory (Read-only Memory and Random Access Memory)

· Input Devices

· Output devices

· Communication interfaces

· Application-specific circuitry



Central Processing Unit (CPU):

The Central Processing Unit (processor, in short) can be any of the following: microcontroller, microprocessor or Digital Signal Processor (DSP). A micro-controller is a low-cost processor. Its main attraction is that on the chip itself, there will be many other components such as memory, serial communication interface, analog-to digital converter etc. So, for small applications, a micro-controller is the best choice as the number of external components required will be very less. On the other hand, microprocessors are more powerful, but you need to use many external components with them. D5P is used mainly for applications in which signal processing is involved such as audio and video processing.

Memory:

The memory is categorized as Random Access 11emory (RAM) and Read Only Memory (ROM). The contents of the RAM will be erased if power is switched off to the chip, whereas ROM retains the contents even if the power is switched off. So, the firmware is stored in the

ROM. When power is switched on, the processor reads the ROM; the program is program is executed.

Input devices:

Unlike the desktops, the input devices to an embedded system have very limited capability. There will be no keyboard or a mouse, and hence interacting with the embedded system is no easy task. Many embedded systems will have a small keypad-you press one key to give a specific command. A keypad may be used to input only the digits. Many embedded systems used in process control do not have any input device *for* user interaction; they take inputs *from* sensors or transducers 1'fnd produce electrical signals that are in turn fed to other systems.

Output devices:

The output devices of the embedded systems also have very limited capability. Some embedded systems will have a *few* Light Emitting Diodes (LEDs) *to* indicate the health status of the system modules, or *for* visual indication of alarms. A small Liquid Crystal Display (LCD) may also be used to display *some* important parameters.

Communication interfaces:

The embedded systems may need to, interact with other embedded systems at they may have to transmit data to a desktop. To facilitate this, the embedded systems are provided with one or a *few* communication interfaces such as RS232, RS422, RS485, Universal Serial Bus (USB), IEEE 1394, Ethernet etc.

Application-specific circuitry:

Sensors, transducers, special processing and control circuitry may be required fat an embedded system, depending on its application. This circuitry interacts with the processor to carry out the necessary work. The entire hardware has to be given power supply either through the 230 volts main supply or through a battery. The hardware has to design in such a way that the power consumption is minimized.

Chapter 3

Hardware Implementation of the Project

This chapter briefly explains about the Hardware Implementation of the project. It discusses the design and working of the design with the help of block diagram and circuit diagram and explanation of circuit diagram in detail. It explains the features, timer programming, serial communication, interrupts of AT89S52 microcontroller. It also explains the various module used in this project.

2.1 Project Design

The implementation of the project design can be divided in two parts.

- Hardware implementation
- Firmware implementation

Hardware implementation deals in drawing the schematic on the plane paper according to the application, testing the schematic design over the breadboard using the various components to find if the design meets the objective. Finally preparing the board and testing the designed hardware.

The firmware part deals in programming the microcontroller so that it can control the operation of the components used in the implementation. In the present work, we have used the Proteus design software for circuit design, the Arduino software development tool to write and compile the source code, which has been written in the Arduino language. The firmware implementation is explained in the next chapter.

The project design and principle are explained in this chapter using the block diagram and circuit diagram. The block diagram discusses about the required components of the design and working condition is explained using circuit diagram and system wiring diagram.

INTRODUCTION TO MICROCONTROLLER

Based on the Processor side Embedded Systems is mainly divided into 3 types

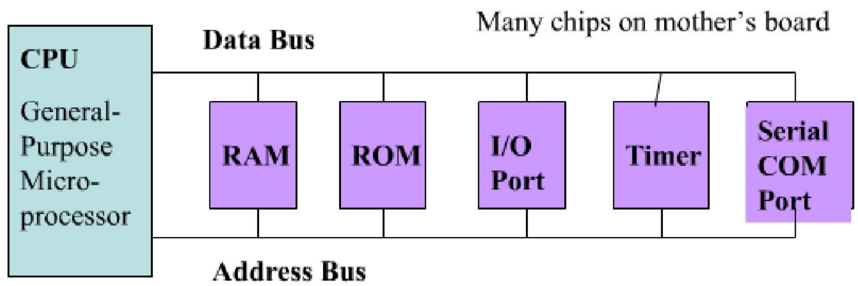
1. Microprocessor: - are for general purpose   eg: our personal computer

2. Microcontroller: - are for specific applications, because of cheaper cost we will go for these

Microprocessors:

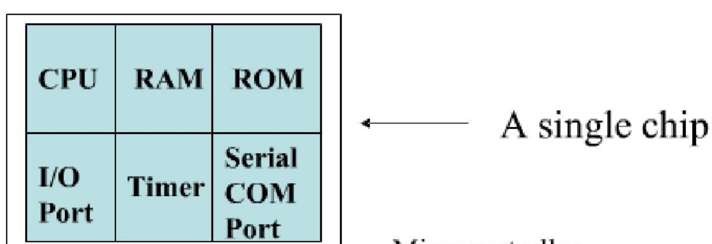
General-purpose microprocessor

- CPU for Computers
- No RAM, ROM, I/O on CPU chip itself
- Example：Intel's x86, Motorola's 680x0



Microcontroller :

- A smaller computer
- On-chip RAM, ROM, I/O ports...
- Example：Motorola's 6811, Intel's 8051, Zilog's Z8 and PIC 16X



Microcontroller

Microprocessor vs. Microcontroller

Microprocessor

- CPU is stand-alone, RAM, ROM, I/O, timer are separate
- designer can decide on the amount of ROM, RAM and I/O ports.
- expansive
- versatility
- general-purpose

Microcontroller

- CPU, RAM, ROM, I/O and timer are all on a single chip
- fix amount of on-chip ROM, RAM, I/O ports
- for applications in which cost, power and space are critical
- single-purpose

CPU platform:

Embedded processors can be broken into two distinct categories: microprocessors (μP) and microcontrollers (μC). Microcontrollers have built-in peripherals on the chip, reducing size of the system.

There are many different CPU architectures used in embedded designs such as ARM, MIPS, Coldfire/68k, PowerPC, x86, PIC, 8051, Atmel AVR, Renesas H8, SH, V850, FR-V, M32R, Z80, Z8, etc. This in contrast to the desktop computer market, which is currently limited to just a few competing architectures.

PC/104 and PC/104+ are a typical base for small, low-volume embedded and ruggedized system design. These often use DOS, Linux, NetBSD, or an embedded real-time operating system such as QNX or VxWorks.

A common configuration for very-high-volume embedded systems is the system on a chip (SoC), an application-specific integrated circuit (ASIC), for which the CPU core was purchased and added as part of the chip design. A related scheme is to use a field-programmable gate array (FPGA), and program it with all the logic, including the CPU.

Embedded systems are based on the concept of the microcontroller, a single integrated circuit that contains all the technology required to run an application. Microcontrollers make integrated systems possible by combining several features together into what is effectively a complete computer.

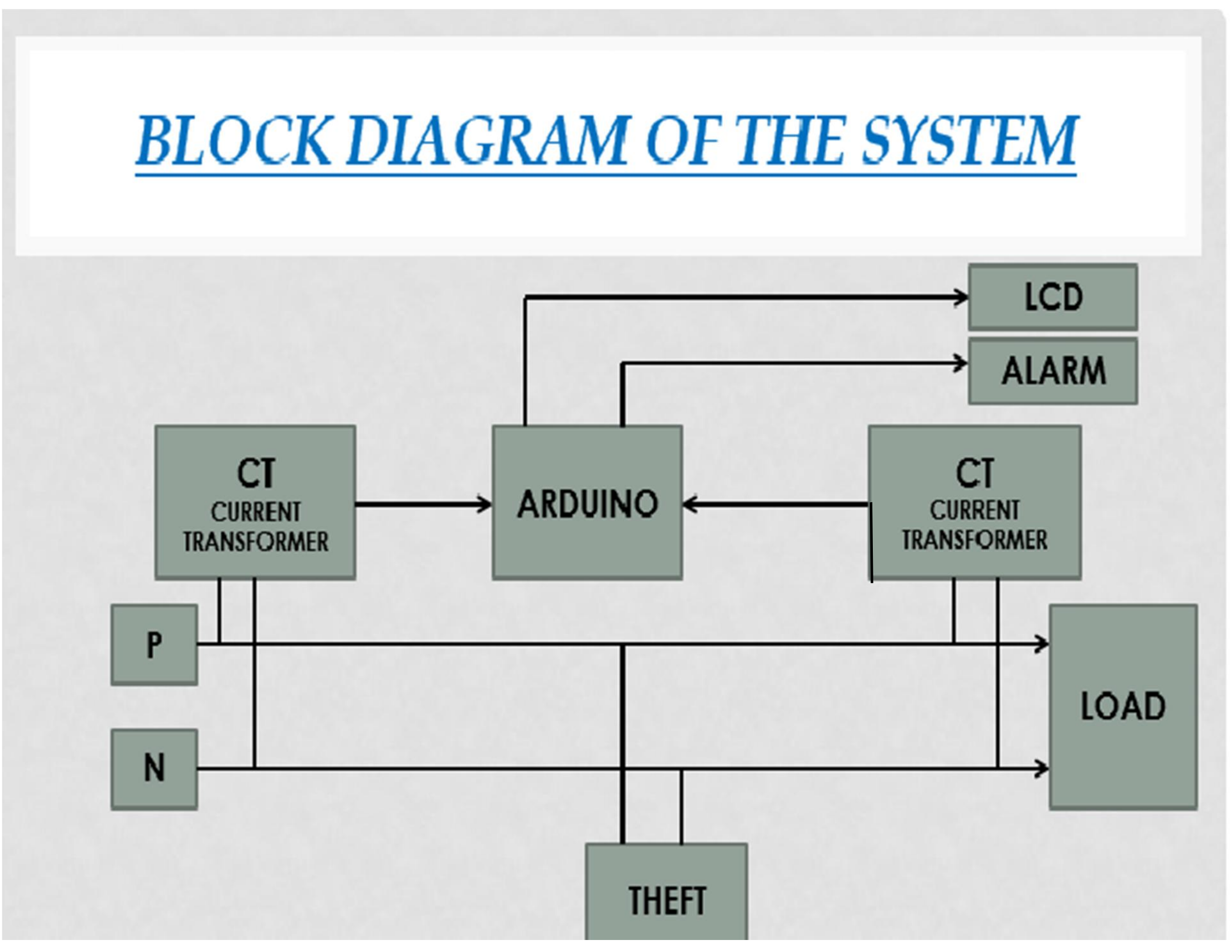
By integrating all of these features into a single chip it is possible to greatly reduce the number of chips and wiring necessary to control an electronic device, dramatically reducing its complexity, size and cost.

* **Size & Weight:** Microcontrollers are designed to deliver maximum performance for minimum size and weight. A centralized on-board computer system would greatly outweigh a collection of microcontrollers.
* **Efficiency:** Microcontrollers are designed to perform repeated functions for long periods of time without failing or requiring service.

MICROCONTROLLER: is a chip through which we can connect many other devices and also those are controlled by the program the program which burn into that chip

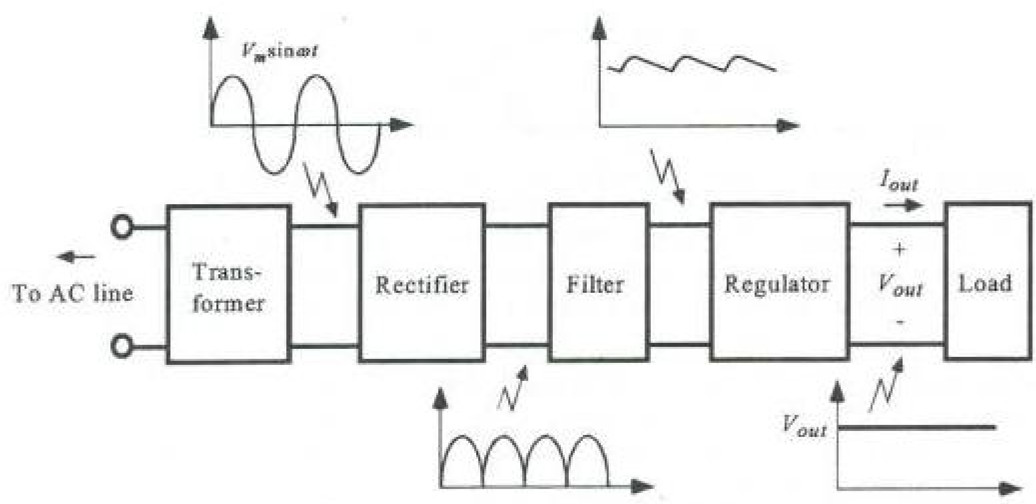
3.1.1 Block Diagram of the Project and its Description

The block diagram of the design is as shown in Fig 3.1. It consists of power supply unit, microcontroller, CTs, LCD. The brief description of each unit is explained as follows.



3.2 Power Supply:

The input to the circuit is applied from the regulated power supply. The a.c. input i.e., 230V from the mains supply is step down by the transformer to 12V and is fed to a rectifier. The output obtained from the rectifier is a pulsating d.c voltage. So in order to get a pure d.c voltage, the output voltage from the rectifier is fed to a filter to remove any a.c components present even after rectification. Now, this voltage is given to a voltage regulator to obtain a pure constant dc voltage.



Components of a regulated power supply

Transformer:

Usually, DC voltages are required to operate various electronic equipment and these voltages are 5V, 9V or 12V. But these voltages cannot be obtained directly. Thus the a.c input available at the mains supply i.e., 230V is to be brought down to the required voltage level. This is done by a transformer. Thus, a step down transformer is employed to decrease the voltage to a required level.

Rectifier:

The output from the transformer is fed to the rectifier. It converts A.C. into pulsating D.C. The rectifier may be a half wave or a full wave rectifier. In this project, a bridge rectifier is used because of its merits like good stability and full wave rectification.

Filter: Capacitive filter is used in this project. It removes the ripples from the output of rectifier and smoothens the D.C. Output received from this filter is constant until the mains voltage and load is maintained constant. However, if either of the two is varied, D.C. voltage received at this point changes. Therefore a regulator is applied at the output stage.

Voltage regulator:

As the name itself implies, it regulates the input applied to it. A voltage regulator is an electrical regulator designed to automatically maintain a constant voltage level. In this project, power supply of 5V and 12V are required. In order to obtain these voltage levels, 7805 and 7812 voltage regulators are to be used. The first number 78 represents positive supply and the numbers 05, 12 represent the required output voltage levels.

3.3 Microcontrollers

Arduino Mega 2560 PIN diagram

Arduino Mega 2560 PIN mapping table

Pin Number	Pin Name	Mapped Pin Name
1	PG5 (OC0B)	Digital pin 4 (PWM)
2	PE0 (RXD0/PCINT8)	Digital pin 0 (RX0)
3	PE1 (TXD0)	Digital pin 1 (TX0)
4	PE2 (XCK0/AIN0)	
5	PE3 (OC3A/AIN1)	Digital pin 5 (PWM)
6	PE4 (OC3B/INT4)	Digital pin 2 (PWM)
7	PE5 (OC3C/INT5)	Digital pin 3 (PWM)
8	PE6 (T3/INT6)	
9	PE7 (CLKO/ICP3/INT7)	
10	VCC	VCC
11	GND	GND
12	PH0 (RXD2)	Digital pin 17 (RX2)
13	PH1 (TXD2)	Digital pin 16 (TX2)

14	PH2 (XCK2)	
15	PH3 (OC4A)	Digital pin 6 (PWM)
16	PH4 (OC4B)	Digital pin 7 (PWM)
17	PH5 (OC4C)	Digital pin 8 (PWM)
18	PH6 (OC2B)	Digital pin 9 (PWM)
19	PB0 (SS/PCINT0)	Digital pin 53 (SS)
20	PB1 (SCK/PCINT1)	Digital pin 52 (SCK)
21	PB2 (MOSI/PCINT2)	Digital pin 51 (MOSI)
22	PB3 (MISO/PCINT3)	Digital pin 50 (MISO)
23	PB4 (OC2A/PCINT4)	Digital pin 10 (PWM)
24	PB5 (OC1A/PCINT5)	Digital pin 11 (PWM)
25	PB6 (OC1B/PCINT6)	Digital pin 12 (PWM)
26	PB7 (OC0A/OC1C/PCINT7)	Digital pin 13 (PWM)
27	PH7 (T4)	
28	PG3 (TOSC2)	
29	PG4 (TOSC1)	
30	RESET	RESET
31	VCC	VCC
32	GND	GND
33	XTAL2	XTAL2
34	XTAL1	XTAL1

35	PL0 (ICP4)	Digital pin 49
36	PL1 (ICP5)	Digital pin 48
37	PL2 (T5)	Digital pin 47
38	PL3 (OC5A)	Digital pin 46 (PWM)
39	PL4 (OC5B)	Digital pin 45 (PWM)
40	PL5 (OC5C)	Digital pin 44 (PWM)
41	PL6	Digital pin 43
42	PL7	Digital pin 42
43	PD0 (SCL/INT0)	Digital pin 21 (SCL)
44	PD1 (SDA/INT1)	Digital pin 20 (SDA)
45	PD2 (RXDI/INT2)	Digital pin 19 (RX1)
46	PD3 (TXD1/INT3)	Digital pin 18 (TX1)
47	PD4 (ICP1)	
48	PD5 (XCK1)	
49	PD6 (T1)	
50	PD7 (T0)	Digital pin 38
51	PG0 (WR)	Digital pin 41
52	PG1 (RD)	Digital pin 40
53	PC0 (A8)	Digital pin 37
54	PC1 (A9)	Digital pin 36
55	PC2 (A10)	Digital pin 35

56	PC3 (A11)	Digital pin 34
57	PC4 (A12)	Digital pin 33
58	PC5 (A13)	Digital pin 32
59	PC6 (A14)	Digital pin 31
60	PC7 (A15)	Digital pin 30
61	VCC	VCC
62	GND	GND
63	PJ0 (RXD3/PCINT9)	Digital pin 15 (RX3)
64	PJ1 (TXD3/PCINT10)	Digital pin 14 (TX3)
65	PJ2 (XCK3/PCINT11)	
66	PJ3 (PCINT12)	
67	PJ4 (PCINT13)	
68	PJ5 (PCINT14)	
69	PJ6 (PCINT 15)	
70	PG2 (ALE)	Digital pin 39
71	PA7 (AD7)	Digital pin 29
72	PA6 (AD6)	Digital pin 28
73	PA5 (AD5)	Digital pin 27
74	PA4 (AD4)	Digital pin 26
75	PA3 (AD3)	Digital pin 25
76	PA2 (AD2)	Digital pin 24

77	PA1 (AD1)	Digital pin 23
78	PA0 (AD0)	Digital pin 22
79	PJ7	
80	VCC	VCC
81	GND	GND
82	PK7 (ADC15/PCINT23)	Analog pin 15
83	PK6 (ADC14/PCINT22)	Analog pin 14
84	PK5 (ADC13/PCINT21)	Analog pin 13
85	PK4 (ADC12/PCINT20)	Analog pin 12
86	PK3 (ADC11/PCINT19)	Analog pin 11
87	PK2 (ADC10/PCINT18)	Analog pin 10
88	PK1 (ADC9/PCINT17)	Analog pin 9
89	PK0 (ADC8/PCINT16)	Analog pin 8
90	PF7 (ADC7)	Analog pin 7
91	PF6 (ADC6)	Analog pin 6
92	PF5 (ADC5/TMS)	Analog pin 5
93	PF4 (ADC4/TMK)	Analog pin 4
94	PF3 (ADC3)	Analog pin 3
95	PF2 (ADC2)	Analog pin 2
96	PF1 (ADC1)	Analog pin 1
97	PF0 (ADC0)	Analog pin 0

98	AREF	Analog Reference
99	GND	GND
100	AVCC	VCC

3.5 TRANSFORMERS

A **transformer** is a device that transfers electrical energy from one circuit to another through inductively coupled conductors the transformer's coils. A varying current in the first or *primary* winding creates a varying magnetic flux in the transformer's core and thus a varying magnetic field through the *secondary*winding. This varying magnetic field induces a varying electromotive force (EMF), or "voltage", in the secondary winding. This effect is called inductive coupling.

If a load is connected to the secondary, current will flow in the secondary winding, and electrical energy will be transferred from the primary circuit through the transformer to the load. In an ideal transformer, the induced voltage in the secondary winding (V_s) is in proportion to the primary voltage (V_p) and is given by the ratio of the number of turns in the secondary (N_s) to the number of turns in the primary (N_p) as follows:

$$\frac{V_s}{V_p} = \frac{N_s}{N_p}$$

By appropriate selection of the ratio of turns, a transformer thus enables an alternating current (AC) voltage to be "stepped up" by making N_s greater than N_p, or "stepped down" by making N_s less than N_p.

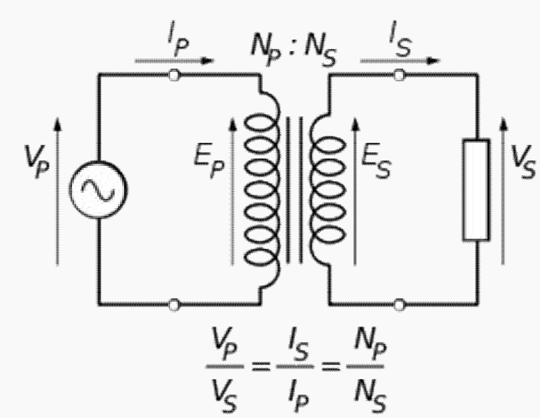
In the vast majority of transformers, the windings are coils wound around a ferromagnetic core, air-core transformers being a notable exception.

Transformers range in size from a thumbnail-sized coupling transformer hidden inside a stage microphone to huge units weighing hundreds of tons used to interconnect portions of power grids. All operate on the same basic principles, although the range of designs is wide. While new technologies have eliminated the need for transformers in some electronic circuits, transformers are still found in nearly all electronic devices designed for household ("mains") voltage. Transformers are essential for high-voltage electric power transmission, which makes long-distance transmission economically practical.

The transformer is based on two principles: first, that an electric current can produce amagnetic field (electromagnetism) and second that a changing magnetic field within a coil of wire induces a voltage across the ends of the coil (electromagnetic induction). Changing the current in the primary coil changes the magnetic flux that is developed. The changing magnetic flux induces a voltage in the secondary coil.

An ideal transformer is shown in the adjacent figure. Current passing through the primary coil creates a magnetic field. The primary and secondary coils are wrapped around a core of very high magnetic permeability, such asiron, so that most of the magnetic flux passes through both the primary and secondary coils. If a load is connected to the secondary winding, the load current and voltage will be in the directions indicated, given the primary current and voltage in the directions indicated (each will be alternating current in practice).

Ideal power equation



If the secondary coil is attached to a load that allows current to flow, electrical power is transmitted from the primary circuit to the secondary circuit. Ideally, the transformer is perfectly efficient. All the incoming energy is transformed from the primary circuit to the magnetic field and into the secondary circuit. If this condition is met, the input electric power must equal the output power:

$$P_{\text{incoming}} = I_{\text{p}}V_{\text{p}} = P_{\text{outgoing}} = I_{\text{s}}V_{\text{s}},$$

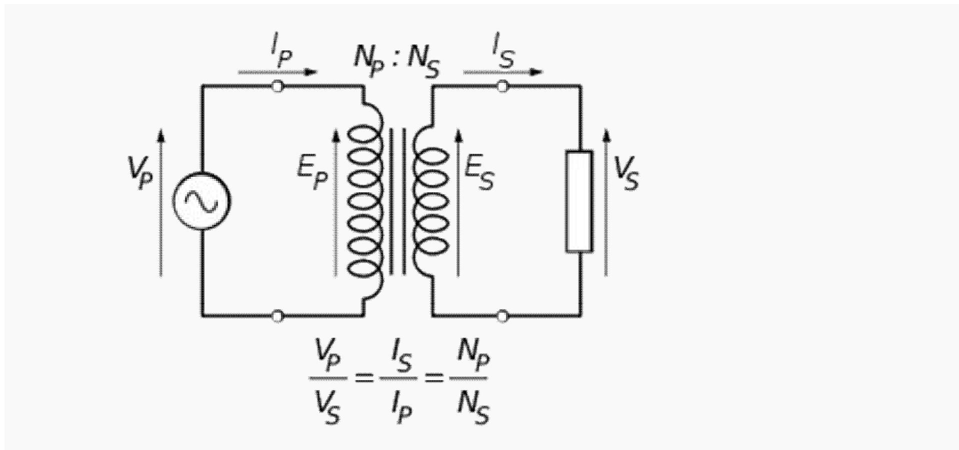
giving the ideal transformer equation

$$\frac{V_{\text{s}}}{V_{\text{p}}} = \frac{N_{\text{s}}}{N_{\text{p}}} = \frac{I_{\text{p}}}{I_{\text{s}}}.$$

This formula is a reasonable approximation for most commercial built transformers today.

If the voltage is increased, then the current is decreased by the same factor. The impedance in one circuit is transformed by the *square* of the turns ratio. For example, if an impedance Z_s is attached across the terminals of the secondary coil, it appears to the primary circuit to have an impedance of $(N_p/N_s)^2Z_s$. This relationship is reciprocal, so that the impedance Z_p of the primary circuit appears to the secondary to be $(N_s/N_p)^2Z_p$.

Ideal power equation



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giving the ideal transformer equation

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Detailed operation

The simplified description above neglects several practical factors, in particular, the primary current required to establish a magnetic field in the core, and the contribution to the field due to current in the secondary circuit.

Models of an ideal transformer typically assume a core of negligible reluctance with two windings of zero resistance. When a voltage is applied to the primary winding, a small current flows, driving flux around the magnetic circuit of the core.: The current required to create the flux is termed the *magnetizing current*. Since the ideal core has been assumed to have near-zero reluctance, the magnetizing current is negligible, although still required, to create the magnetic field.

The changing magnetic field induces an electromotive force (EMF) across each winding. Since the ideal windings have no impedance, they have no associated voltage drop, and so the voltages $V_P$and V_S measured at the terminals of the transformer, are equal to the corresponding EMFs. The primary EMF, acting as it does in opposition to the primary voltage, is sometimes termed the "back EMF". This is in accordance with Lenz's law, which states that induction of EMF always opposes development of any such change in magnetic field.

Energy losses

An ideal transformer would have no energy losses, and would be 100% efficient. In practical transformers, energy is dissipated in the windings, core, and surrounding structures. Larger transformers are generally more efficient, and those rated for electricity distribution usually perform better than 98%.

Experimental transformers using superconducting windings achieve efficiencies of 99.85%. The increase in efficiency can save considerable energy, and hence money, in a large heavily loaded transformer; the trade-off is in the additional initial and running cost of the superconducting design.

Losses in transformers (excluding associated circuitry) vary with load current, and may be expressed as "no-load" or "full-load" loss. Winding resistance dominates load losses, whereas hysteresis andeddy currents losses contribute to over 99% of the no-load loss. The no-load loss can be significant, so that even an idle transformer constitutes a drain on the electrical supply and a running cost. Designing transformers for lower loss requires a larger core, good-quality silicon steel, or even amorphous steel for the core and thicker wire, increasing initial cost so that there is a trade-off between initial cost and running cost (also see energy efficient transformer).

Transformer losses are divided into losses in the windings, termed copper loss, and those in the magnetic circuit, termed iron loss. Losses in the transformer arise from:

Winding resistance

Current flowing through the windings causes resistive heating of the conductors. At higher frequencies, skin effect and proximity effect create additional winding resistance and losses.

Hysteresis losses

Each time the magnetic field is reversed, a small amount of energy is lost due to hysteresis within the core. For a given core material, the loss is proportional to the frequency, and is a function of the peak flux density to which it is subjected.

Eddy currents

Ferromagnetic materials are also good conductors and a core made from such a material also constitutes a single short-circuited turn throughout its entire length. Eddy currents therefore circulate within the core in a plane normal to the flux, and are responsible for resistive heating of the core material. The eddy current loss is a complex function of the square of supply frequency and inverse square of the material thickness. Eddy current losses can be reduced by making the core of a stack of plates electrically insulated from each other, rather than a solid block; all transformers operating at low frequencies use laminated or similar cores.

Magnetostriction

Magnetic flux in a ferromagnetic material, such as the core, causes it to physically expand and contract slightly with each cycle of the magnetic field, an effect known as magnetostriction. This produces the buzzing sound commonly associated with transformers that can cause losses due to frictional heating. This buzzing is particularly familiar from low-frequency (50 Hz or 60 Hz) mains hum, and high-frequency (15,734 Hz (NTSC) or 15,625 Hz (PAL)) CRT noise.

Mechanical losses

In addition to magnetostriction, the alternating magnetic field causes fluctuating forces between the primary and secondary windings. These incite vibrations within nearby metalwork, adding to the buzzing noise and consuming a small amount of power.

Stray losses

Leakage inductance is by itself largely lossless, since energy supplied to its magnetic fields is returned to the supply with the next half-cycle. However, any leakage flux that intercepts nearby conductive materials such as the transformer's support structure will give rise to eddy currents and be converted to heat. There are also radiative losses due to the oscillating magnetic field but these are usually small.

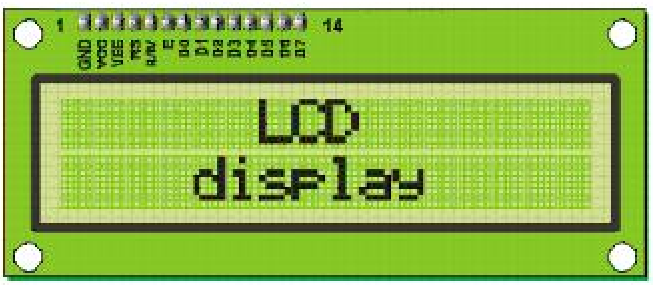
3.6 LIQUID CRYSTAL DISPLAY:

LCD stands for **L**iquid **C**rystal **D**isplay. LCD is finding wide spread use replacing LEDs (seven segment LEDs or other multi segment LEDs) because of the following reasons:

1. The declining prices of LCDs.

2. The ability to display numbers, characters and graphics. This is in contrast to LEDs, which are limited to numbers and a few characters.
3. Incorporation of a refreshing controller into the LCD, thereby relieving the CPU of the task of refreshing the LCD. In contrast, the LED must be refreshed by the CPU to keep displaying the data.
4. Ease of programming for characters and graphics.

These components are “specialized” for being used with the microcontrollers, which means that they cannot be activated by standard IC circuits. They are used for writing different messages on a miniature LCD.



A model described here is for its low price and great possibilities most frequently used in practice. It is based on the HD44780 microcontroller (*Hitachi*) and can display messages in two lines with 16 characters each. It displays all the alphabets, Greek letters, punctuation marks, mathematical symbols etc. In addition, it is possible to display symbols that user makes up on its own.

Automatic shifting message on display (shift left and right), appearance of the pointer, backlight etc. are considered as useful characteristics.

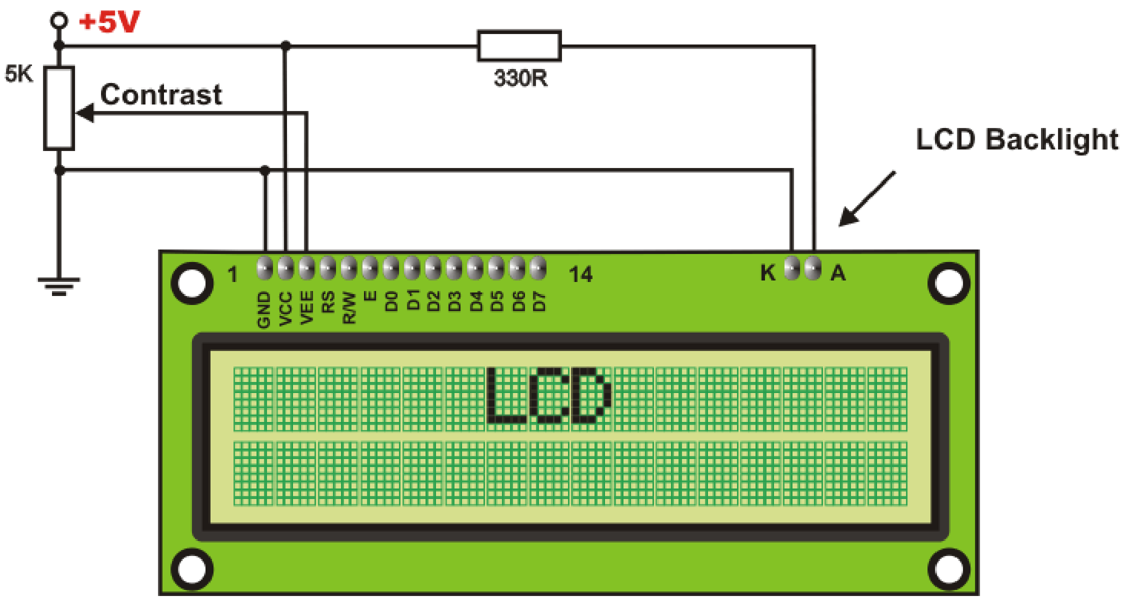
Pins Functions

There are pins along one side of the small printed board used for connection to the microcontroller. There are total of 14 pins marked with numbers (16 in case the background light is built in). Their function is described in the table below:

Function	Pin Number	Name	Logic State	Description
Ground	1	Vss	-	0V
Power supply	2	Vdd	-	+5V
Contrast	3	Vee	-	0 – Vdd
	4	RS	0 1	D0 – D7 are interpreted as commands D0 – D7 are interpreted as data
	4	RS	0 1	D0 – D7 are interpreted as commands D0 – D7 are interpreted as data
Control of operating	5	R/W	0 1	Write data (from controller to LCD) Read data (from LCD to controller)
	6	E	0 1 From 1 to 0	Access to LCD disabled Normal operating Data/commands are transferred to LCD
	7	D0	0/1	Bit 0 LSB
	8	D1	0/1	Bit 1
	9	D2	0/1	Bit 2
	10	D3	0/1	Bit 3
Data / commands	11	D4	0/1	Bit 4
	12	D5	0/1	Bit 5
	13	D6	0/1	Bit 6
	14	D7	0/1	Bit 7 MSB

LCD screen:

LCD screen consists of two lines with 16 characters each. Each character consists of 5x7 dot matrix. Contrast on display depends on the power supply voltage and whether messages are displayed in one or two lines. For that reason, variable voltage 0-Vdd is applied on pin marked as Vee. Trimmer potentiometer is usually used for that purpose. Some versions of displays have built in backlight (blue or green diodes). When used during operating, a resistor for current limitation should be used (like with any LE diode).



LCD Basic Commands

All data transferred to LCD through outputs D0-D7 will be interpreted as commands or as data, which depends on logic state on pin RS:

RS = 1 - Bits D0 - D7 are addresses of characters that should be displayed. Built in processor addresses built in "map of characters" and displays corresponding symbols. Displaying position is determined by DDRAM address. This address is either previously defined or the address of previously transferred character is automatically incremented.

RS = 0 - Bits D0 - D7 are commands which determine display mode. List of commands which LCD recognizes are given in the table below:

Command	RS	RW	D7	D6	D5	D4	D3	D2	D1	D0	Execution Time

Clear display	0	0	0	0	0	0	0	0	0	1	1.64Ms
Cursor home	0	0	0	0	0	0	0	0	1	x	1.64mS
Entry mode set	0	0	0	0	0	0	0	1	I/D	S	40uS
Display on/off control	0	0	0	0	0	0	1	D	U	B	40uS
Cursor/Display Shift	0	0	0	0	0	1	D/C	R/L	x	x	40uS
Function set	0	0	0	0	1	DL	N	F	x	x	40uS
Set CGRAM address	0	0	0	1	CGRAM address						40uS
Set DDRAM address	0	0	1	DDRAM address							40uS
Read “BUSY” flag (BF)	0	1	BF	DDRAM address							-
Write to CGRAM or DDRAM	1	0	D7	D6	D5	D4	D3	D2	D1	D0	40uS
Read from CGRAM or DDRAM	1	1	D7	D6	D5	D4	D3	D2	D1	D0	40uS

I/D 1 = Increment (by 1)

0 = Decrement (by 1)

S 1 = Display shift on

0 = Display shift off

D 1 = Display on

0 = Display off

U 1 = Cursor on

0 = Cursor off

B 1 = Cursor blink on

0 = Cursor blink off

R/L 1 = Shift right

0 = Shift left

DL 1 = 8-bit interface

0 = 4-bit interface

N 1 = Display in two lines

0 = Display in one line

F 1 = Character format 5x10 dots

0 = Character format 5x7 dots

D/C 1 = Display shift

0 = Cursor shift

LCD Connection

Depending on how many lines are used for connection to the microcontroller, there are 8-bit and 4-bit LCD modes. The appropriate mode is determined at the beginning of the process in a phase called "initialization". In the first case, the data are transferred through outputs D0-D7 as it has been already explained. In case of 4-bit LED mode, for the sake of saving valuable I/O pins of the microcontroller, there are only 4 higher bits (D4-D7) used for communication, while other may be left unconnected.

Consequently, each data is sent to LCD in two steps: four higher bits are sent first (that normally would be sent through lines D4-D7), four lower bits are sent afterwards. With the help of initialization, LCD will correctly connect and interpret each data received. Besides, with regards to the fact that data are rarely read from LCD (data mainly are transferred from microcontroller to LCD) one more I/O pin may be saved by simple connecting R/W pin to the Ground. Such saving has its price.

Even though message displaying will be normally performed, it will not be possible to read from busy flag since it is not possible to read from display.

LCD Initialization

Once the power supply is turned on, LCD is automatically cleared. This process lasts for approximately 15mS. After that, display is ready to operate. The mode of operating is set by default. This means that:

1. Display is cleared
2. Mode
   DL = 1 Communication through 8-bit interface
   N = 0 Messages are displayed in one line
   F = 0 Character font 5 x 8 dots
3. Display/Cursor on/off
   D = 0 Display off
   U = 0 Cursor off
   B = 0 Cursor blink off
4. Character entry
   ID = 1 Addresses on display are automatically incremented by 1
   S = 0 Display shift off

Automatic reset is mainly performed without any problems. If for any reason power supply voltage does not reach full value in the course of 10mS, display will start perform completely unpredictably.

If voltage supply unit cannot meet this condition or if it is needed to provide completely safe operating, the process of initialization by which a new reset enabling display to operate normally must be applied.
Algorithm according to the initialization is being performed depends on whether connection to the microcontroller is through 4- or 8-bit interface. All left over to be done after that is to give basic commands and of course- to display messages.

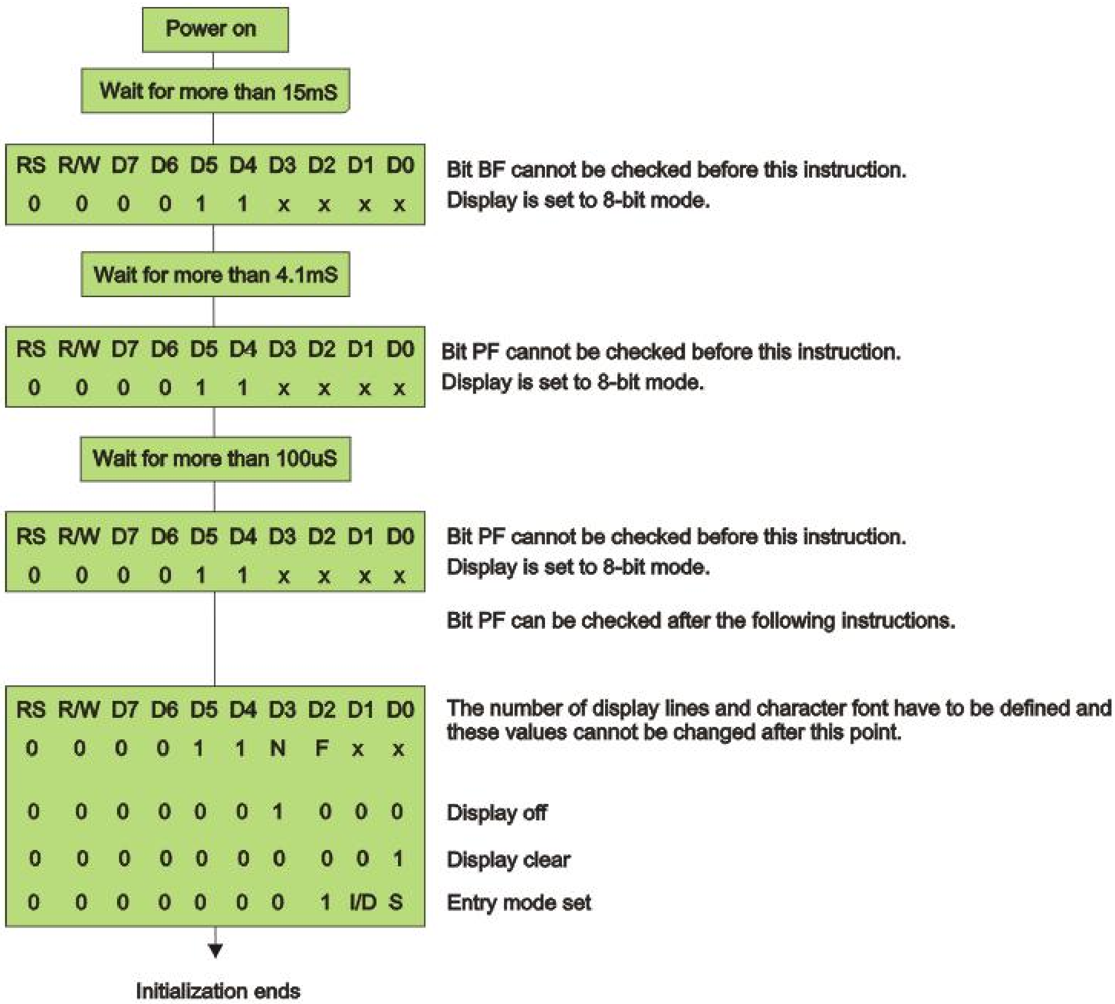
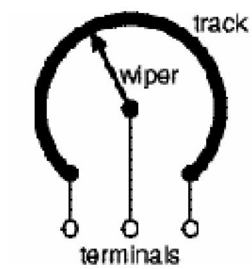


Fig: Procedure on 8-bit initialization

Contrast control:

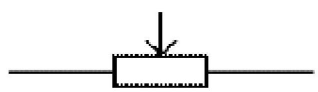
To have a clear view of the characters on the LCD, contrast should be adjusted. To adjust the contrast, the voltage should be varied. For this, a preset is used which can behave like a variable voltage device. As the voltage of this preset is varied, the contrast of the LCD can be adjusted.



Variable resistor

Potentiometer

Variable resistors used as potentiometers have all **three terminals** connected. This arrangement is normally used to **vary voltage**, for example to set the switching point of a circuit with a sensor, or control the volume (loudness) in an amplifier circuit. If the terminals at the ends of the track are connected across the power supply, then the wiper terminal will provide a voltage which can be varied from zero up to the maximum of the supply.



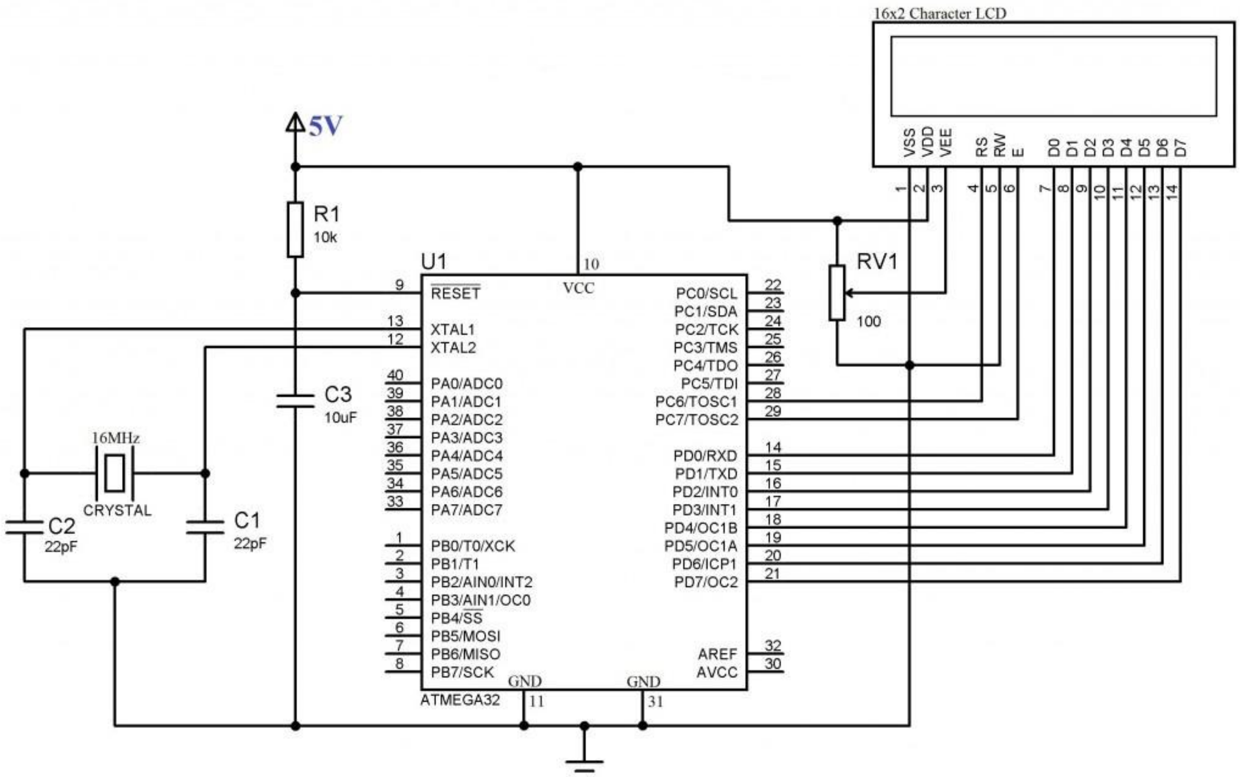
Potentiometer Symbol

Presets

These are miniature versions of the standard variable resistor. They are designed to be mounted directly onto the circuit board and adjusted only when the circuit is built. For example, to set the frequency of an alarm tone or the sensitivity of a light-sensitive circuit, a small screwdriver or similar tool is required to adjust presets.

Presets are much cheaper than standard variable resistors so they are sometimes used in projects where a standard variable resistor would normally be used.

LCD interface with the microcontroller (8-bit mode):


16x2 Character LCD
VSS
VDD
VEE
RS
RW
E
D0
D1
D2
D3
D4
D5
D6
D7
5V
R1
10k
RV1
100
U1
VCC
RESET
XTAL1
XTAL2
PA0/ADC0
PA1/ADC1
PA2/ADC2
PA3/ADC3
PA4/ADC4
PA5/ADC5
PA6/ADC6
PA7/ADC7
PB0/T0/XCK
PB1/T1
PB2/AIN0/INT2
PB3/AIN1/OC0
PB4/SS
PB5/MOSI
PB6/MISO
PB7/SCK
PC0/SCL
PC1/SDA
PC2/TCK
PC3/TMS
PC4/TDO
PC5/TDI
PC6/TOSC1
PC7/TOSC2
PD0/RXD
PD1/TXD
PD2/INT0
PD3/INT1
PD4/OC1B
PD5/OC1A
PD6/ICP1
PD7/OC2
AREF
AVCC
GND
GND
ATMEGA32
C3
10uF
16MHz
CRYSTAL
C2
22pF
C1
22pF

Chapter 4
Firmware Implementation of the project design

This chapter briefly explains about the firmware implementation of the project. The required software tools are discussed in section 4.2. Section 4.3 shows the flow diagram of the project

4.1 Software Tools Required

Arduino software tool

4.1.1 Programming Microcontroller

To program the ATMEGA2560 microcontroller the Arduino software is used. The programming is done strictly in the arduino language.

One of the difficulties of programming microcontrollers is the limited amount of resources the programmer has to deal with. In personal computers resources such as RAM and processing speed are basically limitless when compared to microcontrollers. In contrast, the code on microcontrollers should be as low on resources as possible.

Program:

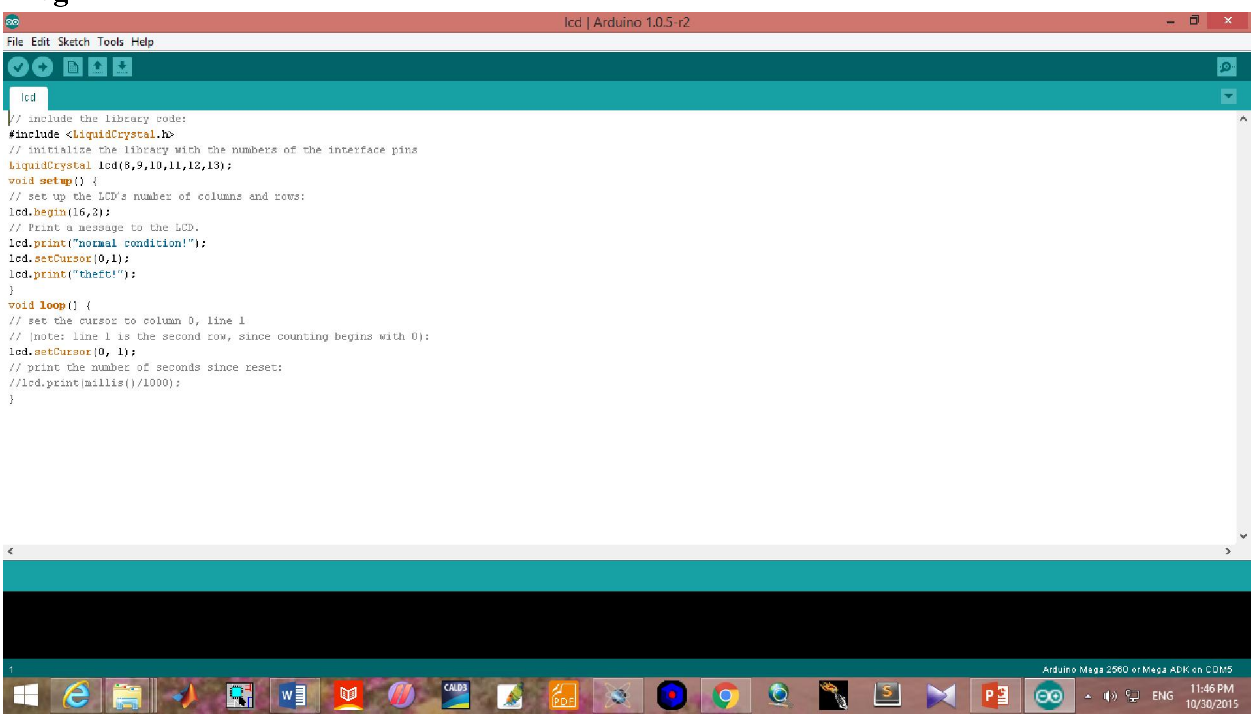


Fig : programming with arduino

CHAPTER 5

CIRCUIT DIAGRAM

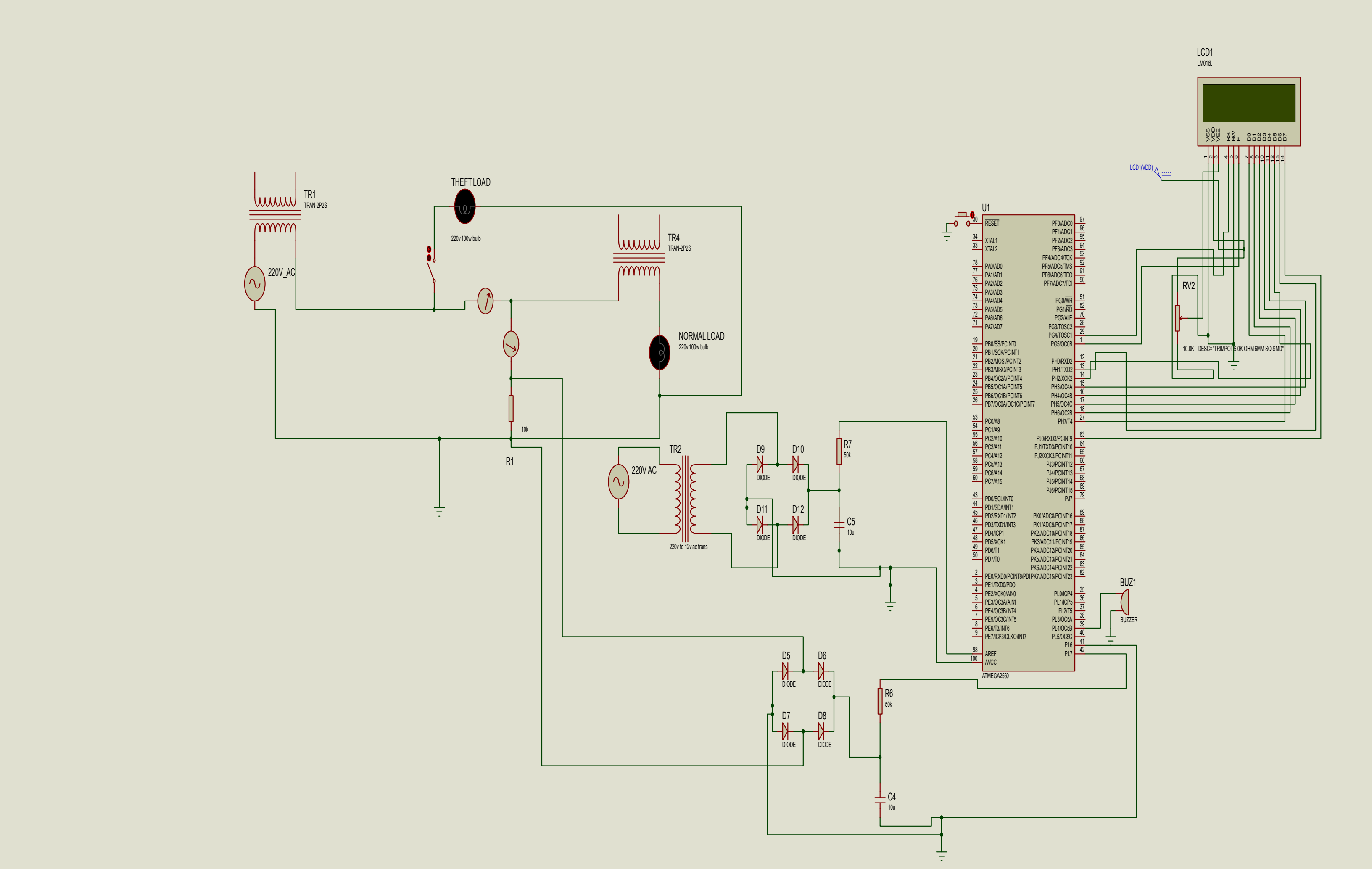


Fig 5.1: Circuit diagram Simulation by Proteus software

WORKING PROCEDURE:

This project is designed to find out such power theft in the normal distribution lines. Even though there are certain practical problems in implementing this kind of systems in future there is a scope for development of these types of systems. This project is using the principle of the differential protection scheme for the identification of the power theft. The differential protection scheme consists of two CTs (current transformers) connected at both the terminals of the load. If there is no fault in the load then the secondary currents of both the CTs will be same. Using the same principle one CT is connected at the starting end of the distributor and the remaining other CT is connected to the different loads which are legal. If there is no power theft in the line then the vector sum of all the ct's which are connected to the load will be equal to the current in the main ct. if there is a difference then we can make out that it should either be the power theft or a fault in the line. The current drawn from the both ends of the transformers are given to the ADC of the Arduino to convert that analog values into the digital and the that converted digital values are displayed on the LCD screen.

Chapter 6

Results and Discussions

6.1 Results

Assemble the circuit on the Breadboard as shown in Fig 5.1. After assembling the circuit , check it for proper connections before switching on the power supply.

6.2 Conclusion

The implementation of Power Theft Identification System in Distribution Lines Using Differential Power Measurement is done successfully. In this way we are going to design the microcontroller based power theft identifier. The purpose of designing such system will ultimately reduce the illegal used of electricity and saves money because it directly affects the economy of nation, because power theft is non ignorable crime which has to be controlled.

This system will be beneficial to consumer as well as for government. And it will require only one time installation cost and can be used further. And the big advantage of this system is that it will increase the revenue.The design of electricity theft monitoring system has been generated using the embedded system Technology.

It can be concluded that the design implemented in the present work provide portability, flexibility and the data transmission is also done with low power consumption.

ADVANTAGES:

1. Field Programmability, Flexibility
2. Highly secured and easy to install
3. The dailies report that Electricity Board suffers a total loss of 22 % in revenue due to power theft every year, which can be controlled now.
4. The consumer will also get benefit because in most of the cases consumer does not aware of that someone is tapped his line and he has to pay extra charge.

5. With the help of this project we can reduce the total illegal use of power & saves electricity.

Disadvantage:-

The disadvantages of this project is that only it has high installation cost. But it can be bearable because it requires only once installation cost and can be used for life time.

APPLICATIONS:

- Power monitoring at homes, apartments
- Industrial power monitoring

REFERENCES

http://www.sunrom.com/

http://www.atmel.com/dyn/resources/prod_documents/doc1919.pdf

http://www.microdigitaled.com/AT2560/Software/arduino_tutorial.pdf

http://en.wikipedia.org/wiki/Zero_crossing

datasheets*.maximintegrated.com*
www.all**datasheet**.com/**datasheet**-pdf/pdf/4518/.../**MCT2E**.html

wiki.answers.com › ... › Engineering › Electronics Engineering

www.dnatechindia.com › TUTORIAL › AT2560 Tutorial

www.engineersgarage.com/.../16x2-**lcd**-module-datasheetwww.microscale-embedded.com/index.php?...**adc-0808**

BOOKS:

1. Embedded Systems Architecture Programming and Design by Raj Kamal.

2. Embedded And Real Time systems by K V Prasad.

3. Electronic Measurement And Instruments by Bakshi.