SIR C.R. REDDY COLLEGE FOR WOMEN

(Affiliated to Adiakavi Nannaya University, Rajamahendravaram)

ELURU, WEST GODAVARI DISTRICT(A.P)

DEPARTMENT OF ELECTRONICS

Project On:

Load Control using Arduino with IR remote

Y. Sridevi

Signature of the Lecturer

Y. Sridevi

Signature of the Examiner

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Certificate

This is to certify that...Nulu. Thanuha Rani.......................................

Bearing Register No:.2033071137411..........has successfully completed the prescribed Embedded Systems project for III B.Sc V semester at SIR CR REDDY COLLEGE FOR WOMEN ,Eluru in the academic year 2022-2023.

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Signature of the Lecturer

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Acknowledgement

We would like to express our gratitude towards our project guide Ms.Y.Sri Devi madam,lecturer in Electronics for supporting us till the end of our project.

We would also like to thank our parents and supporters who encouraged us in completing the project. We are thankful for their aspiring guidance , and friendly advice during the project work.

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INDEX

Abstract – Traditionally electrical appliances in a home are controlled via switches that regulate the electricity to these devices. As the world gets more and more technologically advanced, we find new technology coming in deeper and deeper into our personal lives even at home. Home automation is becoming more and more popular around the world and is becoming a common practice. The process of home automation works by making everything in the house automatically controlled using technology to control and do the jobs that we would normally do manually. Home automation takes care of a lot of different activities in the house. The main objective of this project is that we are controlling our home appliances using a simple circuit. That circuit consist of a IR module. That receive the signal from our TV/VCD remote. Output of that sensor goes to connect the arduino uno microcontroller that is used to shows the status of our home appliances either in on/off state. Output of the IC is given to transistor which amplifies the signal and then through a diode. The appliance to be controlled is connected between the pole of the relay and neutral terminal of mains. It gets connected to live terminal of AC mains via normally opened (N/O) contact when the relay energises. Our project is a Remote Operated Home Appliance or Remote controlled Home appliance. The circuit is connected to any of the home appliances (lamp, fan, radio, etc) to make the appliance turn on/off from a TV, VCD, VCR, Air Conditioner or DVD remote control. The circuit can be activated from up to 10 meters. It is very easy to build and can be assembled on a general-purpose PCB. The circuit essentially consists of a transmitter consisting of a 555 IC, the receiver consisting of an IR module, Atmega328p IC, LED‟s to indicate the reception of the IR radiations, otherwise indicating the ON/OFF state, relay and other components.

Index Terms – Arduino uno microcontroller, Relay module, Liquid crystal display, Infrared receiver module.

CHAPTER 1

INRODUCTION

1.1 Introduction to Embedded Systems

We are living in the Embedded World. You are surrounded with many embedded products and your daily life largely depends on the proper functioning of these gadgets. Television, Radio, CD player of your living room, Washing Machine or Microwave Oven in your kitchen, Card readers, Access Controllers, Palm devices of your work space enable you to do many of your tasks very effectively. Apart from all these, many controllers embedded in your car take care of car operations between the bumpers and most of the times you tend to ignore all these controllers.

In recent days, you are showered with variety of information about these embedded controllers in many places. All kinds of magazines and journals regularly dish out details about latest technologies, new devices; fast applications which make you believe that your basic survival is controlled by these embedded products. Now you can agree to the fact that these embedded products have successfully invaded into our world. You must be wondering about these embedded controllers or systems. The computer you use to compose your mails, or create a document or analyze the database is known as the standard desktop computer. These desktop computers are manufactured to serve many purposes and applications. You need to install the relevant software to get the required processing facility. So, these desktop computers can do many things. In contrast, embedded controllers carryout a specific work for which they are designed. Most of the time, engineers design these embedded controllers with a specific goal in mind. So these controllers cannot be used in any other place.

These days designers have many choices in microprocessors/microcontrollers. Especially, in 8 bit and 32 bit, the available variety really may overwhelm even an experienced designer. Selecting a right microprocessor may turn out as a most difficult first step and it is getting complicated as new devices continue to pop-up very often. In the 8 bit segment, the most popular and used architecture is Intel's 8031. Market acceptance of this particular family has driven many semiconductor manufacturers to develop something new based on this particular architecture. Even after 25 years of existence, semiconductor manufacturers still come out with some kind of device using this 8031 core. An embedded system is a system which is going to do a predefined specified task is the embedded system and is even defined as combination of both software and hardware. A general-purpose definition of embedded systems is that they are devices used to control, monitor or assist the operation of equipment, machinery or plant. "Embedded" reflects the fact that they are an integral part of the system. At the other extreme a general-purpose computer may be used to control the operation of a large complex processing plant, and its presence will be obvious. All embedded systems are including computers or microprocessors. Some of these computers are however very simple systems as compared with a personal computer. The very simplest embedded systems are capable of performing only a single function or set of functions to meet a single predetermined purpose [1]. In more complex systems an application program that enables the embedded system to be used for a particular purpose in a specific application determines the functioning of the embedded system. The ability to have programs means that the same embedded system can be used for a variety of different purposes. In some cases a microprocessor may be designed in such a way that application software for a particular purpose can be added to the basic software in a second process, after which it is not possible to make further changes. The applications software on such processors is sometimes referred to as firmware.

The simplest devices consist of a single microprocessor (often called a "chip”), which may itself be packaged with other chips in a hybrid system or Application Specific Integrated Circuit (ASIC). Its input comes from a detector or sensor and its output goes to a switch or activator which (for example) may start or stop the operation of a machine or, by operating a valve, may control the flow of fuel to an engine.

1.2 Microcontrollers for Embedded Systems:

In the Literature discussing microprocessors, we often see the term Embedded System. Microprocessors and Microcontrollers are widely used in embedded system products. An embedded system product uses a microprocessor (or Microcontroller) to do one task only. A printer is an example of embedded system since the processor inside it performs one task only; namely getting the data and printing it. Contrast this with a Pentium based PC. A PC can be used for any number of applications such as word processor, print-server, bank teller terminal, Video game, network server, or Internet terminal [2]. Software for a variety of applications can be loaded and run. of course the reason a pc can perform myriad tasks is that it has RAM memory and an operating system that loads the application software into RAM memory and lets the CPU run it.

1.3 Need For Embedded System:

Embedded systems are designed to do some specific task, rather than be a general-purpose computer for multiple tasks. Some also have real time performance constraints that must be met, for reason such as safety and usability; others may have low or no performance requirements, allowing the system hardware to be simplified to reduce costs. Wireless communication has become an important feature for commercial products and a popular research topic within the last ten years. There are now more mobile phone subscriptions than wired-line subscriptions. Lately, one area of commercial interest has been low-cost, low-power, and short-distance wireless communication used for personal wireless networks." Technology advancements are providing smaller and more cost effective devices for integrating computational processing, wireless communication, and a host of other functionalities. These embedded communications devices will be integrated into applications ranging from homeland security to industry automation and monitoring [3]. They will also enable custom tailored engineering solutions, creating a revolutionary way of disseminating and processing information. With new technologies and devices come new business activities, and the need for employees in these technological areas. Engineers who have knowledge of embedded systems and wireless communications will be in high demand.

Software deals with the languages like ALP, C, and VB etc., and Hardware deals with Processors, Peripherals, and Memory.

Memory: It is used to store data or address.

Peripherals: These are the external devices connected

Processor: It is an IC which is used to perform some task

Applications of embedded systems

- Manufacturing and process control
- Construction industry
- Transport
- Buildings and premises
- Domestic service

- Communications
- Office systems and mobile equipment
- Banking, finance and commercial
- Medical diagnostics, monitoring and life support
- Testing, monitoring and diagnostic systems

Processors are classified into four types like:

- Micro Processor (µp)
- Micro controller (µc)
- Digital Signal Processor (DSP)
- Application Specific Integrated Circuits (ASIC)

Micro Processor (µp):

A silicon chip that contains a CPU. In the world of personal computers, the terms microprocessor and CPU are used interchangeably. At the heart of all personal computers and most workstations sits a microprocessor. Microprocessors also control the logic of almost all digital devices, from clock radios to fuel-injection systems for automobiles.

Three basic characteristics differentiate microprocessors:

- **Instruction set**: The set of instructions that the microprocessor can execute.
- **Bandwidth :** The number of bits processed in a single instruction.
- **Clock speed :** Given in megahertz (MHz), the clock speed determines how many instructions per second the processor can execute.

In both cases, the higher the value, the more powerful the CPU. For example, a 32-bit microprocessor that runs at 50MHz is more powerful than a 16-bit microprocessor that runs at 25MHz. In addition to bandwidth and clock speed, microprocessors are classified as being either RISC (reduced instruction set computer) or CISC (complex instruction set computer). A microprocessor has three basic elements, as shown below figure. The ALU performs all arithmetic computations, such as addition, subtraction and logic operations (AND, OR, etc). It is controlled by the Control Unit and receives its data from the Register Array [4]. The Register Array is a set of registers used for storing data. These registers can be accessed by the ALU very quickly. Some registers have specific functions - we will deal with these later. The Control Unit controls the entire process. It provides the timing and a control signal for getting data into and out of the registers and the ALU and it synchronizes the execution of instructions (we will deal with instruction execution at a later date).

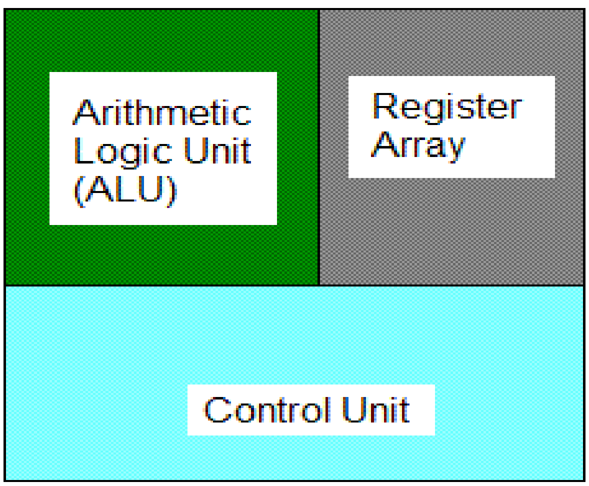


Figure 1.1: Three Basic Elements of a Microprocessor

Micro Controller (μc):

A microcontroller is a small computer on a single integrated circuit containing a processor core, memory, and programmable input/output peripherals. Program memory in the form of NOR flash or OTP ROM is also often included on chip, as well as a typically small amount of RAM. Microcontrollers are designed for embedded applications, in contrast to the microprocessors used in personal computers or other general purpose applications.

Digital Signal Processors (DSPs):

Digital Signal Processors is one which performs scientific and mathematical operation. Digital Signal Processor chips - specialized microprocessors with architectures designed specifically for the types of operations required in digital signal processing. Like a general-purpose microprocessor, a DSP is a programmable device [5], with its own native instruction code. DSP chips are capable of carrying out millions of floating point operations per second, and like their better-known general-purpose cousins, faster and more powerful versions are continually being introduced. DSPs can also be embedded within complex "system-on-chip" devices, often containing both analog and digital circuitry.

Application Specific Integrated Circuit (ASIC)

ASIC is a combination of digital and analog circuits packed into an IC to achieve the desired control/computation function.

ASIC typically contains

- CPU cores for computation and control
- Peripherals to control timing critical functions
- Memories to store data and program
- Analog circuits to provide clocks and interface to the real world which is analog in nature
- I/Os to connect to external components like LEDs, memories, monitors etc.

1.4 Computer Instruction Set

There are two different types of computer instruction set there are:

1. RISC (Reduced Instruction Set Computer) and

2. CISC (Complex Instruction Set computer)

1.4.1 Reduced Instruction Set Computer (RISC)

A RISC (reduced instruction set computer) is a microprocessor that is designed to perform a smaller number of types of computer instruction so that it can operate at a higher speed (perform more million instructions per second, or millions of instructions per second). Since each instruction type that a computer must perform requires additional transistors and circuitry, a larger list or set of computer instructions tends to make the microprocessor more complicated and slower in operation.

Besides performance improvement, some advantages of RISC and related design improvements are:

- A new microprocessor can be developed and tested more quickly if one of its aims is to be less complicated.
- Operating system and application programmers who use the microprocessor's instructions will find it easier to develop code with a smaller instruction set.
- The simplicity of RISC allows more freedom to choose how to use the space on a microprocessor.

Higher-level language compilers produce more efficient code than formerly because they have always tended to use the smaller set of instructions to be found in a RISC computer.

RISC characteristics

- **Simple instruction set:**
  In a RISC machine, the instruction set contains simple, basic instructions, from which more complex instructions can be composed.
- **Same length instructions.**
  Each instruction is the same length, so that it may be fetched in a single operation.
- **1machine-cycleinstructions.**
  Most instructions complete in one machine cycle, which allows the processor to handle

several instructions at the same time. This pipelining is a key technique used to speed up RISC machines.

1.4.2 Complex Instruction Set Computer (CISC)

CISC, which stands for **Complex Instruction Set Computer,** is a philosophy for designing chips that are easy to program and which make efficient use of memory. Each instruction in a CISC instruction set might perform a series of operations [6] inside the processor. This reduces the number of instructions required to implement a given program, and allows the programmer to learn a small but flexible set of instructions.

The advantages of CISC

At the time of their initial development, CISC machines used available technologies to optimize computer performance.

- Microprogramming is as easy as assembly language to implement, and much less expensive than hardwiring a control unit.
- The ease of micro-coding new instructions allowed designers to make CISC machines upwardly compatible: a new computer could run the same programs as earlier computers because the new computer would contain a superset of the instructions of the earlier computers.
- As each instruction became more capable, fewer instructions could be used to implement a given task. This made more efficient use of the relatively slow main memory.
- Because micro program instruction sets can be written to match the constructs of high-level languages, the compiler does not have to be as complicated.

The disadvantages of CISC

Still, designers soon realized that the CISC philosophy had its own problems, including:

- Earlier generations of a processor family generally were contained as a subset in every new version --- so instruction set & chip hardware become more complex with each generation of computers.

- So that as many instructions as possible could be stored in memory with the least possible wasted space, individual instructions could be of almost any length---this means that different instructions will take different amounts of clock time to execute, slowing down the overall performance of the machine.

- Many specialized instructions aren't used frequently enough to justify their existence approximately 20% of the available instructions are used in a typical program.

- CISC instructions typically set the condition codes as a side effect of the instruction. Not only does setting the condition codes take time, but programmers have to remember to examine the condition code bits before a subsequent instruction changes them.

1.5 Memory Architecture

There two different type's memory architectures there are:

- Harvard Architecture
- Von-Neumann Architecture

1.5.1 Harvard Architecture

Computers have separate memory areas for program instructions and data. There are two or more internal data buses, which allow simultaneous access to both instructions and data. The CPU fetches program instructions on the program memory bus. The Harvard architecture is computer architecture with physically separate storage and signal pathways for instructions and data. The term originated from the Harvard Mark I relay-based computer, which stored instructions on punched tape (24 bits wide) and data in electro-mechanical counters [7]. These early machines had limited data storage, entirely contained within the central processing unit, and provided no access to the instruction storage as data. Programs needed to be loaded by an operator, the processor could not boot it.

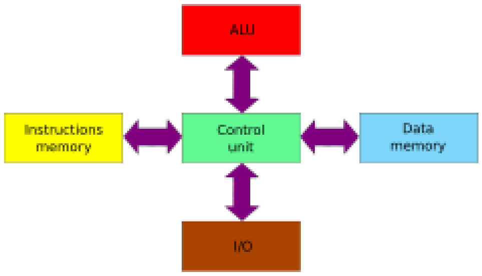


Figure 1.2: Harvard Architecture

Modern uses of the Harvard architecture:

The principal advantage of the pure Harvard architecture - simultaneous access to more than one memory system - has been reduced by modified Harvard processors using modern CPU cache systems. Relatively pure Harvard architecture machines are used mostly in applications where tradeoffs, such as the cost and power savings from omitting caches, outweigh the programming penalties from having distinct code and data address spaces [8].

- Digital signal processors (DSPs) generally execute small, highly-optimized audio or video processing algorithms. They avoid caches because their behavior must be extremely reproducible. The difficulties of coping with multiple address spaces are of secondary concern to speed of execution. As a result, some DSPs have multiple data memories in distinct address spaces to facilitate SIMD and VLIW processing. Texas Instruments TMS320 C55x processors, as one example, have multiple parallel data busses (two write, three read) and one instruction bus.

- Microcontrollers are characterized by having small amounts of program (flash memory) and data (SRAM) memory, with no cache, and take advantage of the Harvard architecture figure shown in above and it can be speed processing by concurrent instruction and data access. The separate storage means the program and data memories can have different bit depths, for example using 16-bit wide instructions and 8-bit wide data. They also mean that instruction pre-fetch can be performed in parallel with other activities. Examples include, the AVR by Atmel Corp, the PIC by Microchip Technology, Inc. and the ARM Cortex-M3 processor (not all ARM chips have Harvard architecture).

Even in these cases, it is common to have special instructions to access program memory as data for read-only tables, or for reprogramming.

1.5.2 Von-Neumann Architecture

A computer has a single, common memory space in which both program instructions and data are stored. There is a single internal data bus that fetches both instructions and data. They cannot be performed at the same time

The von Neumann architecture is a design model for a stored-program digital computer that uses a central processing unit (CPU) and a single separate storage structure ("memory") to hold both instructions and data. It is named after the mathematician and early computer scientist John von Neumann. Such computers implement a universal Turing machine and have a sequential architecture.

A stored-program digital computer is one that keeps its programmed instructions, as well as its data, in read-write, random-access memory (RAM). Stored-program computers were advancement over the program-controlled computers of the 1940s, such as the Colossus and the ENIAC, which were programmed by setting switches and inserting patch leads to route data and to control signals between various functional units. In the vast majority of modern computers, the same memory is used for both data and program instructions. The mechanisms for transferring the data and instructions between the CPU and memory are, however, considerably more complex than the original von Neumann architecture and image shown below.

The terms "von Neumann architecture" and "stored-program computer" are generally used interchangeably, and that usage is followed in this article.

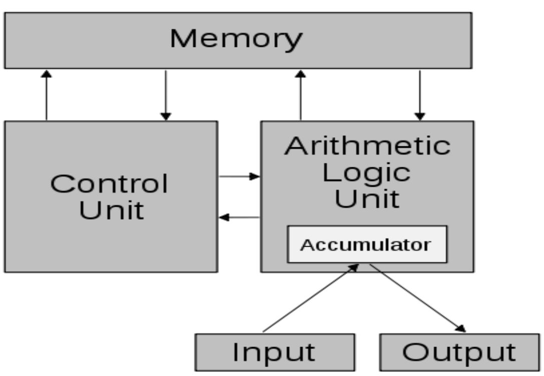


Figure 1.3: Schematic of the Von-Neumann Architecture.

Basic Difference between Harvard and Von-Neumann Architecture

- The primary difference between Harvard architecture and the Von Neumann architecture is in the Von Neumann architecture data and programs are stored in the same memory and managed by the same information handling system.
- Whereas the Harvard architecture stores data and programs in separate memory devices and they are handled by different subsystems.

- In a computer using the Von-Neumann architecture without cache; the central processing unit (CPU) can either be reading and instruction or writing/reading data to/from the memory. Both of these operations cannot occur simultaneously as the data and instructions use the same system bus.

- In a computer using the Harvard architecture the CPU can both read an instruction and access data memory at the same time without cache. This means that a computer with Harvard architecture can potentially be faster for a given circuit complexity because data access and instruction fetches do not contend for use of a single memory pathway.

- Today, the vast majority of computers are designed and built using the Von Neumann architecture template primarily because of the dynamic capabilities and efficiencies gained in designing, implementing, operating one memory system as opposed to two. Von Neumann architecture may be somewhat slower than the contrasting Harvard Architecture for certain specific tasks, but it is much more flexible and allows for many concepts unavailable to Harvard architecture such as self programming, word processing and so on.

- Harvard architectures are typically only used in either specialized systems or for very specific uses. It is used in specialized digital signal processing (DSP), typically for video and audio processing products. It is also used in many small microcontrollers used in electronics applications such as Advanced RISK Machine (ARM) based products for many vendors.

1.6 Categories of Embedded Systems:

Based on performance, functionality, requirement the embedded systems are divided into three categories:

Stand Alone Embedded systems:

These systems takes the input in the form of electrical signals from transducers or commands from human beings such as pressing of a button etc.., process them and produces desired output. This entire process of taking input, processing it and giving output is done in standalone mode. Such embedded systems comes under stand alone embedded systems.

Eg: microwave oven, air conditioner etc..,

Real-time embedded systems:

Embedded systems which are used to perform a specific task or operation in a specific time period those systems are called as real-time embedded systems.

There are two types of real-time embedded systems:

(i) Hard Real-time embedded systems:

These embedded systems follow an absolute dead line time periodi.e.., if the tasking is not done in a particular time period then there is a cause of damage to the entire equipment. eg: consider a system in which we have to open a valve within 30 milliseconds. If this valve is not opened in 30 ms this may cause damage to the entire equipment. So in such cases we use embedded systems for doing automatic operations.

(ii) Soft Real Time embedded systems:

These embedded systems follow a relative dead line time period i.e.., if the task is not done in a particular time that will not cause damage to the equipment. eg: Consider a TV remote control system ,if the remote control takes a few milliseconds delay it will not cause damage either to the TV or to the remote control [9]. These systems which will not cause damage when they are not operated at considerable time period those systems comes under soft real-time embedded systems.

Network communication embedded systems:

A wide range network interfacing communication is provided by using embedded systems and the image shown below.

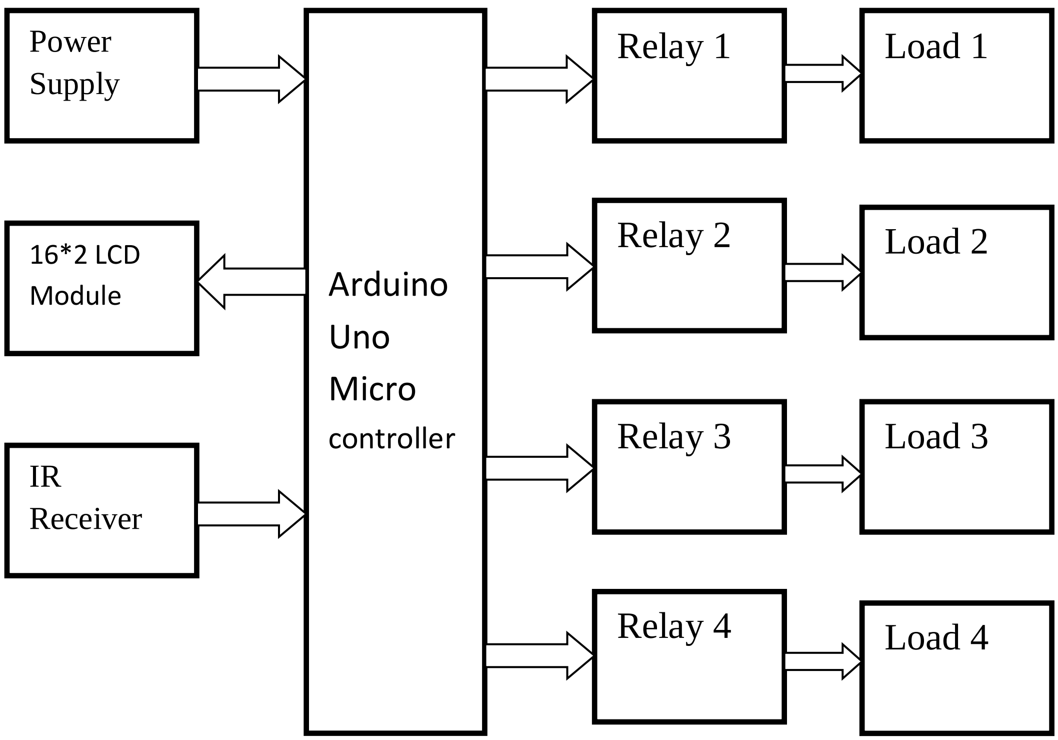
a) consider a web camera that is connected to the computer with internet can be used to spread communication like sending pictures, images, videos etc.., to another computer with internet connection throughout anywhere in the world.

b) Consider a web camera that is connected at the door lock. Whenever a person comes near the door, it captures the image of a person and sends to the desktop of your computer which is connected to internet. This gives an alerting message with image on to the desktop of your computer, and then you can open the door lock just by clicking the mouse.

Figure 1.4: Network communication embedded systems

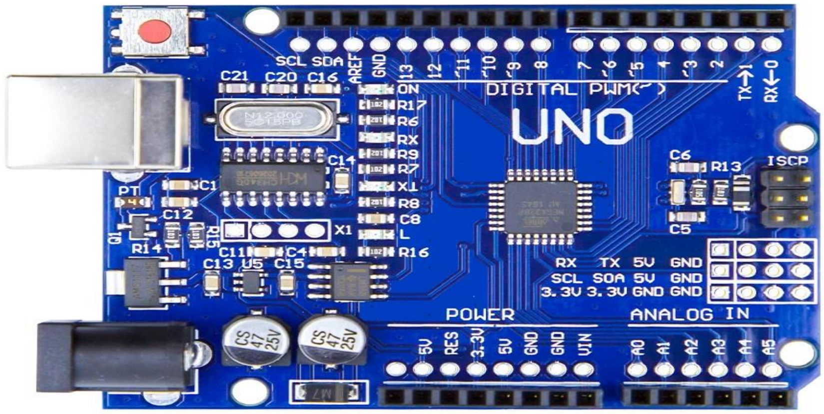
CHAPTER 2

Block Diagram:



Arduino is an open-source electronics prototyping platform based on flexible, easy-to-use hardware and software. It's intended for artists, designers, hobbyists, and anyone interested in creating interactive objects or environments. Arduino can sense the environment by receiving input from a variety of sensors and can affect its surroundings by controlling lights, motors, and other actuators. The microcontroller on the board is programmed using the Arduino programming language (based on Wiring) and the Arduino development environment (based on Processing). Arduino projects can be stand-alone or they can communicate with software on running on a computer (e.g. Flash, Processing, MaxMSP).

Arduino uno microcontroller:



Pin Description

Pin Category	**Pin Name**	**Details**
Power	Vin, 3.3V, 5V, GND	Vin: Input voltage to Arduino when using an external power source. 5V: Regulated power supply used to power microcontroller and other components on the board. 3.3V: 3.3V supply generated by on-board voltage regulator. Maximum current draw is 50mA.GND: ground pins.
Reset	Reset	Resets the microcontroller.
Analog Pins	A0 – A5	Used to provide analog input in the range of 0-5V
I/O Pins	Digital Pins 0 - 13	Can be used as input or output pins.
Serial	0(Rx), 1(Tx)	Used to receive and transmit TTL serial data.
PWM	3, 5, 6, 9, 11	Provides 8-bit PWM output.

SPI	10 (SS), 11 (MOSI), 12 (MISO) and 13 (SCK)	Used for SPI communication.
Inbuilt LED	13	To turn on the inbuilt LED.

Arduino Uno Technical Specifications

Microcontroller	ATmega328P – 8 bit AVR family microcontroller
Operating Voltage	5V
Recommended Input Voltage	7-12V
Input Voltage Limits	6-20V
Analog Input Pins	6 (A0 – A5)
Digital I/O Pins	14 (Out of which 6 provide PWM output)
DC Current on I/O Pins	40 mA
DC Current on 3.3V Pin	50 mA
Flash Memory	32 KB (0.5 KB is used for Bootloader)
SRAM	2 KB

EEPROM	1 KB
Frequency (Clock Speed)	16 MHz

Overview

Arduino Uno is a microcontroller board based on 8-bit ATmega328P microcontroller. Along with ATmega328P, it consists other components such as crystal oscillator, serial communication, voltage regulator, etc. to support the microcontroller. Arduino Uno has 14 digital input/output pins (out of which 6 can be used as PWM outputs), 6 analog input pins, a USB connection, A Power barrel jack, an ICSP header and a reset button.

How to use Arduino Board

The 14 digital input/output pins can be used as input or output pins by using pinMode(), digitalRead() and digitalWrite() functions in arduino programming. Each pin operate at 5V and can provide or receive a maximum of 40mA current, and has an internal pull-up resistor of 20-50 KOhms which are disconnected by default. Out of these 14 pins, some pins have specific functions as listed below:

- **Serial Pins 0 (Rx) and 1 (Tx):** Rx and Tx pins are used to receive and transmit TTL serial data. They are connected with the corresponding ATmega328P USB to TTL serial chip.
- **External Interrupt Pins 2 and 3:** These pins can be configured to trigger an interrupt on a low value, a rising or falling edge, or a change in value.
- **PWM Pins 3, 5, 6, 9 and 11:** These pins provide an 8-bit PWM output by using analogWrite() function.
- **SPI Pins 10 (SS), 11 (MOSI), 12 (MISO) and 13 (SCK):** These pins are used for SPI communication.
- **In-built LED Pin 13:** This pin is connected with an built-in LED, when pin 13 is HIGH – LED is on and when pin 13 is LOW, its off.

Along with 14 Digital pins, there are 6 analog input pins, each of which provide 10 bits of resolution, i.e. 1024 different values. They measure from 0 to 5 volts but this limit can be increased by using AREF pin with analog Reference() function.

- Analog pin 4 (SDA) and pin 5 (SCA) also used for TWI communication using Wire library.

Arduino Uno has a couple of other pins as explained below:

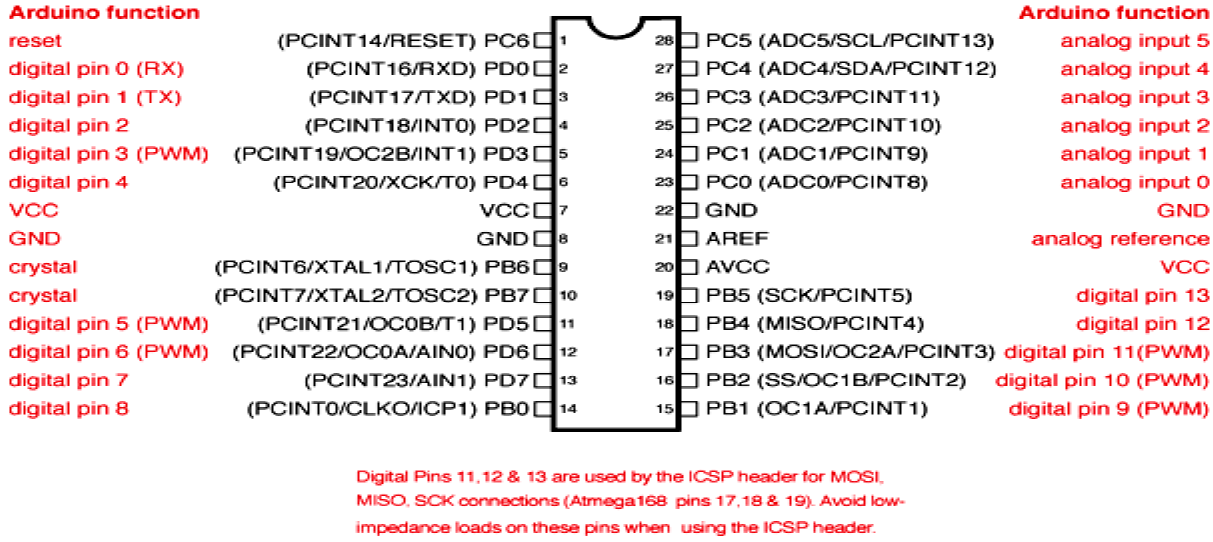
- **AREF:** Used to provide reference voltage for analog inputs with analogReference() function.
- **Reset Pin:** Making this pin LOW, resets the microcontroller.

Communication

Arduino can be used to communicate with a computer, another Arduino board or other microcontrollers. The ATmega328P microcontroller provides UART TTL (5V) serial communication which can be done using digital pin 0 (Rx) and digital pin 1 (Tx). An ATmega16U2 on the board channels this serial communication over USB and appears as a virtual com port to software on the computer. The ATmega16U2 firmware uses the standard USB COM drivers, and no external driver is needed. However, on Windows, a .inf file is required. The Arduino software includes a serial monitor which allows simple textual data to be sent to and from the Arduino board. There are two RX and TX LEDs on the arduino board which will flash when data is being transmitted via the USB-to-serial chip and USB connection to the computer (not for serial communication on pins 0 and 1). A SoftwareSerial library allows for serial communication on any of the Uno's digital pins. The ATmega328P also supports I2C (TWI) and SPI communication. The Arduino software includes a Wire library to simplify use of the I2C bus.

Arduino Uno to ATmega328 Pin Mapping

When ATmega328 chip is used in place of Arduino Uno, or vice versa, the image below shows the pin mapping between the two.



Software

Arduino IDE (Integrated Development Environment) is required to program the Arduino Uno board.

Programming Arduino

Once arduino IDE is installed on the computer, connect the board with computer using USB cable. Now open the arduino IDE and choose the correct board by selecting Tools>Boards>Arduino/Genuino Uno, and choose the correct Port by selecting Tools>Port. Arduino Uno is programmed using Arduino programming language based on Wiring. To get it started with Arduino Uno board and blink the built-in LED, load the example code by selecting Files>Examples>Basics>Blink. Once the example code (also shown below) is loaded into your IDE, click on the 'upload' button given on the top bar. Once the upload is finished, you should see the Arduino's built-in LED blinking. Below is the example code for blinking:

```
// the setup function runs once when you press reset or power the board

void setup() {
```

```
  // initialize digital pin LED_BUILTIN as an output.

  pinMode(LED_BUILTIN, OUTPUT);

}

// the loop function runs over and over again forever

void loop() {

  digitalWrite(LED_BUILTIN, HIGH);   // turn the LED on (HIGH is the voltage level)

  delay(1000);                       // wait for a second

  digitalWrite(LED_BUILTIN, LOW);    // turn the LED off by making the voltage LOW

  delay(1000);                       // wait for a second

}
```

Applications

- Prototyping of Electronics Products and Systems
- Multiple DIY Projects.
- Easy to use for beginner level DIYers and makers.
- Projects requiring Multiple I/O interfaces and communications.

4.2 POWER SUPPLY:

The power supplies are designed to convert high voltage AC mains electricity to a suitable low voltage supply for electronic circuits and other devices. A **RPS** (**Regulated Power Supply**) is the Power Supply with Rectification, Filtering and Regulation being done on the AC mains to get a Regulated power supply for Microcontroller and for the other devices being interfaced to it.

A power supply can by broken down into a series of blocks, each of which performs a particular function. A d.c power supply which maintains the output voltage constant irrespective of a.c mains fluctuations or load variations is known as “Regulated D.C Power Supply”

For example a 5V regulated power supply system as shown below:

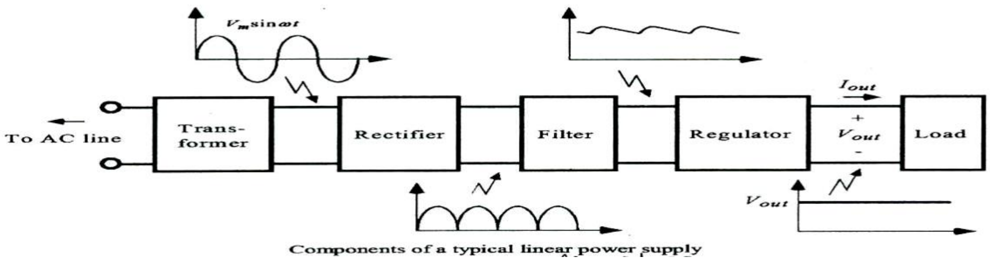
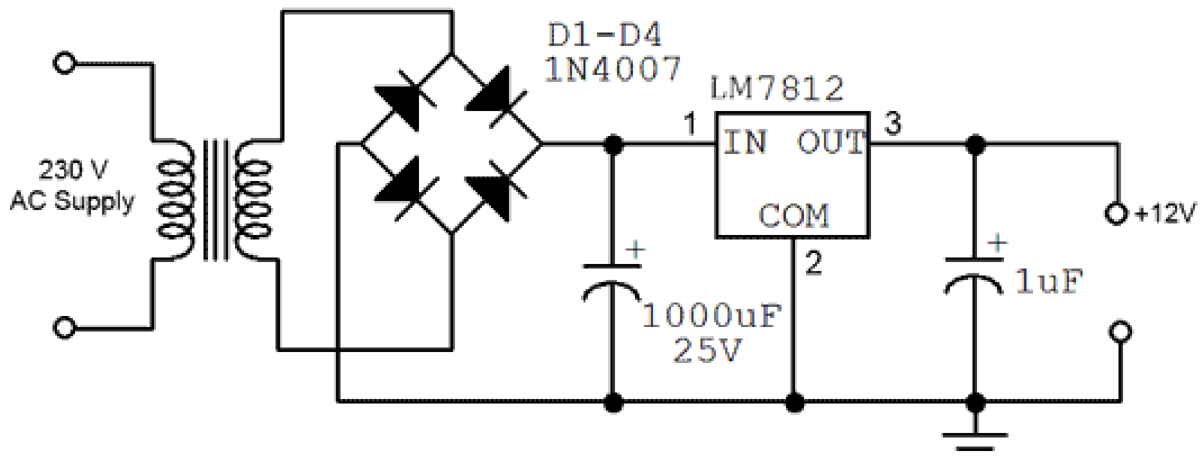


Fig 4.2: Block diagram of power supply



4.2.1 Transformer:

A transformer is an electrical device which is used to convert electrical power from one Electrical circuit to another without change in frequency.

Transformers convert AC electricity from one voltage to another with little loss of power. Transformers work only with AC and this is one of the reasons why mains electricity is AC. Step-up transformers increase in output voltage, step-down transformers decrease in output voltage. Most power supplies use a step-down transformer to reduce the dangerously high mains voltage to a safer low voltage.

The two lines in the middle of the circuit symbol represent the core. Transformers waste very little power so the power out is (almost) equal to the power in. Note that as voltage is stepped down current is stepped up. The ratio of the number of turns on each coil, called the turn's ratio, determines the ratio of the voltages. A step-down transformer has a large number of turns on its primary coil which is connected to the high voltage mains supply, and a small number of turns on its secondary coil to give a low output voltage.

Fig 4.3: Transformer

An Electrical Transformer Turns ratio = $Vp / V_S = Np/Ns$

Power Out= Power In$V_S \times I_S = V_P \times I_P$

Vp = primary (input) voltage

Np = number of turns on primary coil

Ip = primary (input) current

4.2.2 Rectifier:

A circuit which is used to convert ac to dc is known as RECTIFIER. The process of conversion ac to dc is called "rectification"

Types of rectifier:

- Half wave Rectifier
- Full wave rectifier
    1. Bridge type full wave rectifier.

    2 Centre tap full wave rectifier.

Half-wave rectifier:

In half wave rectifier, either the positive or negative half of the AC wave is passed, while the other half is blocked. Because only one half of the input waveform reaches the output, it is very inefficient if used for power transfer. Half-wave rectification can be achieved with a single diode in a one-phase supply, or with three diodes in a three-phase supply.

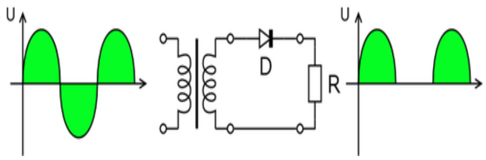


Fig 4.4: Half wave rectifier

Full wave rectifier:

Full wave rectifier is available in two ways like center-tapped full-wave rectifier and bridge full-wave rectifier.

1. Bridge type full wave rectifier:

The Bridge rectifier is a circuit, which converts an ac voltage to dc voltage using both half cycles of the input ac voltage. The Bridge rectifier circuit is shown in the figure. The circuit has four diodes connected to form a bridge. The ac input voltage is applied to the diagonally opposite ends of the bridge. The load resistance is connected between the other two ends of the bridge.

For the positive half cycle of the input ac voltage, diodes D1 and D3 conduct, whereas diodes D2 and D4 remain in the OFF state. The conducting diodes will be in series with the load resistance R_L and hence the load current flows through R_L. For the negative half cycle of the input ac voltage, diodes D2 and D4 conduct whereas, D1 and D3 remain OFF.

The conducting diodes D2 and D4 will be in series with the load resistance R_L and hence the current flows through R_L in the same direction as in the previous half cycle. Thus a bi-directional wave is converted into a unidirectional wave.

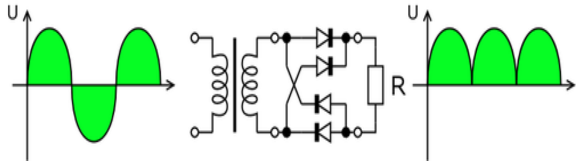


Fig 4.5 : bridge type full-wave rectifier

2. Center Tapped Full wave rectifier:

For single-phase AC, if the transformer is center-tapped, then two diodes back-to-back (i.e. anodes-to-anode or cathode-to-cathode) can form a full-wave rectifier.

Twice as many windings are required on the transformer secondary to obtain the same output voltage compared to the bridge rectifier above.

For the positive half cycle of the input ac voltage, diodes D1 will conducts, whereas diodes D2 is in the OFF state. The conducting diodes D1 will be in series with the load resistance R_L and hence the load current flows through R_L.

For the negative half cycle of the input ac voltage, diodes D2 will conduct, whereas diodes D1 is in the OFF state. The conducting diodes D2 will be in series with the load resistance R_L and hence the load current flows through R_L.

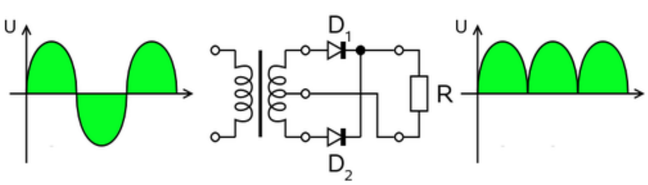


Fig 4.6: Center tapped Full-wave rectifier

4.2.3 Filter:

A Filter is a device which removes the a.c component of rectifier output but allows the dc component to reach the load

Capacitor Filter:

We have seen that the ripple content in the rectified output of half wave rectifier is 121% or that of full-wave or bridge rectifier or bridge rectifier is 48% such high percentages of ripples is not acceptable for most of the applications. Ripples can be removed by one of the following methods of filtering.

(a) A capacitor, in parallel to the load, provides an easier by –pass for the ripples voltage though it due to low impedance. At ripple frequency and leave the D.C. to appear at the load.

(b) An inductor, in series with the load, prevents the passage of the ripple current (due to high impedance at ripple frequency) while allowing the d.c (due to low resistance to d.c)

(c) Various combinations of capacitor and inductor, such as L-section filter π section filter, multiple section filter etc. which make use of both the properties mentioned in (a) and (b) above. Two cases of capacitor filter, one applied on half wave rectifier and another with full wave rectifier.

Filtering is performed by a large value electrolytic capacitor connected across the DC supply to act as a reservoir, supplying current to the output when the varying DC voltage from the rectifier is falling. The capacitor charges quickly near the peak of the varying DC, and then discharges as it supplies current to the output. Filtering significantly increases the average DC voltage to almost the peak value (1.4 × RMS value).

To calculate the value of capacitor(C),

$$C = ¼*\sqrt{3}*f*r*Rl$$

Where,

f = supply frequency,

r = ripple factor,

Rl = load resistance

Note: In our circuit we are using 1000µF hence large value of capacitor is placed to reduce ripples and to improve the DC component.

4.2.4 Regulator:

Voltage regulator ICs is available with fixed (typically 5, 12 and 15V) or variable output voltages. The maximum current they can pass also rates them. Negative voltage regulators are available, mainly for use in dual supplies. Most regulators include some automatic protection from excessive current ('overload protection') and overheating ('thermal protection'). Many of the fixed voltage regulators ICs have 3 leads and look like power transistors, such as the 7805 +5V 1A regulator shown on the right.

The LM7805 is simple to use. You simply connect the positive lead of your unregulated DC power supply (anything from 9VDC to 24VDC) to the Input pin, connect the negative lead to the Common pin and then when you turn on the power, you get a 5 volt supply from the output pin.

Fig 4.7: A Three Terminal Voltage Regulator

78XX:

The Bay Linear LM78XX is integrated linear positive regulator with three terminals. The LM78XX offer several fixed output voltages making them useful in wide range of applications. When used as a Zener diode/resistor combination replacement, the LM78XX usually results in an effective output impedance improvement of two orders of magnitude, lower quiescent current. The LM78XX is available in the TO-252, TO-220 & TO-263package.

Features:

• Output Current of 1.5A

• Output Voltage Tolerance of 5%

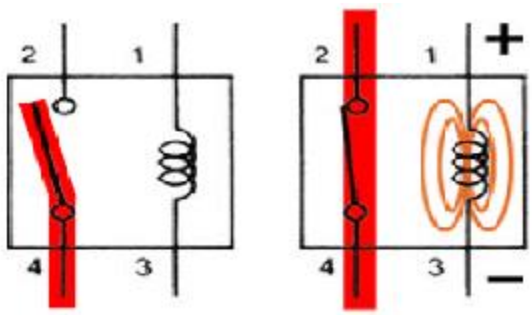
• Internal thermal overload protection

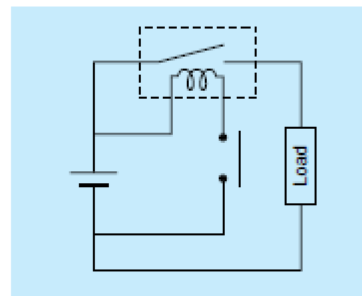
• Internal Short-Circuit Limited

• Output Voltage 5.0V, 6V, 8V, 9V, 10V, 12V, 15V, 18V, 24V.

Relays

A relay is an electrically operated switch. These are remote control electrical switches that are controlled by another switch, such as a horn switch or a computer as in a power train control module, devices in industries, home based applications. Relays allow a small current pin, 4-pin, 5-pin, and 6-pin, single switch or dual switches. Relays are used throughout the automobile. Relays which come in assorted sizes, ratings, and applications, are used as remote control switches. A typical vehicle can have 20 relays or more.

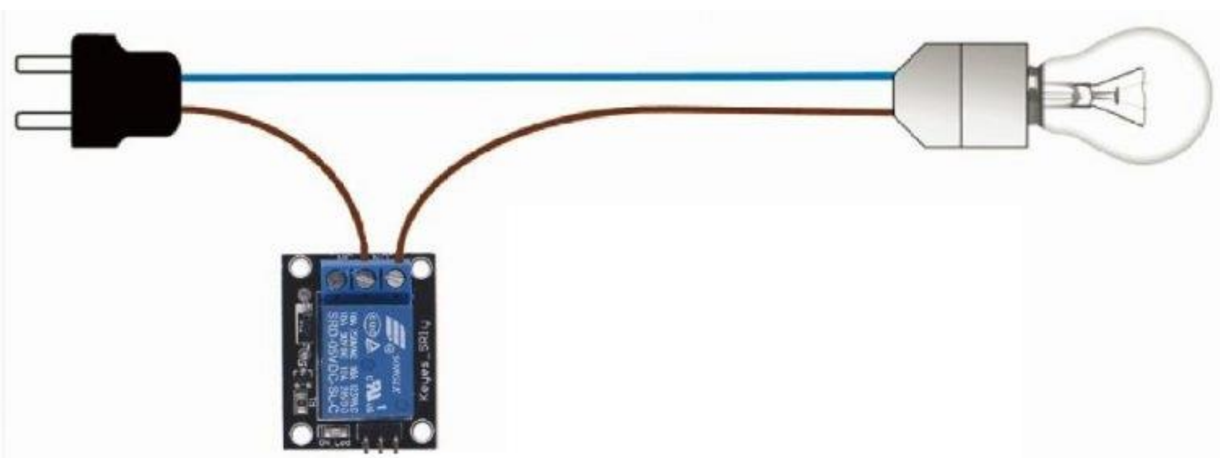




BASICS ON RELAY HANDLING

- To maintain initial performance, care should be taken to avoid dropping or hitting the relay.
- Under normal use, the relay is designed so that the case will not detach. To maintain initial performance, the case should not be removed. Relay characteristics cannot be guaranteed if the case is removed.
- Use of the relay in an atmosphere at standard temperature and humidity with minimal amounts of dust, SO 2, H 2 S, or organic gases is recommended.
- Please avoid the use of silicon-based resins near the relay, because doing so may result in contact failure. (This applies to plastic sealed type relays, too.)
- Care should be taken to observe correct coil polarity (+, –) for polarized relays.
- Proper usage requires that the rated voltage be impressed on the coil. Use rectangular waves for DC coils and sine waves for AC coils.
- Be sure the coil impressed voltage does not continuously exceed the maximum allowable voltage.
- Absolutely avoid using switching voltages and currents that exceed the designated values.

- The rated switching power and life are given only as guides. The physical phenomena at the contacts and contact life greatly vary depending on the type of load and the operating conditions. Therefore, be sure to carefully check the
- type of load and operating conditions before use.
- Do not exceed the usable ambient temperature values listed in the catalog.
- Use the flux-resistant type or sealed type if automatic soldering is to be used.
- Use alcohol based cleaning solvents when cleaning is to be performed using a sealed type relay.
- Avoid ultrasonic cleaning of all types of relays.
- Avoid bending terminals, because it may cause malfunction.
- As a guide, use a Faston mounting pressure of 40 to 70N {4 to 7kgf}for relays with tab terminals.



A relay is used to isolate one electrical circuit from another. It allows a low current control circuit to make or break an electrically isolated high current circuit path. The basic relay consists of a coil and a set of contacts. The most common relay coil is a length of magnet wire wrapped around a metal core. When voltage is applied to the coil, current passes through the wire and creates a magnetic field. This magnetic field pulls the contacts together and holds them there until the current flow in the coil has stopped. The diagram below shows the parts of a simple relay.

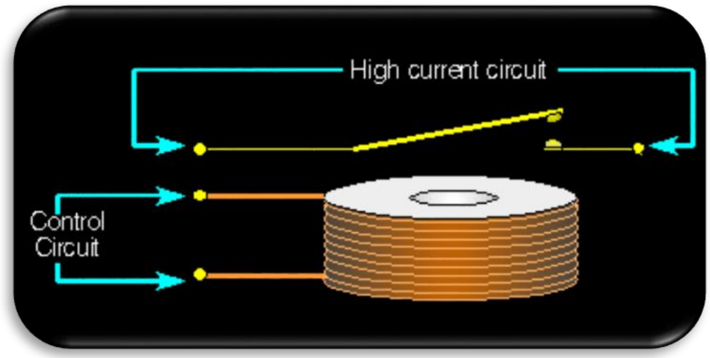


Figure: Relay

Operation:

When a current flows through the coil, the resulting magnetic field attracts an armature that is mechanically linked to a moving contact. The movement either makes or breaks a connection with a fixed contact. When the current is switched off, the armature is usually returned by a spring to its resting position shown in figure 6.6(b). Latching relays exist that require operation of a second coil to reset the contact position.

By analogy with the functions of the original electromagnetic device, a solid-state relay operates a thyristor or other solid-state switching device with a transformer or light-emitting diode to trigger it.

Pole and throw

Since relays are switches the terminology applied to switches is also applied to relays. A relay will switch one or more *poles*, each of whose contacts can be *thrown* by energizing the coil in one of three ways:

- Normally-open (**NO**) contacts connect the circuit when the relay is activated; the circuit is disconnected when the relay is inactive. It is also called a **Form A** contact or "make" contact.
- Normally-closed (**NC**) contacts disconnect the circuit when the relay is activated; the circuit is connected when the relay is inactive. It is also called a **Form B** contact or "break" contact.

- Change-over (**CO**), or double-throw (**DT**), contacts control two circuits: one normally-open contact and one normally-closed contact with a common terminal. It is also called a **Form C** contact or "transfer" contact ("break before make"). If this type of contact utilizes a "make before break" functionality, then it is called a **Form D** contact.

SPST

SPST relay stands for Single Pole Single Throw relay. Current will only flow through the contacts when the relay coil is energized.

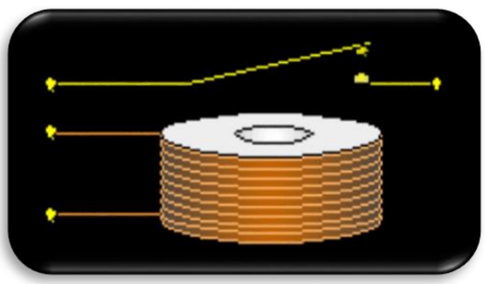


Figure: SPST Relay

SPDT Relay

SPDT Relay stands for Single Pole Double Throw relay. Current will flow between the movable contact and one fixed contact when the coil is De-energized and between the movable contact and the alternate fixed contact when the relay coil is energized. The most commonly used relay in car audio, the Bosch relay, is a SPDT relay.

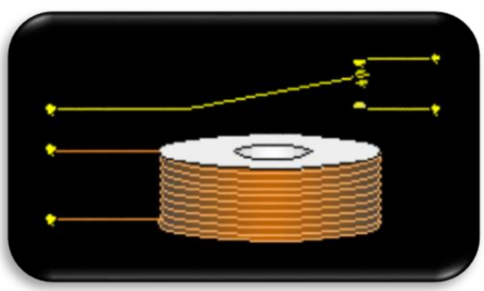


Figure: SPDT Relay

DPST Relay

DPST relay stands for Double Pole Single Throw relay. When the relay coil is energized, two separate and electrically isolated sets of contacts are pulled down to make contact with their stationary counterparts. There is no complete circuit path when the relay is De-energized.

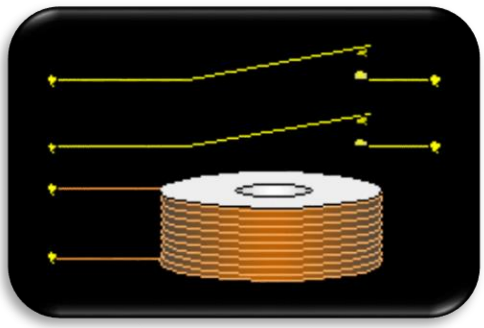


Figure: DPST Relay

DPDT Relay

DPDT relay stands for Double Pole Double Throw relay. It operates like the SPDT relay but has twice as many contacts. There are two completely isolated sets of contacts.

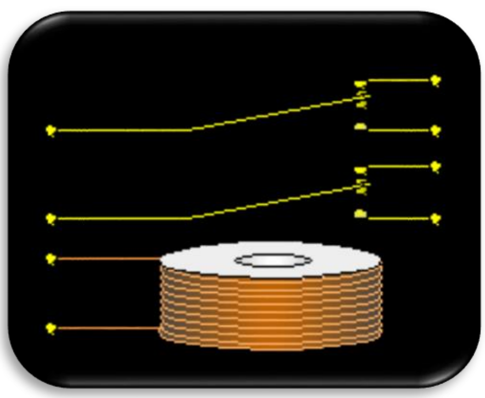


Figure: DPDT Relay

This is a 4 Pole Double Throw relay. It operates like the SPDT relay but it has 4 sets of isolated contacts.

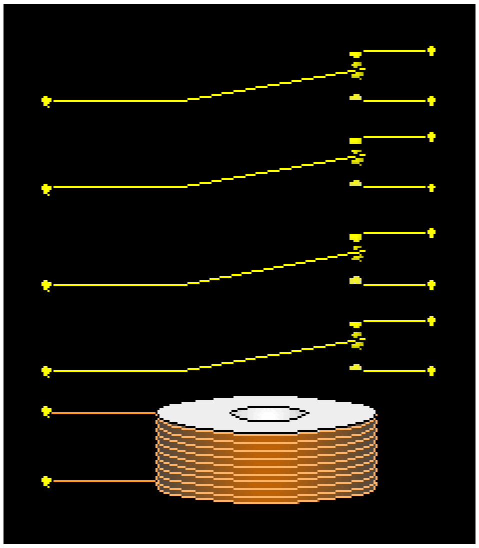


Figure: 4 Pole Double Throw relay

Types of relay:

1. Latching Relay
2. Reed Relay
3. Mercury Wetted Relay
4. Machine Tool Relay
5. Solid State Relay (SSR)

Latching relay

Latching relay, dust cover removed, showing pawl and ratchet mechanism. The ratchet operates a cam, which raises and lowers the moving contact arm, seen edge-on just below it. The moving and fixed contacts are visible at the left side of the image.

A **latching relay** has two relaxed states (bi-stable). These are also called "impulse", "keep", or "stay" relays. When the current is switched off, the relay remains in its last state. This is achieved with a solenoid operating a ratchet and cam mechanism, or by having two opposing coils with an over-center spring or permanent magnet to hold the armature and contacts in position while the coil is relaxed, or with a remanent core. In the ratchet and cam example, the first pulse to the coil turns the relay on and the second pulse turns it off. In the two coil example, a pulse to one coil turns the relay on and a pulse to the opposite coil turns the relay off. This type of relay has the advantage that it consumes power only for an instant, while it is being switched, and it retains its last setting across a power outage. A remanent core latching relay requires a current pulse of opposite polarity to make it change state.

Figure: Latching relay

Reed relay

A reed relay has a set of contacts inside a vacuum or inert gas filled glass tube, which protects the contacts against atmospheric corrosion. The contacts are closed by a magnetic field generated when current passes through a coil around the glass tube. Reed relays are capable of faster switching speeds than larger types of relays, but have low switch current and voltage ratings.

Mercury-wetted relay

A **mercury-wetted reed relay** is a form of reed relay in which the contacts are wetted with mercury. Such relays are used to switch low-voltage signals (one volt or less) because of their low contact resistance, or for high-speed counting and timing applications where the mercury eliminates contact bounce. Mercury wetted relays are position-sensitive and must be mounted vertically to work properly. Because of the toxicity and expense of liquid mercury, these relays are rarely specified for new equipment. See also mercury switch.

Machine tool relay

A **machine tool relay** is a type standardized for industrial control of machine tools, transfer machines, and other sequential control. They are characterized by a large number of contacts (sometimes extendable in the field) which are easily converted from normally-open to normally-closed status, easily replaceable coils, and a form factor that allows compactly installing many relays in a control panel. Although such relays once were the backbone of automation in such industries as automobile assembly, the programmable logic controller (PLC) mostly displaced the machine tool relay from sequential control applications.

Solid-state relay

A solid state relay (SSR) is a solid state electronic component that provides a similar function to an electromechanical relay but does not have any moving components, increasing long-term reliability. With early SSR's, the tradeoff came from the fact that every transistor has a small voltage drop across it. This voltage drop limited the amount of current a given SSR could handle. As transistors improved, higher current SSR's, able to handle 100 to 1,200 Amperes, have become commercially available. Compared to electromagnetic relays, they may be falsely triggered by transients.

Figure: Solid relay, which has no moving parts

Specification

- Number and type of contacts – normally open, normally closed, (double-throw)
- Contact sequence – "Make before Break" or "Break before Make". For example, the old style telephone exchanges required Make-before-break so that the connection didn't get dropped while dialing the number.
- Rating of contacts – small relays switch a few amperes, large contactors are rated for up to 3000 amperes, alternating or direct current
- Voltage rating of contacts – typical control relays rated 300 VAC or 600 VAC, automotive types to 50 VDC, special high-voltage relays to about 15 000 V
- Coil voltage – machine-tool relays usually 24 VAC, 120 or 250 VAC, relays for switchgear may have 125 V or 250 VDC coils, "sensitive" relays operate on a few milli-amperes

Applications:

Relays are used:

- To control a high-voltage circuit with a low-voltage signal, as in some types of modems,
- To control a high-current circuit with a low-current signal, as in the starter solenoid of an automobile,
- To detect and isolate faults on transmission and distribution lines by opening and closing circuit breakers (protection relays),
- To isolate the controlling circuit from the controlled circuit when the two are at different potentials, for example when controlling a mains-powered device from a low-voltage switch. The latter is often applied to control office lighting as the low voltage wires are easily installed in partitions, which may be often moved as needs change. They may also be controlled by room occupancy detectors in an effort to conserve energy,
- To perform logic functions. For example, the boolean AND function is realized by connecting relay contacts in series, the OR function by connecting contacts in parallel. Due to the failure modes of a relay compared with a semiconductor, they are widely used in safety critical logic, such as the control panels of radioactive waste handling machinery.
- As oscillators, also called vibrators. The coil is wired in series with the normally closed contacts. When a current is passed through the relay coil, the relay operates and opens the contacts that carry the supply current. This stops the current and causes the contacts to close again. The cycle repeats continuously, causing the relay to open and close rapidly. Vibrators are used to generate pulsed current.
- To generate sound. A vibrator, described above, creates a buzzing sound because of the rapid oscillation of the armature. This is the basis of the electric bell, which consists of a vibrator with a hammer attached to the armature so it can repeatedly strike a bell.
- To perform time delay functions. Relays can be used to act as an mechanical time delay device by controlling the release time by using the effect of residual magnetism by means of a inserting copper disk between the armature and moving blade assembly.

LCD (Liquid Cristal Display):

A liquid crystal display (LCD) is a thin, flat display device made up of any number of color or monochrome pixels arrayed in front of a light source or reflector. Each pixel consists of a column of liquid crystal molecules suspended between two transparent electrodes, and two polarizing filters, the axes of polarity of which are perpendicular to each other. Without the liquid crystals between them, light passing through one would be blocked by the other. The liquid crystal twists the polarization of light entering one filter to allow it to pass through the other.

A program must interact with the outside world using input and output devices that communicate directly with a human being. One of the most common devices attached to an controller is an LCD display. Some of the most common LCDs connected to the contollers are 16X1, 16x2 and 20x2 displays. This means 16 characters per line by 1 line 16 characters per line by 2 lines and 20 characters per line by 2 lines, respectively.

Many microcontroller devices use 'smart LCD' displays to output visual information. LCD displays designed around LCD NT-C1611 module, are inexpensive, easy to use, and it is even possible to produce a readout using the 5X7 dots plus cursor of the display. They have a standard ASCII set of characters and mathematical symbols. For an 8-bit data bus, the display requires a +5V supply plus 10 I/O lines (RS RW D7 D6 D5 D4 D3 D2 D1 D0). For a 4-bit data bus it only requires the supply lines plus 6 extra lines(RS RW D7 D6 D5 D4). When the LCD display is not enabled, data lines are tri-state and they do not interfere with the operation of the microcontroller.

Features:

(1) Interface with either 4-bit or 8-bit microprocessor.

□(2) Display data RAM

(3) 80x□8 bits (80 characters).

□(4) Character generator ROM

(5). 160 different 5 □□7 dot-matrix character patterns.

(6).□ Character generator RAM

(7) □8 different user programmed 5 □□7 dot-matrix patterns.

(8).Display data RAM and character generator RAM may be

Accessed by the microprocessor.

□(9) Numerous instructions

□(10) .Clear Display, Cursor Home, Display ON/OFF, Cursor ON/OFF,

Blink Character, Cursor Shift, Display Shift.

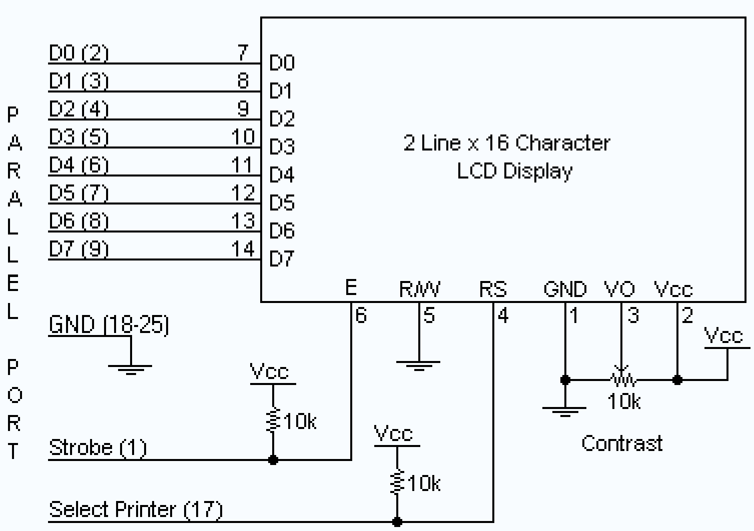
□(11). Built-in reset circuit is triggered at power ON.

□(12). Built-in oscillator.

Description Of 16x2:

This is the first interfacing example for the Parallel Port. We will start with something simple. This example doesn't use the Bi-directional feature found on newer ports, thus it should work with most, if no all Parallel Ports. It however doesn't show the use of the Status Port as an input. So what are we interfacing? A 16 Character x 2 Line LCD Module to the Parallel Port. These LCD Modules are very common these days, and are quite simple to work with, as all the logic required to run them is on board.

Schematic Diagram:



- Above is the quite simple schematic. The LCD panel's *Enable* and *Register Select* is connected to the Control Port. The Control Port is an open collector / open drain output. While most Parallel Ports have internal pull-up resistors, there are a few which don't. Therefore by incorporating the two 10K external pull up resistors, the circuit is more portable for a wider range of computers, some of which may have no internal pull up resistors.
- We make no effort to place the Data bus into reverse direction. Therefore we hard wire the *R/W* line of the LCD panel, into write mode. This will cause no bus conflicts on the data lines. As a result we cannot read back the LCD's internal Busy Flag which tells us if the LCD has accepted and finished processing the last instruction. This problem is overcome by inserting known delays into our program.
- The 10k Potentiometer controls the contrast of the LCD panel. Nothing fancy here. As with all the examples, I've left the power supply out. You can use a bench power supply set to 5v or use a onboard +5 regulator. Remember a few de-coupling capacitors, especially if you have trouble with the circuit working properly.

- The 2 line x 16 character LCD modules are available from a wide range of manufacturers and should all be compatible with the HD44780. The one I used to test this circuit was a Power tip PC-1602F and an old Philips LTN211F-10 which was extracted from a Poker Machine! The diagram to the right, shows the pin numbers for these devices. When viewed from the front, the left pin is pin 14 and the right pin is pin 1

  .

16 x 2 Alphanumeric LCD Module Features:

- Intelligent, with built-in Hitachi HD44780 compatible LCD controller and RAM providing simple interfacing
- 61 x 15.8 mm viewing area
- 5 x 7 dot matrix format for 2.96 x 5.56 mm characters, plus cursor line
- Can display 224 different symbols
- Low power consumption (1 mA typical)
- Powerful command set and user-produced characters

- TTL and CMOS compatible
- Connector for standard 0.1-pitch pin headers

16 x 2 Alphanumeric LCD Module Specifications:

Pin	Symbol	Level	Function
1	V_{SS}	-	Power, GND
2	V_{DD}	-	Power, 5V
3	Vo	-	Power, for LCD Drive
4	RS	H/L	Register Select Signal H: Data Input L: Instruction Input
5	R/W	H/L	H: Data Read (LCD->MPU) L: Data Write (MPU->LCD)
6	E	H,H->L	Enable
7-14	DB0-DB7	H/L	Data Bus; Software selectable 4- or 8-bit mode
15	NC	-	**NOT CONNECTED**
16	NC	-	**NOT CONNECTED**

FEATURES:

• 5 x 8 dots with cursor

• Built-in controller (KS 0066 or Equivalent)

• + 5V power supply (Also available for + 3V)

• 1/16 duty cycle

• B/L to be driven by pin 1, pin 2 or pin 15, pin 16 or A.K (LED)

• N.V. optional for + 3V power supply

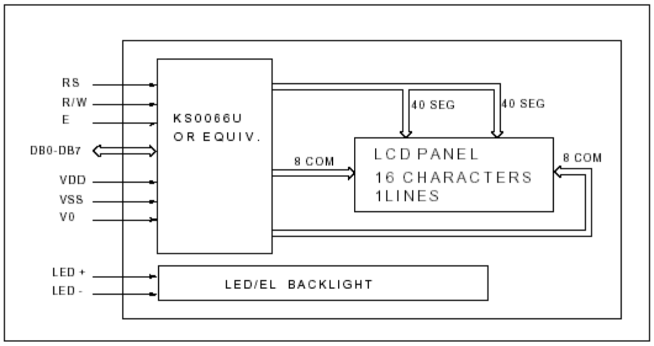
Data can be placed at any location on the LCD. For 16×1 LCD, the address locations are:

POSITION		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
ADDRESS	LINE1	00	01	02	03	04	05	06	07	40	41	42	43	44	45	46	47

Fig :15: Address locations for a 1x16 line LCD

Even limited to character based modules, there is still a wide variety of shapes and sizes available. Line lengths of 8,16,20,24,32 and 40 characters are all standard, in one, two and four line versions.

Several different LC technologies exists. “supertwist” types, for example, offer Improved contrast and viewing angle over the older “twisted nematic” types. Some modules are available with back lighting, so that they can be viewed in dimly-lit conditions. The back lighting may be either “electro-luminescent”, requiring a high voltage inverter circuit, or simple LED illumination.



Electrical Block Diagrm

Power supply for LCD driving:

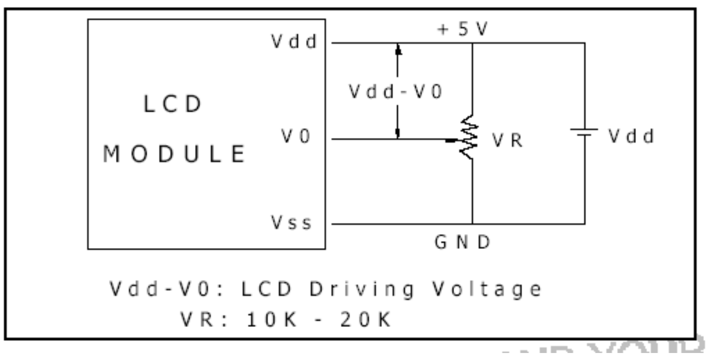


Fig: 18:power supply for LCD

PIN DESCRIPTION:

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).

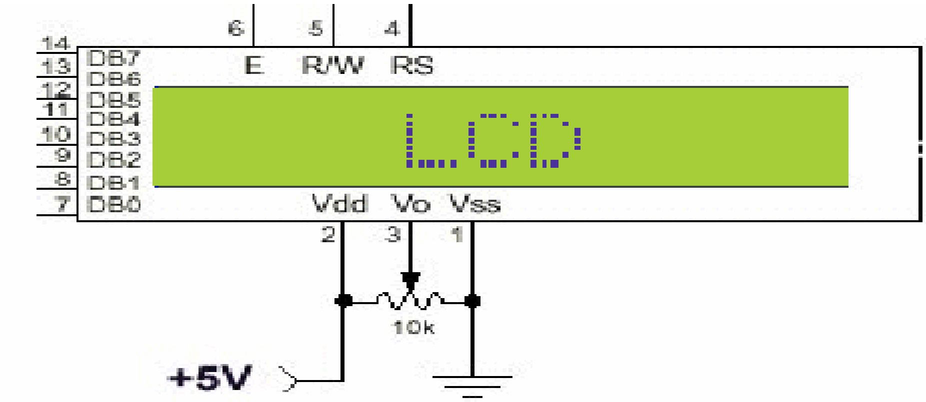


Fig 19: pin diagram of 1x16 lines LCD

PIN	SYMBOL	FUNCTION
1	Vss	Power Supply(GND)
2	Vdd	Power Supply(+5V)
3	Vo	Contrast Adjust
4	RS	Instruction/Data Register Select
5	R/W	Data Bus Line
6	E	Enable Signal
7-14	DB0-DB7	Data Bus Line
15	A	Power Supply for LED B/L(+)
16	K	Power Supply for LED B/L(-)

Fig 17: Pin specifications

CONTROL LINES:

EN: Line is called "Enable." This control line is used to tell the LCD that you are sending it data. To send data to the LCD, your program should make sure this line is low (0) and then set the other two control lines and/or put data on the data bus. When the other lines are completely ready, bring

EN high (1) and wait for the minimum amount of time required by the LCD datasheet (this varies from LCD to LCD), and end by bringing it low (0) again.

RS:

Line is the "Register Select" line. When RS is low (0), the data is to be treated as a command or special instruction (such as clear screen, position cursor, etc.). When RS is high (1), the data being sent is text data which sould be displayed on the screen. For example, to display the letter "T" on the screen you would set RS high.

RW:

Line is the "Read/Write" control line. When RW is low (0), the information on the data bus is being written to the LCD. When RW is high (1), the program is effectively querying (or reading) the LCD. Only one instruction ("Get LCD status") is a read command. All others are write commands, so RW will almost always be low.

Finally, the data bus consists of 4 or 8 lines (depending on the mode of operation selected by the user). In the case of an 8-bit data bus, the lines are referred to as DB0, DB1, DB2, DB3, DB4, DB5, DB6, and DB7.

Logic status on control lines:

• E - 0 Access to LCD disabled

- 1 Access to LCD enabled

• R/W - 0 Writing data to LCD

- 1 Reading data from LCD

• RS - 0 Instructions

- 1 Character

Writing data to the LCD:

1) Set R/W bit to low

2) Set RS bit to logic 0 or 1 (instruction or character)

3) Set data to data lines (if it is writing)

4) Set E line to high

5) Set E line to low

Read data from data lines (if it is reading) on LCD:

1) Set R/W bit to high

2) Set RS bit to logic 0 or 1 (instruction or character)

3) Set data to data lines (if it is writing)

4) Set E line to high

5) Set E line to low

Entering Text:

First, a little tip: it is manually a lot easier to enter characters and commands in hexadecimal rather than binary (although, of course, you will need to translate commands from binary couple of sub-miniature hexadecimal rotary switches is a simple matter, although a little bit into hex so that you know which bits you are setting). Replacing the d.i.l. switch pack with a of re-wiring is necessary.

SWITCHES:

The switches must be the type where On = 0, so that when they are turned to the zero position, all four outputs are shorted to the common pin, and in position "F", all four outputs are open circuit.

All the available characters that are built into the module are shown in Table 3. Studying the table, you will see that codes associated with the characters are quoted in binary and hexadecimal, most significant bits ("left-hand" four bits) across the top, and least significant bits ("right-hand" four bits) down the left.

Most of the characters conform to the ASCII standard, although the Japanese and Greek characters (and a few other things) are obvious exceptions. Since these intelligent modules were designed in the "Land of the Rising Sun," it seems only fair that their Katakana phonetic symbols should also be incorporated. The more extensive Kanji character set, which the Japanese share with the Chinese, consisting of several thousand different characters, is not included!

Using the switches, of whatever type, and referring to Table 3, enter a few characters onto the display, both letters and numbers. The RS switch (S10) must be "up" (logic 1) when sending the characters, and switch E (S9) must be pressed for each of them. Thus the operational order is: set RS high, enter character, trigger E, leave RS high, enter another character, trigger E, and so on.

The first 16 codes in Table 3, 00000000 to 00001111, ($00 to $0F) refer to the CGRAM. This is the Character Generator RAM (random access memory), which can be used to hold user-defined graphics characters. This is where these modules really start to show their potential,

offering such capabilities as bar graphs, flashing symbols, even animated characters. Before the user-defined characters are set up, these codes will just bring up strange looking symbols.

Codes 00010000 to 00011111 ($10 to $1F) are not used and just display blank characters. ASCII codes "proper" start at 00100000 ($20) and end with 01111111 ($7F). Codes 10000000 to 10011111 ($80 to $9F) are not used, and 10100000 to 11011111 ($A0 to $DF) are the Japanese characters.

Initialization by Instructions:

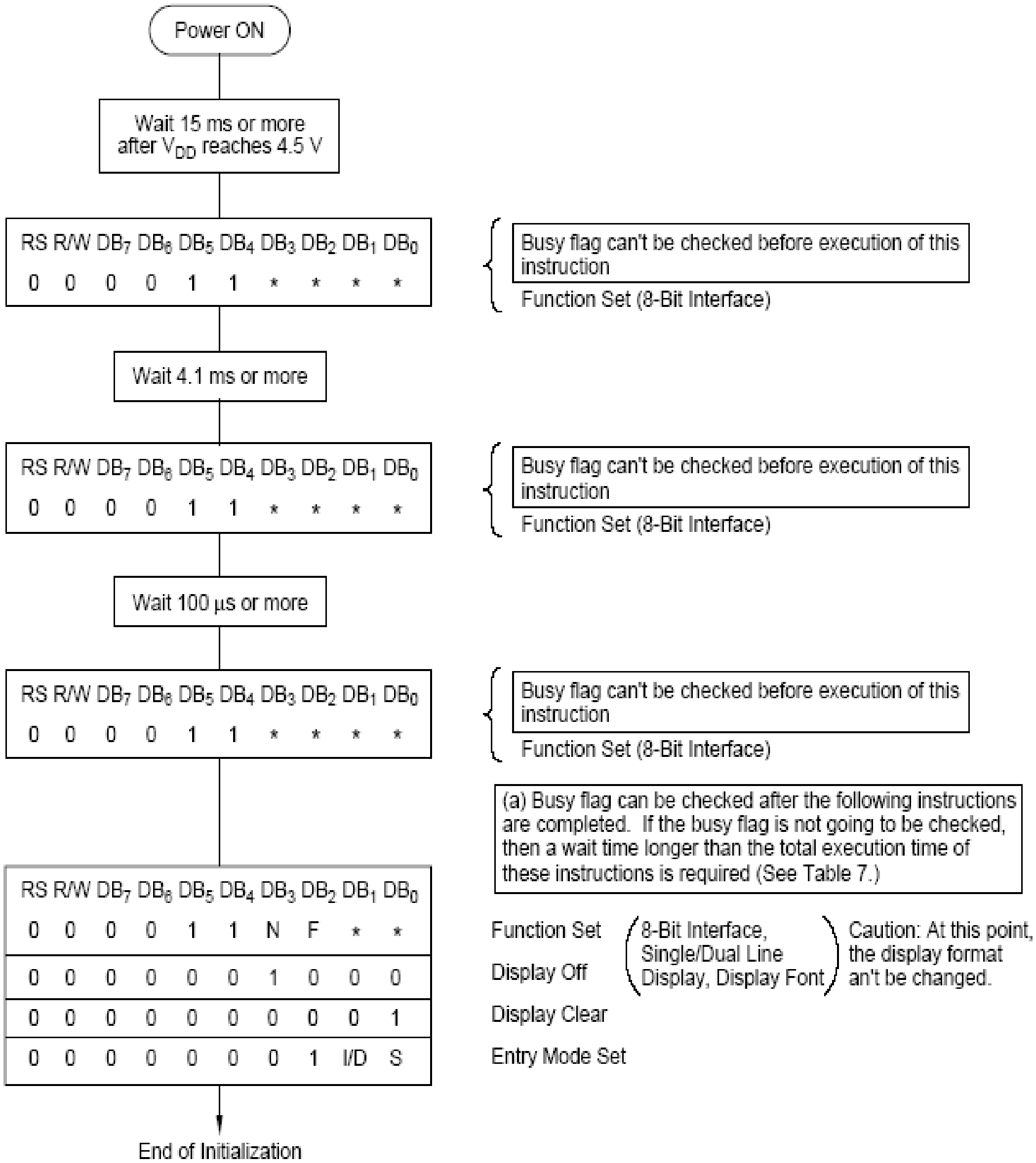


Fig 21: flow chart of lcd

If the power conditions for the normal operation of the internal reset circuit are not satisfied, then executing a series of instructions must initialize LCD unit. The procedure for this initialization process is as above show.

A power sensor tag with interference reduction for electricity monitoring of two-wire household appliances consists of transmitter and receiver section separately. Mainly this project is used for reducing human effect and for increasing water usage in the field of agriculture automatically.

First these kits are connected to the main supply (230V A.C).then it is step down to 5V d.c supply. 230V A.C supply is given as input to the step down transformer then it is step down that voltage to some 18V A.C supply. Then it is given to the Bridge wave Rectifier. This converts A.C to Pulsating D.C. then this is given to the filter circuit. Here capacitive filter is used. So it converts that pulsating D.C to pure D.C. next this is connected to 7805 regulator. It produces our required 5V D.C supply.

Electricity can be monitored by using the parameters like voltage and current these 2 Parameters can be sensed by using the voltage and current sensors. But the controlling of the devices in the house is not possible in the existing system. To overcome these disadvantages we are going for proposed method

4.2 ADVANTAGES

- Decreased field damaging conditions
- Improved safety and security
- High quality receiving data
- Less power consumption
- High speed data rate

4.3 APPLICATIONS

- Field Application
- Industrial Applications
- Protocol based Applications

LED(LIGHT EMITTING DIODE)

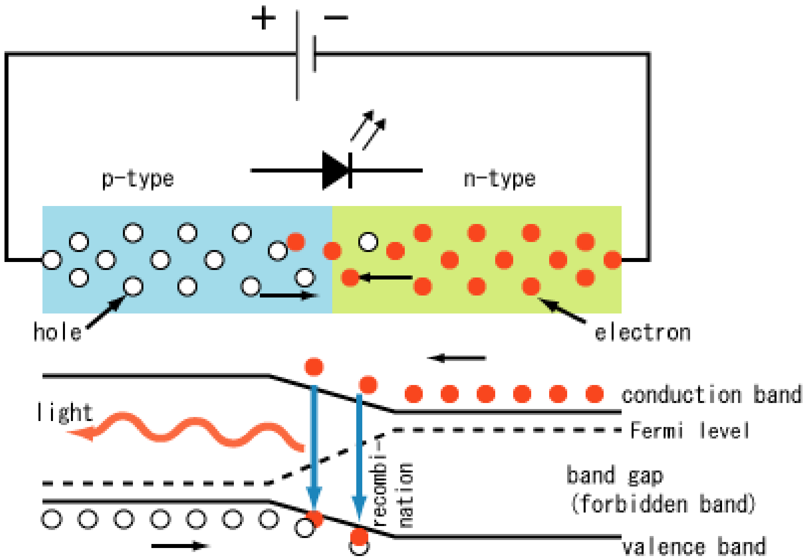
Introduction:

A light-emitting diode (LED) is a semiconductor diode that emits light when an electrical current is applied in the forward direction of the device, as in the simple LED circuit. The effect is a form of electroluminescence. where incoherent and narrow-spectrum light is emitted from the p-n junction. LEDs are widely used as indicator lights on electronic devices and increasingly in higher power applications such as flashlights and area lighting. An LED is usually a small area (less than 1 mm^2) light source, often with optics added to the chip to shape its radiation pattern and assist in reflection . The color of the emitted light depends on the composition and condition of the semi conducting material used, and can be infrared, visible, or ultraviolet. Besides lighting, interesting applications include using UV-LEDs for sterilization of water and disinfection of devices , and as a grow light to enhance photosynthesis in plants.

Basic principle:

Like a normal diode, the LED consists of a chip of semi conducting material impregnated, or *doped*, with impurities to create a *p-n junction*. As in other diodes, current flows easily from the p-side, or anode, to the n-side, or cathode, but not in the reverse direction. Charge-carriers electrons and holes flow into the junction from electrodes with different voltages. When an electron meets a hole, it falls into a lower energy level, and releases energy in the form of a photon.

The wavelength of the light emitted, and therefore its color, depends on the band gap energy of the materials forming the *p-n junction*. In silicon or germanium diodes, the electrons and holes recombine by a *non-radiative transition* which produces no optical emission, because these are indirect band gap materials. The materials used for the LED have a direct band gap with energies corresponding to near-infrared, visible or near-ultraviolet light. LED development began with infrared and red devices made with gallium arsenide. Advances in materials science have made possible the production of devices with ever-shorter wavelengths, producing light in a variety of colors. LEDs are usually built on an n-type substrate, with an electrode attached to the p-type layer deposited on its surface. P-type substrates, while less common, occur as well. Many commercial LEDs, especially GaN/InGaN, also use sapphire substrate.



LED Display types:

- Bar graph
- Seven segment
- Star burst
- Dot matrix

Basic LED types:

Miniature LEDs

Different sized LEDs. 8 mm, 5mm and 3 mm

These are mostly single-die LEDs used as indicators, and they come in various-size packages:

- surface mount
- 2 mm
- 3 mm (T1)
- 5 mm (T1¾)
- 10 mm
- Other sizes are also available, but less common.

Common package shapes:

- Round, dome top
- Round, flat top
- Rectangular, flat top (often seen in LED bar-graph displays)
- Triangular or square, flat top

The encapsulation may also be clear or semi opaque to improve contrast and viewing angle.

There are three main categories of miniature single die LEDs:

- Low current — typically rated for 2 mA at around 2 V (approximately 4 mW consumption).
- Standard — 20 mA LEDs at around 2 V (approximately 40 mW) for red, orange, yellow & green, and 20 mA at 4–5 V (approximately 100 mW) for blue, violet and white.
- Ultra-high output — 20 mA at approximately 2 V or 4–5 V, designed for viewing in direct sunlight.

Five- and twelve-volt LEDs

These are miniature LEDs incorporating a series resistor, and may be connected directly to a 5 V or 12 V supply.

Flashing LEDs

Flashing LEDs are used as attention seeking indicators where it is desired to avoid the complexity of external electronics. Flashing LEDs resemble standard LEDs but they contain an integrated multivibrator circuit inside which causes the LED to flash with a typical period of one second. In diffused lens LEDs this is visible as a small black dot. Most flashing LEDs emit light of a single color, but more sophisticated devices can flash between multiple colors and even fade through a color sequence using RGB color mixing.

High power LEDs

High power LEDs from lumileds mounted on a star shaped heat sink High power LEDs (HPLED) can be driven at more than one ampere of current and give out large amounts of light. Since overheating destroys any LED the HPLEDs must be highly efficient to minimize excess heat, furthermore they are often mounted on a heat sink to allow for heat dissipation. If the heat from a HPLED is not removed the device will burn out in seconds. A single HPLED can often replace an incandescent bulb in a flashlight or be set in an array to form a powerful LED lamp. LEDs have been developed that can run directly from mains power without the need for a DC converter. For each half cycle part of the LED diode emits light and part is dark, and this is reversed during the next half cycle. Current efficiency is 80 lm/W.

Multi-color LEDs

A "bi-color LED" is actually two different LEDs in one case. It consists of two dies connected to the same two leads but in opposite directions. Current flow in one direction produces one color, and current in the opposite direction produces the other color. Alternating the two colors with sufficient frequency causes the appearance of a third color. A "tri-color LED" is also two LEDs in one case, but the two LEDs are connected to separate leads so that the two LEDs can be controlled independently and lit simultaneously. RGB LEDs contain red, green and blue emitters, generally using a four-wire connection with one common (anode or cathode). The Taiwanese LED manufacturer Everlight has introduced a 3 watt RGB package capable of driving each die at 1 watt.

Alphanumeric LEDs

LED displays are available in seven-segment and starburst format. Seven-segment displays handle all numbers and a limited set of letters. Starburst displays can display all letters. Seven-segment LED displays were in widespread use in the 1970s and 1980s, but increasing use of liquid crystal displays, with their lower power consumption and greater display flexibility, has reduced the popularity of numeric and alphanumeric LED displays.

Applications:

Automotive applications with LEDS

Instrument Panels & Switches, Courtesy Lighting, CHMSL, Rear Stop/Turn/Tai, Retrofits, New Turn/Tail/Marker Lights.

Consumer electronics & general indication

Household appliances, VCR/ DVD/ Stereo/Audio/Video devices, Toys/Games Instrumentation, Security Equipment, Switches.

Illumination with LEDs

Architectural Lighting, Signage (Channel Letters), Machine Vision, Retail Displays, Emergency Lighting (Exit Signs), Neon and bulb Replacement, Flashlights, Accent Lighting - Pathways, Marker Lights.

Sign applications with LEDs

Full Color Video, Monochrome Message Boards, Traffic/VMS, Transportation – Passenger Information.

Signal application with LEDs

Traffic, Rail, Aviation, Tower Lights, Runway Lights, Emergency/Police Vehicle Lighting.

Mobile applications with LEDs

Mobile Phone, PDA's, Digital Cameras, Lap Tops, General Backlighting.

Photo sensor applications with LEDs

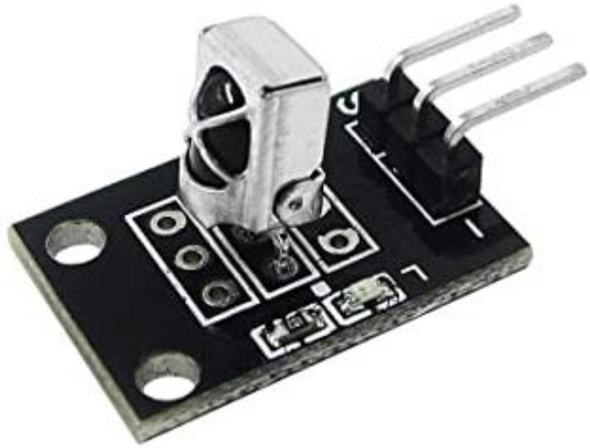
Medical Instrumentation, Bar Code Readers, Color & Money Sensors, Encoders, Optical Switches, Fiber Optic Communication.

IR RECEIVER(TSOP1738)

Photo Modules for PCM Remote Control Systems

Available types for different carrier frequencies

Type	fo	Type	Fo
TSOP1730	30 kHz	TSOP1733	33 kHz
TSOP1736	36 kHz	TSOP1737	36.7 kHz
TSOP1738	38 kHz	TSOP1740	40 kHz
TSOP1756	56 kHz		



Description

The TSOP17.. - series are miniaturized receivers for infrared remote control systems. PIN diode and preamplifier are assembled on lead frame, the epoxy package is designed as IR filter. The demodulated output signal can directly be decoded by a microprocessor. TSOP17.. is the standard IR remote control receiver series, supporting all major transmission codes.

Features

- Photo detector and preamplifier in one package
- Internal filter for PCM frequency
- Improved shielding against electrical field disturbance

- TTL and CMOS compatibility
- Output active low

Low power consumption

- High immunity against ambient light

Continuous data transmission possible (up to 2400 bps)

- Suitable burst length >10 cycles/burst

Block Diagram

Absolute Maximum Ratings

T_{amb} = 25°C

Parameter	Test Conditions	Symbol	Value	Unit
Supply Voltage	(Pin 2)	V_S	-0.3...6.0	V
Supply Current	(Pin 2)	I_S	5	mA
Output Voltage	(Pin 3)	V_O	-0.3...6.0	V
Output Current	(Pin 3)	I_O	5	mA
Junction Temperature		Tj	100	"C
Storage Temperature Range		T_{stg}	-25...+85	"C
Operating Temperature Range		T_{amb}	-25...+85	"C
Power Consumption	(Tamb ^ 85 °C)	Ptot	50	mW
Soldering Temperature	t ^ 10 s, 1 mm from case	T_{sd}	260	"C

Basic Characteristics

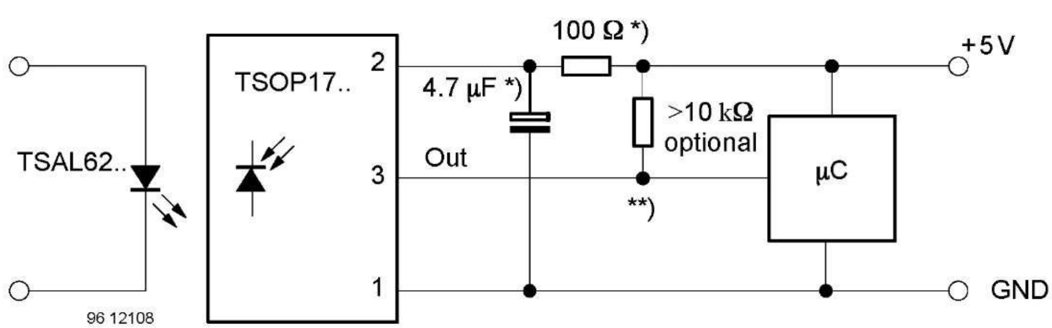
T_{amb} = 25oC

Parameter	Test Conditions	Symbol	Min	Typ	Max	Unit
Supply Current (Pin 2)	VS = 5 V, Ev = 0	I_{SD}	0.4	0.6	1.5	mA
	V_S = 5 V, E_v = 40 klx, sunlight	I_{SH}		1.0		mA
Supply Voltage (Pin 2)		VS	4.5		5.5	V
Transmission Distance	E_v = 0, test signal see fig.7, IR diode TSAL6200, I_F = 400 mA	d		35		m
Output Voltage Low (Pin 3)	I_{osl} = 0.5 mA, E_e = 0.7 mW/m^2, f = fo, tp/T = 0.4	V_{OSL}			250	mV
Irradiance (30 - 40 kHz)	Pulse width tolerance: tpi - 5/fo < tpo < tpi + 6/fo, test signal (see fig.7)	$E_{e\ min}$		0.35	0.5	mW/m^2

Irradiance (56 kHz)	Pulse width tolerance: tpi - 5/fo < tpo < tpi + 6/fo, test signal (see fig.7)	^{E}e min		0.4	0.6	mW/m^2
Irradiance	tpi - 5/fo < tpo < tpi + 6/fo	^{E}e max	30			W/m^2
Directivity	Angle of half transmission distance	j1/2		±45		deg

- recommended to suppress power supply disturbances
- The output voltage should not be hold continuously at a voltage below 3.3V by the external circuit.

Application Circuit



Suitable Data Format

The circuit of the TSOP17.. is designed in that way that unexpected output pulses due to noise or disturbance signals are avoided. A bandpassfilter, an integrator stage and an automatic gain control are used to suppress such disturbances. The distinguishing mark between data signal and disturbance signal are carrier frequency, burst length and duty cycle.

The data signal should fullfill the following condition:

- Carrier frequency should be close to center frequency of the bandpass (e.g. 38kHz).
- Burst length should be 10 cycles/burst or longer.
- After each burst which is between 10 cycles and 70 cycles a gap time of at least 14 cycles is neccessary.
- For each burst which is longer than 1.8ms a corresponding gap time is necessary at some time in the data stream. This gap time should have at least same length as the burst.
- Up to 1400 short bursts per second can be received continuously.

Some examples for suitable data format are: NEC Code, Toshiba Micom Format, Sharp Code, RC5 Code, RC6 Code, R-2000 Code, Sony Format (SIRCS).

When a disturbance signal is applied to the TSOP17.. it can still receive the data signal. However the sensitivity is reduced to that level that no unexpected pulses will occure.

CONCLUSION

In this project, the proposed technique i.e. home automation through IR sensor and arduino board microcontroller has been discussed and its application for home appliances successfully demonstrated. The system is cheap, reliable, and easy to install and operate. The proposed system is however, applicable to automate the appliances of single room only as IR sensor requires line of sight (LOS) to communicate. The same concept can also be extended further to automate multiple rooms by using the combination of IR and RF sensors and the range can also be extended to few more metres by using higher range IR and RF sensors.

FUTURE WORK

This is a very smart and intelligent system approvable for all the age groups and has a variety of uses in almost all the areas where instruments need to be automated and controlled as per the human need and enhance facility. This instrument is basically used to regulate and overcome all the obstacles . It is possible that the operating range and the instrument operability in terms of number of instruments can be modified. It can be used in the case of a number of devices and applications such as TV, VCR, camera, CD speller, radio, lamp, fan, music system or even simple tasks.

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