CONTROL OF APPLIANCES USING GSM TECHNOLOGY

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"The power of God is with you at all times; through the activities of mind, senses, breathing, and emotions; and is constantly doing all the work using you as a mere instrument."

- *Shrimad Bhagvat Geeta*

Surrendered to the lotus feet of the Lord.

Certificate

This is to certify that the work titled "**Control of Aplliances using GSM Technology**", submitted by **Yashim Garg, Sayed Jeeshan Ali and Shubhrangshu Naval** in partial fulfillment for the award of degree of Bachelor of Technology in Electronics and Communication Engineering to Jaypee University of Information Technology, Waknaghat, Solan has been carried out under my supervision. This work has not been submitted partially or wholly to any other University or Institute for the award of this or any other degree or diploma.

Signature of Supervisor ....

Name of Supervisor Mr. Jitendra Mohan

Designation Senior Lecturer

Date 20/05/11

Acknowledgement

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20/5/11 20/05/11 20/05/2011

(Yashim Garg) (Sayed Jeeshan Ali) (ShubhrangshuNaval)

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SUMMARY

Mobile technology has been one of the most dynamic technologies in the world for the last two decades. The daily use of mobiles in any person's life is immense and the growth expected in this sector is exponential. The basic idea of this project has been derived from the same fact after analyzing the future scope and prospects of this technology. GSM technology has been the fore-runner compared to CDMA technology, which are both offshoots of mobile technology. Roughly eighty percent of the world's mobile phones work on GSM as compared almost twenty percent working on CDMA.

Our aim is to construct a GSM based digital lock code system having 10 digit password securities and controlling various electrical appliances using microcontroller 8051. For a system to be dynamic, a mobile phone is used to receive the code from another mobile from any location across the world. When a correct code is received we can control our devices or appliances from remote location.

The project would use 8051 assembly language. It's a project with efficient security system which can also have its application in security systems such as safe vaults, doors, lockers etc. The Master Lock is of 10 digits and designed in such a manner that it's not easy for an intruder to break the lock. The input is taken from a Mobile Phone and displays the user input on a 2x16 LCD. For demonstration we will connect a stepper motor whose speed has to be controlled. We can also control some robotic application with this project.

CHAPTER 1

GSM TECHNOLOGY

1.1 INTRODUCTION

Global System for Mobile (GSM), is a second generation cellular standard developed to cater voice services and data delivery using digital modulation.

Originally (Groupe Spécial Mobile, GSM), is a standard set developed by the European Telecommunications Standards Institute (ETSI) to describe technologies for second generation (or "2G") digital cellular networks. Developed as a replacement for first generation analogue cellular networks, the GSM standard originally described a digital, circuit switched network optimized for full duplex voice telephony. The standard was expanded over time to include first circuit switched data transport, then packet data transport via GPRS. Packet data transmission speeds were later increased via EDGE. The GSM standard is succeeded by the third generation (or "3G") UMTS standard developed by the 3GPP. GSM networks will evolve further as they begin to incorporate fourth generation (or "4G") LTE Advanced standards. "GSM" is a trademark owned by the GSM Association.

The GSM Association estimates that technologies defined in the GSM standard serve 80% of the global mobile market, encompassing more than 1.5 billion people across more than 212 countries and territories, making GSM the most ubiquitous of the many standards for cellular networks.

The GSM family of technologies has provided the world with mobile communications since 1991. In over twenty years of development, GSM has been continually enhanced to provide platforms that deliver an increasingly broad range of mobile services as demand grows.

Where the industry started with plain voice calls, it now has a powerful platform capable of supporting mobile broadband and multimedia services.

Increased sophistication

Since the 1990s, the GSM family of technologies has become increasingly sophisticated and GSM networks now offer a wealth of mobile data and entertainment services.

After voice, the growth of SMS (Short Messaging Service), or text messaging, continues, with an estimated one trillion messages sent globally in 2005. More advanced messaging services – such as MMS (Multimedia Messaging Service), IM (Instant Messaging) and mobile email – offer users an even richer mobile messaging experience.

Media-rich content

Mobile communications also has the opportunity to become the new personal entertainment and information medium of choice. Already dubbed the 'fourth screen,' after television, cinema and the PC, the industry is delivering a vast array of media rich content to users throughout the world including advanced mobile gaming applications, mobile music, and TV and video content.

The benefits of convenience, immediacy and personalisation have fostered the growth of location-based services and mobile commerce applications. Internet-style services on hundreds of thousands of WAP sites contain much of the information and images found on the wider Internet.

What more can GSM offer?

GSM has offered way more than just voice calls. GSM now has widened its arms in the field of real time voice and video calling, fast and more powerful data delivery services, text, multimedia and voice messaging, Railways and Air ticket booking, social networking, mobile payments of bills and taxes.

The scope of GSM technology is vast and can go even farther, it is just the matter of time and human perception. Technical advancements in GSM technology are solely made to make human lifestyle more convenient.

1.2 HISTORY

Early European analog cellular networks employed an uncoordinated mix of technologies and protocols that varied from country to country, preventing interoperability of subscriber equipment and increasing complexity for equipment manufacturers who had to contend with varying standards from a fragmented market. The work to develop a European standard for digital cellular voice telephony began in 1982 when the European Conference of Postal and Telecommunications Administrations (CEPT) created the Groupe Spécial Mobile committee and provided a permanent group of technical support personnel, based in Paris. In 1987, 15 representatives from 13 European countries signed a memorandum of understanding to develop and deploy a common cellular telephone system across Europe. The foresight of deciding to develop a continental standard paid off, eventually resulting in a unified, open, standard-based network larger than that in the United States.

France and Germany signed a joint development agreement in 1984 and were joined by Italy and the UK in 1986. In 1986 the European Commission proposed to reserve the 900 MHz spectrum band for GSM. By 1987, basic parameters of the GSM standard had been agreed upon and 15 representatives from 13 European nations signed a memorandum of understanding in Copenhagen, committing to deploy GSM. In 1989, the Groupe Spécial Mobile committee was transferred from CEPT to the European Telecommunications Standards Institute (ETSI).

Phase I of the GSM specifications were published in 1990. Finnish mobile network operator Radiolinja completed the first GSM telephone call in July, 1991. 1992, the first short messaging service (SMS or "text message") message was sent and Vodafone UK and Telecom Finland signed the first international roaming agreement. Work had begun in 1991 to expand the GSM standard to the 1800 MHz frequency band and the first 1800 MHz network became operational in the UK in 1993. Also in 1993, Telecom Australia became the first network operator to deploy a GSM network outside of Europe and the first practical hand-held GSM mobile phone became available. In 1995, fax, data and SMS messaging services became commercially operational, the first 1900 MHz GSM network in the world became operational in the United States and GSM subscribers worldwide exceeded 10 million. In this same year, the GSM Association was formed. Pre-paid GSM SIM cards were launched in 1996 and worldwide GSM subscribers passed 100 million in 1998.

In 2000, the first commercial GPRS services were launched and the first GPRS compatible handsets became available for sale. In 2001 the first UTMS (W-CDMA) network was launched and worldwide GSM subscribers exceeded 500 million. In 2002 the first multimedia messaging services (MMS) were introduced and the first GSM network in the 800 MHz frequency band became operational. EDGE services first became operational in a network in 2003 and the number of worldwide GSM subscribers exceeded 1 billion in 2004.

By 2005, GSM networks accounted for more than 75% of the worldwide cellular network market, serving 1.5 billion subscribers. Also in 2005 the first HSDPA capable network became operational. The first HSUPA network was launched in 2007 and worldwide GSM subscribers exceeded two billion in 2008.

The GSM Association estimates that technologies defined in the GSM standard serve 80% of the global mobile market, encompassing more than 1.5 billion people across more than 212 countries and territories, making GSM the most ubiquitous of the many standards for cellular networks.

1.3 TECHNICAL SPECIFICATIONS

GSM is a cellular network, which means that mobile phones connect to it by searching for cells in the immediate vicinity. There are five different cell sizes in a GSM network—macro, micro, pico, femto and umbrella cells. The coverage area of each cell varies according to the implementation environment. Macro cells can be regarded as cells where the base station antenna is installed on a mast or a building above average roof top level. Micro cells are cells whose antenna height is under average roof top level; they are typically used in urban areas. Picocells are small cells whose coverage diameter is a few dozen metres; they are mainly used indoors. Femtocells are cells designed for use in residential or small business environments and connect to the service provider's network via a broadband internet connection. Umbrella cells are used to cover shadowed regions of smaller cells and fill in gaps in coverage between those cells.

Cell horizontal radius varies depending on antenna height, antenna gain and propagation conditions from a couple of hundred meters to several tens of kilometres. The longest distance the GSM specification supports in practical use is 35 kilometres (22 mi). There are also several implementations of the concept of an extended cell, where the cell radius could be double or even more, depending on the antenna system, the type of terrain and the timing advance.

Indoor coverage is also supported by GSM and may be achieved by using an indoor picocell base station, or an indoor repeater with distributed indoor antennas fed through power splitters, to deliver the radio signals from an antenna outdoors to the separate indoor distributed antenna system. These are typically deployed when a lot of call capacity is needed indoors; for example, in shopping centres by in-building penetration of the radio signals from any nearby cell.

The modulation used in GSM is Gaussian minimum-shift keying (GMSK), a kind of continuous-phase frequency shift keying. In GMSK, the signal to be modulated onto the carrier is first smoothed with a Gaussian low-pass filter prior to being fed to a frequency modulator, which greatly reduces the interference to neighbouring channels (adjacent-channel interference).

1.3.1 GSM carrier frequencies (GSM frequency bands)

GSM networks operate in a number of different carrier frequency ranges (separated into GSM frequency ranges for 2G and UMTS frequency bands for 3G), with most 2G GSM networks operating in the 900 MHz or 1800 MHz bands. Where these bands were already allocated, the 850 MHz and 1900 MHz bands were used instead (for example in Canada and the United States). In rare cases the 400 and 450 MHz frequency bands are assigned in some countries because they were previously used for first-generation systems.

Most 3G networks in Europe operate in the 2100 MHz frequency band.

Regardless of the frequency selected by an operator, it is divided into timeslots for individual phones to use. This allows eight full-rate or sixteen half-rate speech channels per radio frequency. These eight radio timeslots (or eight burst periods) are grouped into a TDMA frame. Half rate channels use alternate frames in the same timeslot. The channel data rate for all 8 channels is 270.833 kbit/s, and the frame duration is 4.615 ms.

The transmission power in the handset is limited to a maximum of 2 watts in GSM850/900 and 1 watt in GSM1800/1900.

1.3.2 Voice codecs

GSM has used a variety of voice codecs to squeeze 3.1 kHz audio into between 5.6 and 13 kbit/s. Originally, two codecs, named after the types of data channel they were allocated, were used, called Half Rate (5.6 kbit/s) and Full Rate (13 kbit/s). These used a system based upon linear predictive coding (LPC). In addition to being efficient with bitrates, these codecs also made it easier to identify more important parts of the audio, allowing the air interface layer to prioritize and better protect these parts of the signal.

GSM was further enhanced in 1997[8] with the Enhanced Full Rate (EFR) codec, a 12.2 kbit/s codec that uses a full rate channel. Finally, with the development of UMTS, EFR was refactored into a variable-rate codec called AMR-Narrowband, which is high quality and robust against interference when used on full rate channels, and less robust but still relatively high quality when used in good radio conditions on half-rate channels

1.3.3 Network structure

The network is structured into a number of discrete sections:

- The Base Station Subsystem (the base stations and their controllers).
- The Network and Switching Subsystem (the part of the network most similar to a fixed network). This is sometimes also just called the core network.
- The GPRS Core Network (the optional part which allows packet based Internet connections).
- The Operations support system (OSS) for maintenance of the network.

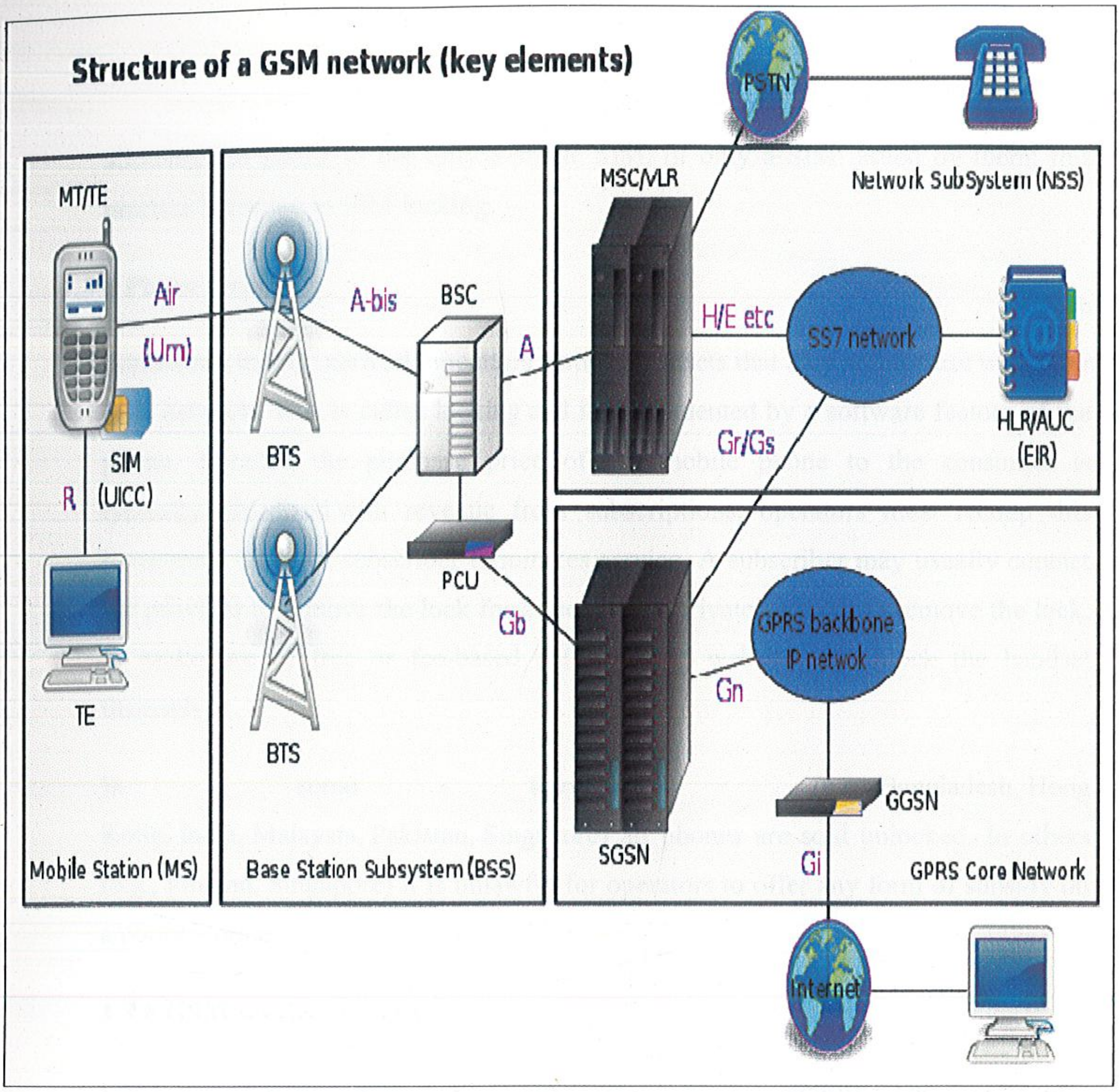


Fig. 1.1 – The Structure of GSM Network

1.3.4 Subscriber Identity Module (SIM)

One of the key features of GSM is the Subscriber Identity Module, commonly known as a SIM card. The SIM is a detachable smart card containing the user's subscription information and phone book. This allows the user to retain his or her information after switching handsets. Alternatively, the user can also change operators while retaining the handset simply by changing the SIM. Some operators will block this by allowing the phone to use only a single SIM, or only a SIM issued by them; this practice is known as SIM locking.

1.3.5 Phone locking

Sometimes mobile network operators restrict handsets that they sell for use with their own network. This is called locking and is implemented by a software feature of the phone. Because the purchase price of the mobile phone to the consumer is typically subsidized with revenue from subscriptions, operators must recoup this investment before a subscriber terminates service. A subscriber may usually contact the provider to remove the lock for a fee, utilize private services to remove the lock, or make use of free or fee-based software and websites to unlock the handset themselves.

In some territories (e.g., Bangladesh, Hong Kong, India, Malaysia, Pakistan, Singapore) all phones are sold unlocked. In others (e.g., Finland, Singapore) it is unlawful for operators to offer any form of subsidy on a phone's price.

1.3.6 GSM service security

GSM was designed with a moderate level of service security. The system was designed to authenticate the subscriber using a pre-shared key and challenge-response. Communications between the subscriber and the base station can be encrypted. The development of UMTS introduces an optional Universal Subscriber Identity Module (USIM), that uses a longer authentication key to give greater security, as well as mutually authenticating the network and the user - whereas GSM only authenticates the user to the network (and not vice versa). The security model therefore offers confidentiality and authentication, but limited authorization capabilities, and no non-repudiation.

GSM uses several cryptographic algorithms for security. The A5/1 and A5/2 stream ciphers are used for ensuring over-the-air voice privacy. A5/1 was developed first and is a stronger algorithm used within Europe and the United States; A5/2 is weaker and used in other countries. Serious weaknesses have been found in both algorithms: it is possible to break A5/2 in real-time with a ciphertext-only attack, and in February 2008, Pico Computing, Inc revealed its ability and plans to commercialize FPGAs that allow A5/1 to be broken with a rainbow table attack. The system supports multiple algorithms so operators may replace that cipher with a stronger one.

On 28 December 2009 German computer engineer Karsten Nohl announced that he had cracked the A5/1 cipher. According to Nohl, he developed a number of rainbow tables (static values which reduce the time needed to carry out an attack) and have found new sources for known plaintext attacks. He also said that it is possible to build "a full GSM interceptor ... from open source components" but that they had not done so because of legal concerns.

In January 2010, threatpost.com reported that researchers had developed a new attack that had "broken Kasumi" (also known as A5/3), the standard encryption algorithm used to secure traffic on 3G GSM wireless networks, by means of a sandwich attack (a type of related-key attack), allowing them to identify a full key. It reported experts as saying that this "is not the end of the world for Kasumi." (Paper) The researchers noted that their attack failed on its predecessor algorithm MISTY1, and observed that the GSM Association's change of standard from MISTY to KASUMI resulted in a "much weaker cryptosystem". This was followed between December 2010 and April 2011 by an announcement from other researchers that they had reverse engineered the GSM encryption algorithms, and demonstrated software capable of real-time interception of GSM voice calls.

New attacks have been observed that take advantage of poor security implementations, architecture and development for smart phone applications. Some wiretapping and eavesdropping techniques hijack the audio input and output providing an opportunity for a 3rd party to listen in to the conversation. At present such attacks often come in the form of a Trojan, malware or a virus and might be detected by security software.

1.4 COMPARISON BETWEEN GSM and CDMA

One of the most contentious battles being waged in the wireless infrastructure industry is the debate over the efficient use and allocation of finite airwaves. For several years, the world's two main methods -- Code-Division Multiple Access (CDMA) and Global System for Mobile communications (GSM) -- have divided the wireless world into opposing camps. Ultimately, the emergence of a victorious technology may owe more to historical forces than the latest wireless innovation, or the merits of one standard over the other.

GSM and CDMA are competing wireless technologies with GSM enjoying about an 82% market share globally. In the U.S., however, CDMA is the more dominant standard. Technically GSM (Global System for Mobile communications, originally from *Groupe Spécial Mobile*) is a specification of an entire wireless networking infrastructure, while CDMA relates only to the air interface — the radio portion of the technology.

Code division multiple access (CDMA) describes a communication channel access principle that employs spread-spectrum technology and a special coding scheme(where each transmitter is assigned a code). CDMA also refers to digital cellular telephony systems that use this multiple access scheme, as pioneered by QUALCOMM, and W-CDMA by the International Telecommunication Union (ITU), which is used in GSM's UMTS.

Another difference between GSM and CDMA is in the data transfer methods. GSM's high-speed wireless data technology, GPRS (General Packet Radio Service), usually offers a slower data bandwidth for wireless data connection than CDMA's high-speed technology (1xRTT, short for single carrier radio transmission technology), which has the capability of providing ISDN (Integrated Services Digital Network)-like speeds of as much as 144Kbps (kilobits per second). However, 1xRTT requires a dedicated connection to the network for use, whereas GPRS sends in packets, which means that data calls made on a GSM handset don't block out voice calls like they do on CDMA phones.

Bad timing may have prevented the evolution of one, single global wireless standard. Just two years before CDMA's 1995 introduction in Hong Kong, European carriers and manufacturers chose to support the first available digital technology - Time Division Multiple Access (TDMA). GSM uses TDMA as its core technology. Therefore, since the majority of wireless users are in Europe and Asia, GSM has taken the worldwide lead as the technology of choice.

Mobile Handset manufacturers ultimately split into two camps, as Motorola, Lucent, and Nextel chose CDMA, and Nokia and Ericsson eventually pushed these companies out and became the dominant GSM players.

1.4.1 Advantages of GSM over CDMA

- GSM is already used worldwide with over 450 million subscribers.
- International roaming permits subscribers to use one phone throughout Western Europe. CDMA will work in Asia, but not France, Germany, the U.K. and other popular European destinations.
- GSM is mature, having started in the mid-80s. This maturity means a more stable network with robust features. CDMA is still building its network.
- GSM's maturity means engineers cut their teeth on the technology, creating an unconscious preference.
- The availability of Subscriber Identity Modules, which are smart cards that provide secure data encryption give GSM m-commerce advantages.

1.4.2 Conclusion

- Today, the battle between CDMA and GSM is muddled. Where at one point Europe clearly favored GSM and North America, CDMA, the distinct advantage of one over the other has blurred as major carriers like AT&T Wireless begin to support GSM, and recent trials even showed compatibility between the two technologies.

- GSM still holds the upper hand however. There's the numerical advantage for one thing: 456 million GSM users versus CDMA's 82 million.

1.4.3 Other factors potentially tipping the scales in the GSM direction include :

AT&T Wireless' move to overlay GSM atop its TDMA network means the European technology (GSM) gains instant access to North America's number two network.

Qualcomm's recently announced that Wideband-CDMA (WCDMA) won't be ready in Europe until 2005. This comes amidst reports that GSM's successor, General Packet Radio Services (GPRS) remains on target for deployment in 2001-2002.

For all of the historical and technological reasons outlined above, it appears that GSM, or some combination of GSM and CDMA, will become the long sought after grail for a global wireless standard. A universalization of wireless technologies can only stand to benefit the compatibility and development costs and demands on all wireless commerce participants.

CHAPTER 2

MICROCONTROLLER

2.1 INTRODUCTION

A microcontroller (sometimes abbreviated μC, uC or MCU) 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.

Microcontrollers are used in automatically controlled products and devices, such as automobile engine control systems, implantable medical devices, remote controls, office machines, appliances, power tools, and toys. By reducing the size and cost compared to a design that uses a separate microprocessor, memory, and input/output devices, microcontrollers make it economical to digitally control even more devices and processes. Mixed signal microcontrollers are common, integrating analog components needed to control non-digital electronic systems.

Some microcontrollers may use Four-bit words and operate at clock rate frequencies as low as 4 kHz, for low power consumption (milliwatts or microwatts). They will generally have the ability to retain functionality while waiting for an event such as a button press or other interrupt; power consumption while sleeping (CPU clock and most peripherals off) may be just nanowatts, making many of them well suited for long lasting battery applications. Other microcontrollers may serve performance-critical roles, where they may need to act more like a digital signal processor (DSP), with higher clock speeds and power consumption.

For this project we have used the ATMEL microcontroller AT89S52 which belongs to the 8051 family. This is one of those microcontrollers which are easily available in the market.

2.2 8051 FAMILY

The 8051 microcontroller family is a Harvard architecture, single chip microcontroller (μC) series which was developed by Intel in 1980 for use in embedded systems. Intel's original versions were popular in the 1980s and early 1990s, but has today largely been superseded by a vast range of faster and/or functionally enhanced 8051-compatible devices manufactured by more than 20 independent manufacturers and is thus one of the more easily available microcontrollers.

Intel's original MCS-51 family was developed using NMOS technology, but later versions, identified by a letter C in their name (e.g., 80C51) used CMOS technology and were less power-hungry than their NMOS predecessors. This made them more suitable for battery-powered devices.

2.2.1 Important Features and Applications

The 8051 architecture provides many functions
(CPU, RAM, ROM, I/O, interrupt logic, timer, etc.) in a single package

- 8-bit ALU, Accumulator and 8-bit Registers; hence it is an 8-bit microcontroller
- 8-bit data bus – It can access 8 bits of data in one operation
- 16-bit address bus – It can access 2^{16} memory locations – 64 KB (65536 locations) each of RAM and ROM
- On-chip RAM – 128 bytes (data memory)
- On-chip ROM – 4 kByte (program memory)
- Four byte bi-directional input/output port
- UART (serial port)
- Two 16-bit Counter/timers

- Two-level interrupt priority
- Power saving mode (on some derivatives)

A particularly useful feature of the 8051 core is the inclusion of a boolean processing engine which allows bit-level boolean logic operations to be carried out directly and efficiently on internal registers and RAM. This feature helped cement the 8051's popularity in industrial control applications. Another valued feature is that it has four separate register sets, which can be used to greatly reduce interrupt latency compared to the more common method of storing interrupt context on a stack.

The MCS-51 UARTs make it simple to use the chip as a serial communications interface. External pins can be conFig.ured to connect to internal shift registers in a variety of ways, and the internal timers can also be used, allowing serial communications in a number of modes, both synchronous and asynchronous. Some modes allow communications with no external components. A mode compatible with an RS-485 multi-point communications environment is achievable, but the 8051's real strength is fitting in with existing ad-hoc protocols (e.g., when controlling serial-controlled devices).

Once a UART, and a timer if necessary, have been conFig.ured, the programmer needs only to write a simple interrupt routine to refill the *send* shift register whenever the last bit is shifted out by the UART and/or empty the full *receive* shift register (copy the data somewhere else). The main program then performs serial reads and writes simply by reading and writing 8-bit data to stacks.

MCS-51 based microcontrollers typically include one or two UARTs, two or three timers, 128 or 256 bytes of internal data RAM (16 bytes of which are bit-addressable), up to 128 bytes ofI/O, 512 bytes to 64 kB of internal program memory, and sometimes a quantity of extended data RAM (ERAM) located in the external data space. The original 8051 core ran at 12 clock cycles per machine cycle, with most instructions executing in one or two machine cycles. With a 12 MHz clock frequency, the 8051 could thus execute 1 million one-cycle instructions per second or 500,000 two-cycle instructions per second. Enhanced 8051 cores are now commonly used which run at six, four, two, or even one clock per machine cycle, and have clock frequencies of up to 100 MHz, and are thus capable of an even greater number of instructions per second. All SILabs, some Dallas and a few Atmel devices have single cycle cores.

Common features included in modern 8051 based microcontrollers include built-in reset timers with brown-out detection, on-chip oscillators, self-programmable Flash ROM program memory, bootloader code in ROM, EEPROM non-volatile data storage, I²C, SPI, and USB host interfaces, CAN or LIN bus, PWM generators, analog comparators, A/D and D/Aconverters, RTCs, extra counters and timers, in-circuit debugging facilities, more interrupt sources, and extra power saving modes.

2.3 MICROCONTROLLER INTERFACES

In this project, the microcontroller is the central and the most important unit. All the instructions and the various controls have been performed using the microcontroller. The other components within the receiver end have been all interfaced with the microcontroller. The input to the microcontroller has been fed through the DTMF. For the convenience of understanding and due to the project demonstration requirements we have also used an LCD screen for the same purpose. In practicality, there is no such use of the LCD screen as there would be no one at the receiver end. This is the main purpose of this project, viz. remote control of appliances using GSM(Mobile Technology) technology. The output on the LCD screen would be all fed by the microcontroller through the connections and programming explained later. The front end of the project which is a steeper motor, is also controlled through the microcontroller, by letting it to function in various different modes. The microcontroller used in this project is one of the 8051 family members. The ATMEL 89S52 or more commonly known as the AT89S52 microcontroller is one of the more easily available microcontroller. The basic functionality and the modality of this microcontroller is similar to that of any other microcontroller in the 8051 family. Its easy usability and durability made it an ideal microcontroller choice for our project.

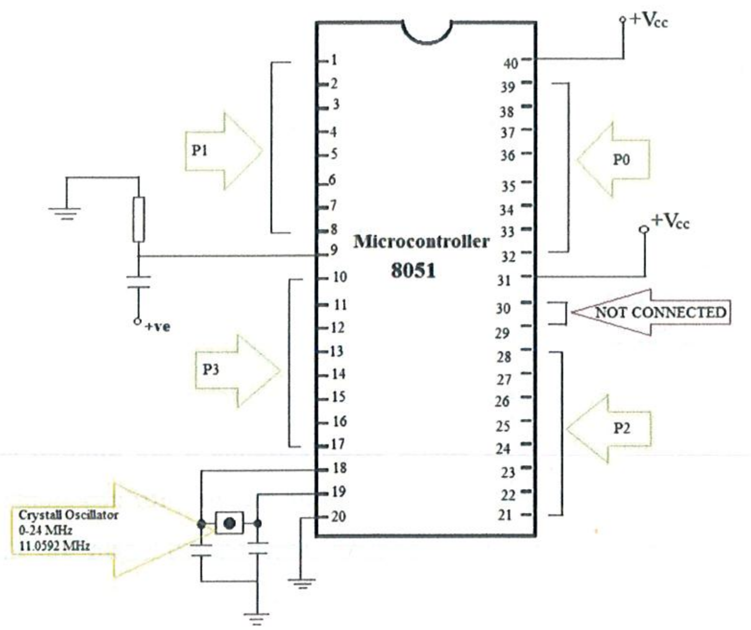


Fig. 2.1 – The 8051 Microcontroller Family: Basic Diagram

2.4 The Microcontroller Code

The following is the detailed microcontroller code used during the making of this project. The coding has been done in basic assembly language using the KEIL software. The code used in the project is given in the Appendix A.

CHAPTER 3
THE RECEIVER END

3.1 INTRODUCTION

The major part of this project and the most important functions are all performed at the receiver end. The circuitry for the receiver end is the circuitry fir the project. The transmitter is nothing but a simple mobile phone in a GSM enabled network, which acting as a remote control provides all the inputs and instructions for the receiver. At the receiver there are many components, ranging from the microcontroller to the simple components such as the resistor and the capacitor used for circuit designing.

There are basically four sub-circuits into which the receiver has been divided. First the DTMF circuit, which receives the signal from the mobile phone attached to it at the receiver. This circuit converts the tone signal into frequency domain signals acceptable by the microcontroller. The importance of this circuit is immense as it is the one which allows permissible input to be fed to the microcontroller.

Second, is the microcontroller circuit which also consists of the LCD screen, used for demonstration purposes. This is a very basic microcontroller circuit used for making the microcontroller function. The microcontroller has been further interfaced with the LCD and the front end of the circuit, through the Johnson's decade counter and subsequently the stepper motor.

The third circuit is the part of the front end. This circuit consists of Johnson's decade counter, the Darlington pair arrays and the stepper motor. The signal to this circuit is fed by the microcontroller.

The fourth circuit is the power supply circuit. This is a very standard circuit comprising of diodes, resistor, voltage regulator and a transformer. This circuit performs the task of supplying the required power to all the other circuits at the receiver end. Namely the DTMF circuit, the microcontroller circuit and the Front end circuit.

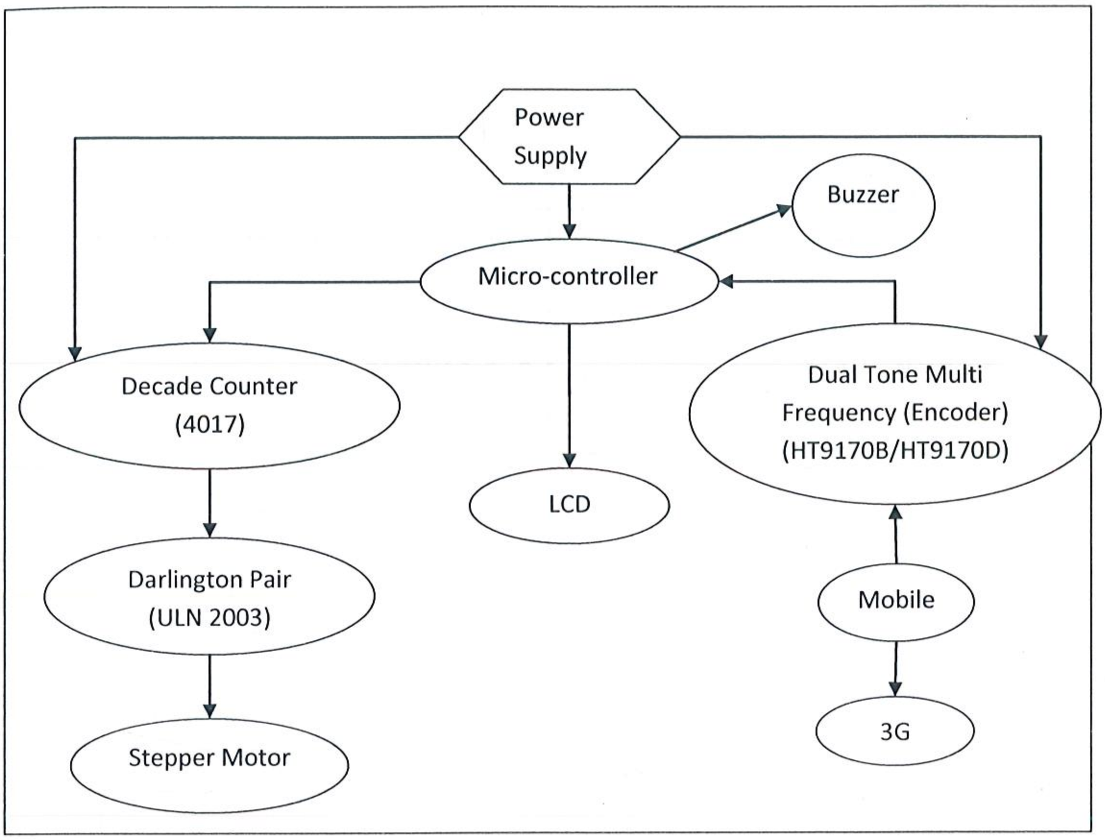


Fig. 3.1 – The flow chart of the Receiver.

Above, the basic flow chart reveals the topology of the circuit and also the direction of the signals or instructions.

3.2 DTMF CIRCUIT

The HT9170B/D are Dual Tone Multi Frequency (DTMF) receivers integrated with digital decoder and bandsplit filter functions as well as power-down mode and inhibit mode operations. Such devices use digital counting techniques to detect and decode all the 16 DTMF tone pairs into a 4-bit code output. Highly accurate switched capacitor filters are implemented to divide tone signals into low and high group signals. A built-in dial tone rejection circuit is provided to eliminate the need for pre-filtering.

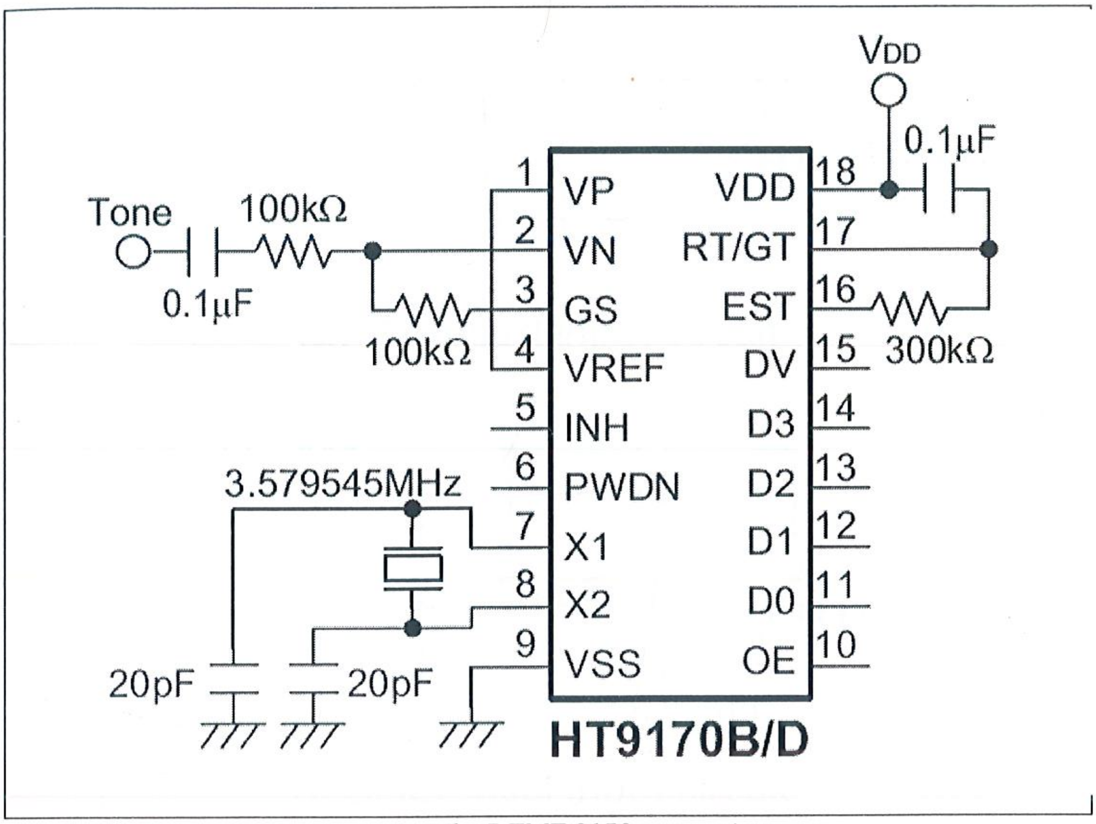


Fig. 3.2 – The DTMF 9170 connections.

The HT9170B/D tone decoders consist of three band pass filters and two digital decode circuits to convert a tone (DTMF) signal into digital code output. An operational amplifier is built-in to adjust the input signal(refer to Fig.ure 3.3). The pre-filter is a band rejection filter which reduces the dialing tone from 350Hz to 400Hz. The low group filter filters low group frequency signal output whereas the high group filter filters high group frequency signal output. Each filter output is followed by a zero-crossing detector with hysteresis. When each signal amplitude at the output exceeds the specified level, it is transferred to full swing logic signal.When input signals are recognized to be effective, DV becomes high, and the correct tone code (DTMF) digit is transferred.

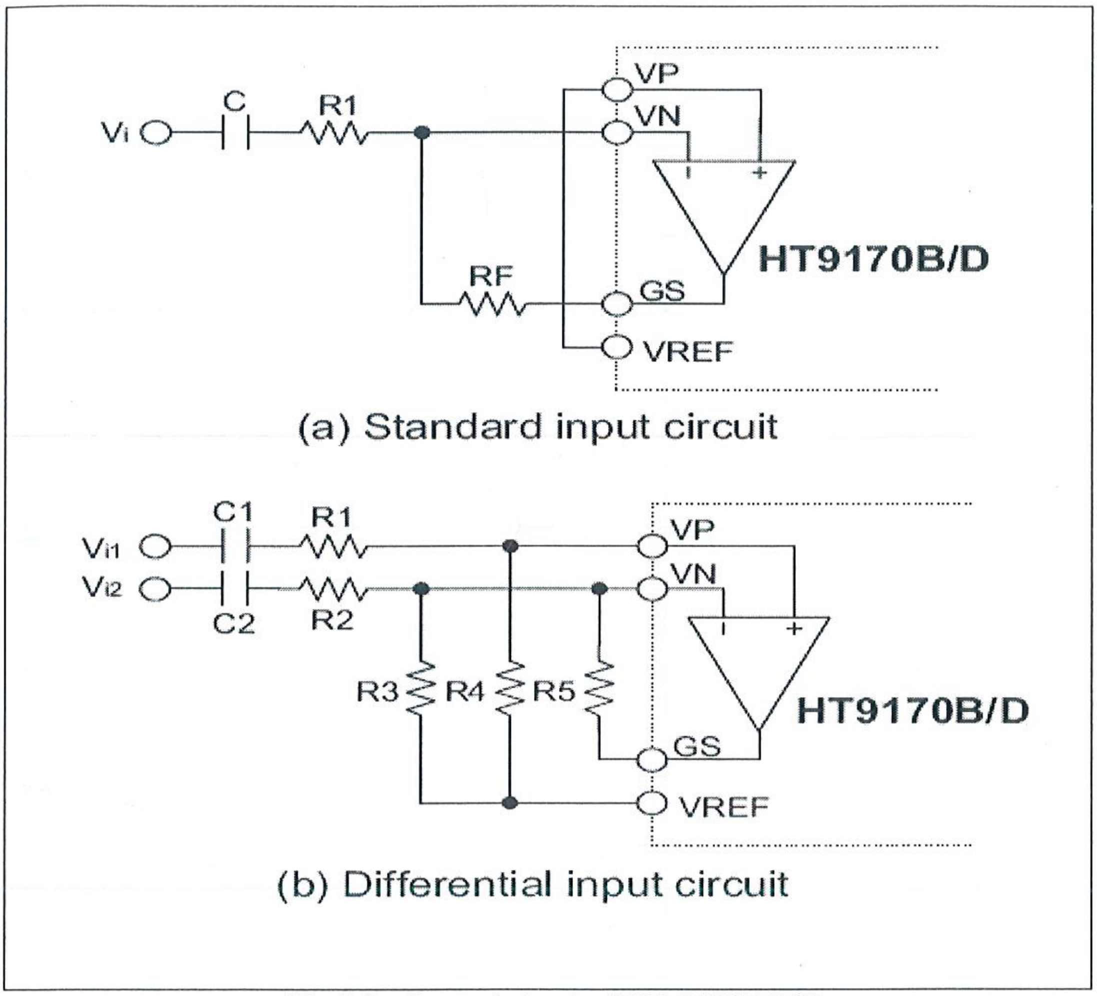


Fig. 3.3 – Internal circuit of DTMF HT9170B

3.3 MICROCONTROLLER CIRCUIT

The microcontroller circuit follows the DTMF at the receiver end. The output from the DTMF circuit acts as an input to the microcontroller circuit. For demonstration purposes, the microcontroller has also been connected to the LCD, barring the connection to the front end. This has been done so as to provide easy demonstration of the working of the project. It helps us in knowing the output for every corresponding input. The basic circuit and the connections have been shown in the diagram below.

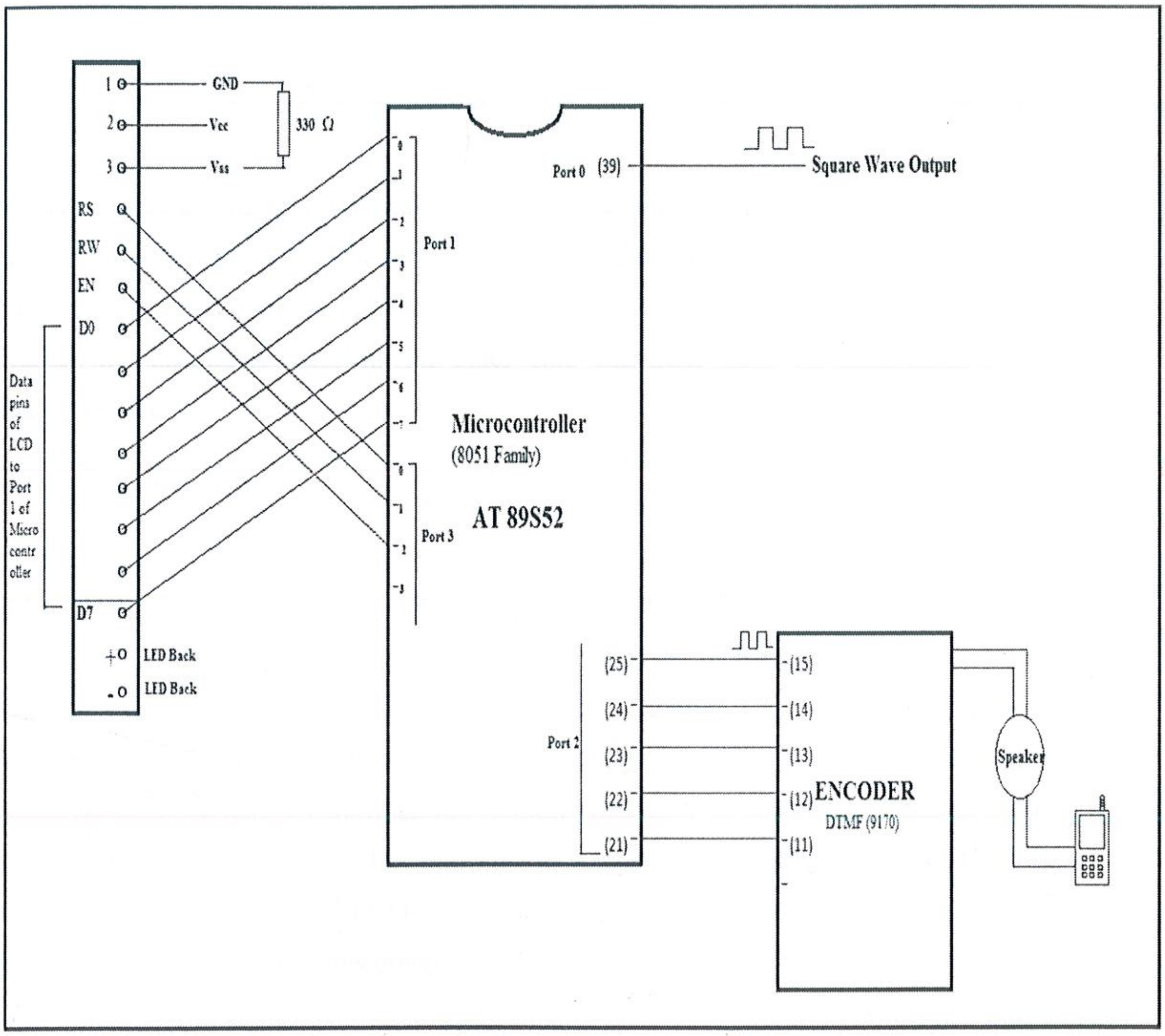


Fig. 3.4 – The microcontroller circuit connections.

The AT89S52 is a low-power, high-performance CMOS 8-bit microcontroller with 8K bytes of in-system programmable Flash memory. The device is manufactured using Atmel's high-density nonvolatile memory technology and is compatible with the industry-standard 80C51 instruction set and pinout. The on-chip Flash allows the program memory to be reprogrammed in-system or by a conventional nonvolatile memory programmer. By combining a versatile 8-bit CPU with in-system programmable Flash on a monolithic chip, the Atmel AT89S52 is a powerful microcontroller which provides a highly-flexible and cost-effective solution to many embedded control applications. The AT89S52 provides the following standard features: 8K bytes of Flash, 256 bytes of RAM, 32 I/O lines, Watchdog timer, two data pointers, three 16-bit timer/counters, a six-vector two-level interrupt architecture, a full duplex serial port, on-chip oscillator, and clock circuitry. In addition, the AT89S52 is designed with static logic for operation down to zero frequency and supports two software selectable power saving modes. The Idle Mode stops the CPU while allowing the RAM, timer/counters, serial port, and interrupt system to continue functioning. The Power-down mode saves the RAM con-tents but freezes the oscillator, disabling all other chip functions until the next interrupt or hardware reset.

3.3.1 LCD Interfacing

A liquid crystal display (LCD) is an electro-optical amplitude modulator realized as a thin, flat display device made up of any number of color or monochrome pixels arrayed in front of a light source or reflector. It is often utilized in battery-powered electronic devices because it uses very small amounts of electric power.
The most commonly used LCDs found in the market today are 1 Line, 2 Line or 4 Line LCDs which have only 1 controller and support at most of 80 characters, whereas LCDs supporting more than 80 characters make use of 2 HD44780 controllers. Most LCDs with 1 controller has 14 Pins and LCDs with 2 controller has 16 Pins (two pins are extra in both for back-light LED connections).

Important factors to consider when evaluating an LCD :

- Resolution: The horizontal and vertical size expressed in pixels (e.g., 1024x768). Unlike monochrome CRT monitors, LCD monitors have a native-supported resolution for best display effect.
- Dot pitch: The distance between the centers of two adjacent pixels. The smaller the dot pitch size, the less granularity is present, resulting in a sharper image. Dot pitch may be the same both vertically and horizontally, or different (less common).

- Viewable size: The size of an LCD panel measured on the diagonal (more specifically known as active display area).
- Response time: The minimum time necessary to change a pixel's color or brightness. Response time is also divided into rise and fall time. For LCD Monitors, this is measured in btb (black to black) or gtg (gray to gray). These different types of measurements make comparison difficult.
- Input ports (e.g., DVI, VGA, LVDS, Display Port, or even S-Video and HDMI).

Features -

- 1.16 Characters x 2 Lines
- 2. 5x7 Dot Matrix Character + Cursor
- 3. HD44780 Equivalent LCD Controller/driver Built-In
- 4. 4-bit or 8-bit MPU Interface
- 5. Uses HD44780 Controller.
- 6. Works with almost any Microcontroller.
- 7. Low cost

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

The most commonly used ALPHANUMERIC displays are 1x16 (Single Line & 16 characters), 2x16 (Double Line & 16 character per line) & 4x20 (four lines & Twenty characters per line).

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

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

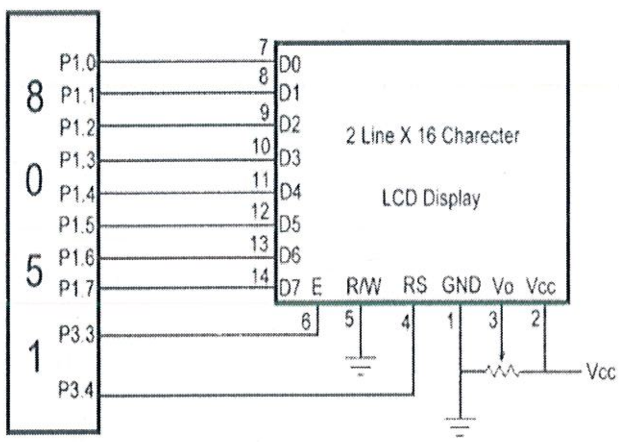


Fig. 3.5 – LCD Interfacing with Microcontroller 8051

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

3.4 THE FRONT-END CIRCUIT

The front end of the receiver consists of the Johnson's decade counter, the Darlington pair arrays and the stepper motor. The signal from the microcontroller is fed to the Johnson's decade counter, which gives only one high bit signal for a corresponding high bit clock signal. This is done so as to let the stepper motor work perfectly, giving it only one input for every clock signal high bit. The Johnson's decade counter is connected to the Darlington pair arrays. Darlington pair arrays also known as Darlington transistor array are high current and high voltage device. It cosists of seven Darlington pairs, which are NPN transistors. Their basic aim is to amplify the signal coming from the Johnson's decade counter. Since the stepper motor requires high input current, the Darlington pair arrays assume a very pivotal role in the designing of the front end circuit. Once the signal coming into the Darlington pair arrays have been amplified, the output signal is fed to the stepper motor. The stepper motor is the last part of this circuit. The stepper motor has been used for the demonstration purpose in place of the other electrical appliances due to the economic constraints and the feasibility of the project at this level. The stepper motor works at different modes. This is controlled by the remote mobile phone which acts as the transistor.

3.4.1 Johnson's Decade Counter (CD4017BC)

A decade counter is one that counts in decimal digits, rather than binary. A decade counter may have each digit binary encoded (that is, it may count in binary-coded decimal, as the 7490 integrated circuit did) or other binary encodings (such as the bi-quinary encoding of the 7490 integrated circuit). Alternatively, it may have a "fully decoded" or one-hot output code in which each output goes high in turn (the 4017 is such a circuit). The latter type of circuit finds applications in multiplexers and demultiplexers, or wherever a scanning type of behaviour is useful. Similar counters with different numbers of outputs are also common.

The decade counter is also known as a mod-counter when it counts to ten (0, 1, 2, 3, 4, 5, 6, 7, 8, 9). A Mod Counter that counts to 64 stops at 63 because 0 counts as a valid digit.

A Johnson counter (or switchtail ring counter, twisted-ring counter, walking-ring counter, or Moebius counter) is a modified ring counter, where the output from the last stage is inverted and fed back as input to the first stage. The register cycles through a sequence of bit-patterns, whose length is equal to twice the length of the shift register, continuing indefinitely. These counters find specialist applications, including those similar to the decade counter, digital-to-analog conversion, etc. They can be implemented easily using D- or JK-type flip-flops.

The CD4017BC is a 5-stage divide-by-10 Johnson counter, hence known as decade counter, with 10 decoded outputs and a carry out bit. These counters are cleared to their zero count by a logical "1" on their reset line. These counters are advanced on the positive edge of the clock signal when the clock enable signal is in the logical "0" state.

The conFig.uration of the CD4017BC permits medium speed operation and assures a hazard free counting sequence. The 10 decoded outputs are normally in the logical "0" state and go to the logical "1" state only at their respective time slot. Each decoded output remains high for 1 full cycle. The carry-out signal completes a full cycle for every 10 clock input cycles and is used as a ripple carry signal to any succeeding stages.

Features of CD4017BC –

- Wide supply voltage range: 3.0V to 15V
- High noise immunity: 0.45 V_{DD} (typ.)
- Low Power Fan out of 2 driving 74L
- TTL compatibility: or 1 driving 74LS
- Medium speed operation: 5.0 MHz (typ.) with 10V V_{DD}
- Low power: 10 μW (typ.)
- Fully static operation

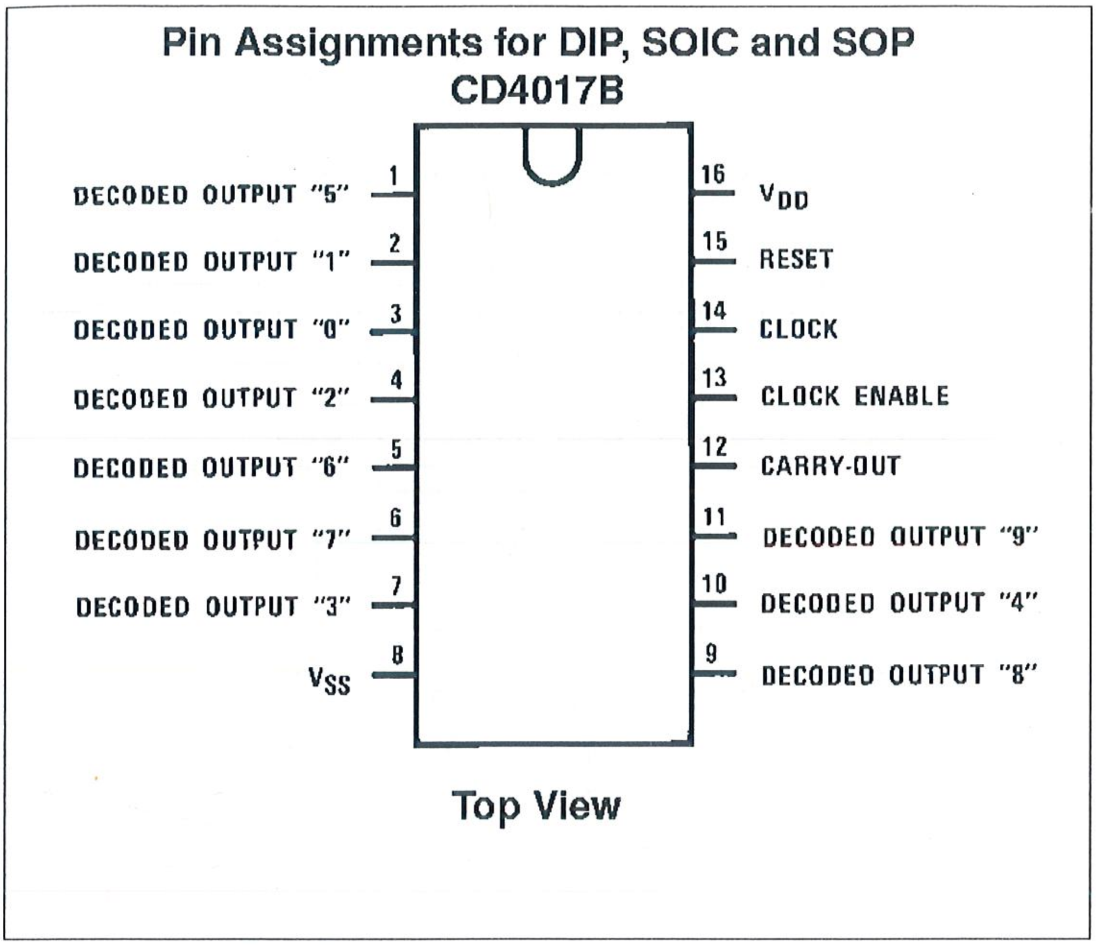


Fig. 3.6 – The pinout diagram of Johnson's Decade Counter

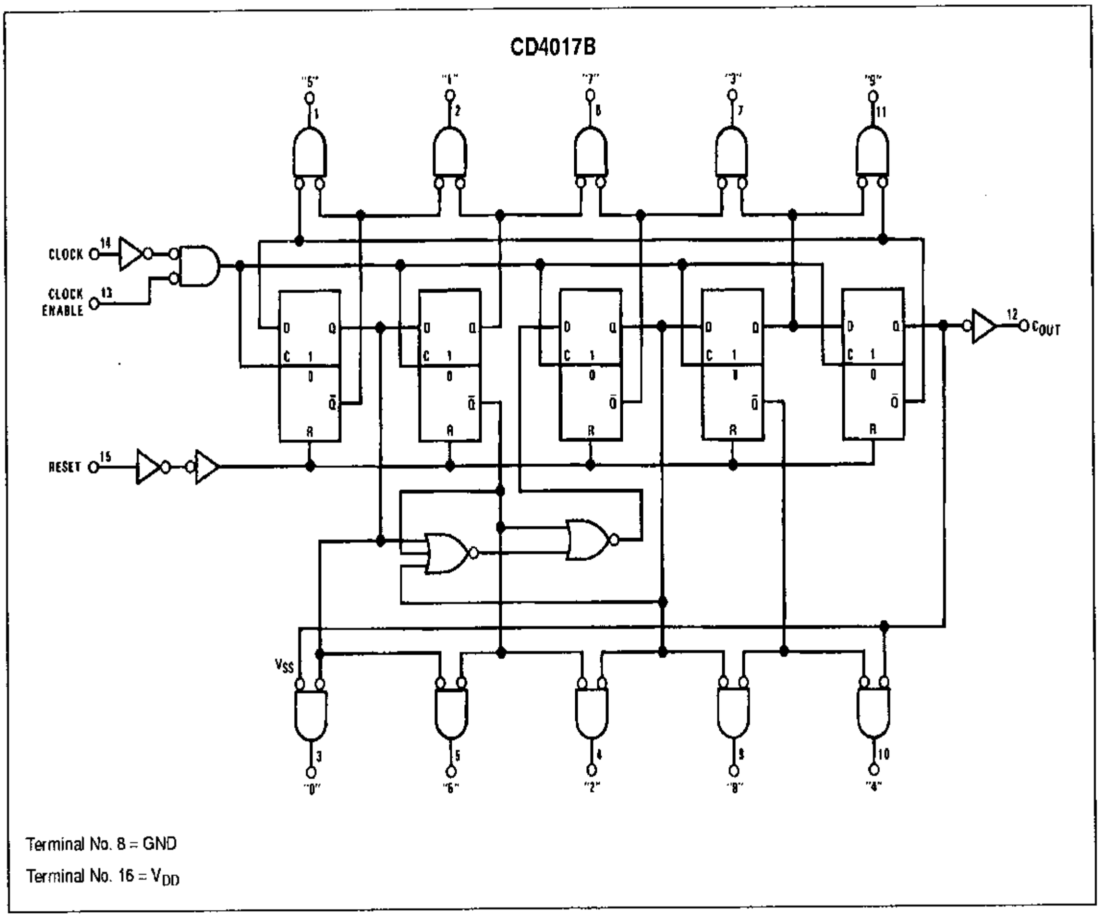


Fig. 3.7 – Logic Diagram of CD4017BC

Applications –

- Automotive
- Instrumentation
- Medical Electronics
- Alarm Systems
- Industrial Electronics
- Remote Metering

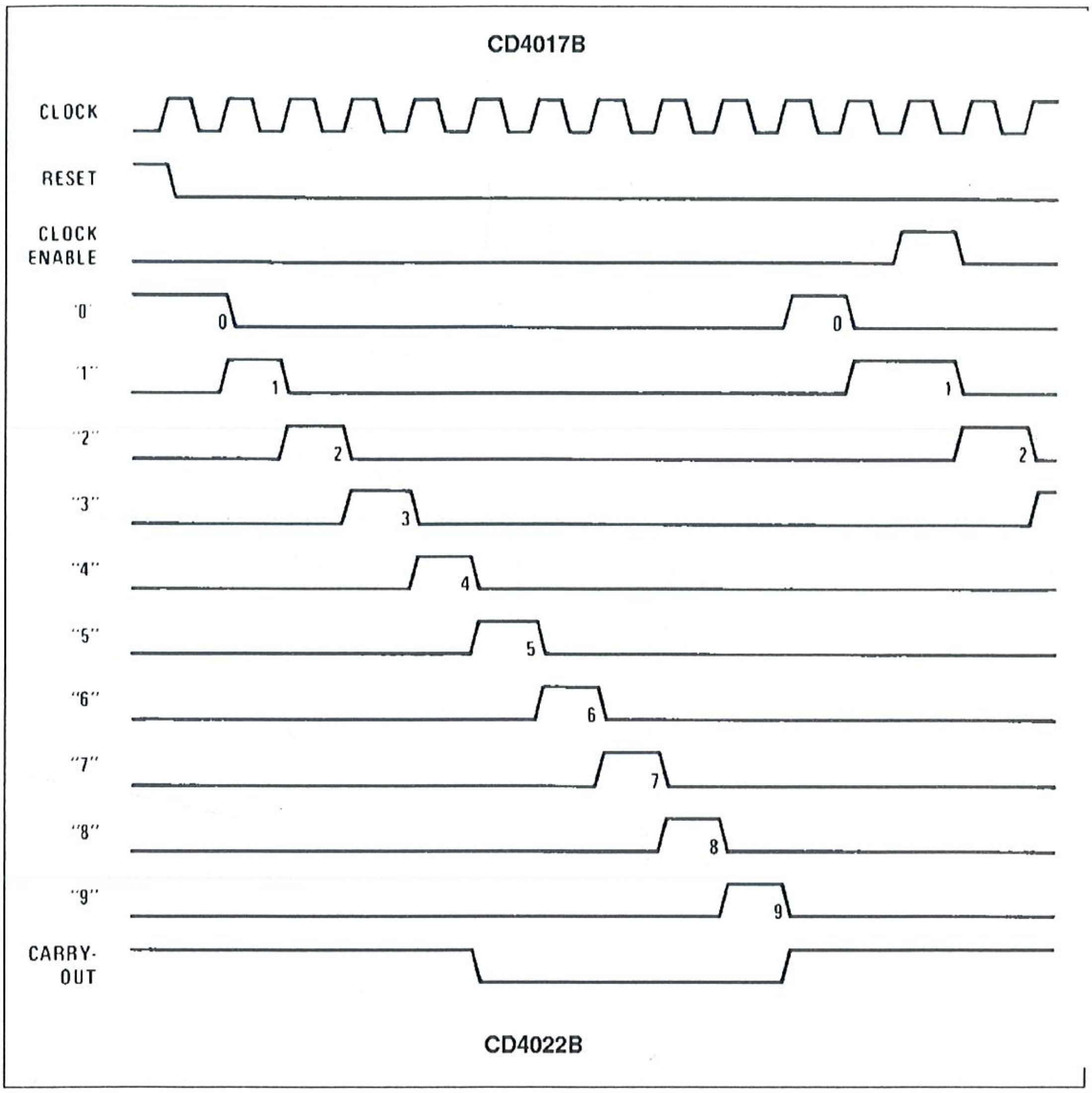


Fig. 3.8 – Timing Diagram for Johnson's Decade Counter

3.4.2 Darlington Transistor Array ULN2003

In electronics, the Darlington transistor (often called a Darlington pair) is a compound structure consisting of two bipolar transistors (either integrated or separated devices) connected in such a way that the current amplified by the first transistor is amplified further by the second one. This conFig.uration gives a much higher current gain (written β, h_{fe}, or h_{FE}) than each transistor taken separately and, in the case of integrated devices, can take less space than two individual transistors because they can use a *shared* collector. Integrated Darlington pairs come packaged singly in transistor-like packages or as an array of devices (usually eight) in an integrated circuit.

The Darlington conFig.uration was invented by Bell Laboratories engineer Sidney Darlington in 1953. He patented the idea of having two or three transistors on a single chip, sharing a collector.

A similar conFig.uration but with transistors of opposite type (NPN and PNP) is the Sziklai pair, sometimes called the "complementary Darlington."

A Darlington pair behaves like a single transistor with a high current gain (approximately the product of the gains of the two transistors). In fact, integrated devices have three leads (B, C and E), broadly equivalent to those of a standard transistor.

A general relation between the compound current gain and the individual gains is given by:

$$\beta_{\mathbf{Darlington}} = \beta_1 \cdot \beta_2 + \beta_1 + \beta_2$$

If β_1 and β_2 are high enough (hundreds), this relation can be approximated with:

$$\beta_{\mathbf{Darlington}} \approx \beta_1 \cdot \beta_2$$

A typical modern device has a current gain of 1000 or more, so that only a small base current is needed to make the pair switch on. However, this high current gain comes with several drawbacks.

The ULN2003 is a monolithic high voltage and high current Darlington transistor arrays. It consists of seven NPN Darlington pairs that features high-voltage outputs with common-cathode clamp diode for switching inductive loads. The collector-current rating of a single Darlington pair is 500mA. The Darlington pairs may be parrlleled for higher current capability. Applications include relay drivers, hammer drivers, lampdrivers, display drivers(LED gas discharge),line drivers, and logic buffers. The ULN2003 has a 2.7kW series base resistor for each Darlington pair for operation directly with TTL or 5V CMOS devices.

Features of ULN2003 -

- 500mA rated collector current(Single output)
- High-voltage outputs: 50V
- Inputs compatible with various types of logic.
- Relay driver application

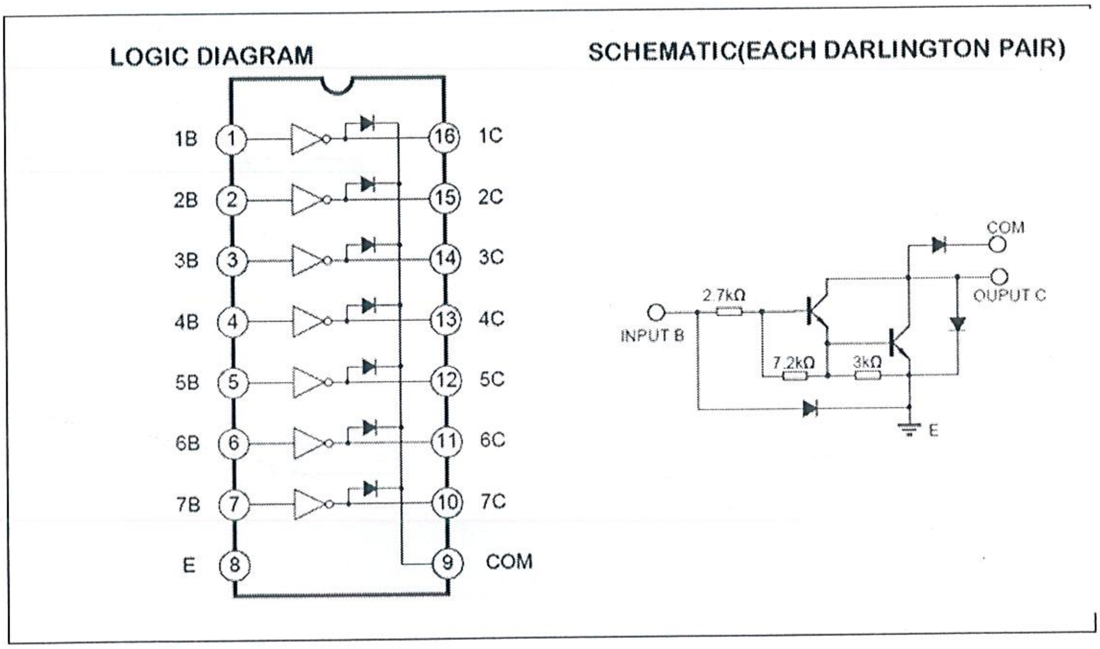


Fig. 3.9 – Logic and schematic diagram of ULN2003

3.4.3 Stepper Motor

A stepper motor is an electromechanical device which converts electrical pulses into discrete mechanical movements. The shaft or spindle of a stepper motor rotates in discrete step increments when electrical command pulses are applied to it in the proper sequence. The motors rotation has several direct relationships to these applied input pulses. The sequence of the applied pulses is directly related to the direction of motor shafts rotation. The speed of the motor shafts rotation is directly related to the frequency of the input pulses and the length of rotation is directly related to the number of input pulses applied.

Motion Control, in electronic terms, means to accurately control the movement of an object based on either speed, distance, load, inertia or a combination of all these factors. There are numerous types of motion control systems, including; Stepper Motor, Linear Step Motor, DC Brush, Brushless, Servo, Brushless Servo and more. This document will concentrate on Step Motor technology. In Theory, a Stepper motor is a marvel in simplicity. It has no brushes, or contacts. Basically it's a synchronous motor with the magnetic field electronically switched to rotate the armature magnet around.

Stepper motor construction:

A Stepping Motor System consists of three basic elements, often combined with some type of user interface (Host Computer, PLC or Dumb Terminal):

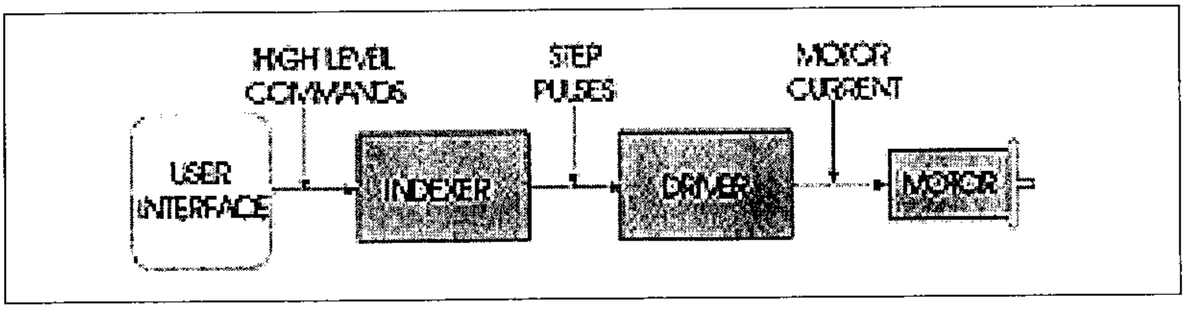


Fig. 3.10 – Stepper Motor Construction

The Indexer (or Controller) is a microprocessor capable of generating step pulses and direction signals for the driver. In addition, the indexer is typically required to perform many other sophisticated command functions.

The Driver (or Amplifier) converts the indexer command signals into the power necessary to energize the motor windings. There are numerous types of drivers, with different current/amperage ratings and construction technology. Not all drivers are suitable to run all motors, so when designing a Motion Control System the driver selection process is critical.

Advantages of step motors :

- Low cost
- High reliability
- High torque at low speeds and a simple
- Rugged construction that operates in almost any environment.

Disadvantages in using a step motor :

- The resonance effect often exhibited at low speeds and decreasing torque with increasing speed

Types of Stepper Motor :

There are basically three types of stepping motors:

- Variable reluctance
- Permanent magnet
- Hybrid

They differ in terms of construction based on the use of permanent magnets and/or iron rotors with laminated steel stators.

Variable Reluctance :

The variable reluctance motor does not use a permanent magnet. Thus, the motor rotor moves without constraint or "detent" torque. This type of construction is good in non industrial applications that do not require a high degree of motor torque, such as the positioning of a micro slide.

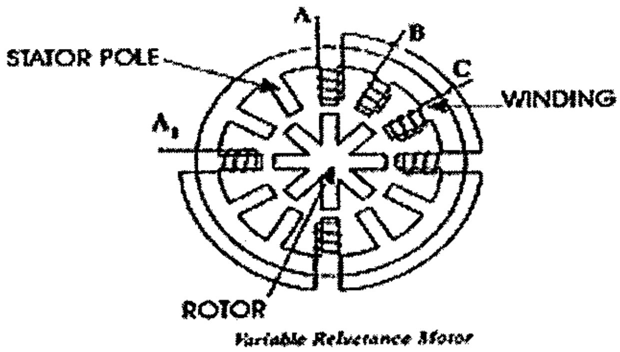


Fig. 3.11 – Variable Reluctance Motor

The variable reluctance motor in the above illustration has four "stator pole sets" (A, B,C,), set 15 degrees apart. Current applied to pole A through the motor winding causes a magnetic attraction that aligns the rotor (tooth) to pole A. Energizing stator pole B causes the rotor to rotate 15 degrees in alignment with pole B. This process will continue with pole C and back to A in a clockwise direction. Reversing the procedure (C to A) would result in a counterclockwise rotation.

Permanent Magnet:

The permanent magnet motor, also referred to as a "canstack" motor, has, as the name implies, a permanent magnet rotor. It is a relatively low speed, low torque device with large step angles of either 45 or 90 degrees. It's simple construction and low cost make it an ideal choice for non industrial applications, such as a line printer print wheel positioner.

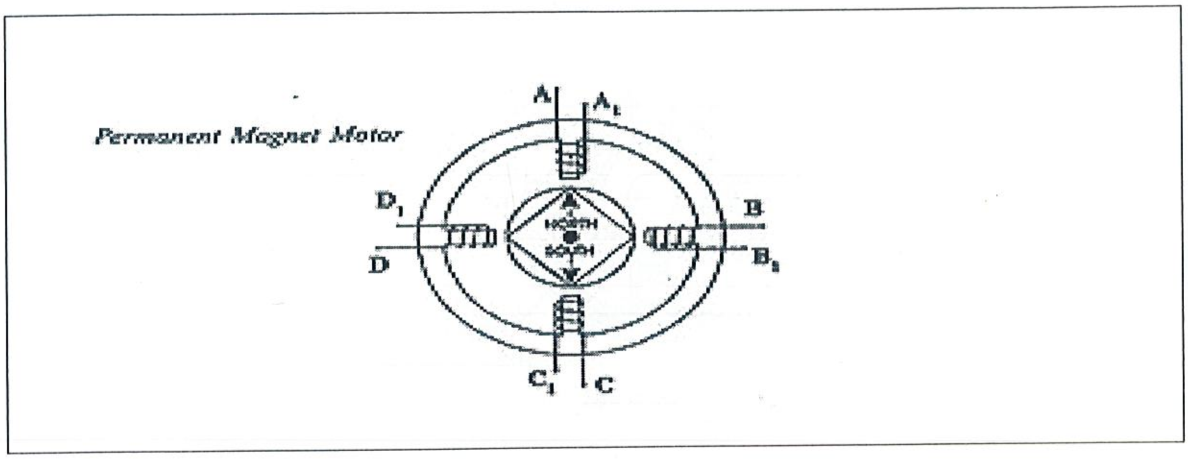


Fig. 3.12 – Permanent Magnet Motor

Unlike the other stepping motors, the PM motor rotor has no teeth and is designed to be magnetized at a right angle to it's axis. The above illustration shows a simple, 90 degree PM motor with four phases (A-D). Applying current to each phase in sequence will cause the rotor to rotate by adjusting to the changing magnetic fields. Although it operates at fairly low speed the PM motor has a relatively high torque characteristic.

Hybrid :

Hybrid motors combine the best characteristics of the variable reluctance and permanent magnet motors. They are constructed with multi-toothed stator poles and a permanent magnet rotor. Standard hybrid motors have 200 rotor teeth and rotate at 1.80 step angles. Other hybrid motors are available in 0.9°and 3.6° step angle conFig.urations. Because they exhibit high static and dynamic torque and run at very high step rates, hybrid motors are used in a wide variety of industrial applications.

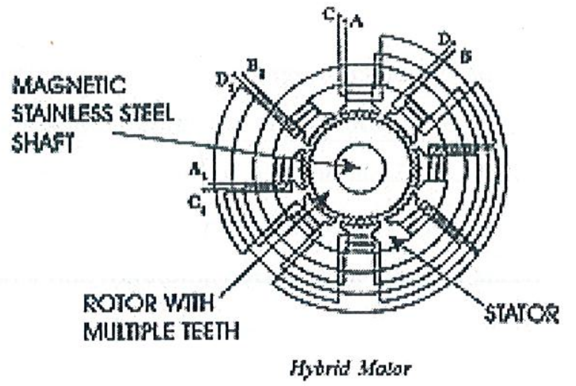


Fig. 3.13 – Hybrid Motor

Step Modes :

Stepper motor "step modes" include Full, Half and Microstep. The type of step mode output of any motor is dependent on the design of the driver.

Full Steps:

Standard (hybrid) stepping motors have 200 rotor teeth, or 200 full steps per revolution of the motor shaft. Dividing the 200 steps into the 360º's rotation equals a 1.8º full step angle. Normally, full step mode is achieved by energizing both windings while reversing the current alternately. Essentially one digital input from the driver is equivalent to one step.

Half Step:

Half step simply means that the motor is rotating at 400 steps per revolution. In this mode, one winding_is energized and then two windings are energized alternately, causing the rotor to rotate at half the_distance, or 0.9º's. (The same effect can be achieved by operating in full step mode with a 400 step per_revolution motor). Half stepping is a more practical solution however, in industrial applications. Although it provides slightly less torque, half step mode reduces the amount "jumpiness" inherent in running in a full step mode.

Micro Step:

Micro stepping is a relatively new stepper motor technology that controls the current in the motor winding to a degree that further subdivides the number of positions between poles. AMS micro steppers are capable of rotating at 1/256 of a step (per step), or over 50,000 steps per revolution. Micro stepping is typically used in applications that require accurate positioning and a fine resolution over a wide range of speeds.

Types of Motor Winding:

Uniflair: Unifilar, as the name implies, has only one winding per stator pole. Stepper motors with a unifilar winding will have 4 lead wires. The following wiring diagram illustrates a typical unifilar motor:

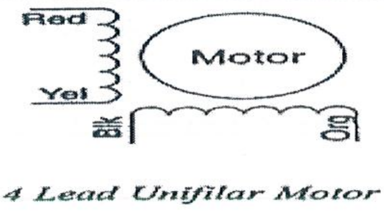


Fig. 3.14 – 4 Lead Uniflair Motor

Biflair: Bifilar wound motors means that there are two identical sets of windings on each stator pole. This type of winding conFig.uration simplifies operation in that transferring current from one coil to another one, wound in the opposite direction, will reverse the rotation of the motor shaft. Whereas, in a unifilar application, to change direction requires reversing the current in the same winding.

The most common wiring conFig.uration for bifilar wound stepping motors is 8 leads because they offer the flexibility of either a Series or parallel connection. There are however, many 6 lead stepping motors available for Series connection applications.

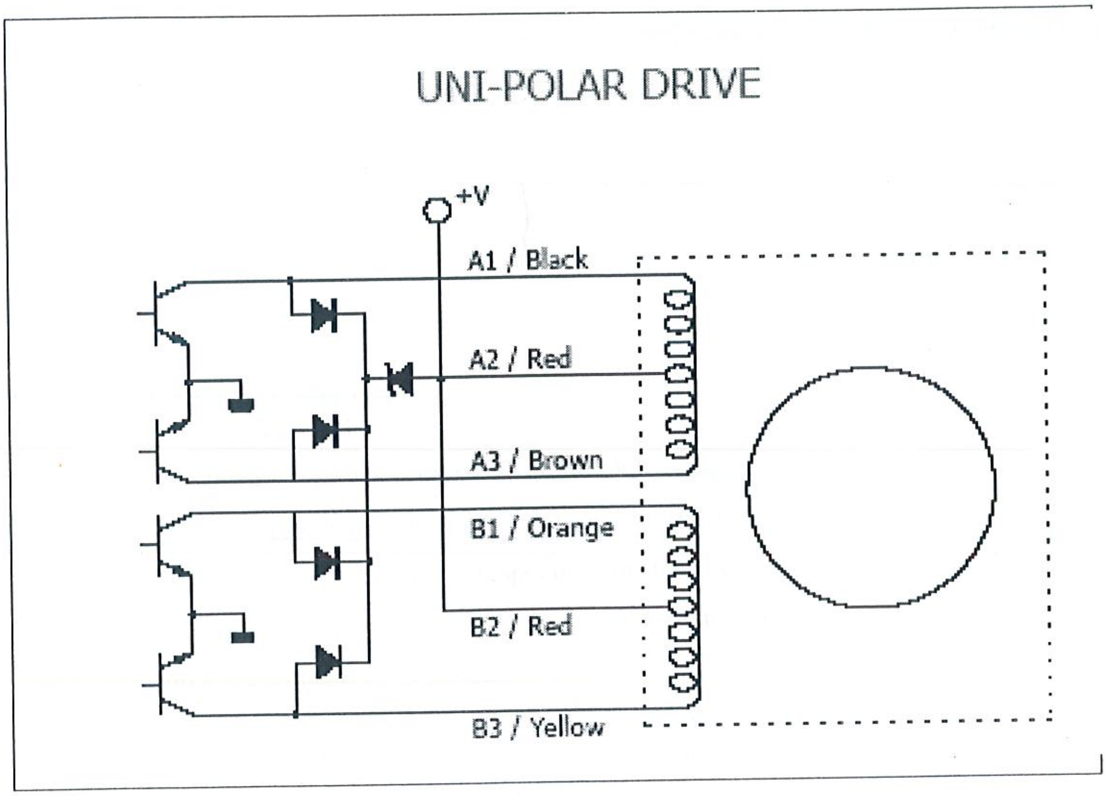


Fig. 3.15 – Unipolar Drive Stepper Motor

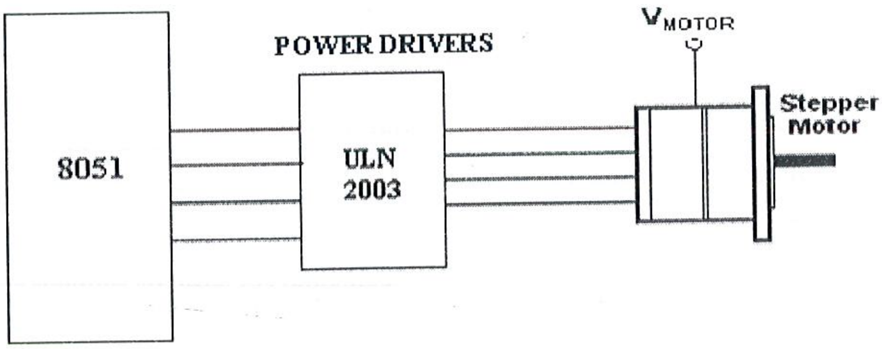


Fig. 3.16 – Stepper Motor Interfacing

Here a stepper motor is used for controlling the gates. A stepper motor is a widely used device that translates electrical pulses into mechanical movement. They function as their name suggests - they "step" a little bit at a time. Steppers don't simply respond to a clock signal. They have several windings which need to be energized in the correct sequence before the motor's shaft will rotate. Reversing the order of the sequence will cause the motor to rotate the other way.

3.5 POWER SUPPLY CIRCUIT

Regulated DC power supplies provide accurate DC voltage, which are derived from AC mains. These DC supplies are cheaper in nature than the DC sources from battery. Such supplies provide constant voltage irrespective of load variations for which they are designed. DC power supplies are used extensively in various electronics laboratories, industries and communication departments to feed DC voltage to the electronic modules, R and D sections, institutions and colleges to impart practical training etc. Present range of electronic equipment produced in the country makes use of transistors and integrated circuits. These IC's are designed to work on fixed regulated DC voltages. Therefore, such supplies have become the part and parcel of such equipment and are:

1. Preset Power supplies (single or dual supply type)

2. Variable power supplies

1.)Preset Power Supplies (Single or Dual supply type):

These power supplies are generally customs made and preset for fixed voltages like 5V/10V/15 Volts etc. These supply units are normally mounted on/ integrated into the electronic equipment. As such these power supplies are not fitted with any cabinets. These power supplies are used in computers.

2.)Variable Power Supplies :

Variable power supplies are supplies in which the voltage can be varied continuously with the knob as per requirement. They are generally available in the range of 5 to 30 volts in 0.5 to 10 amps capacities. These supplies are generally used in research institutions, colleges, practical training centers and electronic industries, etc.

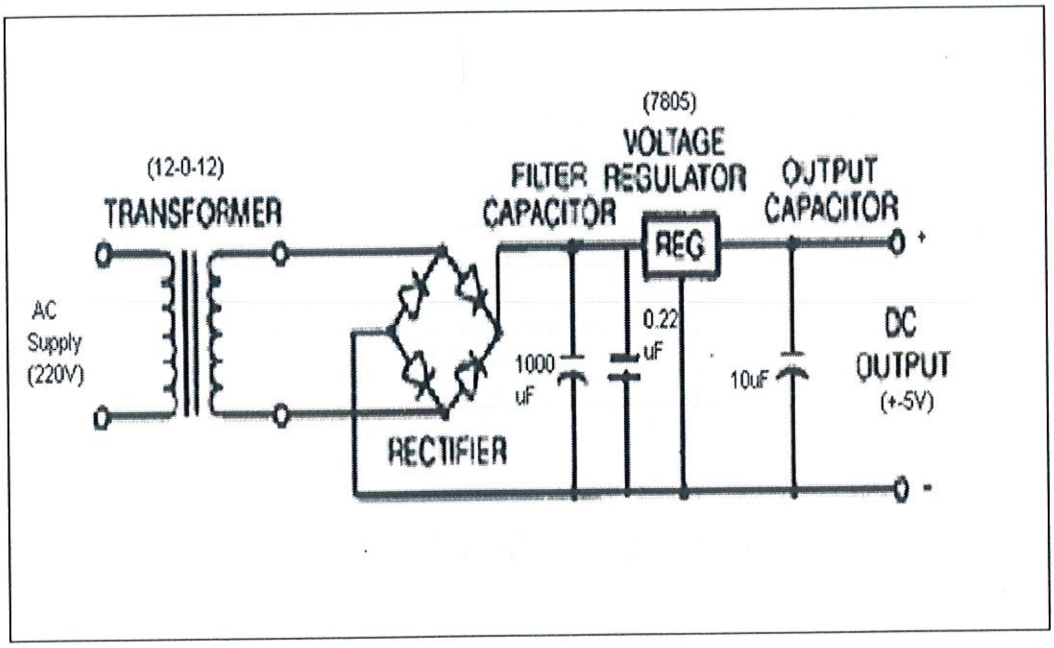


Fig. 3.17 – Circuit Diagram of Power Supply

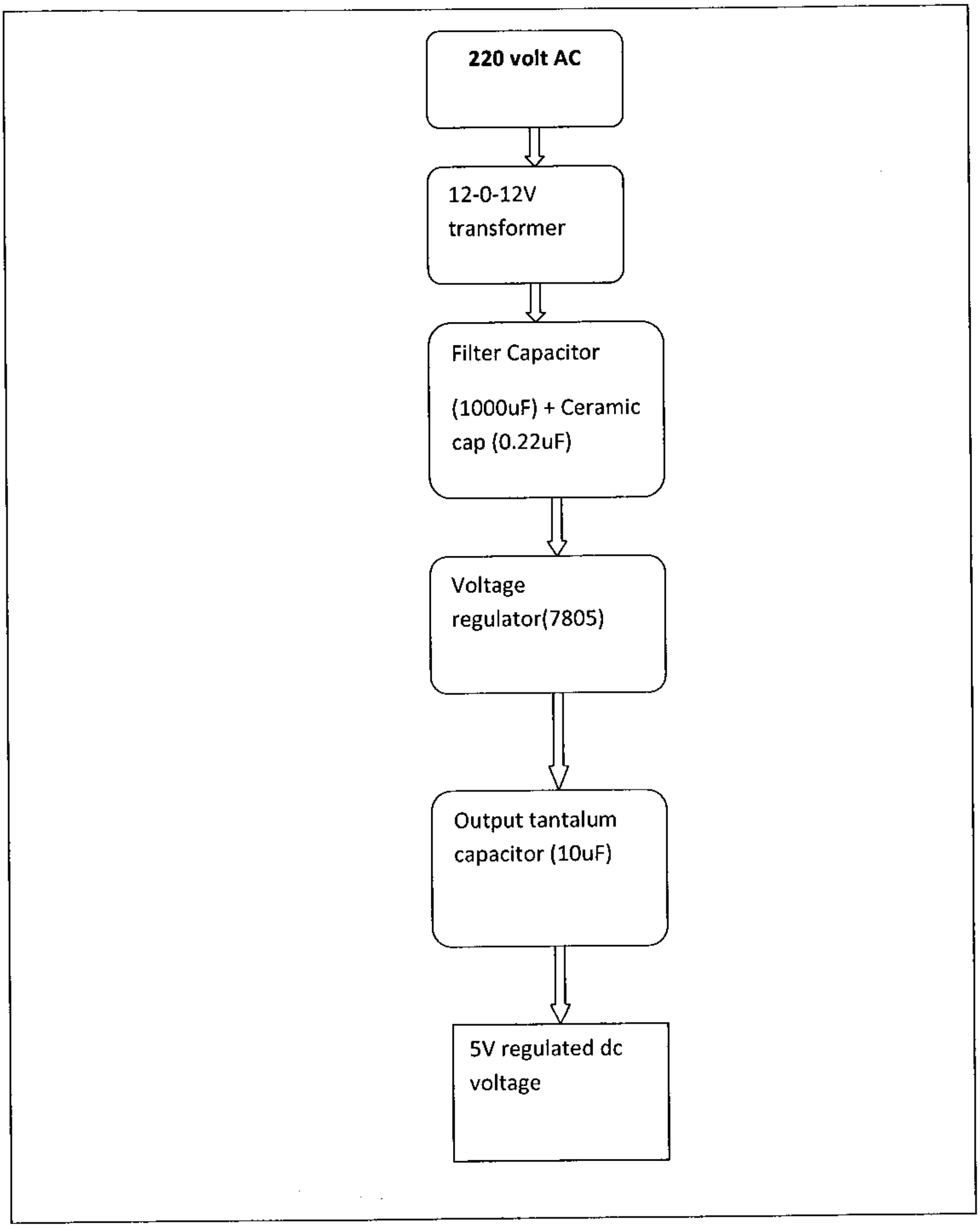


Fig. 3.18– Block Diagram of Power Supply

3.5.1Components Used

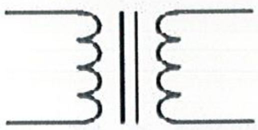
A.C. Power supply - There are many types of power supply. Most are designed to convert high voltage AC mains electricity to a suitable low voltage supply for electronics circuits and other devices. A power supply can by broken down into a series of blocks, each of which performs a particular function.

This AC mains voltage is the one that is coming to our houses for commercial purposes. AC power supply is generally 220V or 230V .

All generators are AC. As the rotor passes through the magnetic field, the voltage rises until it reaches the strongest part of the magnetic field and then falls to zero as the field weakens, only to reverse electrical polarity as the rotor passes through an area of the opposite magnetic polarity..
The brushes in AC generators don't suffer that abrasive effects of constantly hitting the little edges of the contact areas on a commutator because slip-rings are smooth, and they don't spark because they never reverse polartiy or open a circuit under load. As a result, they require a bit less maintainance.AC Generators don't require as much additional circuitry to regulate the voltage fluctuations since AC voltage fluctuates by definition. DC power is very unlean and requires a lot of filtering if you want to use it in electronics. AC is more efficient to transmit over long distances. That is why we use this AC voltage to be converted to constant DC voltage to drive our various electronic circuits.

Transformer - 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 voltage, step-down transformers reduce voltage. Most power supplies use a step-down transformer to reduce the dangerously high mains voltage (230V in UK) to a safer low voltage.



Transformer
circuit symbol

Transformer

Fig. 3.19 - Transformer

The input coil is called the **primary** and the output coil is called the **secondary**. There is no electrical connection between the two coils, instead they are linked by an alternating magnetic field created in the soft-iron core of the transformer. 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 **turns ratio**, determines the ratio of the voltages. A step-down transformer has a large number of turns on its primary (input) coil which is connected to the high voltage mains supply, and a small number of turns on its secondary (output) coil to give a low output voltage.

$$\text{turns ratio} = \frac{V_p}{V_s} = \frac{N_p}{N_s}$$

and

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

Vs = secondary (output) voltage
Ns = number of turns on secondary coil
Is = secondary (output) current

3.5.2 Rectifier

There are several ways of connecting diodes to make a rectifier to convert AC to DC. The bridge rectifier is the most important and it produces **full-wave** varying DC. A full-wave rectifier can also be made from just two diodes if a centre-tap transformer is used, but this method is rarely used now that diodes are cheaper. A single diode can be used as a rectifier but it only uses the positive (+) parts of the AC wave to produce **half-wave** varying DC.

Types of Rectifiers :

There are two types of rectifier, namely half wave and full wave. Each type can either be uncontrolled, half-controlled or fully controlled. An uncontrolled rectifier uses diodes, while a full-controlled rectifier uses thyristor or popularly known as Silicon Controlled Rectifier (SCR). A half controlled is a mix of diodes and thyristors. The thyristors need to be turned on using a special triggering circuit

Half-Wave Rectifier:

In practice, the half-wave rectifier is used most often in low-power applications because the average current in the supply will not be zero. This may cause problems in transformer performance. While practical applications of half wave rectifier are limited, the analysis is important because it will enable us to understand more complicated circuits such as full wave-and three-phase rectifiers.

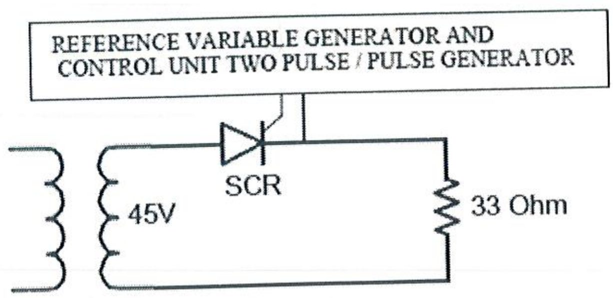


Figure 1

Fig. 3.20 – Half Wave Rectifier

Full-Wave Rectifier:

Like half-wave, the objective of a full-wave rectifier is to produce a voltage or current which is purely DC or has some specified dc component. While the purpose of the fullwave rectifier is basically the same as that of the half-wave rectifiers have some fundamental advantages. The average current in the ac source is zero in the full-wave rectifier, thus avoiding problems associated with nonzero average source currents. The average (dc) output voltage is higher than half-wave. The output of the full-wave is inherently less ripple that the half-wave rectifier

Bridge rectifier

A bridge rectifier can be made using four individual diodes, but it is also available in special packages containing the four diodes required. It is called a full-wave rectifier because it uses the entire AC wave (both positive and negative sections). 1.4V is used up in the bridge rectifier because each diode uses 0.7V when conducting and there are always two diodes conducting, as shown in the diagram below. Bridge rectifiers are rated by the maximum current they can pass and the maximum reverse voltage they can withstand (this must be at least three times the supply RMS voltage so the rectifier can withstand the peak voltages). Please see the Diodes page for more details, including pictures of bridge rectifiers.

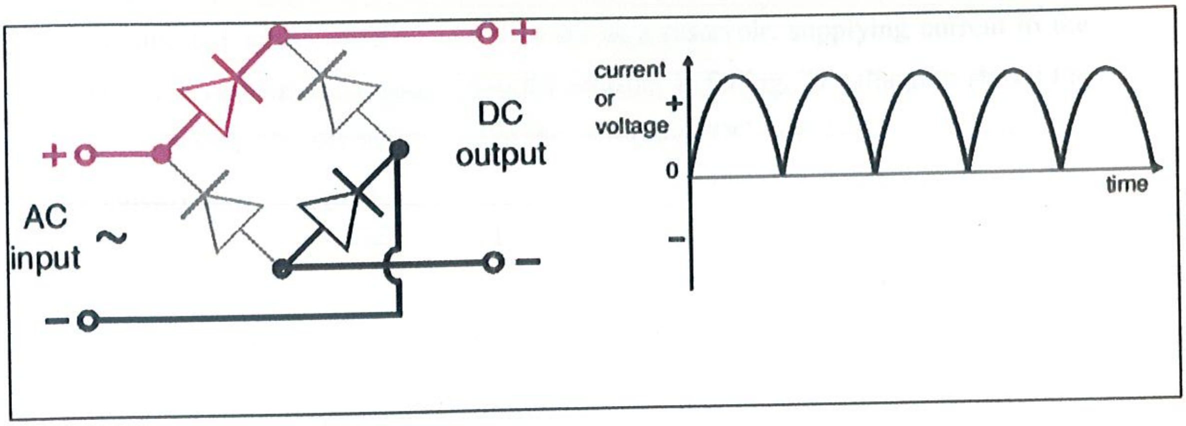


Fig. 3.21 – Bridge rectifier and output Waveform

Single diode rectifier

A single diode can be used as a rectifier but this produces half-wave varying DC which has gaps when the AC is negative. It is hard to smooth this sufficiently well to supply electronic circuits unless they require a very small current so the smoothing capacitor does not significantly discharge during the gaps. Please see the Diodes page for some examples of rectifier diodes.

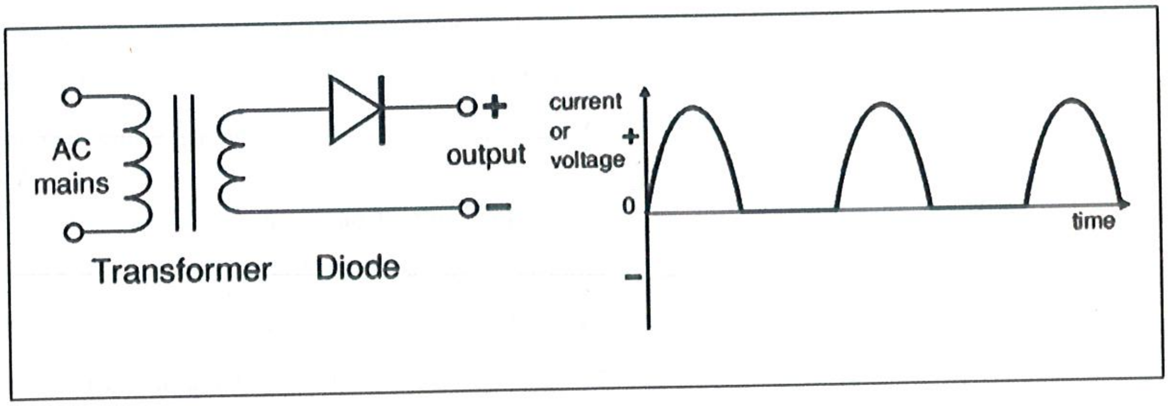


Fig. 3.22 – Single Diode Rectifier and Output Waveform

Smoothing: Smoothing is performed by a large value electrolytic capacitor (HERE 1000uF) 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 diagram shows the unsmoothed varying DC (dotted line) and the smoothed DC (solid line). The capacitor charges quickly near the peak of the varying DC, and then discharges as it supplies current to the output.

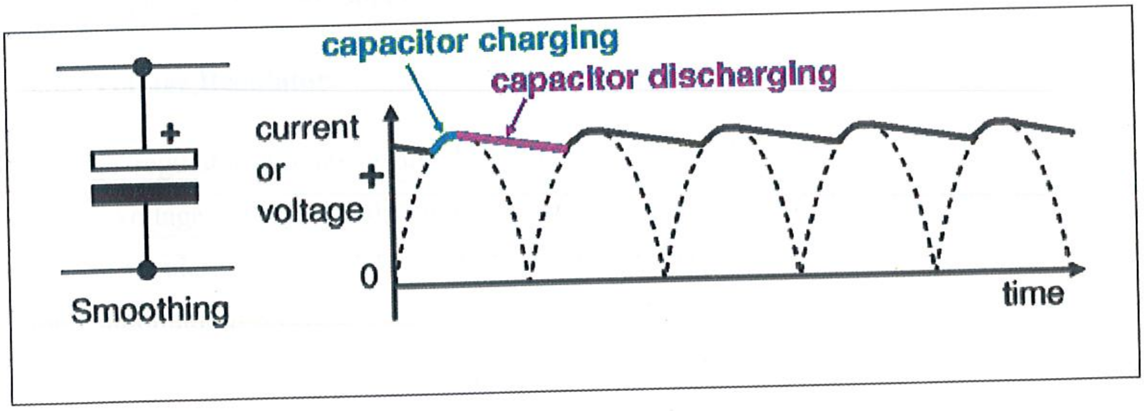


Fig. 3.23 – Smoothing Capacitor and output waveform

Note that smoothing significantly increases the average DC voltage to almost the peak value (1.4 × RMS value). For example 6V RMS AC is rectified to full wave DC of about 4.6V RMS (1.4V is lost in the bridge rectifier), with smoothing this increases to almost the peak value giving $1.4 \times 4.6 = 6.4$V smooth DC.

Smoothing is not perfect due to the capacitor voltage falling a little as it discharges, giving a small ripple voltage. For many circuits a ripple which is 10% of the supply voltage is satisfactory and the equation below gives the required value for the smoothing capacitor. A larger capacitor will give less ripple. The capacitor value must be doubled when smoothing half-wave DC.

$$\text{Smoothing capacitor for 10\% ripple, } C = \frac{5 \times Io}{Vs \times f}$$

C = smoothing capacitance in Farads (F)

Io = output current from the supply in Amps (A)

Vs = supply voltage in volts (V), this is the peak value of the unsmoothed DC

f = frequency of the AC supply in hertz (Hz), 50Hz

3.5.3 Voltage Regulator

Voltage regulator ICs are available with fixed (typically 5, 12 and 15V) or variable output voltages. They are also rated by the maximum current they can pass. 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 regulator ICs have 3 leads and look like power transistors, such as the 7805 +5V 1A regulator shown on the right. They include a hole for attaching a heatsink if necessary. The **78xx** (also sometimes known as **LM78xx**) series of devices is a family of self-contained fixed linear voltage regulator integrated circuits. The 78xx family is a very popular choice for many electronic circuits which require a regulated power supply, due to their ease of use and relative cheapness. When specifying individual ICs within this family, the *xx* is replaced with a two-digit number, which indicates the output voltage the particular device is designed to provide (for example, the 7805 has a 5 volt output, while the 7812 produces 12 volts). The 78xx line are positive voltage regulators, meaning that they are designed to produce a voltage that is positive relative to a common ground. There is a related line of **79xx** devices which are complementary negative voltage regulators. 78xx and 79xx ICs can be used in combination to provide both positive and negative supply voltages in the same circuit, if necessary. 78xx ICs have three terminals and are most commonly found in the TO220 form factor, although smaller surface-mount and larger TO3 packages are also available from some manufacturers. These devices typically support an input voltage which can be anywhere from a couple of volts over the intended output voltage, up to a maximum of 35 or 40 volts, and can typically provide up to around 1 or 1.5 amps of current (though smaller or larger packages may have a lower or higher current rating).

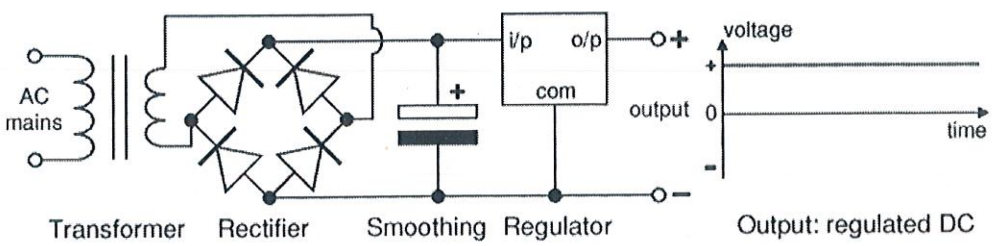


Fig. 3.24 – Transformed, Rectified, Smoothed and Regulated Waveform

CHAPTER 4

CONCLUSION

The project work which was started in July, 2010 has been completed in May, 2011. The progress of the project was immensely satisfying. The main objective, which was to create a system which could control appliances from a remote location by using the GSM technology has been achieved successfully and has been demonstrated successfully using a stepper motor. The objective was achieved in phases. From the initial phase of determining the exact objective, we proceeded to the next step which was to make a blueprint of the circuit design. The research work and the studies which have gone into the making of the project have been immense and detailed. From the designing level, we progressed to the implementation level, which is the most important and time consuming task. The main implementation was done at the receiver end. Unlike the usual approach of back-to-front implementation, we took a different path involving front-to-back implementation of the circuits. Thus we first designed and implemented the front end circuit which is the circuit involving the stepper motor, the Darlington transistor arrays and the Johnson's decade counter. After that we proceeded to the microcontroller-LCD circuit and the DTMF circuit. All throughout the work on the microcontroller coding was being carried out simultaneously. The research and the study helped us identify the components which were of our use. The designing of the plastic circuit board was the next step. This was done with the help of the Dip-trace software and would not have been possible without the able guidance of the various lab engineers of electronics and communication department at JUIT. The manufacture of the PCB was outsourced to an industry in Parwanoo.

4.1 FUTURE SCOPE and LIMITATIONS

The limitations of this project are mainly due to the reasons concerning economics and feasibility. The use of stepper motor implies that feasibility and scale were a major issue during the tenure of this project. Appliances such as air conditioners, microwave Owens and washing machine can be controlled using the same logic, but some advanced circuitry involving new and much more advanced microcontrollers and other power driving devices. The microcontroller coding for such advanced circuits would accordingly change as it would have to be very appliance specific and cannot be generic in nature. But the fact that we could not extend our project to such levels is mainly due to the economic constraints faced by us and also the issues of practicality. It was not feasible for us to work on such massive electrical devices as it ws not ably supported by our laboratory infrastructure.

The other area where this project could not achieve its desired results was the feedback system. Initially it was planned that the project should have a proper feedback system which let the user at the transmitter end know whether or not the task had been completed and the instruction executed at the receiver end or not. This was to be done using a GSM modem which would have sent a SMS back to the transmitter upon completion of the task. But this GSM modem could not be included in the project due to economic constraints and the viability associated. The solution to this can be found in the newly implemented (or being implemented) technique of 3G. That could enable live video feedback to the transmitter and then the system can also be termed as a real time system.

The future scope of this project covers a variety of topics. Since the project can majorly be defined as use of mobile phone as a remote to control devices or appliances using microcontroller interfacing, thus this project can be partly or wholly used at lots of places. The major use could be in the various divisions of wireless robotics, and with the future scope of 3G technology being imbibed; the use of this project becomes all the more seriously considerable. Also since this project involves a semi-security system involving a 10 digit master password, the project can also have its applications in security systems.

APPENDIX – A

Microcontroller Code in Assembly Language

```
;------LCD at PORT1
;buzzer at p0.4
;dtmf data pins at p2.0 to p2.3  ,VD pin at p2.4

;sqaure wave at p0.0  for stepper motor control
;----------------------------------------------------------
---
;-------1---slow
;------2---medium
;------3---fast

org 0000h
buzzer equ p0.4
setb buzzer

;----------------------------------------------------------
----
mov a,#38h            ;initialise two line 5x7 matrix
    |
acall command         ;sub routine
         |
mov a,#38h            ;initialise two line 5x7 matrix
    |
acall command         ;sub routine
         |
mov a,#0ch            ;display on,cursor blinking
    |
acall command         ;sub routine
         |
mov a,#01h            ;clear lcd
    |
acall command         ;sub routine
         |
mov a,#83h            ;shift cursor TO 1st line
    |
acall command            ;
             |
;-------welcome to JAYPEE--------------------------------
-
mov a,#'W'
```

```
acall data1
mov a,#'e'
acall data1
mov a,#'l'
acall data1
mov a,#'c'
acall data1
mov a,#'o'
acall data1
mov a,#'m'
acall data1
mov a,#'e'
acall data1
mov a,#20h
acall data1
mov a,#'t'
acall data1
mov a,#'o'
acall data1
mov a,#20h
acall data1

mov a,#0c3h                 ;shift cursor TO 1st line

acall command                ;

mov a,#'C'
acall data1
mov a,#'h'
acall data1
mov a,#'i'
acall data1
mov a,#'t'
acall data1
mov a,#'k'
acall data1
mov a,#'a'
acall data1
mov a,#'r'
acall data1
mov a,#'a'
acall data1

acall delay2
acall delay2
```

```
;------------------GSM SYSTEM---------------------------
--

mov a,#01h              ;clear lcd

acall command           ;sub routine

mov a,#82h              ;shift cursor TO 1st line

acall command             ;
mov a,#'G'
acall datal
mov a,#'S'
acall datal
mov a,#'M'
acall datal
mov a,#20h
acall datal
mov a,#'S'
acall datal
mov a,#'p'
acall datal
mov a,#'e'
acall datal
mov a,#'e'
acall datal
mov a,#'d'
acall datal

mov a,#0c5h              ;shift cursor TO 1st line

acall command              ;


mov a,#20h
acall datal
mov a,#'C'
acall datal
mov a,#'o'
acall datal
mov a,#'n'
acall datal
mov a,#'t'
acall datal
mov a,#'r'
acall datal
mov a,#'o'
```

```
acall data1
mov a,#'l'
acall data1

acall delay2
;---------------------------------------Enter password---
-
ag:
setb buzzer
mov a,#01h              ;clear lcd
acall command          ;sub routine
mov a,#80h              ;shift cursor TO 1st line
acall command           ;command subroutine


mov a, #'E'
acall data1              ; subroutine
mov a, #'n'
acall data1              ; subroutine
mov a, #'t'
acall data1              ; subroutine
mov a, #'e'
acall data1              ; subroutine
mov a, #'r'
acall data1              ; subroutine


mov a,#86h              ;shift cursor TO 1st line
acall command           ;command subroutine


mov a, #'P'
acall data1              ; subroutine
mov a, #'a'
acall data1              ; subroutine
mov a, #'s'
acall data1              ; subroutine
mov a, #'s'
acall data1              ; subroutine
mov a, #'w'
acall data1              ; subroutine
mov a, #'o'
acall data1              ; subroutine
mov a, #'r'
acall data1              ; subroutine
mov a, #'d'
acall data1              ; subroutine
```

```
mov a, #':'
acall data1                 ; subroutine
mov a, #'-'
acall data1                 ; subroutine


mov a,#0c0h                 ;shift cursor TO 2ND line
acall command               ;command subroutine




;-----------------------------STORAGE OF PASSWORD-------
---------------------------

mov 30h,#'9'    ;_________stored password__________at ram
location 30h onward
mov 31h,#'9'    ;
mov 32h,#'8'
mov 33h,#'8'
;mov 34h,#'2'
;mov 35h,#'1'
;mov 36h,#'8'
;mov 37h,#'7'
;mov 38h,#'7'
;mov 39h,#'0'

mov r0,#30h      ;__________________data
pointer__________________________________________________

_________________
mov r1,#50h      ;
;-------------------------------------------------------
-----------------------------------------------
ho:clr p2.4
   jb p2.4,gop
   sjmp ho                             ;after delete scan
keypad again
gop:
 mov p2,#00h
 mov a, p2
 acall delay3
 anl a ,#0fh
 cjne a,#01h,next2
 mov a,#'1'
 lcall store

next2:
```

```
 mov p2,#00h
 mov a, p2
 acall delay3
 anl a ,#0fh
 cjne a,#02h,next3
 mov a,#'2'
 lcall store


next3:
 mov p2,#00h
 mov a, p2
 acall delay3
 anl a ,#0fh
 cjne a,#03h,next4
 mov a,#'3'
 lcall store

next4:
 mov p2,#00h
 mov a, p2
 acall delay3
 anl a ,#0fh
 cjne a,#04h,next5
 mov a,#'4'
 lcall store

next5:
 mov p2,#00h
 mov a, p2
 acall delay3
 anl a ,#0fh
 cjne a,#05h,next6
 mov a,#'5'
 lcall store


next6:
 mov p2,#00h
 mov a, p2
 acall delay3
 anl a ,#0fh
 cjne a,#06h,next7
 mov a,#'6'
 lcall store
```

```
next7:
 mov p2,#00h
 mov a, p2
 acall delay3
 anl a ,#0fh
 cjne a,#07h,next8
 mov a,#'7'
 lcall store

next8:
 mov p2,#00h
 mov a, p2
 acall delay3
 anl a ,#0fh
 cjne a,#08h,next9
 mov a,#'8'
 lcall store

next9:
 mov p2,#00h
 mov a, p2
 acall delay3
 anl a ,#0fh
 cjne a,#09h,next0
 mov a,#'9'
 lcall store


 next0:
 mov p2,#00h
 mov a, p2
 acall delay3
 anl a ,#0fh
 cjne a,#0ah,nextb
 mov a,#'0'
 lcall store

 nextb:
 mov p2,#00h
 mov a, p2
 acall delay3
 anl a ,#0fh
 cjne a,#0bh,nextc
 mov a,#76h
 lcall store

 nextc:
```

```
 mov p2,#00h
 mov a, p2
 acall delay3
 anl a ,#0fh
 cjne a,#0ch,hoo
 mov a,#75h
 lcall store

 hoo:ljmp ho



dd:clr a

;---------------------------------------------------------------------
---------------------------------------------------------------------
-
;----------------------------COUNTER SET FOR MATCHING OF
CODE ----------------------------------------------------------
-

mov r6,#4d

mov r0,#30h
mov r1,#50h

;--------------------------------MATCHING STARTED--------
---------------------------------------------------------------------
-

loop: mov a,@r1
cpl a

add a,@r0
cjne a,#0ffh,wrong


inc r0
inc r1

djnz r6,loop

sjmp cont
wrong:ljmp invalid
```

```
cont:
;-----------------------------------CORRECT PASSWORD-----
---------------------------------------------------------
--
;--------------------------------------------------------
lock open-----------------------------------------------
mov a,#01h                 ;clear lcd
acall command           ;sub routine
mov a,#80h                 ;clear lcd
acall command           ;sub routine

clr buzzer

 mov a, #'C'
acall data1                 ; subroutine
mov a, #'o'
acall data1                 ; subroutine
mov a, #'d'
acall data1                 ; subroutine
mov a, #'e'
acall data1                 ; subroutine

mov a,#85h                 ;clear lcd
acall command           ;sub routine


mov a, #'M'
acall data1                 ; subroutine
mov a, #'a'
acall data1                 ; subroutine
mov a, #'t'
acall data1                 ; subroutine
mov a, #'c'
acall data1                 ; subroutine
mov a, #'h'
acall data1                 ; subroutine
mov a, #'e'
acall data1
mov a, #'d'
acall data1

 acall delay3
 setb buzzer

acall delay2
```

```
;----------------------------------------------------------------------------
mov 50h,#'0'    ;_________stored password__________at ram location 30h onward
mov 51h,#'0'    ;
mov 52h,#'0'
mov 53h,#'0'
mov 54h,#'0'
mov 55h,#'0'
mov 56h,#'0'
mov 57h,#'0'
mov 58h,#'0'
mov 59h,#'0'
;----------------------------------------------------------------------------

mov a,#01h                ;clear lcd
acall command          ;sub routine
mov a,#80h                ;shift cursor TO 1st line
acall command           ;command subroutine


mov a, #'C'
acall datal                ; subroutine
mov a, #'o'
acall datal                ; subroutine
mov a, #'n'
acall datal                ; subroutine
mov a, #'t'
acall datal                ; subroutine
mov a, #'r'
acall datal                ; subroutine
mov a, #'o'
acall datal
mov a, #'l'
acall datal                ; subroutine
mov a, #20h
acall datal                ; subroutine
mov a, #'S'
acall datal                ; subroutine
mov a, #'p'
acall datal                ; subroutine
mov a, #'e'
acall datal                ; subroutine
mov a, #'e'
acall datal
mov a, #'d'
```

```
acall data1


puk:clr p2.4
   jb p2.4,gop2
   sjmp puk                              ;after delete scan
keypad again
gop2:
 mov p2,#00h
 mov a, p2
 acall delay3
 anl a ,#0fh
 cjne a,#01h,next22 ; if 1
 acall slow
u9:          setb p0.0
        acall delayslow
        clr p2.4
         jb p2.4,gop2
        clr p0.0
        acall delayslow
        clr p2.4
         jb p2.4,gop2
        sjmp u9

next22:
 mov p2,#00h
 mov a, p2
 acall delay3
 anl a ,#0fh
 cjne a,#02h,next33 ; if 2
 acall medium
   u99:setb p0.0
        acall delaymedium
        clr p2.4
         jb p2.4,gop2
        clr p0.0
        acall delaymedium
        clr p2.4
         jb p2.4,gop2
        sjmp u99



next33:
 mov p2,#00h
 mov a, p2
 acall delay3
```

```
anl a ,#0fh
cjne a,#03h,next44    ; if 3
acall fast
  u999:setb p0.0
         acall delayfast
         clr p2.4
          jb p2.4,gop2
         clr p0.0
         acall delayfast
         clr p2.4
          jb p2.4,gop2
         sjmp u999


next44:
mov p2,#00h
mov a, p2
acall delay3
anl a ,#0fh
cjne a,#04h,holl ; if 4 logout
sjmp goo
holl:ljmp puk
goo:
mov p0,#00000000b  ; Stop
mov p0,#00000000b  ; Stop
setb buzzer


mov a,#01h
acall command
mov a,#80h
acall command

clr buzzer
acall delay3
setb buzzer
clr buzzer
acall delay3
setb p0.4

mov a, #'L'
acall data1                  ; subroutine
mov a, #'o'
acall data1                  ; subroutine
mov a, #'g'
```

```
acall data1                  ; subroutine
mov a, #'g'
acall data1                  ; subroutine
mov a, #'i'
acall data1                  ; subroutine
mov a, #'n'
acall data1
mov a, #'g'
acall data1                  ; subroutine
mov a, #20h
acall data1                  ; subroutine
mov a, #'o'
acall data1                  ; subroutine
mov a, #'u'
acall data1                  ; subroutine
mov a, #'t'
acall data1                  ; subroutine
mov a, #'.'
acall data1
mov a, #'.'
acall data1

 clr buzzer
 acall delay3
 setb buzzer
 clr buzzer
 acall delay3
 setb buzzer
 clr buzzer
 acall delay3
 setb buzzer

acall delay2

 ljmp ag


;---------------------WRONG PASSWORD---------------------
---------------------------------------------------------
-
invalid:
 clr buzzer
        acall delay3
setb buzzer
mov a,#01h              ;clear lcd
acall command         ;sub routine
```

```
mov a,#80h                  ;shift cursor TO 1st line
acall command             ;command subroutine


mov a, #'R'
acall data1                 ; subroutine
mov a, #'e'
acall data1                 ; subroutine
mov a, #'t'
acall data1                 ; subroutine

        clr buzzer
        acall delay3
        setb buzzer
mov a, #'r'
acall data1                 ; subroutine
mov a, #'y'
acall data1
mov a, #'!'
acall data1
        clr buzzer
        acall delay3
        setb buzzer

acall delay2
ljmp ag


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


;----------------------------------------------------------
----------------------------------------------------------
store:
      cjne a,#75h,yo
      ljmp dd

yo:   cjne a,#76h,go
      lcall del
      ljmp ho

go:   mov @r1,a             ; STORE DATA IN LOCATION 50H
LINE
      inc r1
```

```
      ;mov a,#'*'                                  ;display on
screen '*' password
      acall data1
      acall delay1
      ret

slow:

mov a,#0c0h                ;shift cursor TO 1st line
acall command           ;command subroutine


mov a, #'S'
acall data1                ; subroutine
mov a, #'l'
acall data1                ; subroutine
mov a, #'o'
acall data1
mov a, #'w'
acall data1                ; subroutine
mov a, #20h
acall data1                ; subroutine
mov a, #20h
acall data1
ret

medium:

mov a,#0c0h                ;shift cursor TO 1st line
acall command           ;command subroutine


mov a, #'M'
acall data1                ; subroutine
mov a, #'e'
acall data1                ; subroutine
mov a, #'d'
acall data1
mov a, #'i'
acall data1                ; subroutine
mov a, #'u'
acall data1                ; subroutine
mov a, #'m'
acall data1
ret

fast:
```

```
mov a,#0c0h                   ;shift cursor TO 1st line
acall command              ;command subroutine


mov a, #'F'
acall data1                   ; subroutine
mov a, #'a'
acall data1                   ; subroutine
mov a, #'s'
acall data1
mov a, #'t'
acall data1                   ; subroutine
mov a, #20h
acall data1                   ; subroutine
mov a, #20h
acall data1
ret

delay1:
      mov r4,#120d
h11:  mov r5,#100d
h21:   djnz r5,h21
      djnz r4,h11
        ret
delay3:
      mov r4,#200d
h114:  mov r5,#130d
h214:   djnz r5,h214
      djnz r4,h114
        ret

command:
mov p1,a
clr p3.2
clr p3.1
setb p3.0
clr p3.0
acall delay1
ret

data1:
mov p1,a
setb p3.2
clr p3.1
setb p3.0
clr p3.0
```

```
acall delay1
ret

del:
      mov a,#10h                ;shift cursor left
      acall command             ;command subroutine

      mov a,#20h                ;shift cursor left
      acall data1            ;command subroutine

      mov a,#10h                ;shift cursor left
      acall command             ;command subroutine

     dec r1
      ret

delay2:

       mov r4,#15d
h3:   mov r5,#255d
h1:   mov r3,#255d
h2:   djnz r3,h2
      djnz r5,h1
      djnz r4,h3
       ret
delayslow:

       mov r4,#1d
h3g:   mov r5,#100d
h1g:   mov r3,#255d
h2g:   djnz r3,h2g
       clr p2.4
      jb p2.4,f6
     djnz r5,h1g
      djnz r4,h3g
      f6:
     ret
delaymedium:

       mov r4,#1d
h3gg:   mov r5,#50d
h1gg:   mov r3,#250d
h2gg:   djnz r3,h2gg
       clr p2.4
      jb p2.4,f6g
     djnz r5,h1gg
      djnz r4,h3gg
```

```
      f6g:
     ret
delayfast:

       mov r4,#1d
h3ggg:   mov r5,#50d
h1ggg:   mov r3,#70d
h2ggg:   djnz r3,h2ggg
       clr p2.4
      jb p2.4,f6gg
    djnz r5,h1ggg
      djnz r4,h3ggg
      f6gg:
     ret
delay:
mov r5,#30d
h13:  mov r4,#45d
h23:   djnz r4,h23
      djnz r5,h13
        ret
        end
```

APPENDIX-B

List of Components Used

Component	Value	Quantity
Transformer	-	1
p-n junction diode	-	4
Capacitor	1000 uf	1
	33 uf	2
	10 uf	1
	0.1 uf	2
	22 pf	4
Resistor	92 ohm	1
	440 ohm	1
	19 ohm	1
	990k ohm	1
	100k ohm	2
ICs	µc-89S52	1
	DTMF-HT9170B	1
	ULN-2003	1
	IC-7495	1
Crystal Oscillator	11.0592	1
	3.5795	1

Female LCD	-	1
Buzzer	-	1
Battery Cells	1.5 V	4
LED	-	4
Stepper Motor	-	1
Speaker Cord	-	1

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