

ABSTRACT

The main aim of this paper is to provide information about automatic irrigation to the plants which helps in saving money and water. The entire system is controlled using microcontroller which is giving the interrupt signal to the motor. Temperature sensor and soil sensor are connected to internal ports of micro controller via comparator, whenever there is a fluctuation in temperature and soil of the environment these sensors senses the change in temperature and soil and gives an interrupt signal to the micro-controller and thus the motor is activated, along with this buzzer is used to indicate that pump is on.

CHAPTER-1

INTRODUCTION

1.1 GENERAL:

Water shortage is one of the major problem in the world. Many different methods are incorporated for conservation of water. We need water in each and every field & is needed for every human beings, animals, plants, etc. Agriculture is one such field where water is required in high quantity. Wastage of water is a major problem in agriculture. Every time excess of water is given to the fields. A number of techniques are available to save or to control wastage of water from agriculture. Ditch Irrigation: Ditch Irrigation is one of the old methodology, where ditches are dug out and seedlings are planted in horizontally aligned pattern. Water is made to move to different canals via siphon tubes. Terraced Irrigation: In this process the land is cut into multiple steps and supported by keeping walls while the plain areas are used for plantation and the idea is that the water runs down each step watering each column. This led steep land to be used for multiple crops. This is a very labour involvement method of irrigation. Drip Irrigation: The most water effective method of irrigation is the drip irrigation method. In this method, water is dropped near the root level of a plant in a slow steady motion. The loss of water through evaporation and runoff can be decreased to a much high extent if the system is installed effectively. Sprinkler System: This irrigation system is designed on overhead sprinklers fixed on permanent risers. The system is installed underground and the sprinklers level up when water pressure increases, which is a famous irrigation system for use on golf courses and parks.

Rotary Systems: This method can be used when irrigating area is large. In this method sprinklers can reach the area of up to 100 feet. In this method sprinklers move in circular direction covering larger areas. In this method small amount of water can irrigate large area of a field.

NEED OF AUTOMATIC IRRIGATION Automatic irrigation system proves to be very helpful for those who travel. If designed and coded properly, automatic irrigation systems can be very cost effective and can do a lot of water conservation. Watering with a pipe or with oscillator wastes water and none of these method aim plant roots. Automatic irrigation systems can be designed in such a way which gives required amount of water in a targeted area, and which will also promotes water conservation.

1.2 EXISTING SYSTEM

Currently, plant watering is usually done manually or with basic automated timers that do not account for soil moisture or environmental conditions, often leading to over or under-watering.

1.3 PROPOSED SYSTEM

The proposed remote control plant watering system employs an 8051 microcontroller, soil moisture sensor, temperature sensor, water pump, and RF module. The system monitors soil moisture and temperature levels in real-time, transmitting data via RF to a remote controller. Based on preset thresholds, the microcontroller activates the pump to water the plants as needed, ensuring optimal soil moisture and reducing water waste.

CHAPTER 2

PROJECT DESCRIPTION

2.1 GENERAL INTRODUCTION TO EMBEDDED SYSTEM

An embedded system can be defined as a computing device that does a specific focused job. Appliances such as the air-conditioner, VCD player, DVD player, printer, fax machine, mobile phone etc. are examples of embedded systems. Each of these appliances will have a processor and special hardware to meet the specific requirement of the application along with the embedded software that is executed by the processor for meeting that specific requirement. The embedded software is also called “firm ware”. The desktop/laptop computer is a general purpose computer. You can use it for a variety of applications such as playing games, *word* processing, accounting, software development and so on. In contrast, the software in the embedded systems is always fixed listed below:

- Embedded systems do a very specific task, they cannot be programmed to do different things.
- Embedded systems have very limited resources, particularly the memory. Generally, they do not have secondary storage devices such as the CDROM or the floppy disk. Embedded systems have to work against some deadlines. A specific job has to be completed within a specific time. In some embedded systems, called real-time systems, the deadlines are stringent. Missing a deadline may cause a catastrophe-loss of life or damage to property. Embedded systems are constrained for power. As many embedded systems operate through a battery, the power consumption has to be very low.
- Some embedded systems have to operate in extreme environmental conditions such as very high temperatures and humidity.

- **Application Areas**

Nearly 99 per cent of the processors manufactured end up in embedded systems. The embedded system market is one of the highest growth areas as these systems are used in very market segment- consumer electronics, office automation, industrial automation, biomedical engineering, wireless communication, data communication, telecommunications, transportation, military and so on.

- **Consumer appliances:**

At home we use a number of embedded systems which include digital camera, digital diary, DVD player, electronic toys, microwave oven, remote controls for TV and air-conditioner, VCO player, video game consoles, video recorders etc. Today's high-tech car has about 20 embedded systems for transmission control, engine spark control, air-conditioning, navigation etc. Even wristwatches are now becoming embedded systems. The palmtops are powerful embedded systems using which we can carry out many general-purpose tasks such as playing games and word processing.

- **Office Automation:**

The office automation products using embedded systems are copying machine, fax machine, key telephone, modem, printer, scanner etc.

- **Industrial Automation:**

Today a lot of industries use embedded systems for process control. These include pharmaceutical, cement, sugar, oil exploration, nuclear energy, electricity generation and transmission. The embedded systems for industrial use are designed to carry out specific tasks such as monitoring the temperature, pressure, humidity, voltage, current etc., and then take appropriate action based on the monitored levels to control other devices or to send information to a centralized monitoring station. In hazardous industrial environment, where human presence has to be avoided, robots are used, which are programmed to do specific jobs. The robots are now becoming very powerful and carry out many interesting and complicated tasks such as hardware assembly.

- **Medical Electronics:**

Almost every medical equipment in the hospital is an embedded system. These equipments include diagnostic aids such as ECG, EEG, blood pressure measuring devices, X-ray scanners; equipment used in blood analysis, radiation, colonoscopy, endoscopy etc. Developments in medical electronics have paved way for more accurate diagnosis of diseases.

- **Computer Networking:**

Computer networking products such as bridges, routers, Integrated Services Digital Networks (ISDN), Asynchronous Transfer Mode (ATM), X.25 and frame relay switches are embedded systems which implement the necessary data communication protocols. For example, a router interconnects two networks. The two networks may be running different protocol stacks. The router's function is to obtain the data packets from incoming ports, analyze the packets and send them towards the destination after doing necessary protocol conversion. Most networking equipments, other than the end systems (desktop computers) we use to access the networks, are embedded systems.

- **Telecommunications:**

In the field of telecommunications, the embedded systems can be categorized as subscriber terminals and network equipment. The subscriber terminals such as key telephones, ISDN phones, terminal adapters, web cameras are embedded systems. The network equipment includes multiplexers, multiple access systems, Packet Assemblers Disassemblers (PADs), satellite modems etc. IP phone, IP gateway, IP gatekeeper etc. are the latest embedded systems that provide very low-cost voice communication over the Internet.

- **Wireless Technologies:**

Advances in mobile communications are paving way for many interesting applications using embedded systems. The mobile phone is one of the marvels of the last decade of the 20th century. It is a very powerful embedded system that provides voice communication while we are on the move. The Personal Digital Assistants and the palmtops can now be used to access multimedia service over the Internet. Mobile communication infrastructure such as base station controllers, mobile switching centers are also powerful embedded systems.

- **Insemination:**

Testing and measurement are the fundamental requirements in all scientific and engineering activities. The measuring equipment we use in laboratories to measure parameters such as weight, temperature, pressure, humidity, voltage, current etc. are all embedded systems. Test equipment such as oscilloscope, spectrum analyzer, logic analyzer, protocol analyzer, radio communication test set etc. are embedded systems built around powerful processors. Thank to

miniaturization, the test and measuring equipment are now becoming portable facilitating easy testing and measurement in the field by field-personnel.

- **Security:**

Security of persons and information has always been a major issue. We need to protect our homes and offices; and also the information we transmit and store. Developing embedded systems for security applications is one of the most lucrative businesses nowadays. Security devices at homes, offices, airports etc. for authentication and verification are embedded systems. Encryption devices are nearly 99 per cent of the processors that are manufactured end up in~ embedded systems. Embedded systems find applications in every industrial segment- consumer electronics, transportation, avionics, biomedical engineering, manufacturing, process control and industrial automation, data communication, telecommunication, defense, security etc. Used to encrypt the data/voice being transmitted on communication links such as telephone lines. Biometric systems using fingerprint and face recognition are now being extensively used for user authentication in banking applications as well as for access control in high security buildings.

- **Finance:**

Financial dealing through cash and cheques are now slowly paving way for transactions using smart cards and ATM (Automatic Teller Machine, also expanded as Any Time Money) machines. Smart card, of the size of a credit card, has a small micro-controller and memory; and it interacts with the smart card reader! ATM machine and acts as an electronic wallet. Smart card technology has the capability of ushering in a cashless society. Well, the list goes on. It is no exaggeration to say that eyes wherever you go, you can see, or at least feel, the work of an embedded system.

• Overview of Embedded System Architecture

Every embedded system consists of custom-built hardware built around a Central Processing Unit (CPU). This hardware also contains memory chips onto which the software is loaded. The software residing on the memory chip is also called the 'firmware'. The embedded system architecture can be represented as a layered architecture as shown in Fig. The operating system runs above the hardware, and the application software runs above the operating system. The same architecture is applicable to any computer including a desktop computer. However, there are significant differences. It is not compulsory to have an operating system in every embedded system. For small appliances such as remote control units, air conditioners, toys etc., there is no need *for* an operating system and you can write only the software specific to that application. For applications involving complex processing, it is advisable to have an operating system. In such a case, you need to integrate the application software with the operating system and then transfer the entire software on to the memory chip.

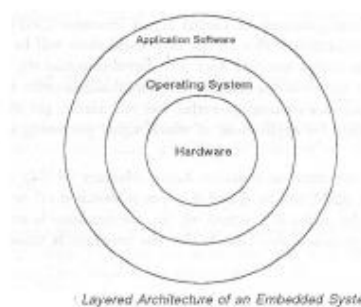


Fig 2.1 : Layered Architecture Of An Embedded Systems

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

- Central Processing Unit (CPU)
- Memory (Read-only Memory and Random Access Memory)
- Input Devices
- Output devices
- Communication interfaces
- Application-specific circuitry

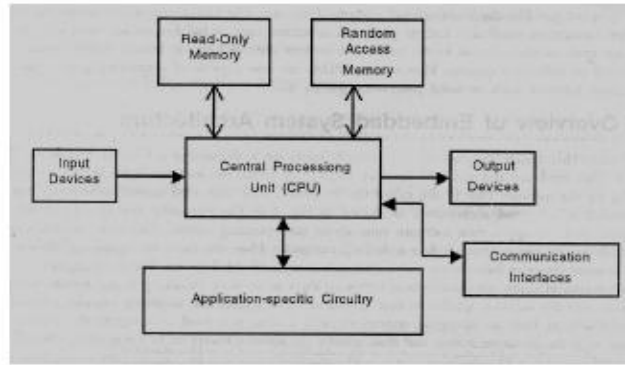


Fig 2.2 : Architecture Of CPU

- **Central Processing Unit (CPU):**

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

- **Memory:**

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

- **Input Devices:**

Unlike the desktops, the input devices to an embedded system have very limited capability. There will be no keyboard or a mouse, and hence interacting with the embedded system is no easy task. Many embedded systems will have a small keypad-you press one key to give a specific command. A keypad may be used to input only the digits. Many embedded systems

used in process control do not have any input device for user interaction; they take inputs from sensors or transducers and produce electrical signals that are in turn fed to other systems.

- **Output Devices:**

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

- **Communication Interfaces:**

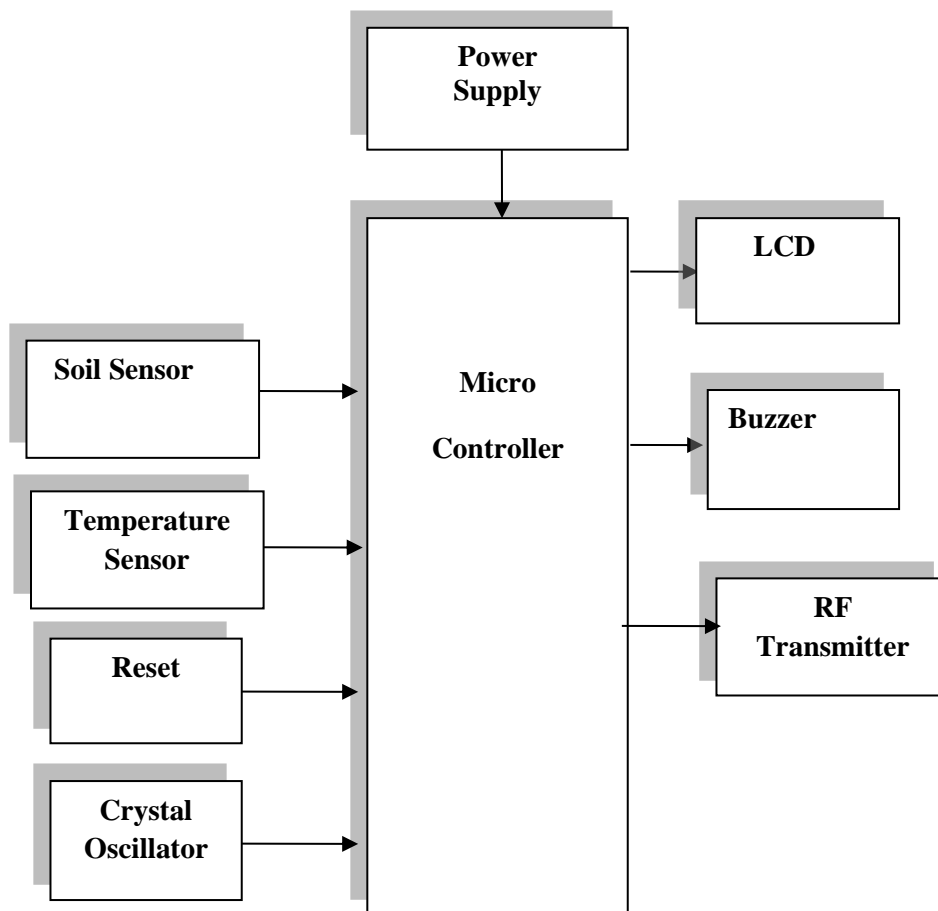
The embedded systems may need to, interact with other embedded systems as they may have to transmit data to a desktop. To facilitate this, the embedded systems are provided with one or a few communication interfaces such as RS232, RS422, RS485, Universal Serial Bus (USB), IEEE 1394, Ethernet etc.

- **Application-Specific Circuitry:**

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

2.2 BLOCK DIAGRAM:

i) TRANSMITTER SECTION:



ii) RECEIVER SECTION

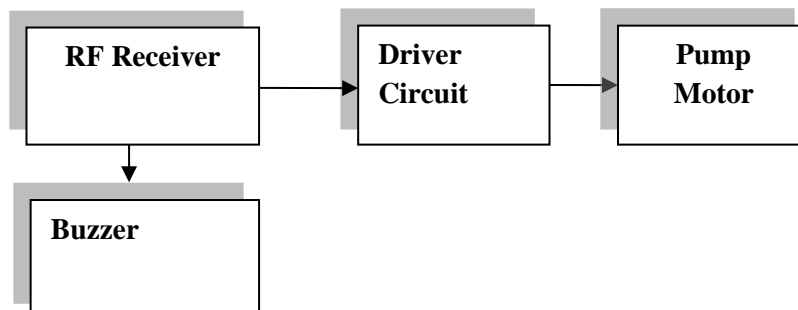


Fig 2.3 : Block Diagram

2.3 MODULES:

2.3.1 POWER SUPPLY:

The power supply section is the section which provide +5V for the components to work. IC LM7805 is used for providing a constant power of +5V.

The ac voltage, typically 220V, is connected to a transformer, which steps down that ac voltage down to the level of the desired dc output. A diode rectifier then provides a full-wave rectified voltage that is initially filtered by a simple capacitor filter to produce a dc voltage. This resulting dc voltage usually has some ripple or ac voltage variation.

A regulator circuit removes the ripples and also retains the same dc value even if the input dc voltage varies, or the load connected to the output dc voltage changes. This voltage regulation is usually obtained using one of the popular voltage regulator IC units.

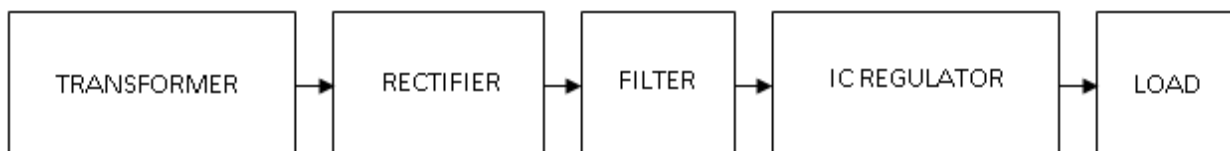


Fig 2.4 Block Diagram of Power Supply

2.3.2 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 India) to a safer low voltage.

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. 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 transformer will step down the power supply voltage (0-230V) to (0- 6V) level. Then the secondary of the potential transformer will be connected to the bridge rectifier, which is constructed with the help of PN junction diodes. The advantages of using bridge rectifier are it will give peak voltage output as DC.

2.3.3 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

2.3.4 Bridge Rectifier

When four diodes are connected as shown in figure, the circuit is called as bridge rectifier. The input to the circuit is applied to the diagonally opposite corners of the network, and the output is taken from the remaining two corners. Let us assume that the transformer is working properly and there is a positive potential, at point A and a negative potential at point B. the positive potential at point A will forward bias D3 and reverse bias D4.

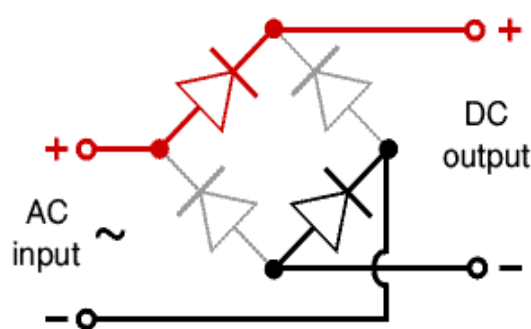


Fig 2.5 Bridge Rectifier

The negative potential at point B will forward bias D1 and reverse D2. At this time D3 and D1 are forward biased and will allow current flow to pass through them; D4 and D2 are reverse biased and will block current flow.

One advantage of a bridge rectifier over a conventional full-wave rectifier is that with a given transformer the bridge rectifier produces a voltage output that is nearly twice that of the conventional full-wave circuit.

- i. The main advantage of this bridge circuit is that it does not require a special centre tapped transformer, thereby reducing its size and cost.
- ii. The single secondary winding is connected to one side of the diode bridge network and the load to the other side as shown below.
- iii. The result is still a pulsating direct current but with double the frequency.

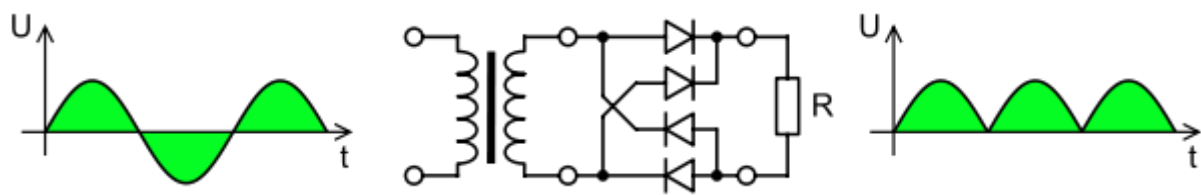


Fig 2.6 Output Waveform Of DC

Smoothing

Smoothing 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.

2.3.5 Voltage Regulators

Voltage regulators comprise a class of widely used ICs. Regulator IC units contain the circuitry for reference source, comparator amplifier, control device, and overload protection all in a single IC. IC units provide regulation of either a fixed positive voltage, a fixed negative voltage, or an adjustably set voltage. The regulators can be selected for operation with load currents from hundreds of milli amperes to tens of amperes, corresponding to power ratings from milli watts to tens of watts.

A fixed three-terminal voltage regulator has an unregulated dc input voltage, V_i , applied to one input terminal, a regulated dc output voltage, V_o , from a second terminal, with the third terminal connected to ground.

The series 78 regulators provide fixed positive regulated voltages from 5 to 24 volts. Similarly, the series 79 regulators provide fixed negative regulated voltages from 5 to 24 volts. 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 has 3 leads and look like power transistors, such as the 7805 +5V 1Amp regulator. They include a hole for attaching a heat sink if necessary.

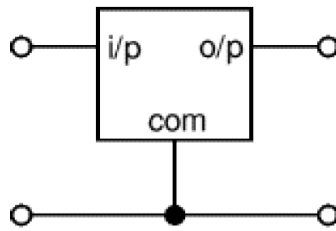


Fig 2.7 Regulator

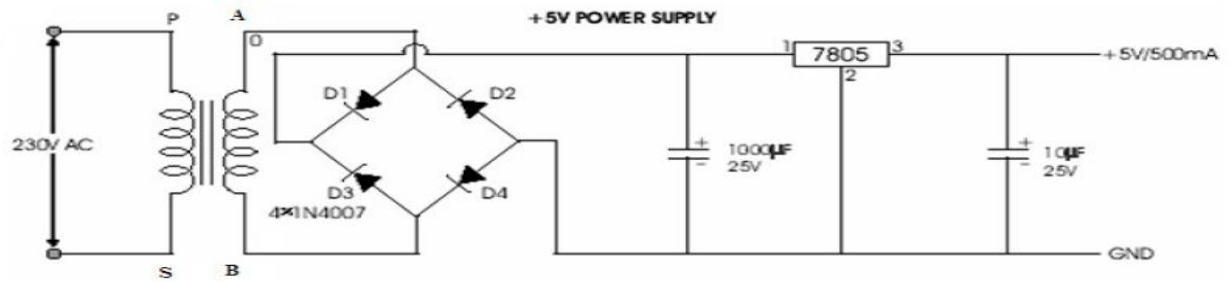


Fig 2.8 Circuit Diagram Of Power Supply

2.4 MICROCONTROLLER:

A Microcontroller (or MCU) is a computer-on-a-chip used to control electronic devices. It is a type of microprocessor emphasizing self-sufficiency and cost-effectiveness, in contrast to a general-purpose microprocessor (the kind used in a PC). A typical microcontroller contains all the memory and interfaces needed for a simple application, whereas a general purpose microprocessor requires additional chips to provide these functions.

A microcontroller is a single integrated circuit with the following key features:

- central processing unit - ranging from small and simple 8-bit processors to sophisticated 32- or 64-bit processors
- input/output interfaces such as serial ports
- RAM for data storage
- ROM, EEPROM or Flash memory for program storage
- clock generator - often an oscillator for a quartz timing crystal, resonator or RC circuit

Microcontrollers are inside many kinds of electronic equipment (see embedded system). They are the vast majority of all processor chips sold. Over 50% are "simple" controllers, and another 20% are more specialized digital signal processors (DSPs) (ref?). A typical home in a developed country is likely to have only one or two general-purpose microprocessors but somewhere between one and two dozen microcontrollers. A typical mid-range vehicle has as many as 50 or more microcontrollers. They can also be found in almost any electrical device: washing machines, microwave ovens, telephones etc.

2.4.1 FEATURES:

- Compatible with MCU®-51 Products
- 8K Bytes of In-System Programmable (ISP) Flash Memory
 - Endurance: 10,000 Write/Erase Cycles
- 4.0V to 5.5V Operating Range
- Fully Static Operation: 0 Hz to 33 MHz
- 256 x 8-bit Internal RAM
- 32 Programmable I/O Lines
- Three 16-bit Timer/Counters
- Eight Interrupt Sources
- Full Duplex UART Serial Channel
- Low-power Idle and Power-down Modes

- Interrupt Recovery from Power-down Mode
- Fast Programming Time
- Flexible ISP Programming (Byte and Page Mode)

Description

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 pin-out. 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, 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 contents but freezes the oscillator, disabling all other chip functions until the next interrupt or hardware reset.

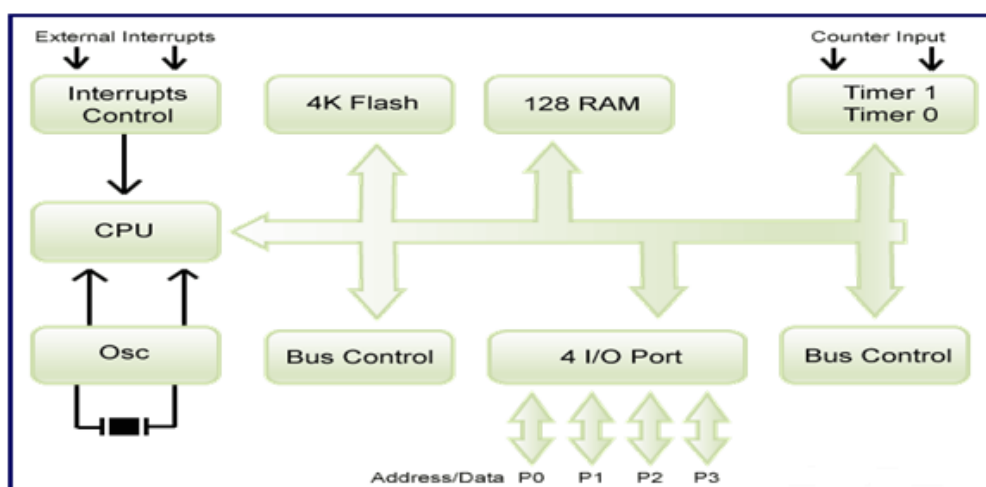


Fig 2.9. BLOCK DIAGRAM OF 8052

2.4.2 PIN DIAGRAM:

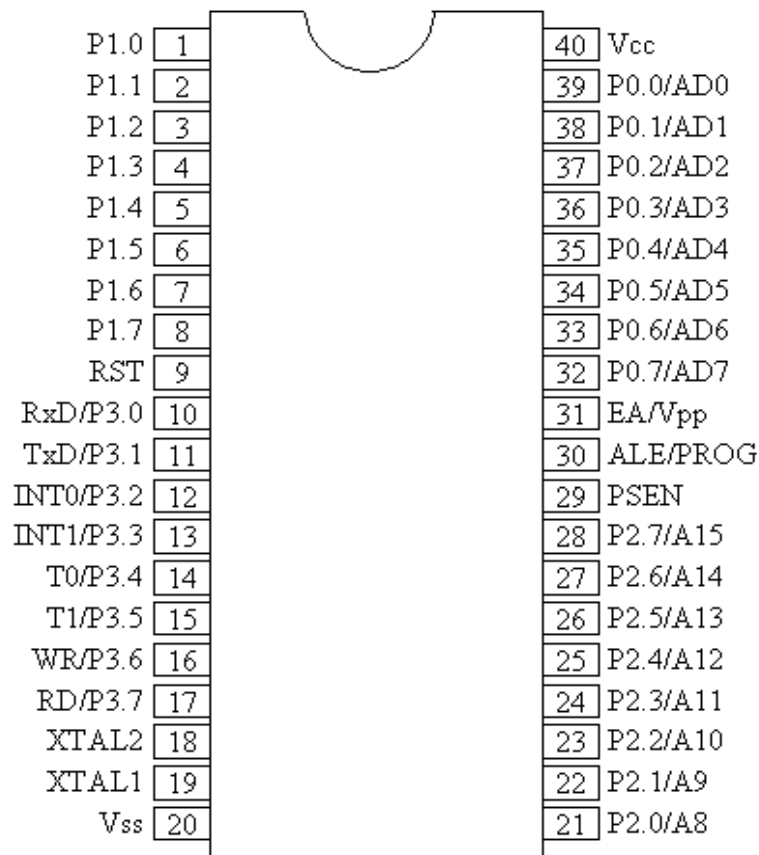


Fig.2.10 PIN DIAGRAM OF 8052

PIN DESCRIPTION

40 pin VCC Supply voltage.

20 pin GND Ground.

Port 0

Port 0 is an 8-bit open drain bidirectional I/O port. As an output port, each pin can sink eight TTL inputs. When 1s are written to port 0 pins, the pins can be used as high-impedance inputs. Port 0 can also be configured to be the multiplexed low-order address/data bus during accesses to external program and data memory. Port 0 also receives the code bytes during Flash programming and outputs the code bytes during program verification. External pull-ups are required during program verification.

Port 1

Port 1 is an 8-bit bidirectional I/O port with internal pull-ups. The Port 1 output buffers can sink/source four TTL inputs. When 1s are written to Port 1 pins, they are pulled high by the

internal pull-ups and can be used as inputs. As inputs, Port 1 pins that are externally being pulled low will source current (IIL) because of the internal pull-ups.

Port 2

Port 2 is an 8-bit bidirectional I/O port with internal pull-ups. The Port 2 output buffers can sink/source four TTL inputs. When 1s are written to Port 2 pins, they are pulled high by the internal pull-ups and can be used as inputs. As inputs, Port 2 pins that are externally being pulled low will source current because of the internal pull-ups. In this application, Port 2 uses strong internal pull-ups when emitting 1s. During accesses to external data memory that use 8-bit addresses, Port 2 emits the contents of the P2 Special Function Register. Port 2 also receives the high-order address bits and some control signals during Flash programming and verification.

Port 3

Port 3 is an 8-bit bidirectional I/O port with internal pull-ups. The Port 3 output buffers can sink/source four TTL inputs. When 1s are written to Port 3 pins, they are pulled high by the internal pull-ups and can be used as inputs. As inputs, Port 3 pins that are externally being pulled low will source current because of the pull-ups. Port 3 also serves the functions of various special features of the AT89S52, as shown in the following table.

Port Pin	Alternate Functions
P3.0	RXD (serial input port)
P3.1	TXD (serial output port)
P3.2	INT0 (external interrupt 0)
P3.3	INT1 (external interrupt 1)
P3.4	T0 (timer 0 external input)
P3.5	T1 (timer 1 external input)
P3.6	WR (external data memory write strobe)
P3.7	RD (external data memory read strobe)

RST

Reset input. A high on this pin for two machine cycles while the oscillator is running resets the device.

WR

It is active low write O/P control signal. During External RAM (Data memory). Write to external RAM.

RD

It is active low read O/P control signal. During External RAM (Data memory). Read from External RAM.

XTAL1 Input to the inverting oscillator amplifier and input to the internal clock operating circuit.

XTAL2 Output from the inverting oscillator amplifier.

ALE/PROG

Address Latch Enable (ALE) is an output pulse for latching the low byte of the address during accesses to external memory. This pin is also the program pulse input (PROG) during Flash programming. In normal operation, ALE is emitted at a constant rate of 1/6 the oscillator frequency and may be used for external timing or clocking purposes. If desired, ALE operation can be disabled by setting bit 0 of SFR location 8EH. With the bit set, ALE is active only during a MOVX or MOVC instruction. Otherwise, the pin is weakly pulled high. Setting the ALE-disable bit has no effect if the microcontroller is in external execution mode.

PSEN

Program Store Enable (PSEN) is the read strobe to external program memory. When the AT89S52 is executing code from external program memory, PSEN is activated twice each machine cycle.

EA

External Access Enable. EA must be strapped to GND in order to enable the device to fetch code from external program memory locations starting at 0000H up to FFFFH. Note, however, that if lock bit 1 is programmed, EA will be internally latched on reset. EA should be strapped to VCC for internal program executions.

2.4.3 ARCHITECTURE OF 8052:

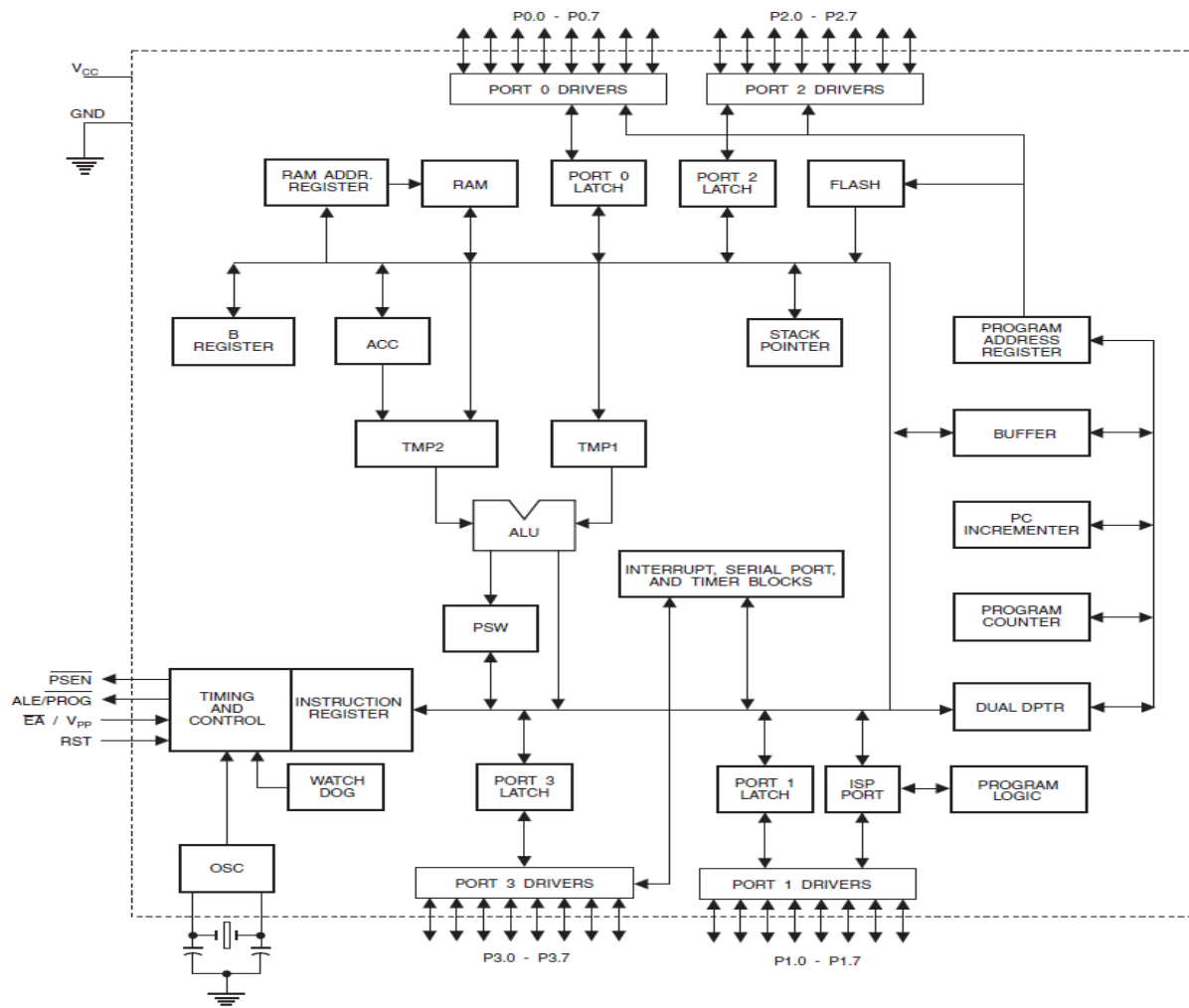


Fig.2.11 INTERNAL ARCHITECTURE OF 8052

2.4.4 REGISTERS:

Registers and accumulators serve as temporary memory locations during CPU operations. The exchange of information among them takes place through one or more internal buses. The length of each register is equal to the width of the internal data bus.

Registers are categorized as general-purpose registers and special-purpose registers.

A general-purpose register may be used as an accumulator or as a data register for (arithmetic) and logic operations. An accumulator is a register for storing the results of an arithmetic operation. A general-purpose register may also be used as an address register.

A special-purpose register is dedicated to a specific function. Some of these registers are the program counter (PC), the instruction register (IR), the address register (AR), the status register, and the stack pointer (SP).

The program counter holds the address of the next instruction to be executed. When the CPU executes a branch instruction telling it to branch to another part of the program, the new address is loaded into the program counter and the sequential order resumes.

The instruction register extracts the operation code (op code) from an instruction. An instruction consists of op code and operand(s). The contents of the instruction register are decoded by the control unit. The status register or condition code register consists of status or flag bits and control bits.

The flag bits are: carry/borrow (C), overflow (V), negative (N), zero (Z), and half-carry (H). The logic states of the flag bits are used by the CPU's branch instructions to make decisions. The program counter sends its contents (address) to the address register. The address register then sends this address to the address bus.

A stack is a specially reserved area in memory where information is stored or removed in a last-in-first-out (LIFO) fashion. The stack pointer points to the next free location on the stack. That is, it holds the address of the top of the stack. Each time data is stored in the stack, the stack pointer is automatically decremented and each time data is retrieved from the stack, the stack pointer is automatically incremented.

2.4.5 Memory Organization:

MCU-51 devices have a separate address space for Program and Data Memory. Up to 64K bytes each of external Program and Data Memory can be addressed.

The instructions to be executed by the microcontroller CPU and the data to be operated on by these instructions are stored in memory. When the CPU accesses the information stored in memory, it is performing a read operation. When the CPU sends information to be stored in the memory, it is performing a write operation. Memory is classified as internal and external memory. Internal memory is on-chip memory and is a semiconductor type with low capacity and high speeds. External memory is outside the chip and includes the semiconductor type and serial memory such as magnetic disks, magnetic tapes, and bubble memory. Semiconductor memory may be volatile or nonvolatile. Volatile memory loses its contents after the power is removed from the memory chip. Nonvolatile memory does not lose its contents when power is removed. The nonvolatile memory can store information permanently or at least semi-permanently (ten years or more). Volatile memory includes RAM while nonvolatile memory includes ROM, EPROM, EEPROM, and battery-backed RAM.

RAM (random access memory) comprises DRAM (Dynamic RAM) and SRAM (Static RAM). Each storage cell of DRAM consists of a capacitor and a MOSFET (Metal Oxide Semiconductor Field Effect Transistor). If the capacitor is charged, a logic 1 is stored in the cell. If the capacitor has no charge, a logic 0 is stored in the cell. The charge stored in the capacitors dissipates fast because of leakage. Therefore, a DRAM has to be periodically refreshed otherwise its contents will fade away after some time even in the presence of the power to memory chip.

The storage cell of a ROM (Read-only memory) consists of a BJT (Bipolar Junction Transistor). A ROM may be programmed at the manufacturing stage using a mask process. Such a ROM is called mask-programmed ROM. The contents of a mask-programmed ROM cannot be changed once it is programmed.

2.4.6 Data Memory:

The AT89S52 implements 256 bytes of on-chip RAM. The upper 128 bytes occupy a parallel address space to the Special Function Registers. This means that the upper 128 bytes have the same addresses as the SFR space but are physically separate from SFR space.

When an instruction accesses an internal location above address 7FH, the address mode used in the instruction specifies whether the CPU accesses the upper 128 bytes of RAM or the SFR space. Instructions which use direct addressing access the SFR space.

UART (Universal Asynchronous Receiver and Transmitter)

One of the microcontroller features making it so powerful is an integrated UART, better known as a serial port. It is a full-duplex port, thus being able to transmit and receive data simultaneously and at different baud rates. Without it, serial data send and receive would be an enormously complicated part of the program in which the pin state is constantly changed and checked at regular intervals. When using UART, all the programmer has to do is to simply select serial port mode and baud rate. When it's done, serial data transmit is nothing but writing to the SBUF register, while data receive represents reading the same register. The microcontroller takes care of not making any error during data transmission.

2.4.7 TIMERS:

Timer is used to generate time delay, a timer always counts up. It doesn't matter whether the timer is being used as a timer, a counter, or a baud rate generator: A timer is always incremented by the microcontroller. There are 3 timers i.e., Timer 0, Timer 1 and Timer 2.

Timer 0 and 1

Timer 0 and Timer 1 in the AT89S52 operate the same way as Timer 0 and Timer 1 in the 8051.

Timer T0 is a 16 bit timer. The 16-bit Timer 0 is accessed as low byte and high byte. the low byte is called TL0(Timer 0 low byte) and the high byte is referred to as TH0(Timer 0 high byte).

As like Timer 1 is also 16-bit timer is split into two bytes, referred to as TL1 (Timer 1 low byte) and TH1(Timer 1 high byte). These timer are accessible in the same way as the Timer 0.

Timer 2

Timer 2 is a 16-bit Timer/Counter that can operate as either a timer or an event counter. The type of operation is selected by bit C/T2 in the SFR T2CON (shown in Table 5-2). Timer 2 has three operating modes: capture, auto-reload (up or down counting), and baud rate generator. Timer 2 consists of two 8-bit registers, TH2 and TL2. In the Timer function, the TL2 register is incremented every machine cycle. Since a machine cycle consists of 12 oscillator periods, the count rate is 1/12 of the oscillator frequency.

In the Counter function, the register is incremented in response to a 1-to-0 transition at its corresponding external input pin, T2. In this function, the external input is sampled during S5P2 of every machine cycle. When the samples show a high in one cycle and a low in the next cycle, the count is incremented. The new count value appears in the register during S3P1 of the cycle following the one in which the transition was detected. Since two machine cycles (24 oscillator periods) are required to recognize a 1-to-0 transition, the maximum count rate is 1/24 of the oscillator frequency. To ensure that a given level is sampled at least once before it changes, the level should be held for at least one full machine cycle.

2.4.8 INTERRUPTS:

The AT89S52 has a total of six interrupt vectors: two external interrupts (INT0 and INT1), three timer interrupts (Timers 0, 1, and 2), and the serial port interrupt.

Each of these interrupt sources can be individually enabled or disabled by setting or clearing a bit in Special Function Register IE. IE also contains a global disable bit, EA, which disables all interrupts at once.

Timer 2 interrupt is generated by the logical OR of bits TF2 and EXF2 in register T2CON. Neither of these flags is cleared by hardware when the service routine is vectored to. In fact, the service routine may have to determine whether it was TF2 or EXF2 that generated the interrupt, and that bit will have to be cleared in software.

The Timer 0 and Timer 1 flags, TF0 and TF1, uses the cycle in which the timers overflow. The values are then polled by the circuitry in the next cycle. However, the Timer 2 flag, TF2, is set at S2P2 and is polled in the same cycle in which the timer overflows.

2.5 LIQUID CRYSTAL DISPLAY (LCD):

LCD (Liquid Crystal Display) screen is an electronic display module and find a wide range of applications. A 16x2 LCD display is very basic module and is very commonly used in various devices and circuits. These modules are preferred over seven segments and other multi segment LEDs. The reasons being: LCDs are economical; easily programmable; have no limitation of displaying special & even custom characters (unlike in seven segments), animations and so on.

A **16x2 LCD** means it can display 16 characters per line and there are 2 such lines. In this LCD each character is displayed in 5x7 pixel matrix. This LCD has two registers, namely, Command and Data.

The command register stores the command instructions given to the LCD. A command is an instruction given to LCD to do a predefined task like initializing it, clearing its screen, setting the cursor position, controlling display etc. The data register stores the data to be displayed on the LCD. The data is the ASCII value of the character to be displayed on the LCD.

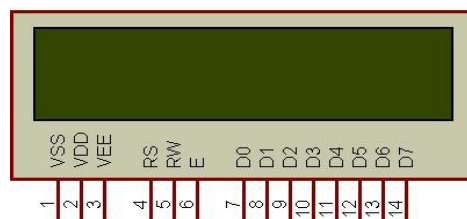


Fig.2.12 16x2 LCD

2.5.1 Introduction

The most commonly used Character based LCDs are based on Hitachi's HD44780 controller or other which are compatible with HD44580.

2.5.2 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). Pin description is shown in the table below.

Pin Configuration table for a 16X2 LCD character display:-

Pin Number	Symbol	Function
1	Vss	Ground Terminal
2	Vcc	Positive Supply
3	Vdd	Contrast adjustment
4	RS	Register Select; 0→Instruction Register, 1→Data Register
5	R/W	Read/write Signal; 1→Read, 0→ Write
6	E	Enable; Falling edge
7	DB0	Bi-directional data bus, data transfer is performed once, thru DB0 to DB7, in the case of interface data length is 8-bits; and twice, through DB4 to DB7 in the case of interface data length is 4-bits. Upper four bits first then lower four bits.
8	DB1	
9	DB2	
10	DB3	
11	DB4	
12	DB5	
13	DB6	
14	DB7	
15	LED-(K)	Back light LED cathode terminal
16	LED+(A)	Back Light LED anode terminal

Table 2.1 Pin Description of LCD**Data/Signals/Execution of LCD**

Coming to data, signals and execution.

LCD accepts two types of signals, one is data, and another is control. These signals are recognized by the LCD module from status of the RS pin. Now data can be read also from the LCD display, by pulling the R/W pin high. As soon as the E pin is pulsed, LCD display reads data at the falling edge of the pulse and executes it, same for the case of transmission.

LCD display takes a time of 39-43 μ S to place a character or execute a command. Except for clearing display and to seek cursor to home position it takes 1.53ms to 1.64ms. Any attempt to send any data before this interval may lead to failure to read data or execution of the current data in some devices. Some devices compensate the speed by storing the incoming data to some temporary registers.

Instruction Register (IR) and Data Register (DR)

There are two 8-bit registers in HD44780 controller Instruction and Data register. Instruction register corresponds to the register where you send commands to LCD e.g LCD shift command, LCD clear, LCD address etc. and Data register is used for storing data which is to be displayed on LCD. when send the enable signal of the LCD is asserted, the data on the pins is latched in to the data register and data is then moved automatically to the DDRAM and hence is displayed on the LCD. Data Register is not only used for sending data to DDRAM but also for CGRAM, the address where you want to send the data, is decided by the instruction you send to LCD. We will discuss more on LCD instruction set further in this tutorial.

Commands and Instruction set

Only the instruction register (IR) and the data register (DR) of the LCD can be controlled by the MCU. Before starting the internal operation of the LCD, control information is temporarily stored into these registers to allow interfacing with various MCUs, which operate at different speeds, or various peripheral control devices. The internal operation of the LCD is determined by signals sent from the MCU. These signals, which include register selection signal (RS), read/write signal (R/W), and the data bus (DB0 to DB7), make up the LCD instructions (Table 3). There are four categories of instructions that:

- Designate LCD functions, such as display format, data length, etc.
- Set internal RAM addresses
- Perform data transfer with internal RAM
- Perform miscellaneous functions

Command	Code										Description	Execution Time	
	RS	R/W	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0			
Clear Display	0	0	0	0	0	0	0	0	0	1	Clears the display and returns the cursor to the home position (address 0).	82µs~1.64ms	
Return Home	0	0	0	0	0	0	0	0	0	1	*	Returns the cursor to the home position (address 0). Also returns a shifted display to the home position. DD RAM contents remain unchanged.	40µs~1.64ms
Entry Mode Set	0	0	0	0	0	0	0	0	1	I/D	S	Sets the cursor move direction and enables/disables the display.	40µs
Display ON/OFF Control	0	0	0	0	0	0	0	1	D	C	B	Turns the display ON/OFF (D), or the cursor ON/OFF (C), and blink of the character at the cursor position (B).	40µs
Cursor & Display Shift	0	0	0	0	0	0	1	S/C	R/L	*	*	Moves the cursor and shifts the display without changing the DD RAM contents.	40µs
Function Set	0	0	0	0	0	1	DL	N\$	F	*	#	Sets the data width (DL), the number of lines in the display (L), and the character font (F).	40µs
Set CG RAM Address	0	0	0	0	1	A _{CG}					Sets the CG RAM address. CG RAM data can be read or altered after making this setting.	40µs	
Set DD RAM Address	0	0	0	1	A _{DD}					Sets the DD RAM address. Data may be written or read after making this setting.	40µs		
Read Busy Flag & Address	0	1	BF	AC					Reads the BUSY flag (BF) indicating that an internal operation is being performed and reads the address counter contents.			1µs	
Write Data to CG or DD RAM	1	0	Write Data					Writes data into DD RAM or CG RAM.			46µs		
Read Data from CG or DD RAM	1	1	Read Data					Reads data from DD RAM or CG RAM.			46µs		
	I/D = 1: Increment I/D = 0: Decrement S = 1: Accompanies display shift. S/C = 1: Display shift S/C = 0: cursor move R/L = 1: Shift to the right. R/L = 0: Shift to the left. DL = 1: 8 bits DL = 0: 4 bits N = 1: 2 lines N = 0: 1 line F = 1: 5x10 dots F = 0: 5 x 7 dots BF = 1: Busy BF = 0: Can accept data # Set to 1 on 24x4 modules \$ With KS0072 is Address Mode.										DD RAM: Display data RAM CG RAM: Character generator RAM A _{CG} : CG RAM Address A _{DD} : DD RAM Address Corresponds to cursor address. AC: Address counter Used for both DD and CG RAM address.	Execution times are typical. If transfers are timed by software and the busy flag is not used, add 10% to the above times.	

Table 2.2 Showing various LCD Command Description

Although looking at the table you can make your own commands and test them. Below is a brief list of useful commands which are used frequently while working on the LCD.

2.5.3 List of Command

No.	Instruction	Hex	Decimal
1	Function Set: 8-bit, 1 Line, 5x7 Dots	0x30	48
2	Function Set: 8-bit, 2 Line, 5x7 Dots	0x38	56
3	Function Set: 4-bit, 1 Line, 5x7 Dots	0x20	32
4	Function Set: 4-bit, 2 Line, 5x7 Dots	0x28	40
5	Entry Mode	0x06	6
	Display off Cursor off		
6	(clearing display without clearing DDRAM content)	0x08	8
7	Display on Cursor on	0x0E	14
8	Display on Cursor off	0x0C	12
9	Display on Cursor blinking	0x0F	15
10	Shift entire display left	0x18	24
12	Shift entire display right	0x1C	30
13	Move cursor left by one character	0x10	16
14	Move cursor right by one character	0x14	20
15	Clear Display (also clear DDRAM content)	0x01	1
16	Set DDRAM address or courser position on display	0x80+add*	128+add*
17	Set CGRAM address or set pointer to CGRAM location	0x40+add**	64+add**

Table:2.3 Frequently Used Commands and Instructions for LCD

* DDRAM address given in LCD basics section see Figure 2,3,4

** CGRAM address from 0x00 to 0x3F, 0x00 to 0x07 for char1 and so on.

Liquid crystal displays interfacing with Controller

The LCD standard requires 3 control lines and 8 I/O lines for the data bus.

- **8 data pins D7:D0**

Bi-directional data/command pins.

Alphanumeric characters are sent in ASCII format.

- **RS: Register Select**

RS = 0 -> Command Register is selected

RS = 1 -> Data Register is selected

- **R/W: Read or Write**

0 -> Write, 1 -> Read

- **E: Enable (Latch data)**

Used to latch the data present on the data pins.

A high-to-low edge is needed to latch the data.

2.6 RADIO FREQUENCY (RF) MODULE

RF TRANSMITTER

The function of a radio frequency (RF) transmitter is to modulate, up convert, and amplify signals for transmission into free space. An RF transmitter generally includes a modulator that modulates an input signal and a radio frequency power amplifier that is coupled to the modulator to amplify the modulated input signal. The radio frequency power amplifier is coupled to an antenna that transmits the amplified modulated input signal. The RF transmitter used in our project is TWS-434A. This RF transmitter transmits data in the frequency range of 433.92 MHz with a range of approximately 400 foot (open area) outdoors. Indoors, the range is approximately 200 foot, and will go through most walls. TWS-434A has features which includes small in size, low power consumption i.e. 8mW and operate from 1.5 to 12 Volts- DC, excellent for applications requiring short-range RF signal. Data to be send is Amplitude modulation with the carrier RF signal.

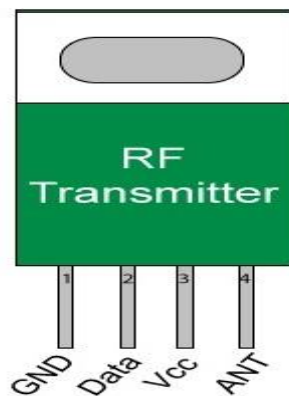


Fig.2.13 RF TRANSMITTER

Pin Description of Transmitter

- Pin 1: Ground (0v)
- Pin2: Input pin for data from encoder
- Pin3: Supply (+5v)
- Pin 4: Pin for external RF antenna

RF RECEIVER

The RF receiver receives an RF signal, converts the RF signal to an IF signal, and then converts the IF signal to a base band signal, which it then provides to the base band processor. As is also known, RF transceivers typically include sensitive components susceptible to noise and interference with one another and with external sources. The RF receiver is coupled to the antenna and includes a low noise amplifier, one or more intermediate frequency stages, a filtering stage, and a data recovery stage. The low noise amplifier receives an inbound RF signal via the antenna and amplifies it. The RF receiver used is RWS-434. This RF receiver receives RF signal which is in the frequency of 434.92 MHz and has a sensitivity of 3uV. The RWS- 434 receiver operates from 4.5 to 5.5 volts-DC, and has both linear and digital outputs and its tunable to match the frequency of the transmitter unit.

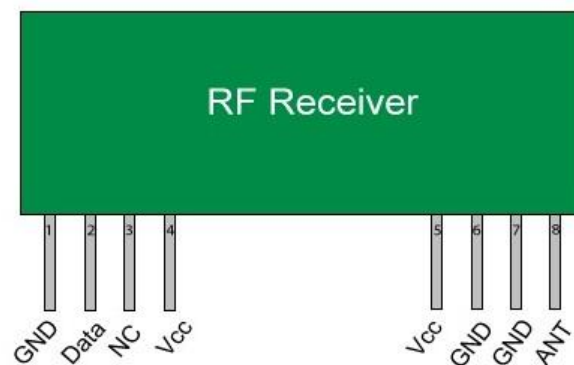


Fig.2.14 RF RECEIVER

Pin Description of Receiver

- Pin1: Ground (0v)
- Pin2: Output Pin For Digital Data Recieved
- Pin 3: Output Pin For Analog Data Recieved
- Pin4: Supply (+5v)
- Pin5: Supply (+5v)
- Pin6: Ground (0v)
- Pin7: Ground (0v)
- Pin 8: Pin For External RF Antenna

ENCODER

An encoder can be a device used to change a signal (such as a bit stream) or data into a code. The code serves any of a number of purposes such as compressing information for transmission or storage, encrypting or adding redundancies to the input code, or translating from one code to another. This is usually done by means of a programmed algorithm, especially if any part is digital, while most analog encoding is done with analog circuitry. Encoder used here is HT 12E. The HT12E encoder is a CMOS IC It is capable of encoding 8 bits of address (A0-A7) and 4- bits of data (AD8-AD11) information. Each address/data input can be set to one of the two logic states, 0 or 1. Grounding the pins is taken as a 0 while a high can be given by giving +5V or leaving the pins open (no connection). Upon reception of transmit enable (TE-active low), the programmed address/data are transmitted together with the header bits via an RF medium.

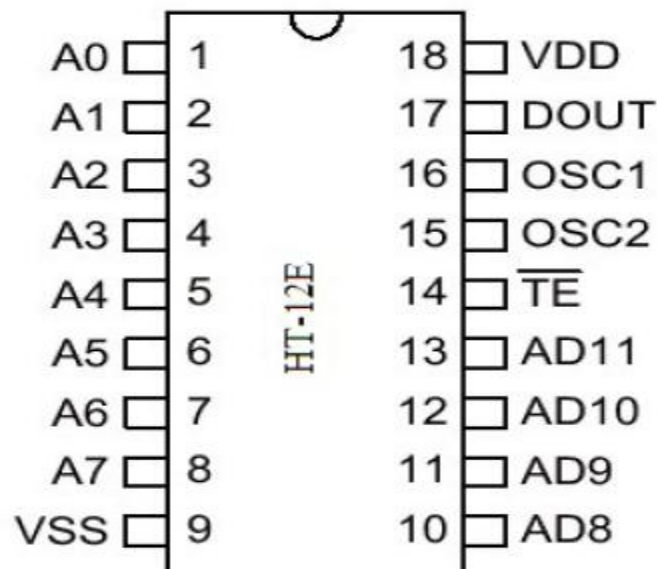


Fig.2.15 RF ENCODER IC

Pin Description of Encoder

Pin	I/O	Internal Connection	Description
A0~A7	I	CMOS IN Pull-high	Input pins for address A0~A7 setting These pins can be externally set to VSS or left open
		NMOS TRANSMISSION GATE PROTECTION DIODE (HT12E)	
AD8~AD11	I	NMOS TRANSMISSION GATE PROTECTION DIODE (HT12E)	Input pins for address/data AD8~AD11 setting These pins can be externally set to VSS or left open
D8~D11	I	CMOS IN Pull-High	Input pins for data D8~D11 setting and transmission enable, active low These pins should be externally set to VSS or left open
DOUT	O	CMOS OUT	Encoder data serial transmission output

L/MB	I	CMOS IN Pull-high	Latch/Momentary transmission format selection pin: Latch: Floating or VDD Momentary: VSS
TE	I	CMOS IN Pull-high	Transmission enable, active low (see Note)
OSC1	I	OSCILLATOR 1	Oscillator input pin
OSC2	O	OSCILLATOR 1	Oscillator output pin
X1	I	OSCILLATOR 2	455kHz resonator oscillator input
X2	O	OSCILLATOR 2	455kHz resonator oscillator output
VSS	I		Negative power supply, grounds
VDD	I		Positive power supply

Table.2.4 Pin Description of Encoder

DECODER

A decoder is a device which does the reverse of an encoder, undoing the encoding so that the original information can be retrieved. The same method used to encode is usually just reversed in order to decode. In digital electronics this would mean that a decoder is a multiple-input, multiple-output logic circuit that converts coded inputs into coded outputs. Enable inputs must be on for the decoder to function, otherwise its outputs assume a single "disabled" output code word. Decoding is necessary in applications such as data multiplexing, 7 segment display and memory address decoding. The decoder used here is HT 12D. The HT12D is a decoder IC made especially to pair with the HT 12E encoder. It is a CMOS IC. The decoder is capable of decoding 8 bits of address (A0 - A7) and 4 bits of data (AD8 - AD11) information. For proper operation, a pair of encoder/decoder with the same number of addresses and data format should be chosen. The decoders receive serial addresses and data from programmed encoders that are transmitted by a carrier using an RF or an IR transmission medium. They compare the serial input data three times continuously with their local addresses. If no error or unmatched codes are found, the input data codes are decoded and then transferred to the output pins. The VT pin also goes high to indicate a valid transmission. The decoders are capable of decoding information that consists of N bits of address and 12_N bits of data. Of this series, the HT 12D is arranged to provide 8 address bits and 4 data bits.

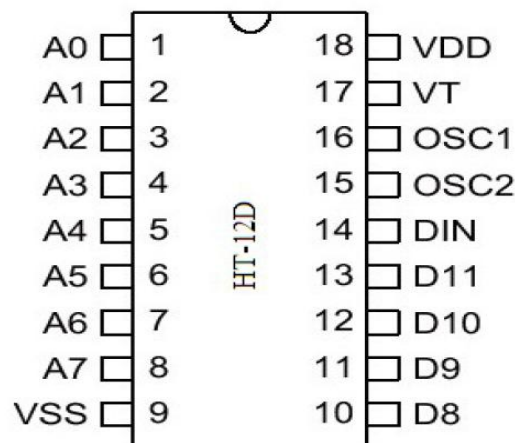


Fig.2.16 RF Decoder IC

Pin Description of Decoder

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

Table.2.5 Pin Description of Decoder

RF Advantages:

1. Not line of sight
2. Not blocked by common materials: can penetrate most solids and pass through walls
3. Longer range
4. Not light sensitive
5. Not as sensitive to weather/environmental conditions

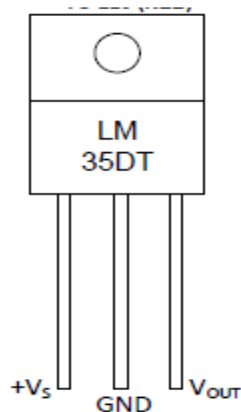
RF Disadvantages:

1. Interference: communication devices using similar frequencies - wireless phones, scanners, wrist radios and personal locators can interfere with transmission
2. Lack of security: easier to "eavesdrop" on transmissions since signals are spread out in space rather than confined to a wire
3. Higher cost than infrared
4. Federal Communications Commission(FCC) licenses required for some products
5. Lower speed: data rate transmission is lower than wired and infrared transmission

2.7 TEMPERATURE SENSOR

Temperature is the most-measured process variable in industrial automation. Most commonly, a temperature sensor is used to convert temperature value to an electrical value. Temperature Sensors are the key to read temperatures correctly and to control temperature in industrial applications.

A large distinction can be made between temperature sensor types. Sensors differ a lot in properties such as contact-way, temperature range, calibrating method and sensing element. The temperature sensors contain a sensing element enclosed in housings of plastic or metal. With the help of conditioning circuits, the sensor will reflect the change of environmental temperature.

Temperature sensor (LM35)**Fig 2.17 Temperature sensor (LM35)****Pin Definition**

The definition of gray-scale sensor pin is

1. Signal Output
2. GND
3. Power

Features Of Temperature Sensor

- Calibrated directly in Celsius (centigrade)
- 0.5⁰ C Ensured accuracy (at +25⁰ C)
- Suitable for remote applications
- Operate from 4 to 30 V
- Low cost due to wafer-level trimming

Specifications

- Type: Analog
- Sensitivity: 10mV per degree Celcius
- Functional range: 0 degree Celsius to 100 degree Celsius

Description

The LM35 series are precision integrated-circuit temperature sensors, with an output voltage linearly proportional to the Centigrade temperature. Thus LM35 has an advantage over linear temperature sensors calibrated in ° Kelvin, as the user is not required to subtract a large constant voltage from the output to obtain convenient Centigrade scaling.

In the temperature functional module we developed, we use the LM34 series of temperature sensors. The LM34 series are precision integrated-circuit temperature sensors, whose output voltage is linearly proportional to the Fahrenheit temperature. The LM34 thus has an advantage over linear temperature sensors calibrated in degrees Kelvin, as the user is not required to subtract a large constant voltage from its output to obtain convenient Fahrenheit scaling. The LM34 does not require any external calibration or trimming to provide typical accuracies of $\pm 1.2^{\circ}\text{F}$ at room temperature and $\pm 11.2^{\circ}\text{F}$ over a full -50 to $+300^{\circ}\text{F}$ temperature range. The LM34 is rated to operate over a -50° to $+300^{\circ}\text{F}$ temperature range.

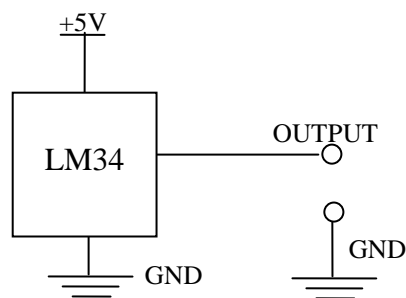


Figure 2.18 Circuit diagram for the LM34 temperature sensor functional module

It is easy to include the LM34 series in a temperature measuring application. The output voltage of LM34 is linearly proportional to the Fahrenheit temperature, it has a Linear $+10.0 \text{ mV}/^{\circ}\text{F}$ scale factor which means that you will get $n \times 10.0 \text{ mV}$ output voltage if the environment temperature is $n^{\circ}\text{F}$.

The LM34 series is available packaged in hermetic TO-46 transistor packages, while the LM34C, LM34CA and LM34D are also available in the plastic TO-92 transistor package. The LM34D is also available in an 8-lead surface mount small outline package. In our functional module, LM34H in metal can package (TO-46) is used in the functional module, it is very important to know that the wiring of sensor should be based on the positions of the leading pins in different packages.

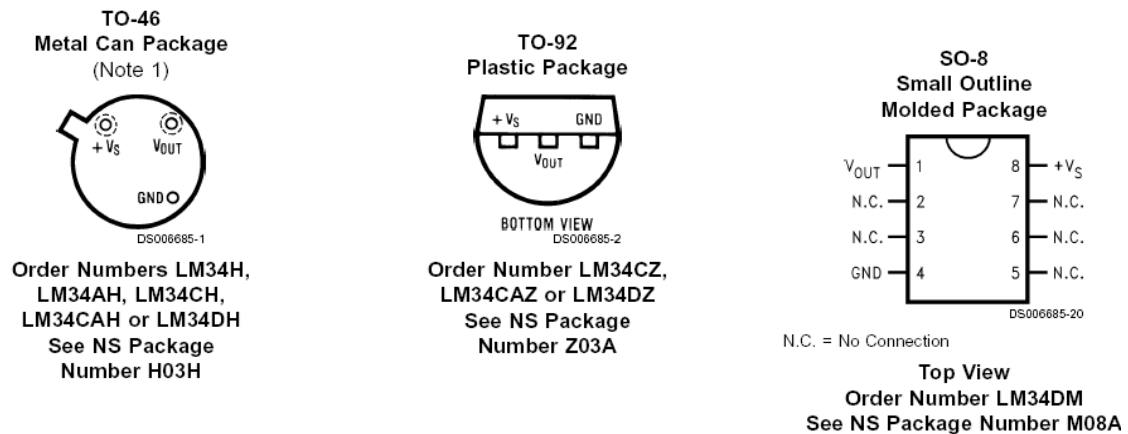


Figure 2.19 Package Diagram of LM34

DESCRIPTION OF TEMPERATURE SENSOR FUNCTIONAL MODULE

The temperature sensor functional module consists of two parts: the function module box and the probe head. The LM34 temperature sensor is mounted on the probe head. Be careful to make sure that the sensor is properly mounted on the probe head. (refer to Figure 4 Labeled picture of the probe head.)

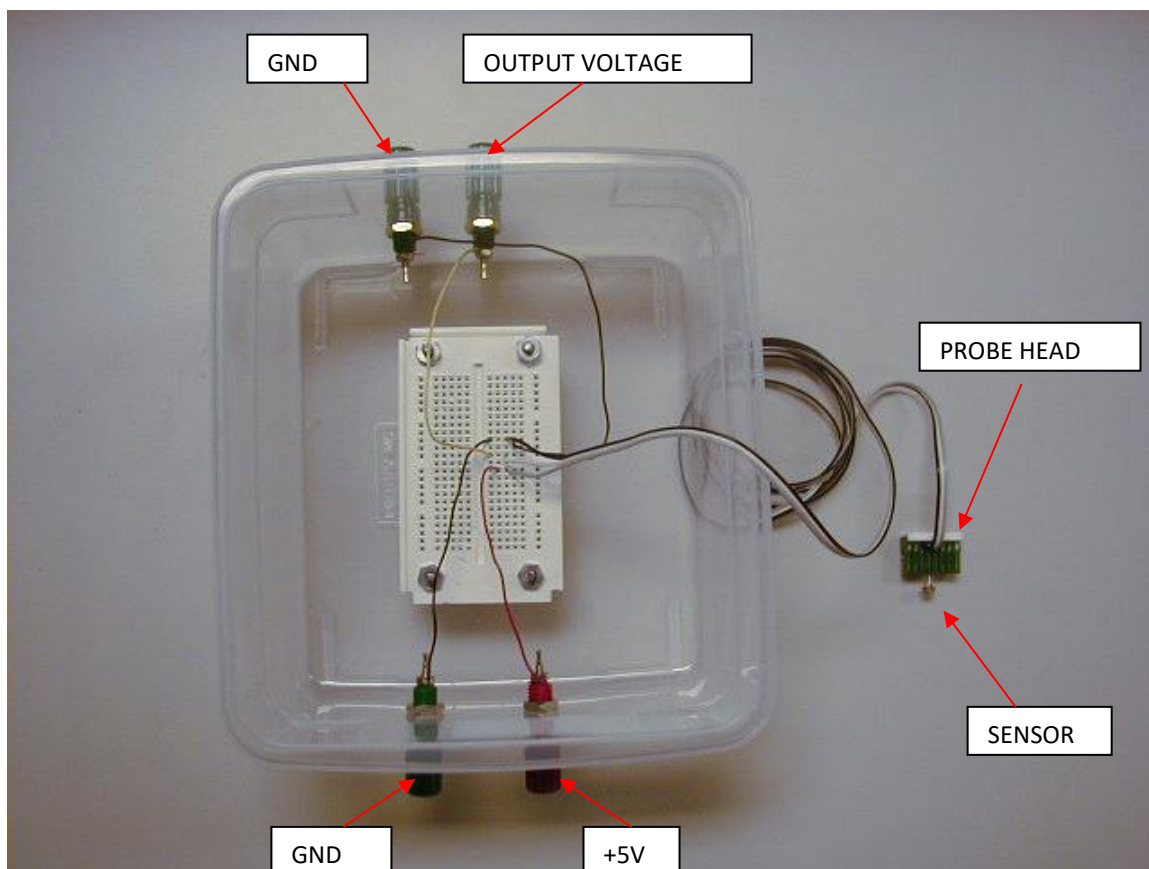


Figure 2.20 Labeled picture of the temperature sensor circuit functional module.

By replacing the LM34 with another precision integrated-circuit temperature sensor LM35, we can easily get an output voltage proportional to the centigrade temperature. The LM35 sensor has a linear $+10.0 \text{ mV}/^{\circ}\text{C}$ scale factor and a temperature range from -55°C to $+150^{\circ}\text{C}$. In fact LM34 and LM35 are among the same series of temperature sensors so that they can be easily exchanged in different applications. The wiring for LM 35 is the same as that of LM34. Please refer to the datasheets of LM34 and LM35 for more detailed packaging and features information.

APPLICATIONS

The LM35 is applied easily in the same way as other integrated-circuit temperature sensors. Glue or cement the device to a surface and the temperature should be within about 0.01°C of the surface temperature.

This presumes that the ambient air temperature is almost the same as the surface temperature. If the air temperature were much higher or lower than the surface temperature, the actual temperature of the LM35 die would be at an intermediate temperature between the surface temperature and the air temperature, which is especially true for the TO-92 plastic package where the copper leads are the principal thermal path to carry heat into the device, so its temperature might be closer to the air temperature than to the surface temperature.

To minimize this problem, ensure that the wiring to the LM35, as it leaves the device, is held at the same temperature as the surface of interest. The easiest way to do this is to cover up these wires with a bead of epoxy which will insure that the leads and wires are all at the same temperature as the surface, and that the temperature of the LM35 die is not affected by the air temperature.

2.8 SOIL SENSOR

Soil water content has important effects on many fundamental biophysical processes. It influences seed germination, plant growth and nutrition, microbial degradation of soil organic matter, conversion of nutrients in the root zone and water transfer at the land air interface. Quantification of soil water content is necessary for a variety of applications ranging from large scale calibration of global climate models to field monitoring in agricultural and horticultural

systems when we need to measure water content in the soil the soil moisture sensor comes to mind.

A soil moisture sensor is a type of sensor used to measure the volumetric water content of the soil. Because, a direct gravimetric amount of soil moisture must be removed, dried and weighed. These sensors do not directly measure volumetric water content using other soil laws such as permittivity, electrical resistivity, interaction with neutrons, and water content displacement.

The relationship between calculated properties and soil moisture needs to be adjusted and can change with ecological factors such as temperature, soil type and other conductivity. Reflected microwave radiation can be affected by soil moisture and is mainly used in remote sensing in agriculture and hydrology.

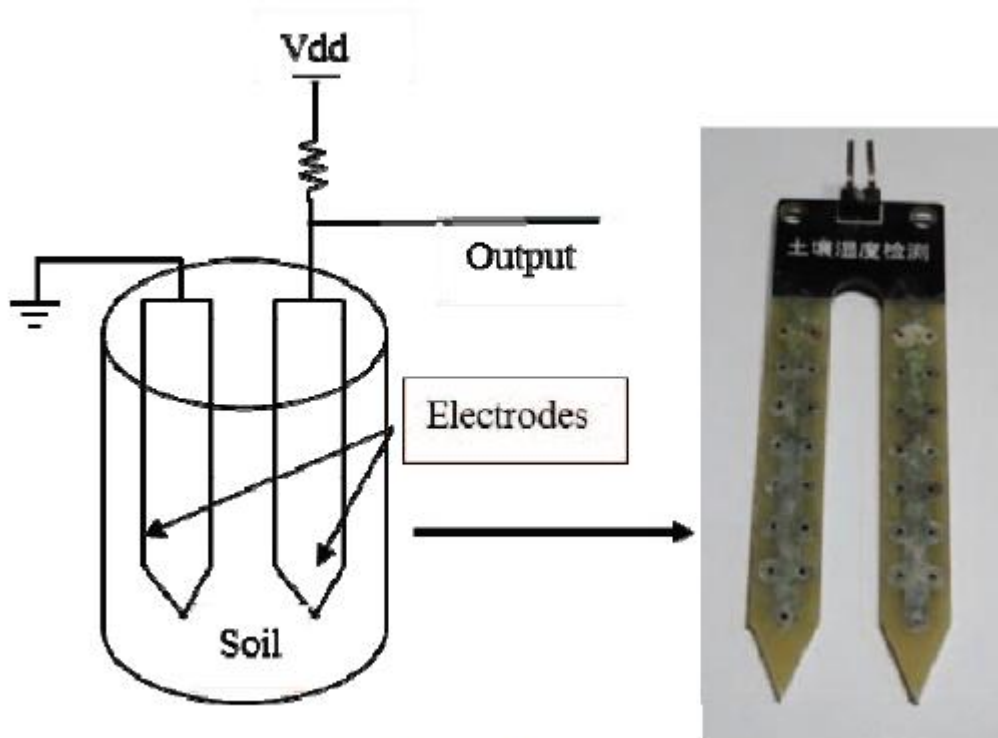


FIG 2.21 SOIL SENSOR

The main advantage of using soil moisture sensors to plan irrigation is more efficient water usage, thus reducing water consumption while allowing plant roots to grow deeper and avoiding over-watering or over-watering.

Nutrient leaching is avoided. Avoiding overwatering also eliminates favorable conditions for some pests and fungal diseases. These statements are especially true for trees affected by citrus blight. This is because reduced root size and function can exacerbate the effects of drought.

A SOIL type sensor is the easiest of soil moisture sensor but it is considered as being highly crude. It is suitable for an inaccurate measurement such as the soil being wet or not. The sensor uses the soil as the resistance medium and passes the current through the soil between the two electrodes. The resistance value represents the moisture content of the soil. By accumulating more water this makes the soil to have more conductivity; the moisture soil will be less than the dry soil. Fig shows a simple and very low-cost circuit of a resistor-based sensor



WORKING PRINCIPLE AND SPECIFICATION

This sensor primarily uses capacitance to measure soil moisture content (permittivity). The functionality of this sensor can be performed by inserting this sensor into the soil and reporting the moisture content status of the soil in percentage. This sensor is ideal for conducting experiments in science courses such as environmental science, agriculture, biology, soil science, botany and horticulture.

This soil moisture sensor is integrated with the LM393 comparator chip, this is an integrated circuit (IC), a dual differential comparator, consisting of two integrated operational amplifiers. They are commonly used in devices that measure analog signals and act as Analog-to-digital converters (ADC) also each comparator accepts two inputs for comparison. A comparator compares these two input voltages, measures which input voltage is greater, and provides an output.



Fig 2.22 Comparator chip

This module has a built-in potentiometer to set the sensitivity of the digital output (DO). You can set the threshold with a potentiometer. So when the moisture level exceeds the threshold, the module will output LOW, otherwise, it will output HIGH. This setting is very useful for triggering actions when certain thresholds are reached. For example, when the soil moisture level exceeds a threshold, a relay can be activated to start pumping water.

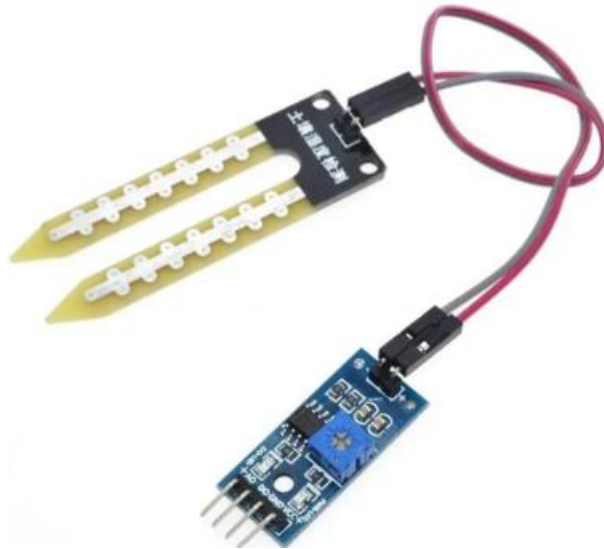
FEATURES:

- It is integrated with the LM393 comparator module chip.
- Dual output module, analog and digital
- The soil moisture sensor have to fix bolt holes for easy mounting.
- There are two LED indicators, red (power indicator) and green (output indicator).
- Soil moisture sensors are the most sensitive to the environment and typically use soil moisture content.

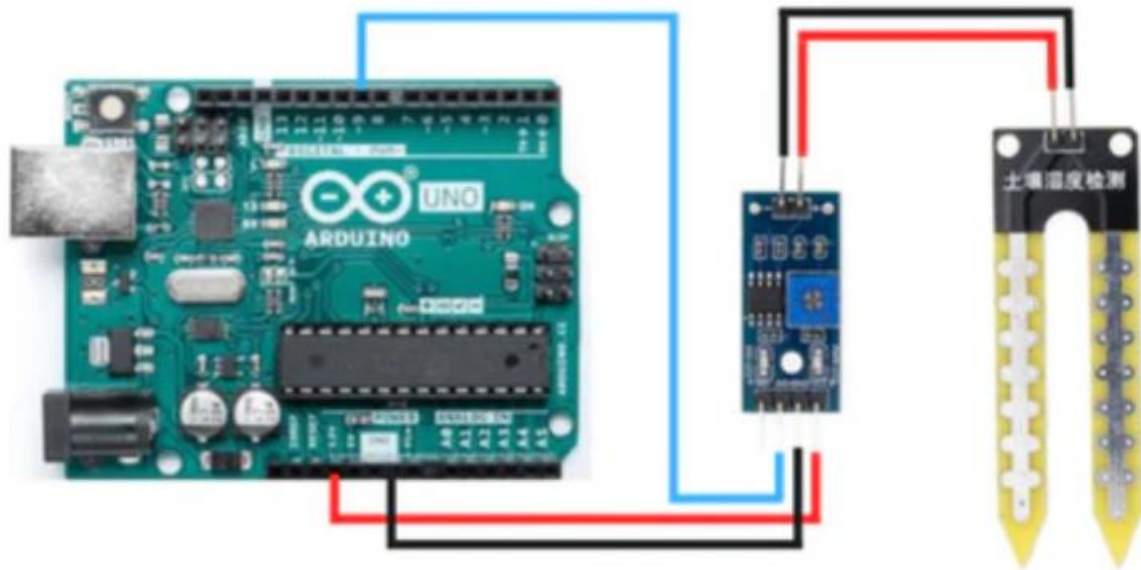
SPECIFICATIONS:

SENSOR TYPE	SOIL MOISTURE SENSOR
Operating Voltage	3.3V- 5V
Current flow	<20 Am
Type of interface	Analog Type
Working temperature of the sensor	10 – 30 degree Celcius
PCB dimension of comparator	3 cm x 1.5 cm
Soil Probe Dimension	6 cm x 3 cm
Cable Length	20 cm
Weight	50 gms

Table 2.6 Specifications of Sensor



+	Voltage Supply
-	-ve pin
LM393 Comparator	
VCC	Power supply
Gnd	Common GND
AO	Analog pin
DO	Digital pin

Interface Arduino with soil moisture sensor:**Fig 2.23 : Interface Arduino with soil moisture sensor****BENEFITS OF SOIL MOISTURE SENSOR**

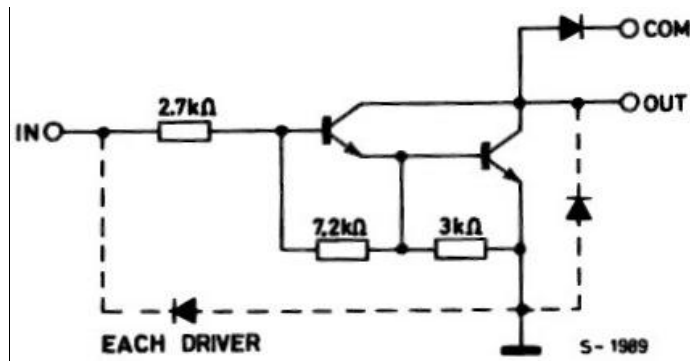
- Less water use can be modified to lower and higher thresholds to preserve ideal soil moisture saturation and reduce plant withering.
- It can result in deeper plant root growth, decreased soil runoff and leaching, and unfavorable circumstances for pests and fungi.

APPLICATIONS:

- Agriculture
- Landscape irrigation
- Research
- Simple sensors for gardeners

2.9 ULN2003:-

The ULN2003 is a monolithic IC consists of seven NPN darlington transistor pairs with high voltage and current capability. It is commonly used for applications such as relay drivers, motor, display drivers, led lamp drivers, logic buffers, line drivers, hammer drivers and other high voltage current applications. It consists of common cathode clamp diodes for each NPN darlington pair which makes this driver IC useful for switching inductive loads.



The output of the driver is open collector and the collector current rating of each darlington pair is 500mA. Darlington pairs may be paralleled if higher current is required. The driver IC also consists of a 2.7KΩ base resistor for each darlington pair. Thus, each darlington pair can be operated directly with TTL or 5V CMOS devices. This driver IC can be used for high voltage applications up to 50V.

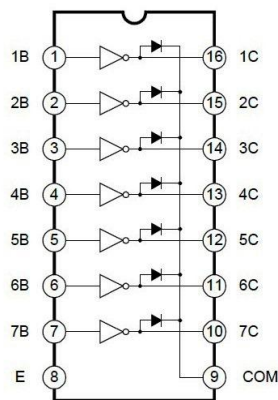


Fig 2.24 Logic Diagram of ULN2003

Note that the driver provides open collector output, so it can only sink current, cannot source. Thus when a 5V is given to 1B terminal, 1C terminal will be connected to ground via darlington pair and the maximum current that it can handle is 500A. From the above logic diagram we can see that cathode of protection diodes are shorted to 9th pin called COM. So for driving inductive loads, it must connect to the supply voltage.

ULN2003 is widely used in relay driving and stepper motor driving applications.

FEATURES

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

2.10 RELAY

INTRODUCTION

A relay is an electromechanical switch, which perform ON and OFF operations without any human interaction. General representation of double contact relay is shown in fig. Relays are used where it is necessary to control a circuit by a low-power signal (with complete electrical isolation between control and controlled circuits), or where several circuits must be controlled by one signal.



Fig.2.25 Relay

History

The first relay was invented by Joseph Henry in 1835. The name relay derives from the French noun 'relais' that indicates the horse exchange place of the postman. Generally a relay is an electrical hardware device having an input and output gate. The output gate consists in one or more electrical contacts that switch when the input gate is electrically excited. It can implement a decoupled, a router or breaker for the electrical power, a negation, and, on the base of the wiring, complicated logical functions containing and, or, and flip-flop. In the past relays had a wide use, for instance the telephone switching or the railway routing and crossing systems. In spite of electronic progresses (as programmable devices), relays are still used in applications where ruggedness, simplicity, long life and high reliability are important factors (for instance in safety applications)

Working

Generally, the relay consists a inductor coil, a spring (not shown in the figure), Swing terminal, and two high power contacts named as normally closed (NC) and normally opened (NO). Relay uses an Electromagnet to move swing terminal between two contacts (NO and

NC). When there is no power applied to the inductor coil (Relay is OFF), the spring holds the swing terminal is attached to NC contact.

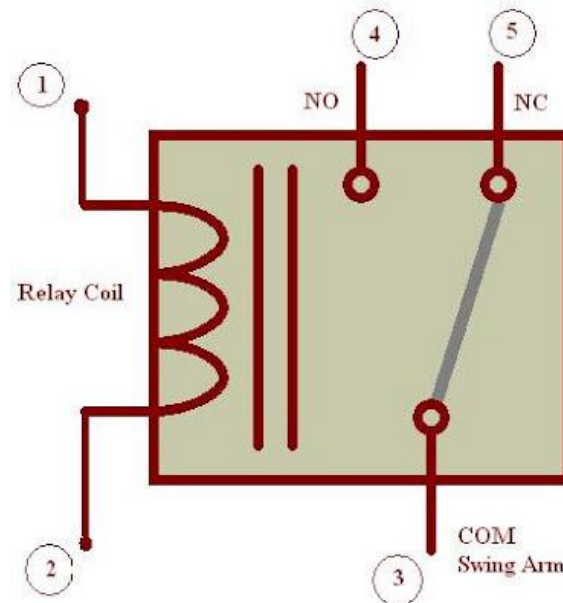


Fig.2.26 Representation of Relay

Whenever required power is applied to the inductor coil, the current flowing through the coil generates a magnetic field which is helpful to move the swing terminal and attached it to the normally open (NO) contact. Again when power is OFF, the spring restores the swing terminal position to NC.

Advantage of relay:

A relay takes small power to turn ON, but it can control high power devices to switch ON and OFF. Consider an example; a relay is used to control the ceiling FAN at our home. The ceiling FAN may runs at 230V AC and draws a current maximum of 4A. Therefore the power required is $4 \times 230 = 920$ watts. Off course we can control AC, lights, etc., depend up on the relay ratings. Relays can be used to control DC motors in ROBOTICS.

2.11 SUBMERSIBLE WATER PUMP

DESCRIPTION:

This submersible pump is designed for reliability and ultra-quiet operation to provide years of service. The small profile size makes the pump easy to hide or disguise. Has adjustable flow and is easy to clean. This submersible water pump is great for aquarium, fountains, spout and hydroponic systems.

WORKING PRINCIPLE:

It is often used as a booster pump for home water pressure. It can be completely submerged into the fluid and the motor is hermetically sealed. The motor is close-coupled to the body of the water booster pump. It pumps the water to the surface by energy conversion that works in a cycle. The rotary energy is converted into kinetic energy that is further converted into pressure energy.

The submersible pump works by pulling the fluid towards itself. During the intake, the rotating impeller pushes the fluid through the diffuser. From there, the fluid goes to the surface. The submersible pumps are self-priming as they are already submerged in the fluid. Cavitation is never an issue and they are also quiet because they work underwater.

FEATURE:

- Adjustable water flow rate
- Suction cup mounting feet for either vertical or horizontal mounting
- Contains no seals or messy oils
- Good for both fresh water and salt water

SPECIFICATION:

- Max Flow Rate: 20L/H
- H-Max (Lift height): 1.6 feet
- Power: 6-18 Watt
- Voltage: 110 – 120/230 V @ 50 Hz
- Outlet: Fits 0.315" ID (inside diameter) tubing



Fig 2.27 Pump Motor

INCLUDES:

- (1) Pump
- (1) Outlet adapter

2.12 BUZZER

A buzzer or beeper is a signaling device, usually electronic, typically used in automobiles, house hold appliances such as a microwave oven, or game shows.

It most commonly consists of a number of switches or sensors connected to a control unit that determines if and which button was pushed or a preset time has lapsed, and usually illuminates a light on the appropriate button or control panel, and sounds a warning in the form of a continuous or intermittent buzzing or beeping sound. Initially this device was based on an electromechanical system which was identical to an electric bell without the metal gong (which makes the ringing noise). Often these units were anchored to a wall or ceiling and used the ceiling or wall as a sounding board. Another implementation with some AC-connected devices was to implement a circuit to make the AC current into a noise loud enough to drive a loudspeaker and hook this circuit up to a cheap 8-ohm speaker. Nowadays, it is more popular to use a ceramic-based piezoelectric sounder like a Sonalert which makes a high-pitched tone. Usually these were hooked up to “driver” circuits which varied the pitch of the sound or pulsed the sound on and off. In game shows it is also known as a “lockout system,” because when one person signals (“buzzes in”), all others are locked out from signalling. Several game shows have large buzzer buttons which are identified as “plungers”.

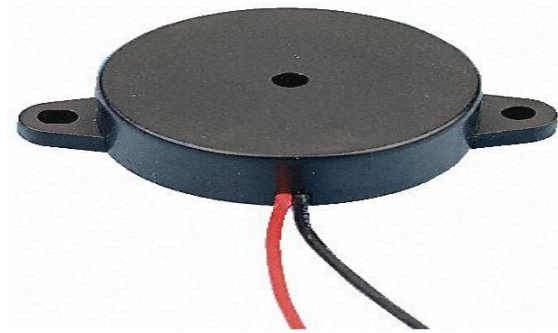


Fig.2.28 Buzzer

2.6.1 USES

- Annunciator panels
- Electronic metronomes
- Game shows
- Microwave ovens and other household appliances
- Sporting events such as basketball games
- Electrical alarms

CHAPTER 3

SOFTWARE SPECIFICATION

3. KEIL SOFTWARE:

Keil compiler is a software used where the machine language code is written and compiled. After compilation, the machine source code is converted into hex code which is to be dumped into the microcontroller for further processing. Keil compiler also supports C language code.

3.1 GENERAL INTRODUCTION:

Keil Software is the leading vendor for 8/16-bit development tools (ranked at first position in the 2004 Embedded Market Study of the Embedded Systems and EE Times magazine). Keil Software is represented world-wide in more than 40 countries. Since the market introduction in 1988, the Keil C51 Compiler is the de facto industry standard and supports more than 500 current 8051 device variants. Now, Keil Software offers development tools for ARM.

Keil Software makes C compilers, macro assemblers, real-time kernels, debuggers, simulators, integrated environments, and evaluation boards for the 8051, 251, ARM, and XC16x/C16x/ST10 microcontroller families.

Keil Software is pleased to announce simulation support for the Atmel AT91 ARM family of microcontrollers. The Keil μ Vision Debugger simulates the complete ARM instruction-set as well as the on-chip peripherals for each device in the AT91 ARM/Thumb microcontroller family. The integrated simulator provides complete peripheral simulation. Other new features in the μ Vision Debugger include:

- An integrated Software Logic Analyzer that measures I/O signals as well as program variables and helps developers create complex signal processing algorithms.
- An Execution Profiler that measures time spent in each function, source line, and assembler instruction. Now developers can find exactly where programs spend the most time.

"Using nothing more than the provided simulation support and debug scripts, developers can create a high-fidelity simulation of their actual target hardware and environment. No extra hardware or test equipment is required. The Logic Analyzer and Execution Profiler will help

developers when it comes time to develop and tune signaling algorithms." said Jon Ward, President of Keil Software USA, Inc.

3.2 μ Vision3 Overview:

The μ Vision3 IDE is a Windows-based software development platform that combines a robust editor, project manager, and makes facility. μ Vision3 integrates all tools including the C compiler, macro assembler, linker/locator, and HEX file generator. μ Vision3 helps expedite the development process of your embedded applications by providing the following:

- Full-featured source code editor,
- Device database for configuring the development tool setting,
- Project manager for creating and maintaining your projects,
- Integrated make facility for assembling, compiling, and linking your embedded applications,
- Dialogs for all development tool settings,
- True integrated source-level Debugger with high-speed CPU and peripheral simulator,
- Advanced GDI interface for software debugging in the target hardware and for connection to Keil ULINK,
- Flash programming utility for downloading the application program into Flash ROM,
- Links to development tools manuals, device datasheets & user's guides.

The μ Vision3 IDE offers numerous features and advantages that help you quickly and successfully develop embedded applications. They are easy to use and are guaranteed to help you achieve your design goals.

The μ Vision3 IDE and Debugger is the central part of the Keil development tool chain. μ Vision3 offers a Build Mode and a Debug Mode.

In the μ Vision3 Build Mode you maintain the project files and generate the application.

In the μ Vision3 Debug Mode you verify your program either with a powerful CPU and peripheral simulator or with the Keil ULINK USB-JTAG Adapter (or other AGDI drivers) that connect the debugger to the target system. The ULINK allows you also to download your application into Flash ROM of your target system.

3.3 STEPS TO WRITE AN ASSEMBLY LANGUAGE PROGRAM IN KEIL AND HOW TO COMPILE IT:

- Install the Keil Software in the PC in any of the drives.
- After installation, an icon will be created with the name “Keil uVision3”. Just drag this icon onto the desktop so that it becomes easy whenever you try to write programs in keil.
- Double click on this icon to start the keil compiler.
- A page opens with different options in it showing the project workspace at the leftmost corner side, output window in the bottom and an ash coloured space for the program to be written.
- Now to start using the keil, click on the option “project”.
- A small window opens showing the options like new project, import project, open project etc. Click on “New project”.
- A small window with the title bar “Create new project” opens. The window asks the user to give the project name with which it should be created and the destination location. The project can be created in any of the drives available. You can create a new folder and then a new file or can create directly a new file.
- After the file is saved in the given destination location, a window opens where a list of vendors will be displayed and you have to select the device for the target you have created.
- The most widely used vendor is Atmel. So click on Atmel and now the family of microcontrollers manufactured by Atmel opens. You can select any one of the microcontrollers according to the requirement.
- When you click on any one of the microcontrollers, the features of that particular microcontroller will be displayed on the right side of the page. The most appropriate microcontroller with which most of the projects can be implemented is the AT89C51. Click on this microcontroller and have a look at its features. Now click on “OK” to select this microcontroller.
- A small window opens asking whether to copy the startup code into the file you have created just now. Just click on “No” to proceed further.
- Now you can see the TARGET and SOURCE GROUP created in the project workspace.
- Now click on “File” and in that “New”. A new page opens and you can start writing program in it.
- After the program is completed, save it with any name but with the .asm extension. Save the program in the file you have created earlier.

- You can notice that after you save the program, the predefined keywords will be highlighted in bold letters.
- Now add this file to the target by giving a right click on the source group. A list of options open and in that select “Add files to the source group”. Check for this file where you have saved and add it.
- Right click on the target and select the first option “Options for target”. A window opens with different options like device, target, output etc. First click on “target”.
- Since the set frequency of the microcontroller is 11.0592 MHz to interface with the PC, just enter this frequency value in the Xtal (MHz) text area and put a tick on the Use on-chip ROM. This is because the program what we write here in the keil will later be dumped into the microcontroller and will be stored in the inbuilt ROM in the microcontroller.
- Now click the option “Output” and give any name to the hex file to be created in the “Name of executable” text area and put a tick to the “Create HEX file” option present in the same window. The hex file can be created in any of the drives. You can change the folder by clicking on “Select folder for Objects”.
- Now to check whether the program you have written is errorless or not, click on the icon exactly below the “Open file” icon which is nothing but Build Target icon. You can even use the shortcut key F7 to compile the program written.
- To check for the output, there are several windows like serial window, memory window, project window etc. Depending on the program you have written, select the appropriate window to see the output by entering into debug mode.
- The icon with the letter “d” indicates the debug mode.
- Click on this icon and now click on the option “View” and select the appropriate window to check for the output.
- After this is done, click the icon “debug” again to come out of the debug mode.
- The hex file created as shown earlier will be dumped into the microcontroller with the help of another software called Proload/Topwin.

CHAPTER 4

IMPLEMENTATION

4.1 CODE 1

```
#INCLUDE<REG52.H>
#include<POST.H>
#include<LCD4.H>
#include<STDIO.H>
#include<SERIAL.H>

SBIT TEMP = P1 ^ 0;
SBIT SOIL= P1 ^ 1;
SBIT RF2 = P1 ^ 3;
SBIT RF1 = P1 ^ 2;
SBIT BUZ = P0 ^ 6;

VOID MAIN()
{
    RF1 = 1;
    RF2 = 0;
    TEMP = 1;
    SOIL= 1;
    BUZ = 0;
    SERIALINIT();
    INITLCD();
    STRINGLCD(0X80, "REMOTE CONTROL");
    STRINGLCD(0XC0, "PLANT WATERING");
    POST(400);
    WHILE (1)
    {
        IF (TEMP == 0)
        {
            RF2 = 0;
```

```

    STRINGLCD(0X80, "TEMPERATURE IS");
    STRINGLCD(0XC0, "ABNORMAL");
    BUZ = 1;
    POST(200);
    BUZ = 0;
}

ELSE
{
    RF2 = 1;
    STRINGLCD(0X80, "TEMPERATURE IS");
    STRINGLCD(0XC0, "NORMAL");
    BUZ = 0;
    POST(200);
}

IF (SOIL == 1)
{
    RF2 = 0;
    RF1 = 0;
    STRINGLCD(0X80, "SOIL IS DRY");
    POST(500);
    BUZ = 0;
}
ELSE
{
    RF1 = 1;
    RF2 = 0;
    STRINGLCD(0X80, "SOIL IS WET");
    POST(400);
}
}
}

```

4.2 CODE 2

```
#INCLUDE<REG52.H>
#include<POST.H>
#include<LCD4.H>
#include<SERIAL.H>

SBIT RF0 = P1 ^ 0;
SBIT MOT = P1 ^ 1;
SBIT BUZ = P0 ^ 6;

VOID MAIN()
{
    RF0 = 1;
    MOT = 0;
    BUZ = 0;
    SERIALINIT();
    INITLCD();
    STRINGLCD(0X80, "WELCOME");
    POST(400);
    WHILE (1)
    {
        IF (RF0 == 0)
        {
            MOT = 1;
            STRINGLCD(0X80, "ALERT DANGER");
            STRINGLCD(0XC0, "");
            POST(400);
        }
        ELSE
        {
            MOT = 0;
            STRINGLCD(0X80, "NORMAL STATE");
            STRINGLCD(0XC0, "");
            POST(400);
        }
    }
}
```

}

}

}

4.3 SCHEMATIC

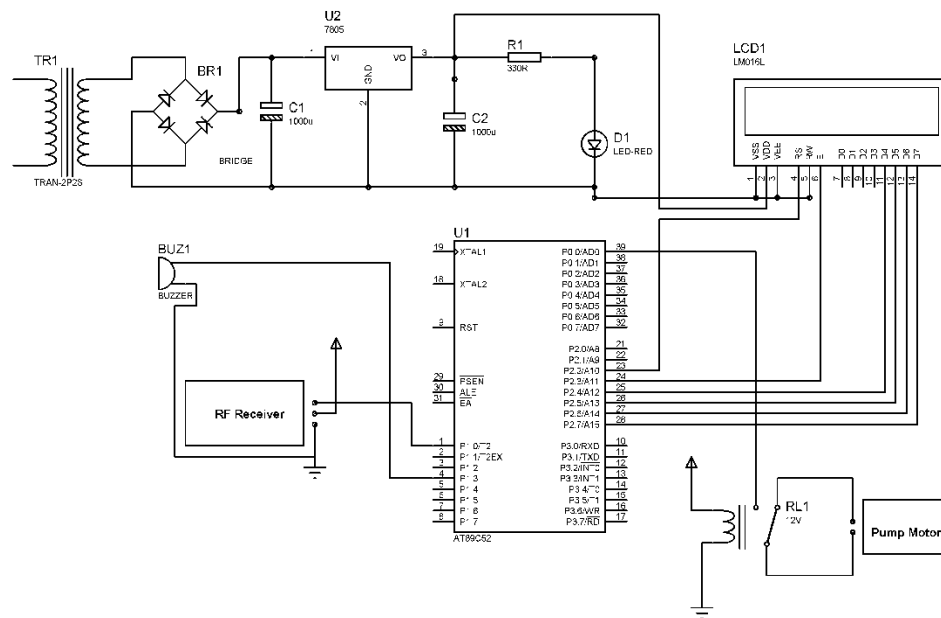
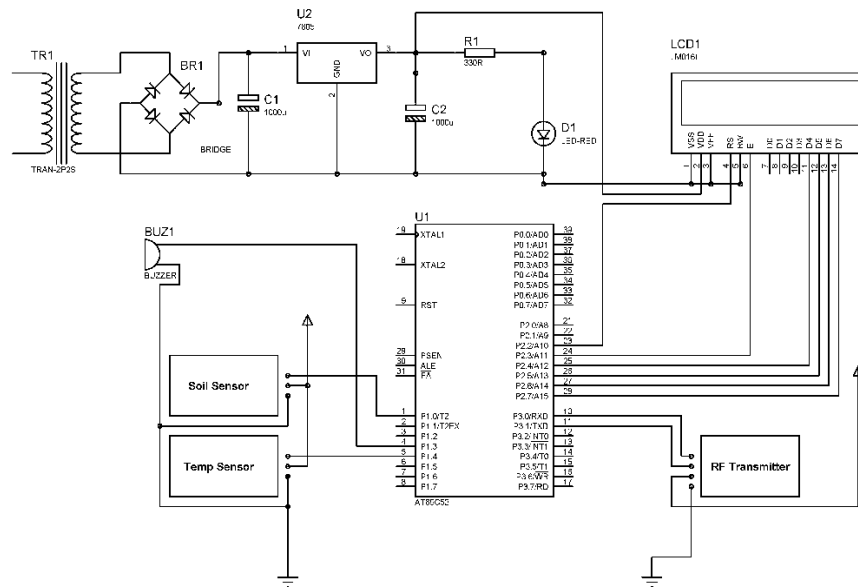


FIG 4.1 : SCHEMATIC 1



CHAPTER 5

SIMULATION AND CIRCUIT DESIGN

5.1 OUTPUTS

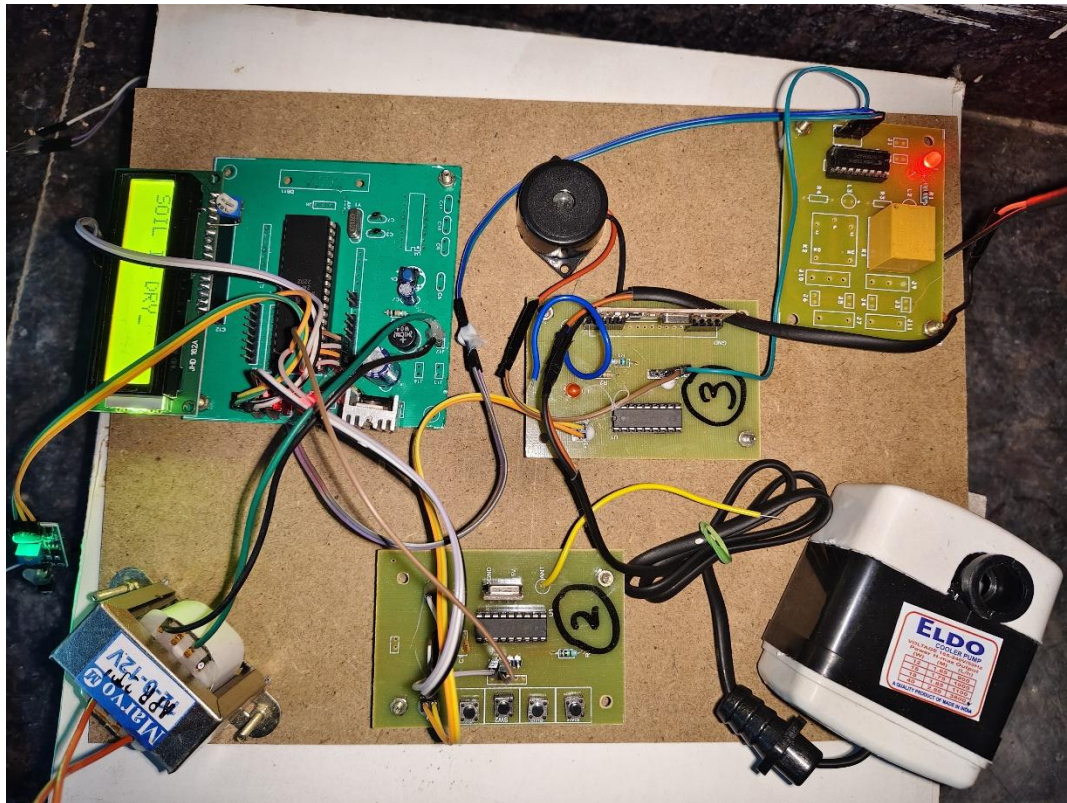


FIG 5.1 : OUTPUT OF THE REMOTE CONTROL PLANT WATERING SYSTEM

CHAPTER 6

CONCLUSION

During the implementation, number of conclusions has been considered based on the practical results obtained from the implemented systems and the following are the most important ones: The system designed is cost effective when compared with other approaches to build such systems. The purpose of designing of Automatic Plant Irrigation System is successfully achieved and fulfills the desired objectives. The hardware and software used performed their function properly to produce desired result which is the required for the farmers in the irrigation field. Interfacing of run time switches with microcontroller makes it flexible in respect of time settings for running a water pipe line. Using this system, farmers will get the protection while doing the irrigation work in extremely odd weather conditions, hard work of repeated assembly and will get rid of poisonous reptiles. The system, which is designed, will help the farmers to do the irrigation process in night also. The system designed do not requires the physical presence of the farmers during irrigation in the fields. The system is automatically monitored and controls the pump on and off.

CHAPTER 7

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