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Full Signature of the Student

Place:

Date:

Department of Electrical Engineering
RCC INSTITUTE OF INFORMATION TECHNOLOGY
GROUND FLOOR, NEW BUILDING,
CANAL SOUTH ROAD, BELIAGHATA, KOLKATA – 700015, WEST BENGAL

CERTIFICATE
To whom it may concern

This is to certify that the project work entitled ***(DIGITAL CLOCK CIRCUIT USING DS1307 AND 8051 MICROPROCESSOR)*** is the bona fide work carried out by **Dhrubojoybar(EE2015055), Ashishranjan(EE2015061), Subhajitroy(EE2015050)** , a student of B.Tech in the Dept. of Electrical Engineering, RCC Institute of Information Technology (RCCIIT), Canal South Road, Beliaghata, Kolkata-700015, affiliated to Maulana Abul Kalam Azad University of Technology (MAKAUT), West Bengal, India, during the academic year **2018-19**, in partial fulfillment of the requirements for the degree of Bachelor of Technology in Electrical Engineering and that this project has not submitted previously for the award of any other degree, diploma and fellowship.

Signature of the Guide
Name:
Designation

Signature of the HOD
Name:
Designation

Signature of the External Examiner
Name:
Designation:

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INTRODUCTION

At this time most peoples in the whole world use an automated digital clock in their everyday use. Starting from the hand watch we were to those huge street clocks every one of us are dependent on the display the make. In 21th century time being more than money, regarding this change our hobbies of checking our time every minute is dramatically increasing. About 99% of today's digital clocks are made using microcontrollers which make them more hand able from the rest, those we can set the time to start any minute or second we want and also set an alarm for reminder so that the system will store the value in a memory and then when the time reaches the alarm will be on. As the microcontroller consists almost all the logical devices external logic gates doesn't exist. In order to be used properly and for a long life usage digital clocks must cover a very small place as much as it could but the size of most of the digital clocks manufactured this time is unexpectedly increasing as the use the give increases. This are the list of problems that exists in today's digital clocks

a) Displays only hour and minute. This makes the use they give us limited on the range given.
b) Not easy to maintain. When the clock gets damaged some can't tell where the problem is easily, on the microcontroller or on the other driver ICS.

LITERATURE SURVEY

In all walks of life, digitals system are making sophisticated approach to the mankind. Of course the machines cannot be replaced by human beings in exact accuracy in some fields. For a long time humans were using analog devices in our case analog clocks in their daily life.

The first digital pocket watch was the invention of Austrian engineer Josef Pallweber who created his "jump-hour" mechanism in 1883. Instead of a conventional dial, the jump-hour featured two windows in an enamel dial, through which the hours and minutes are visible on rotating discs. The second hand remained conventional. By 1885 Pallweber mechanism was already on the market in pocket watches by Cortébert and IWC; arguably contributing to the subsequent rise and commercial success of IWC. The principles of Pallweber jump-hour movement had appeared in wristwatches by the 1920s (Cortébert) and are still used today (Chronoswiss Digiteur). While the original inventor didn't have a watch brand at the time, his name has since been resurrected by a newly established watch manufacturer.

Plato clocks used a similar idea but a different layout. These spring-wound pieces consisted of a glass cylinder with a column inside, affixed to which were small digital cards with numbers printed on them, which flipped as time passed. The Plato clocks were introduced at the St. Louis World Fair in 1904, produced by Ansonia Clock Company. Eugene Fitch of New York patented the clock design in 1903. 13 years earlier Josef Pallweber had patented the same invention using digital cards (different from his 1885 patent using moving disks) in Germany (DRP No. 54093).The German factory Aktiengesellschaft für Uhrenfabrikation Lenzkirch made such digital clocks in 1893 and 1894.

The earliest patent for a digital alarm clock was registered by D.E Protzmann and others on October 23, 1956, in the United States. Protzmann and his associates also patented another digital clock in 1970, which was said to use a minimal amount of moving parts. Two side-plates held digital numerals between them, while an electric motor and cam gear outside controlled movement.

THEORY

I. **IC 7805 VOLTAGE REGULATOR -**Voltage sources in a circuit may have fluctuations resulting in not providing fixed voltage outputs. A voltage regulator IC maintains the output voltage at a constant value. 7805 IC, a member of 78xx series of fixed linear voltage regulators used to maintain such fluctuations, is a popular voltage regulator integrated circuit (IC). The xx in 78xx indicates the output voltage it provides. 7805 IC provides +5 volts regulated power supply with provisions to add a heat sink.

II. **DS 1307 RTC-**Real time clocks (RTC), as the name recommends are clock modules. The DS1307 real time clock (RTC) IC is an 8 pin device using an I2C interface. The DS1307 is a low-power clock/calendar with 56 bytes of battery backup SRAM. The clock/calendar provides seconds, minutes, hours, day, date, month and year qualified data. They are available as integrated circuits (ICs) and supervise timing like a clock and also operate date like a calendar. The main advantage of RTC is that they have an arrangement of battery backup which keeps the clock/calendar running even if there is power failure. An exceptionally little current is required for keeping the RTC animated.

III. **MICROCONTROLLER 8051-**8051 microcontroller is designed by Intel in 1981. It is an 8-bit microcontroller. It is built with 40 pins DIP (dual inline package), 4kb of ROM storage and 128 bytes of RAM storage, 2 16-bit timers. It consists of are four parallel 8-bit ports, which are programmable as well as addressable as per the requirement. An on-chip crystal oscillator is integrated in the microcontroller having crystal frequency of 12 MHz.

IV. **16*2 ALPHANUMERIC LCD-** is named so because; it has 16 Columns and 2 Rows. There are a lot of combinations available like, 8×1, 8×2, 10×2, 16×1, etc. but the most used one is the 16×2 LCD. So, it will have (16×2=32) 32 characters in total and each character will be made of 5×8 Pixel Dots.

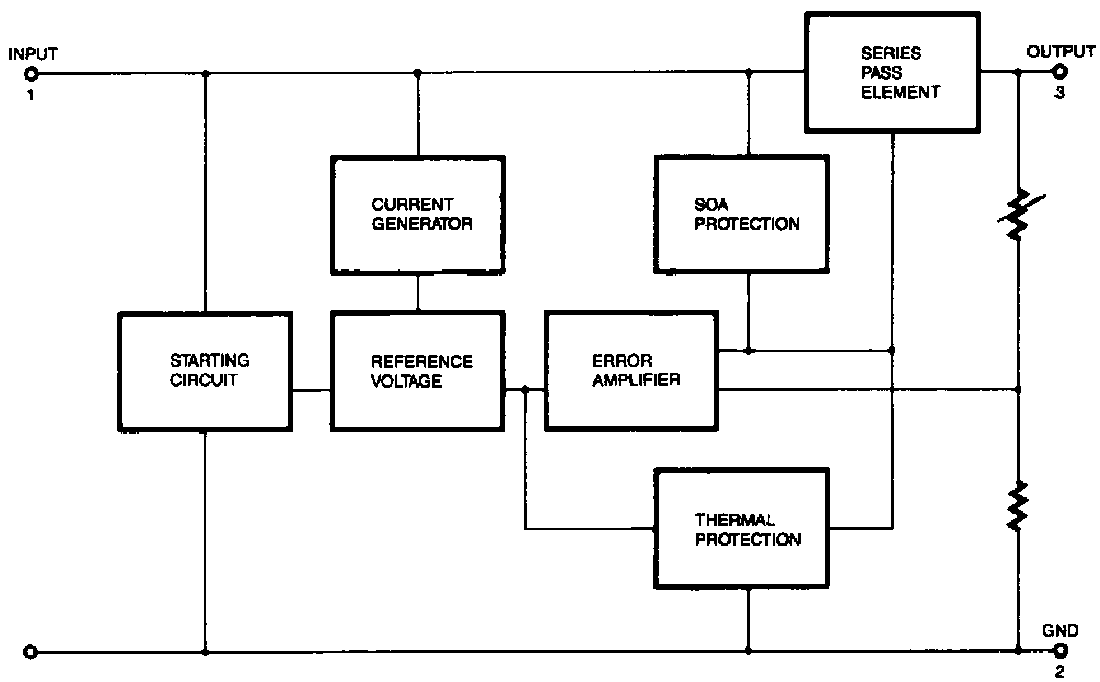
HARDWARE COMPONENTS/SOFTWARES REQUIRED

- **IC 7805**

IC 7805 | VOLTAGE REGULATOR

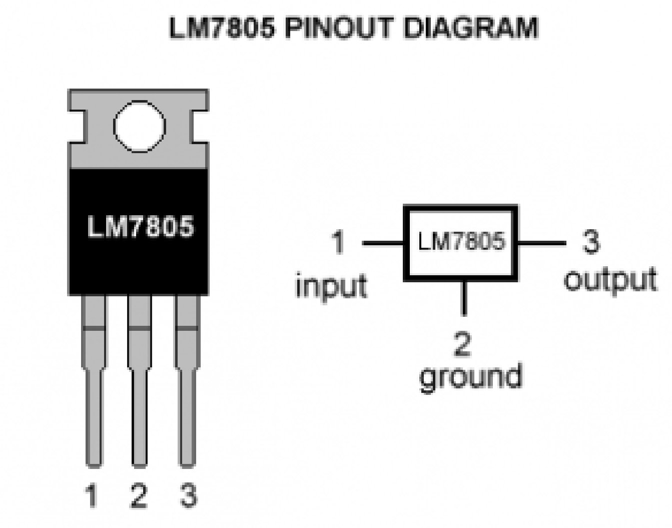
Voltage sources in a circuit may have fluctuations resulting in not providing fixed voltage outputs. A voltage regulator IC maintains the output voltage at a constant value. 7805 IC, a member of 78xx series of fixed linear voltage regulators used to maintain such fluctuations, is a popular voltage regulator integrated circuit (IC). The xx in 78xx indicates the output voltage it provides. 7805 IC provides +5 volts regulated power supply with provisions to add a heat sink.
IC 7805 is a 5V Voltage Regulator that restricts the output voltage to 5V output for various ranges of input voltage. It acts as an excellent component against input voltage fluctuations for circuits, and adds an additional safety to your circuitry. It is inexpensive, easily available and very much commonly used. With few capacitors and this IC you can build pretty solid and reliable voltage regulator in no time.

Internal Block Diagram



7805 IC RATINGS

- Input voltage range 7V- 35V
- Current rating $I_{c\,=}$ 1A
- Output voltage range $V_{Max=5.2V}$,$V_{Min=4.8V}$



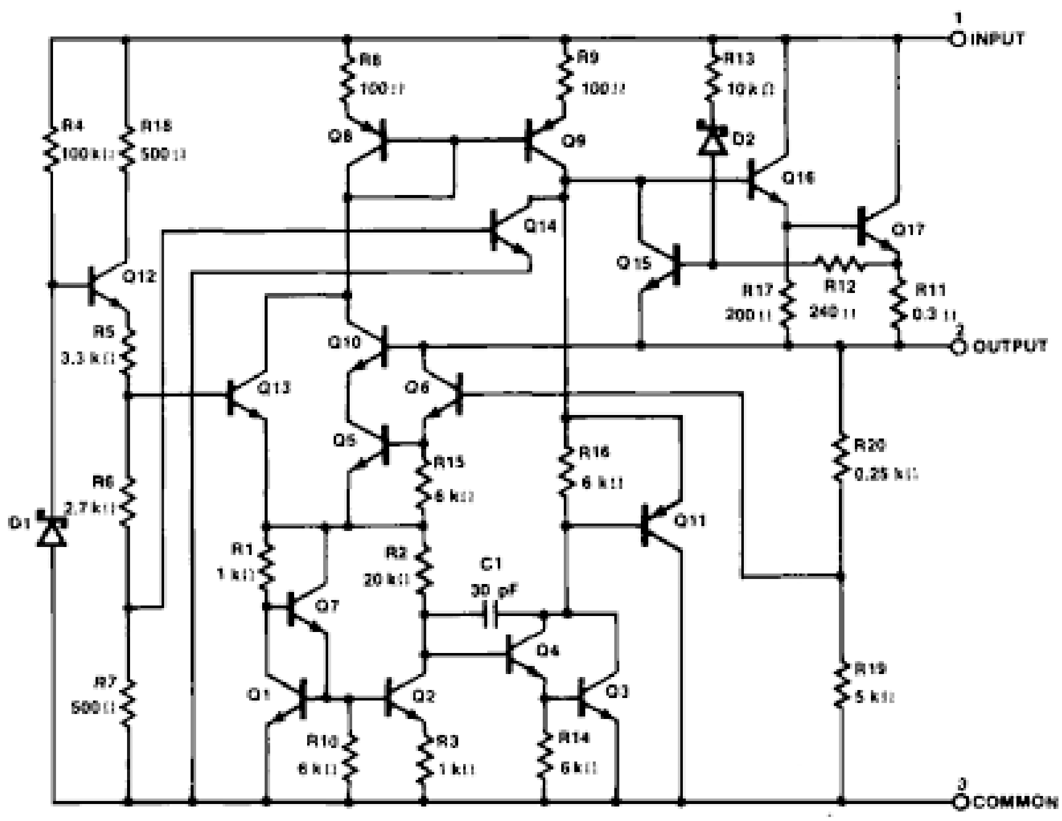
Pin Details of 7805 IC

Pin No.	Pin	Function	Description
1	INPUT	Input voltage (7V-35V)	In this pin of the IC positive unregulated voltage is given in regulation.
2	GROUND	Ground (0V)	In this pin where the ground is given. This pin is neutral for equally the input and output.
3	OUTPUT	Regulated output; 5V (4.8V-5.2V)	The output of the regulated 5V volt is taken out at this pin of the IC regulator.

As you may have noticed, there is a significant difference between the input voltage & the output voltage of the voltage regulator. This difference between the input and output voltage is released

as heat. The greater the difference between the input and output voltage, more the heat generated. If the regulator does not have a heat sink to dissipate this heat, it can get destroyed and malfunction. Hence, it is advisable to limit the voltage to a maximum of 2-3 volts above the output voltage. So, we now have 2 options. Either design your circuit so that the input voltage going into the regulator is limited to 2-3 volts above the output regulated voltage or place an appropriate heatsink that can efficiently dissipate heat.
However, for a mobile phone charger or logic assessment, you require a nice clean DC line. Capacitors will be beneficial in this case as they are good at maximizing voltage regulation. The values of capacitors can also be changed slightly.

<u>Schematic of 7805 IC</u>



The heart of the 7805 IC is a transistor (Q16) that controls the current between the input and output and thus controlling the output voltage. The bandgap reference (yellow) keeps the voltage stable. It takes the scaled output voltage as input (Q1 and Q6) and provides an error signal (to Q7) for indication if the voltage is too high or low. The key task of the bandgap is to provide a stable and accurate reference, even as the chip’s temperature changes.

The error signal from the bandgap reference is amplified by the error amplifier (orange). This amplified signal controls the output transistor through Q15. This closes the negative feedback loop controlling the output voltage. The startup circuit (green) provides initial current to the bandgap circuit, so it doesn't get stuck in an "off" state. The circuit in purple provides protection against overheating (Q13), excessive input voltage (Q19) and excessive output current (Q14). These circuits reduce the output current or shutdown the regulator, protecting it from damage in case of a fault. The voltage divider (blue) scales down the voltage on the output pin for use by the bandgap reference.

Scaling the output

The 7805's scaled output provides the input voltage (Vin) to the bandgap reference and the bandgap provides an error signal as the output. The 7805's bandgap circuit removes the feedback loop that exists inside a traditional bandgap reference. Instead, the entire chip becomes the feedback loop.

If the output voltage is correct (5V), then the voltage divider provides 3.75V at Vin. Any change in output voltage propagates through Q6 and R7, causing the voltage at the base of Q7 to rise or fall accordingly. This change is amplified by Q7 and Q8, generating the error output. The error output, in turn, decreases or increases the current through the output transistor. The negative feedback loop adjusts the output voltage until it is correct.

Application areas for 7805 IC

7805 IC is used in a wide range of circuits. The major ones being:

- Fixed-Output Regulator
- Positive Regulator in Negative Configuration
- Adjustable Output Regulator
- Current Regulator
- Adjustable DC Voltage Regulator
- Regulated Dual-Supply
- Output Polarity-Reversal-Protection Circuit
- Reverse bias projection Circuit

7805 IC also finds usage in building circuits for inductance meter, phone charger, portable CD player, infrared remote control extension and UPS power supply circuits.

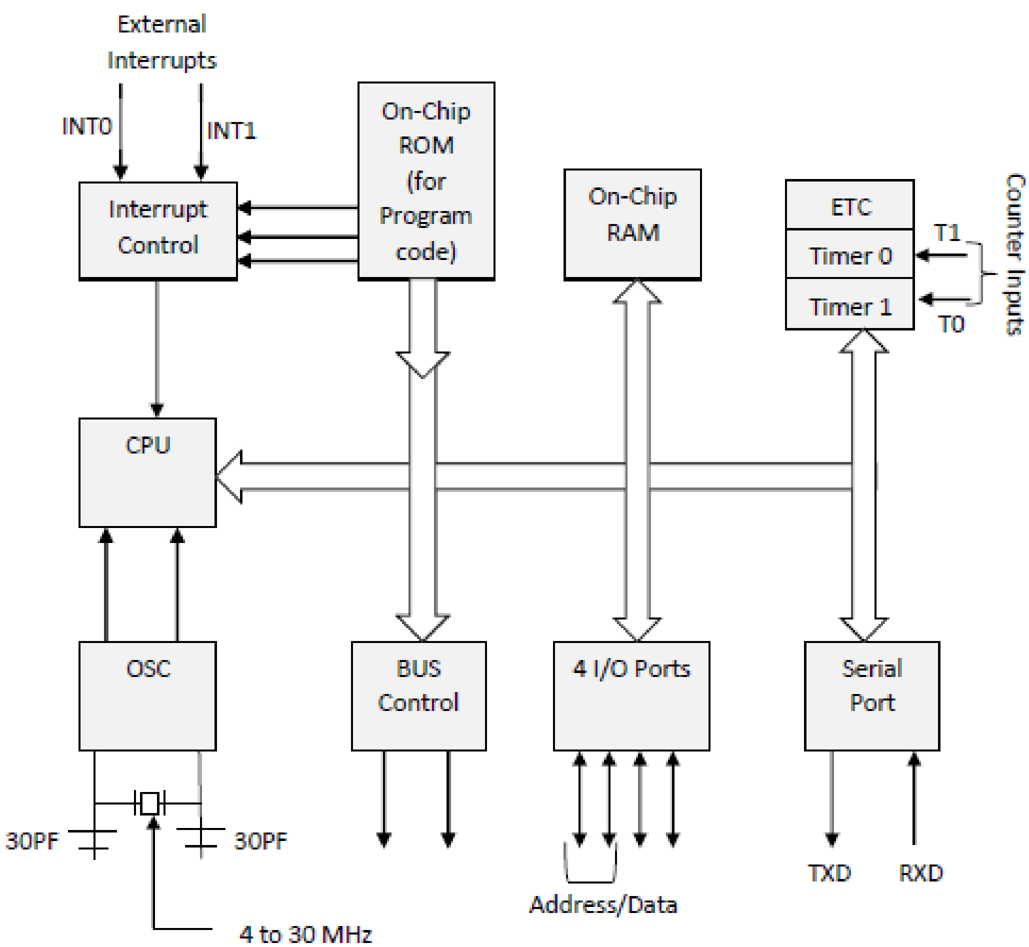
- **8051 microcontroller(AT89S52)**

Microcontrollers - 8051 Architecture

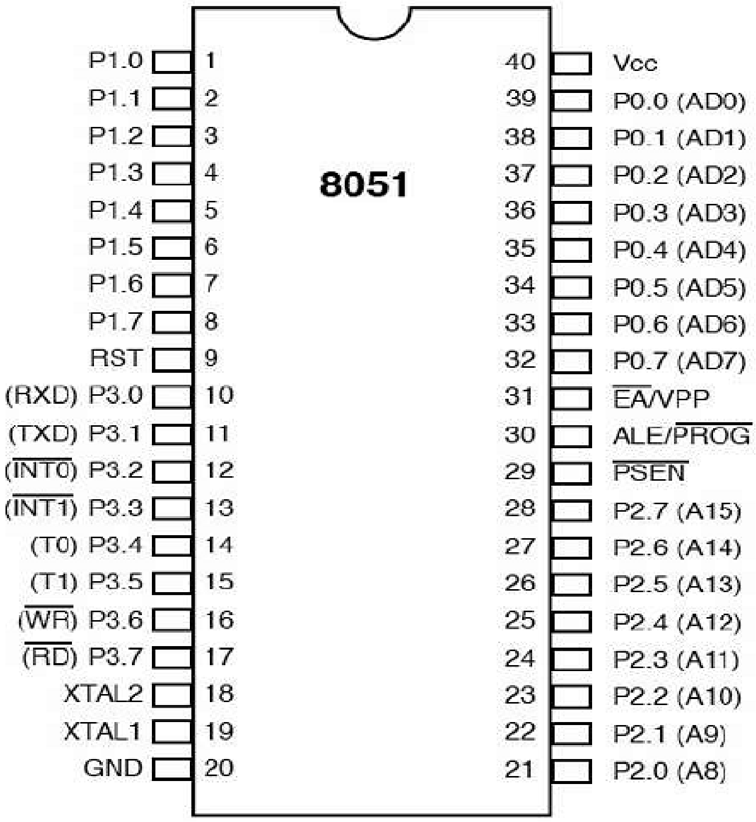
8051 microcontroller was designed by Intel in 1981. It is an 8-bit microcontroller. It is built with 40 pins DIP (dual inline package), 4kb of ROM storage and 128 bytes of RAM storage, 2 16-bit timers. It consists of are four parallel 8-bit ports, which are programmable as well as addressable as per the requirement. An on-chip crystal oscillator is integrated in the microcontroller having crystal frequency of 12 MHz.

Let us now discuss the architecture of 8051 Microcontroller.

In the following diagram, the system bus connects all the support devices to the CPU. The system bus consists of an 8-bit data bus, a 16-bit address bus and bus control signals. All other devices like program memory, ports, data memory, serial interface, interrupt control, timers, and the CPU are all interfaced together through the system bus.



The pin diagram of 8051 microcontroller looks as follows –

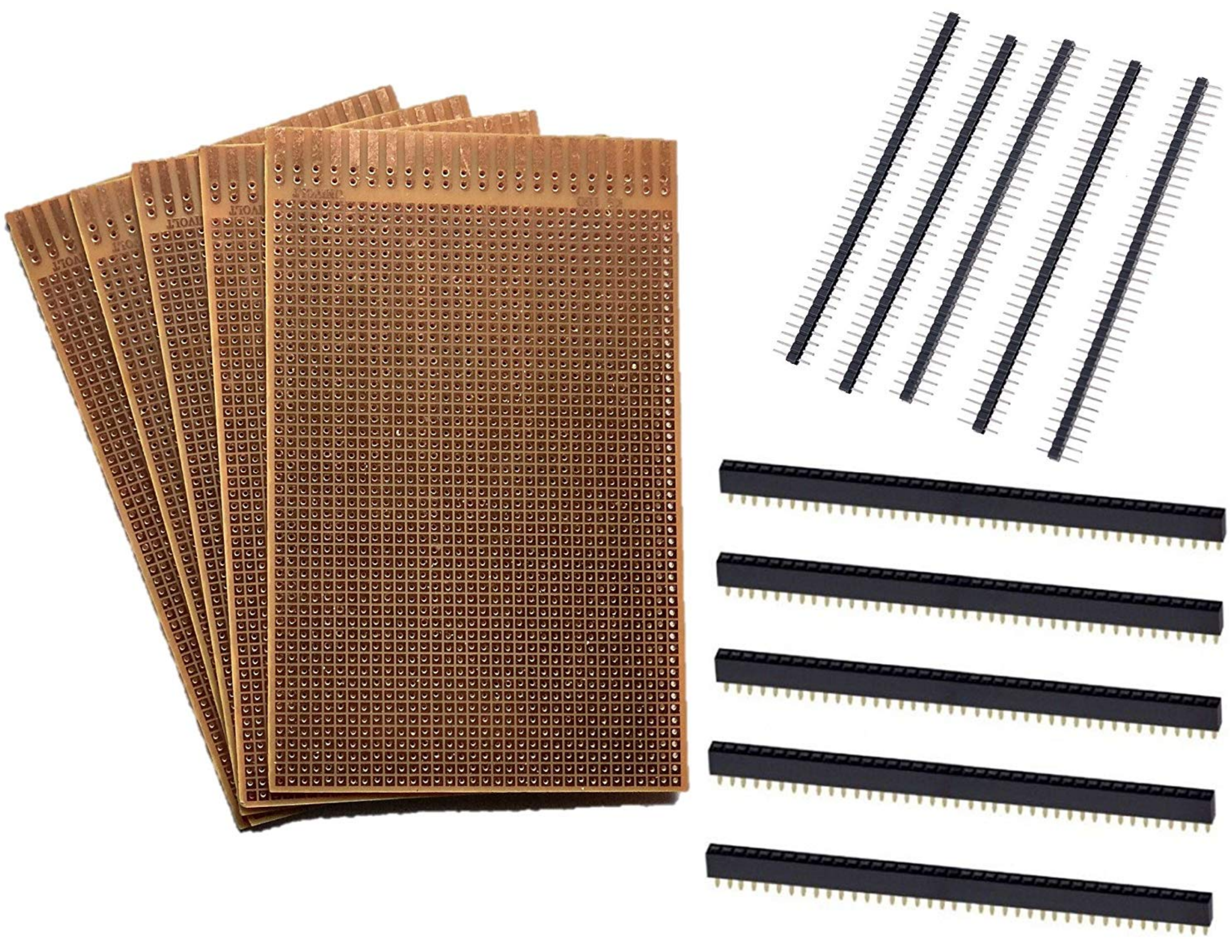


- **Pins 1 to 8** − These pins are known as Port 1. This port doesn't serve any other functions. It is internally pulled up, bi-directional I/O port.
- **Pin 9** − It is a RESET pin, which is used to reset the microcontroller to its initial values.
- **Pins 10 to 17** − These pins are known as Port 3. This port serves some functions like interrupts, timer input, control signals, serial communication signals RxD and TxD, etc.
- **Pins 18 & 19** − These pins are used for interfacing an external crystal to get the system clock.
- **Pin 20** − This pin provides the power supply to the circuit.
- **Pins 21 to 28** − These pins are known as Port 2. It serves as I/O port. Higher order address bus signals are also multiplexed using this port.
- **Pin 29** − This is PSEN pin which stands for Program Store Enable. It is used to read a signal from the external program memory.
- **Pin 30** − This is EA pin which stands for External Access input. It is used to enable/disable the external memory interfacing.
- **Pin 31** − This is ALE pin which stands for Address Latch Enable. It is used to demultiplex the address-data signal of port.
- **Pins 32 to 39** − These pins are known as Port 0. It serves as I/O port. Lower order address and data bus signals are multiplexed using this port.
- **Pin 40** − This pin is used to provide power supply to the circuit.

- **KS-100 Board**

KS-100 Board

General Purpose Zero PCB. As its name suggests, general purpose PCB's are widely used to embed circuits randomly for running of hardware. Its layer is coated with copper and allows proper soldering without any short circuit. General purpose board, connections are not built so connections are to be created.



- **12V, 1A adapter**

ADAPTER

An AC adapter, AC/DC adapter, or AC/DC converter is a type of external power supply, often enclosed in a case similar to an AC plug. Adapters for battery-powered equipment may be described as chargers or rechargers . AC adapters are used with electrical devices that require power but do not contain internal components to derive the required voltage and power from mains power. The internal circuitry of an external power supply is very similar to the design that would be used for a built-in or internal supply.

External power supplies are used both with equipment with no other source of power and with battery-powered equipment, where the supply, when plugged in, can sometimes charge the battery in addition to powering the equipment.

Advantages

External AC adapters are widely used to power small or portable electronic devices. The advantages include:

- Safety – External power adapters can free product designers from worrying about some safety issues. Much of this style of equipment uses only voltages low enough not to be a safety hazard internally, although the power supply must out of necessity use dangerous mains voltage. If an external power supply is used (usually via a power connector, often of coaxial type), the equipment need not be designed with concern for hazardous voltages inside the enclosure. This is particularly relevant for equipment with lightweight cases which may break and expose internal electrical parts.
- Heat reduction – Heat reduces reliability and longevity of electronic components, and can cause sensitive circuits to become inaccurate or malfunction. A separate power supply removes a source of heat from the apparatus.
- Electrical noise reduction – Because radiated electrical noise falls off with the square of the distance, it is to the manufacturer's advantage to convert potentially noisy AC line power or automotive power to "clean", filtered DC in an external adapter, at a safe distance from noise-sensitive circuitry.
- Weight and size reduction – Removing power components and the mains connection plug from equipment powered by rechargeable batteries reduces the weight and size which must be carried.
- Ease of replacement – Power supplies are more prone to failure than other circuitry due to their exposure to power spikes and their internal generation of waste heat. External power supplies can be replaced quickly by a user without the need to have the powered device repaired.

- Configuration versatility – Externally powered electronic products can be used with different power sources as needed (e.g. 120 VAC, 240 VAC, 12 VDC, or external battery pack), for convenient use in the field, or when traveling.

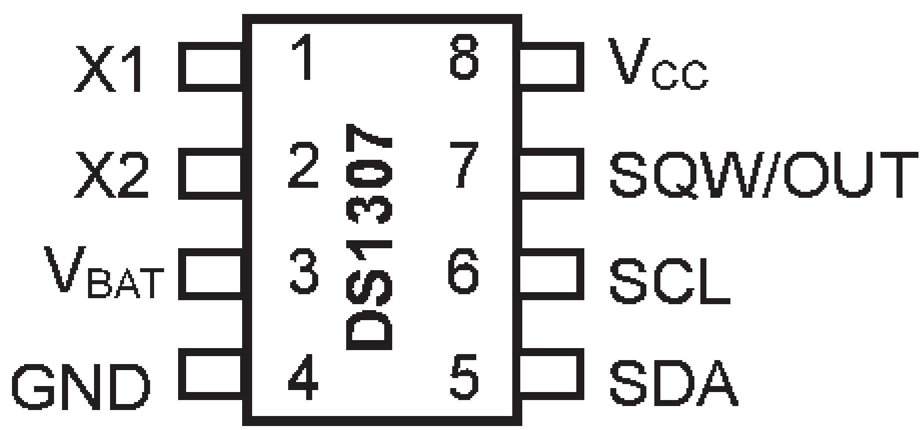
- **DS1307 RTC IC**

RTC DS1307

What are Real Time Clocks?

Real time clocks (RTC), as the name recommends are clock modules. The DS1307 real time clock (RTC) IC is an 8 pin device using an I2C interface. The DS1307 is a low-power clock/calendar with 56 bytes of battery backup SRAM. The clock/calendar provides seconds, minutes, hours, day, date, month and year qualified data. The end date of each month is automatically adjusted, especially for months with less than 31 days.

They are available as integrated circuits (ICs) and supervise timing like a clock and also operate date like a calendar. The main advantage of RTC is that they have an arrangement of battery backup which keeps the clock/calendar running even if there is power failure. An exceptionally little current is required for keeping the RTC animated. We can find these RTCs in many applications like embedded systems and computer mother boards, etc. In this article we are going to see about one of the real time clock (RTC), i.e. DS1307.



Pin Description of DS1307:

Pin 1, 2: Connections for standard 32.768 kHz quartz crystal. The internal oscillator circuitry is intended for operation with a crystal having a specified load capacitance of 12.5pF. X1 is the input to the oscillator and can alternatively be connected to an external 32.768 kHz oscillator. The output of the internal oscillator, X2 is drifted if an external oscillator is connected to X1.

Pin 3: Battery input for any standard 3V lithium cell or other energy source. Battery voltage should be between 2V and 3.5V for suitable operation. The nominal write protect trip point voltage at which access to the RTC and user RAM is denied is set by the internal circuitry as 1.25 x VBAT nominal. A lithium battery with 48mAhr or greater will backup the DS1307 for more than 10 years in the absence of power at 25ºC. UL recognized to ensure against reverse charging current when utilized as a part of conjunction with a lithium battery.

Pin 4: Ground.

Pin 5: Serial data input/output. The input/output for the I2C serial interface is the SDA, which is open drain and requires a pull up resistor, allowing a pull up voltage upto 5.5V. Regardless of the voltage on VCC.

Pin 6: Serial clock input. It is the I2C interface clock input and is used in data synchronization.

Pin 7: Square wave/output driver. When enabled, the SQWE bit set to 1, the SQW/OUT pin outputs one of four square-wave frequencies (1Hz, 4 kHz, 8 kHz, and 32 kHz). This is also open drain and requires an external pull-up resistor. It requires application of either Vcc or Vb at to operate SQW/OUT, with an allowable pull up voltage of 5.5V and can be left floating, if not used.

Pin 8: Primary power supply. When voltage is applied within normal limits, the device is fully accessible and data can be written and read. When a backup supply is connected to the device and VCC is below VTP, read and writes are inhibited. However at low voltages, the timekeeping function still functions.

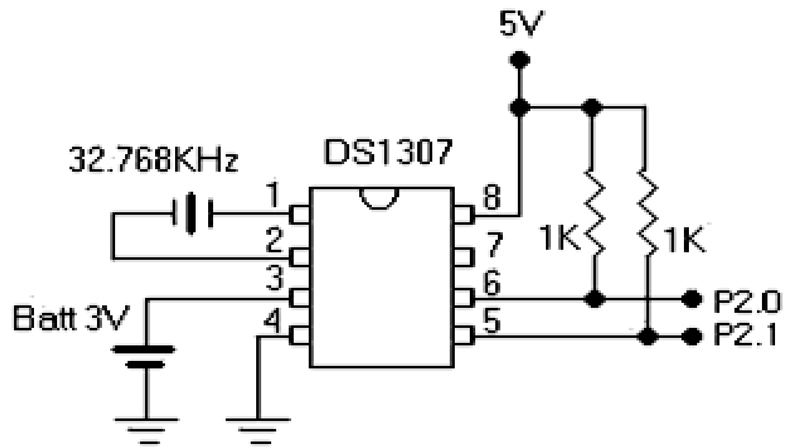
Features:

- Programmable square wave output signal
- Automatic power-fail detect and switch circuitry
- Consumes less than 500nA in battery backup mode with oscillator running
- Available in 8-pin DIP or SOIC
- Underwriters Laboratory (UL) recognized
- Real-time clock (RTC) counts seconds, minutes, hours, date of the month, month, day of the week, and year with leap-year compensation valid up to 2100
- 56-byte non-volatile RAM for data storage
- Two-wire interface (I2C)

Using the DS1307 is primarily written to and read the registers of this chip. The memory contains all 64 DS1307 8-bit registers are addressed from 0 to 63 (from 00H to 3FH the hexadecimal system). The first eight registers are used for the clock register the remaining 56 vacant can be used as RAM contains temporary variable if desired. The first seven registers contain information about the time of the clock including: seconds, minutes, hours, secondary, date, month and year. The DS1307 include several components such as power circuits, oscillator circuits, logic controller and I2C interface circuit and the address pointer register (or RAM). Let's see the working of DS1307.

Working of DS1307:

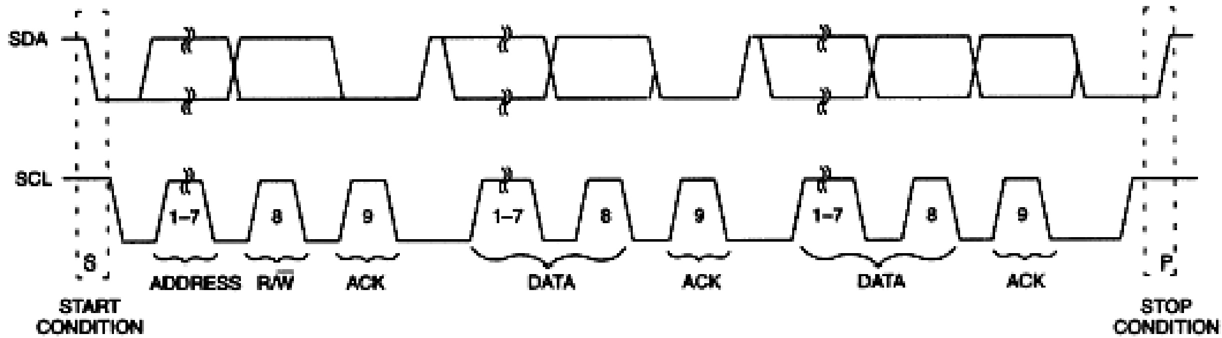
In the simple circuit the two inputs X1 and X2 are connected to a 32.768 kHz crystal oscillator as the source for the chip. VBAT is connected to positive culture of a 3V battery chip. Vcc power to the I2C interface is 5V and can be given using microcontrollers. If the power supply Vcc is not granted read and writes are inhibited.



START and STOP conditions are required when a device wants to establish communication with a device in the I2C network.

- By providing a device identification code and a register address, we can implement the START condition to access the device.
- The registers can be accessed in serial order until a STOP condition is implemented

The START condition and STOP condition when the DS1307 I2C communication with the microcontroller is shown in the figure below.



The device is configured mentioned in the figure below. The DS1307 has the 2-wire bus connected to two I/O port pins of the DS5000: SCL – P1.0, SDA – P1.1. The V_{DD} voltage is 5V, R_P = 5KΩ and the DS5000 is by means of a 12-MHz crystal. The other secondary device could be any other device that recognizes the 2-wire protocol, such as the DS1621 Digital Thermometer and Thermostat. The interface with the D5000 was skilled using the DS5000T Kit hardware and software. These development kits allow the PC to be used as a dumb terminal using the DS5000's serial ports to substitute a few words with the keyboard and monitor.

Typical 2-wire bus arrangement, the following bus protocol has been defined during data exchange information; the data line must remain stable whenever the clock line is high. Changes in the data line while the clock line is high will be interpreted as control signals.

Accordingly, the following bus conditions have been defined:

Start data transfer: A change in the state of the data line from high to low, while the clock line is high, defines a START condition.

Stop data transfer: A change in the state of the data line from low to high, while the clock line is high, defines the STOP condition.

Data valid: The state of the data line represents valid data when, after a START condition, the data line is stable for the duration of the high period of the clock signal. The data on the line must be changed during the low period of the clock signal. There is one clock pulse per bit of data.
Each data transfer is initiated with a START condition and terminated with a STOP condition. The number of data bytes transferred between the START and the STOP conditions is not

limited, and is determined by the master device. The information is transferred byte-wise and each receiver acknowledges with a ninth bit.

TIMEKEEPER REGISTERS

- The content of Timekeeper registers is in BCD (Binary Coded Decimal value) format.
- There are total eight registers in timekeeper register for setting seconds, Minutes, Hours, Day, Date, Month, year and control.
- Once we set the value of these registers, they will keep updating themselves, and we can read these registers to get updated values.

ADDRESS	Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0	FUNCTION	RANGE
00H	CH	10 Seconds			Seconds				Seconds	00–59
01H	0	10 Minutes			Minutes				Minutes	00–59
02H	0	12 24	10 Hour PM/AM	10 Hour	Hours				Hours	1–12 +AM/PM 00–23
03H	0	0	0	0	0	DAY			Day	01–07
04H	0	0	10 Date		Date				Date	01–31
05H	0	0	0	10 Month	Month				Month	01–12
06H	10 Year				Year				Year	00–99
07H	OUT	0	0	SQWE	0	0	RS1	RS0	Control	—
08H-3FH									RAM 56 x 8	00H–FFH

From datasheet

Address - 00H:02H: Clock Registers

Address - 00H:

- In this register bit- 7 is CH bit, which is crystal oscillator enable / disable bit, when it is zero, the crystal oscillator is enabled otherwise oscillator is not enabled, so we always make this bit zero while using RTC.

- Other bits are used for read / write the second. As timekeeper register stores the value in BCD format, here Bit- 4 to Bit-6 stores the upper BCD digit of the seconds (value from 0 to 5), and Bit- 0 to Bit-3 stores lower BCD digit of the seconds (value from 0 to 9). As seconds' value starts from 00 and ends at 59.

Address - 01H:

- This address is used to read / write minutes' value.
- Upper BCD digit of minutes is stored in Bit-4 to Bit-6 and lower BCD digit is stored in Bit-0 to Bit- 3

Address - 02H:

- This address is used to read / write Hour.
- Clock can run in either 12Hr or 24Hr format.
- 12-hour format: To set 12-hour clock format, we need to set Bit- 6 to logic 1. In 12- hour clock format Bit-5 will indicate AM / PM, Logic 1 is for PM and Logic 0 is for AM. Bit-4 is indicated as 10 Hour, which is to store higher digit of hour value, which is 0 or 1 in case of 12-hour system. Bit-0 to Bit- 3 stores the value of lower digit of hour (value from 0 to 9).
- 24-hour Format: To set 24-hour clock format, we need to reset Bit- 6 to logic 0. Bit-4 and Bit- 5 are indicated as 10 Hour, which is to store higher digit of hour value, which is 0 to 2 in case of 24-hour system. Bit-0 to Bit- 3 stores the value of lower digit of hour (value from 0 to 9).

Address - 03H: 06H: Calendar Register

Address - 03H:

- This address issued to read /write day value from 1 to 7. Bit-0 to Bit-2 are used to read /write day value.

Address - 04H:

- This address issued to read / write the date value. Bit- 4 and Bit-5 are used to read / write upper digit value of date (value from 0 to 3). Bit- 0 to Bit-3 are used for lower digit of date value (value from 0 to 9).

Address - 05H:

- This address is used to read / write the month. Bit- 4 used for upper digit value of month that is 0 or 1. And Bit- 0 to Bit- 3 are used to store the lower digit value of the month (value from 0 to 9).

Address-06H:

- This address issued to read / write the year value. It provides only last two digits of year value. Bit- 0 to Bit- 3 stores lower digit, and Bit- 4 to Bit- 7 stores higher digit of the year.

Address-07H: Control Register

7	6	5	4	3	2	1	0
OUT	0	0	SQWE	0	0	RS1	RS0

Bit 7 - OUT: Output

This controls the output level of pin SQW/OUT. When square wave output is disabled, SQWE bit is zero. So, logic level on SQW/OUT is high when this OUT bit is high, and zero when this OUT bit is zero.

Bit 4 – SQWE

To Enable / Disable square wave output on SQW / OUT pin

1 = Enable oscillator output

0 = Disable oscillator output

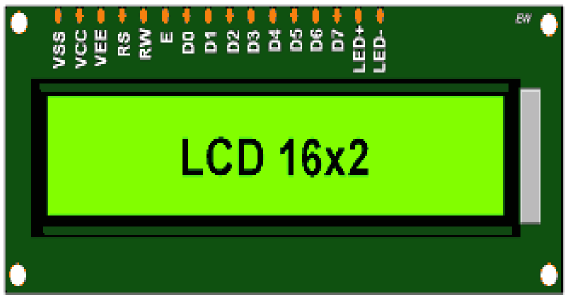
The frequency of square wave is depending on RS0 and RS1 bit.

Bit 0:1 - RS0 & RS1

RS1	RS0	Square-Wave Output Frequency
0	0	1Hz
0	1	4.096kHz
1	0	8.192kHz
1	1	32.768kHz

- **16*2 alphanumeric LCD**

Liquid Crystal Display (LCD):



No.	PIN	Function
1	VSS	Ground
2	VCC	+5 Volt
3	VEE	Contrast control 0 Volt: High contrast.

No.	PIN	Function
4	RS	Register Select 0: Commannd Reg. 1: Data Reg.
5	RW	Read / write 0: Write 1: Read
6	E	Enable H-L pulse
7-14	D0 - D7	Data Pins D7: Busy Flag Pin
15	LED+	+5 Volt
16	LED-	Ground

EW

General Description of LCD:

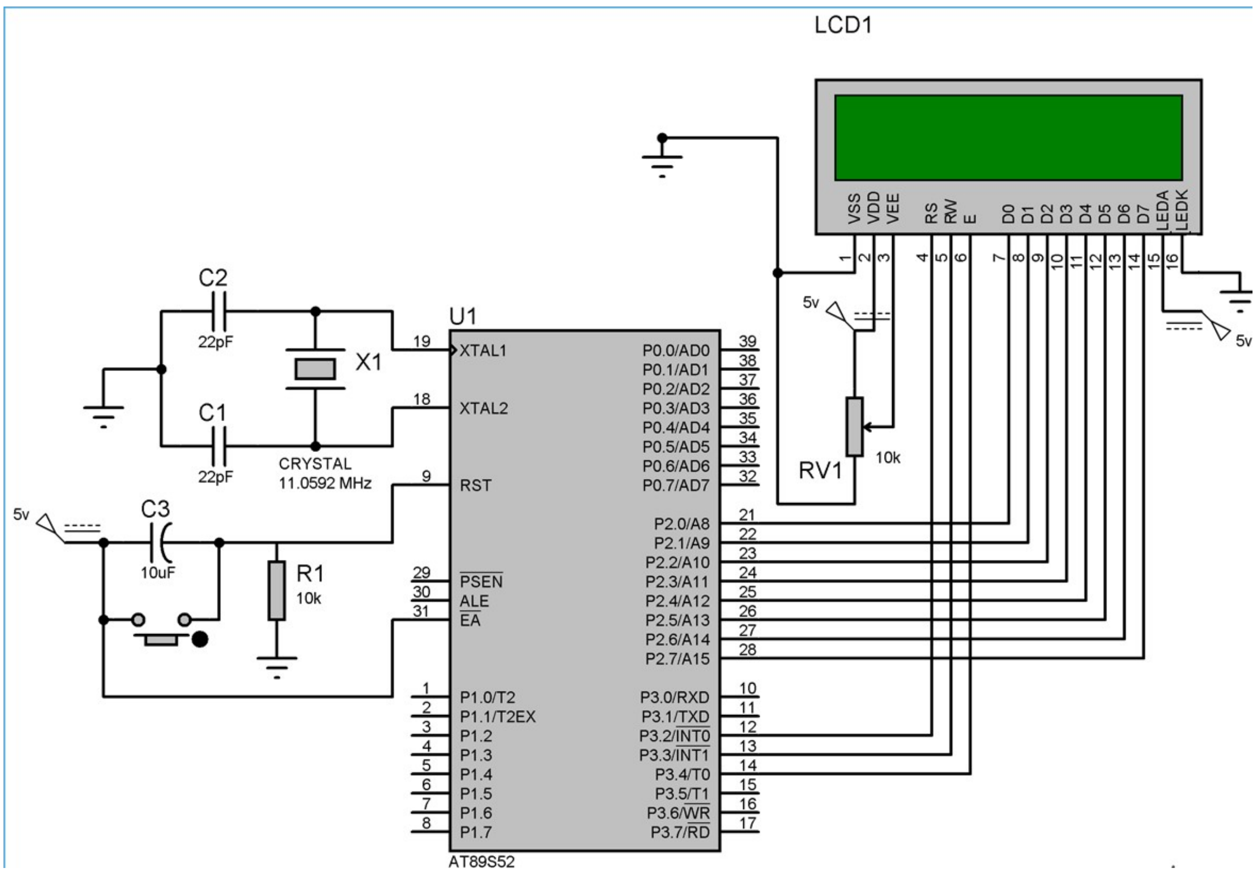
- Alphanumeric displays are used in a wide range of applications, including palmtop computers, word processors, photocopiers, point of sale terminals, medical instruments, cellular phones, etc. The 16 x 2 intelligent alphanumeric dot matrix display is capable of displaying 224 different characters and symbols. A full list of the characters and symbols is printed on pages 7/8 (note these symbols can vary between brand of LCD used). This booklet provides all the technical specifications for connecting the unit, which requires a single power supply (+5V).

- Available as an optional extra is the Serial LCD Firmware, which allows serial control of the display. This option provides much easier connection and use of the LCD module. The firmware enables microcontrollers (and microcontroller based systems such as the PICAXE) to visually output user instructions or readings onto an LCD module. All LCD commands are transmitted serially via a single microcontroller pin. The firmware can also be connected to the serial port of a computer.

- To display the notifications of dedicated charges and also to display the information. It contain certain characteristics like.

- 5 x 8 dots with cursor.

- + 5V power supply (Also available for + 3V).
- 1/16 duty cycle.



- Circuit diagram for LCD interfacing with 8051 microcontroller is shown in the above figure. If you have basic understanding of 8051 then you must know about EA(PIN 31), XTAL1 & XTAL2, RST pin(PIN 9), Vcc and Ground Pin of 8051 microcontroller
- So besides these above pins we have connected the data pins (D0-D7) of LCD to the Port 2 (P2_0 – P2_7) microcontroller. And control pins RS, RW and E to the pin 12,13,14 (pin 2,3,4 of port 3) of microcontroller respectively.
- PIN 2(VDD) and PIN 15(Backlight supply) of LCD are connected to voltage (5v), and PIN 1 (VSS) and PIN 16(Backlight ground) are connected to ground.
- Pin 3(V0) is connected to voltage (Vcc) through a variable resistor of 10k to adjust the contrast of LCD. Middle leg of the variable resistor is connected to PIN 3 and other two legs are connected to voltage supply and Ground.

- **Push buttons -4**

PUSH BUTTON

A push button is a momentary or non-latching switch which causes a temporary change in the state of an electrical circuit only while the switch is physically actuated. An automatic mechanism (i.e. a spring) returns the switch to its default position immediately afterwards, restoring the initial circuit condition. There are two types:

- A push to make switch allows electricity to flow between its two contacts when held in. When the button is released, the circuit is broken. This type of switch is also known as a Normally Open (NO) Switch. (Examples: doorbell, computer case power switch, calculator buttons, individual keys on a keyboard).
- A push to break switch does the opposite, i.e. when the button is not pressed, electricity can flow, but when it is pressed the circuit is broken. This type of switch is also known as a Normally Closed (NC) Switch. (Examples: Fridge Light Switch, Alarm Switches in Fail-Safe circuits)

- **2 ceramic capacitors – 22Pf**

CERAMIC CAPACITORS

A ceramic capacitor is a fixed-value capacitor where the ceramic material acts as the dielectric. It is constructed of two or more alternating layers of ceramic and a metal layer acting as the electrodes. The composition of the ceramic material defines the electrical behavior and therefore applications. Ceramic capacitors are divided into two application classes:

- Class 1 ceramic capacitors offer high stability and low losses for resonant circuit applications.
- Class 2 ceramic capacitors offer high volumetric efficiency for buffer, by-pass, and coupling applications.

Construction

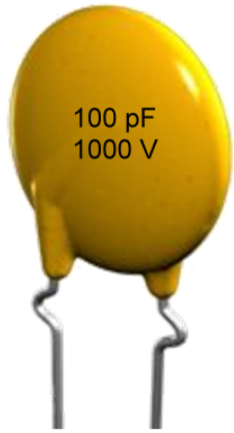
Ceramic capacitors are composed of a mixture of finely ground granules of paraelectric or ferroelectric materials, appropriately mixed with other materials to achieve the desired characteristics. From these powder mixtures, the ceramic is sintered at high temperatures. The ceramic forms the dielectric and serves as a carrier for the metallic electrodes. The minimum thickness of the dielectric layer, which as of 2013 for low voltage capacitors is in the size range of 0.5 micrometers is limited downwards by the grain size of the ceramic powder. The thickness of the dielectric for capacitors with higher voltages is determined by the dielectric strength of the desired capacitor.

The electrodes of the capacitor are deposited on the ceramic layer by metallization. For MLCCs alternating metallized ceramic layers are stacked one above the other. The outstanding metallization of the electrodes at both sides of the body are connected with the contacting terminal. A lacquer or ceramic coating protects the capacitor against moisture and other ambient influences.

Ceramic capacitors come in various shapes and styles. Some of the most common are:

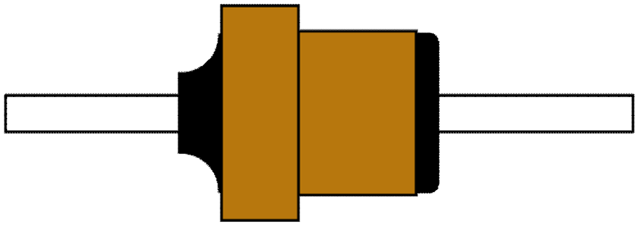
- Multilayer ceramic chip capacitor (MLCC), rectangular block, for surface mounting
- Ceramic disc capacitor, single layer disc, resin coated, with through-hole leads
- Feedthrough ceramic capacitor, used for bypass purposes in high-frequency circuits. Tube shape, inner metallization contacted with a lead, outer metallization for soldering
- Ceramic power capacitors, larger ceramic bodies in different shapes for high voltage applications

Some different styles of ceramic capacitors for use in electronic equipment



Multilayer ceramic chip capacitor (MLCC)

Ceramic disc capacitor (single layer)



Feedthrough ceramic capacitor

High voltage ceramic power capacitor

- **11.0592 MHz crystal**

CRYSTAL OSCILLATOR

A crystal oscillator is an electronic oscillator circuit that uses the mechanical resonance of a vibrating crystal of piezoelectric material to create an electrical signal with a precise frequency.This frequency is often used to keep track of time, as in quartz wristwatches, to provide a stable clock signal for digital integrated circuits, and to stabilize frequencies for radio transmitters and receivers. The most common type of piezoelectric resonator used is the quartz crystal, so oscillator circuits incorporating them became known as crystal oscillators, but other piezoelectric materials including polycrystalline ceramics are used in similar circuits.

A crystal oscillator, particularly one using a quartz crystal, works by distorting the crystal with an electric field, when voltage is applied to an electrode near or on the crystal. This property is known as electrostriction or inverse piezoelectricity. When the field is removed, the quartz - which oscillates in a precise frequency - generates an electric field as it returns to its previous shape, and this can generate a voltage. The result is that a quartz crystal behaves like an RLC circuit, but with a much higher Q.(Quality Factor).

- **Electrolytic capacitor – 0.01uF/25V,470uF/25V**

Electrolytic Capacitor

An electrolytic capacitor is a polarized capacitor whose anode or positive plate is made of a metal that forms an insulating oxidelayer through anodization. This oxide layer acts as the dielectric of the capacitor. A solid, liquid, or gel electrolyte covers the surface of this oxide layer, serving as the (cathode) or negative plate of the capacitor. Due to their very thin dielectric oxide layer and enlarged anode surface, electrolytic capacitors have a much higher capacitance-voltage (CV) product per unit volume than ceramic capacitors or film capacitors, and so can have large capacitance values. There are three families of electrolytic capacitor: aluminum electrolytic capacitors, tantalum electrolytic capacitors, and niobium electrolytic capacitors.

The large capacitance of electrolytic capacitors makes them particularly suitable for passing or bypassing low-frequency signals, and for storing large amounts of energy. They are widely used for decoupling or noise filtering in power supplies and DC link circuits for variable-frequency drives, for coupling signals between amplifier stages, and storing energy as in a flashlamp.

Electrolytic capacitors are polarized components due to their asymmetrical construction and must be operated with a higher voltage (i.e. more positive) on the anode than on the cathode at all times. For this reason the anode terminal is marked with a plus sign and the cathode with a minus sign. Applying a reverse polarity voltage, or a voltage exceeding the maximum rated working voltage of as little as 1 or 1.5 volts, can destroy the dielectric and thus the capacitor. The failure of electrolytic capacitors can be hazardous, resulting in an explosion or fire. Bipolar electrolytic capacitors which may be operated with either polarity are also made, using special constructions with two anodes connected in series.

Basic materials and construction

Electrolytic capacitors use a chemical feature of some special metals, previously called "valve metals", which on contact with a particular electrolyte form a very thin insulating oxide layer on their surface by anodic oxidation which can function as a dielectric. There are three different anode metals in use for electrolytic capacitors:

1. Aluminum electrolytic capacitors use a high-purity etched aluminium foil with aluminium oxide as dielectric
2. Tantalum electrolytic capacitors use a sintered pellet (“slug”) of high-purity tantalum powder with tantalum pentoxide as dielectric
3. Niobium electrolytic capacitors use a sintered "slug" of high-purity niobium or niobium oxide powder with niobium pentoxide as dielectric.

To increase their capacitance per unit volume, all anode materials are either etched or sintered and have a rough surface structure with a much higher surface area compared to a smooth surface of the same area or the same volume. By applying a positive voltage to the above-mentioned anode material in an electrolytic bath an oxide barrier layer with a thickness corresponding to the applied voltage will be formed (formation). This oxide layer acts as dielectric in an electrolytic capacitor.

After forming a dielectric oxide on the rough anode structure, a counter electrode has to match the rough insulating oxide surface. This is accomplished by the electrolyte, which acts as the cathode electrode of an electrolytic capacitor. There are many different electrolytes in use. Generally they are distinguished into two species, “non-solid” and “solid” electrolytes. As a liquid medium which has ion conductivity caused by moving ions, non-solid electrolytes can easily fit the rough structures. Solid electrolytes which have electron conductivity can fit the rough structures with the help of special chemical processes like pyrolysisfor manganese dioxide or polymerization for conducting polymers.

Comparing the permittivities of the different oxide materials it is seen that tantalum pentoxide has a permittivity approximately three times higher than aluminum oxide. Tantalum electrolytic capacitors of a given CV value theoretically are therefore smaller than aluminium electrolytic capacitors.

The anodically generated insulating oxide layer is destroyed if the polarity of the applied voltage changes.

- **Resistor (1/4 watt) – 10k**

Resistor

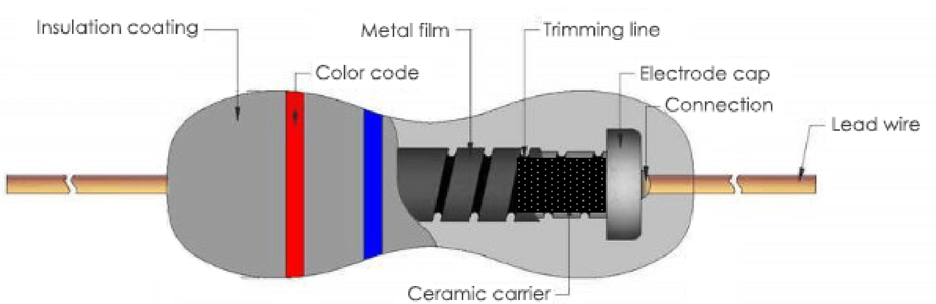
A resistor is a passive two-terminal electrical component that implements electrical resistance as a circuit element. In electronic circuits, resistors are used to reduce current flow, adjust signal levels, to divide voltages, bias active elements, and terminate transmission lines, among other uses. High-power resistors that can dissipate many watts of electrical power as heat, may be used as part of motor controls, in power distribution systems, or as test loads for generators. Fixed resistors have resistances that only change slightly with temperature, time or operating voltage. Variable resistors can be used to adjust circuit elements (such as a volume control or a lamp dimmer), or as sensing devices for heat, light, humidity, force, or chemical activity.

Resistors are common elements of electrical networks and electronic circuits and are ubiquitous in electronic equipment. Practical resistors as discrete components can be composed of various compounds and forms. Resistors are also implemented within integrated circuits.

The electrical function of a resistor is specified by its resistance: common commercial resistors are manufactured over a range of more than nine orders of magnitude.

Fixed value Resistors: Fixed resistors are the type of resistors which offers a fixed amount of resistance in the circuit. A fixed resistor cannot be changed as it is set at a specific value.

Metal oxide film Resistor



Metal oxides (metal film) like tin oxide are deposited on the ceramic carrier. Then resistance is adjusted by using the trimming line. The resistance varies depending upon the thickness of deposition and after that by helix curve. After that outer covering is covered by an epoxy protection layer (insulation coating). These resistors have low noise and can be supplied to much more close tolerance and thus make them far superior from carbon film resistors. This type of resistors is used in almost all applications now.

- **Pot – 10k**

Potentiometer

A potentiometer is a three-terminal resistor with a sliding or rotating contact that forms an adjustable voltage divider.If only two terminals are used, one end and the wiper, it acts as a variable resistor or rheostat.

The measuring instrument called a potentiometer is essentially a voltage divider used for measuring electric potential (voltage); the component is an implementation of the same principle, hence its name.

- **5V DC power supply circuit**

5V DC POWER SUPPLY

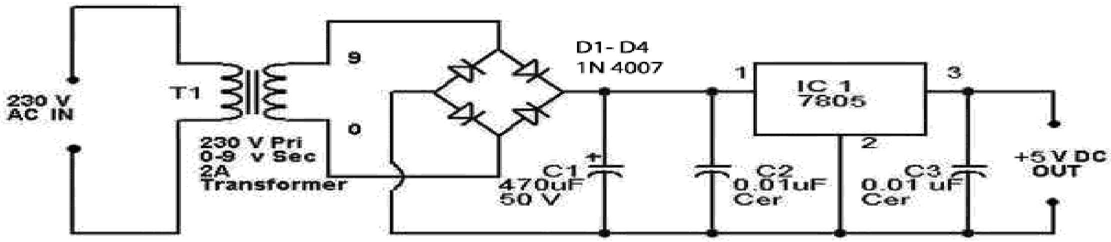
The 5V power supplies (or 5V DC power supplies) are one of the most common power supplies in use today. In general, a 5V DC output is obtained from a 50V AC or 240V AC input using a combination of transformers, diodes and transistors. 5V power supplies can be of two types: 5V regulated power supplies, and 5V unregulated power supplies.5V regulated power supplies come in three styles: Switching regulated AC to DC, Linear regulated AC to DC, and Switching regulated DC to DC.
Switching regulated 5V DC power supplies, sometimes referred to as SMPS power supplies, switchers, or switched mode power supplies, regulate the 5V DC output voltage using a complex high frequency switching technique that employs pulse width modulation and feedback. Acopian switching regulated power supplies also employ extensive EMI filtering and shielding to attenuate both common and differential mode noise conducted to the line and load. Galvanic isolation is standard in our 5V DC switchers, affording our users input to output and output to ground isolation for maximum versatility. Acopian switching regulated power supplies are highly efficient, small and lightweight, and are available in both AC-DC single and wide-adjust output and DC-DC configurations. Our Low Profile wide adjust output switchers can be voltage or current regulated and are externally programmable.

Linear regulated 5V DC power supplies regulate the output using a dissipative regulating circuit. They are extremely stable, have very low ripple, and have no switching frequencies to produce EMI. Galvanic isolation is standard in our 5V DC linears, affording our users input to output and output to ground isolation for maximum versatility. Acopian linear regulated power supplies are available AC to DC single and wide adjust outputs.

Unregulated 5VDC power supplies are basic power supplies with an AC input and an unregulated 5VDC output. The output voltage changes with the input voltage and load. These power supplies are inexpensive and extremely reliable.

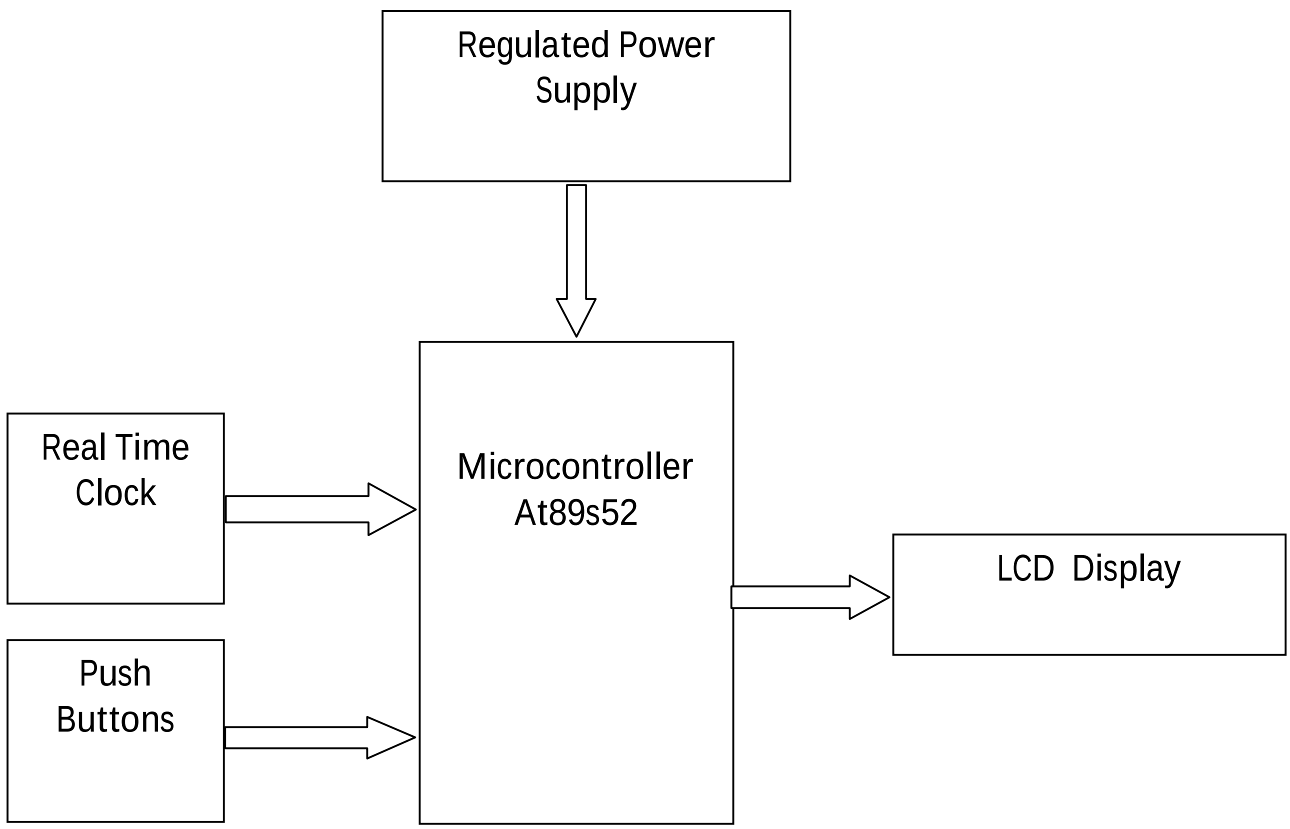
Typical applications for 5VDC power supplies:

- Industrial automation
- TTL circuit power
- Precision control circuits
- Research projects

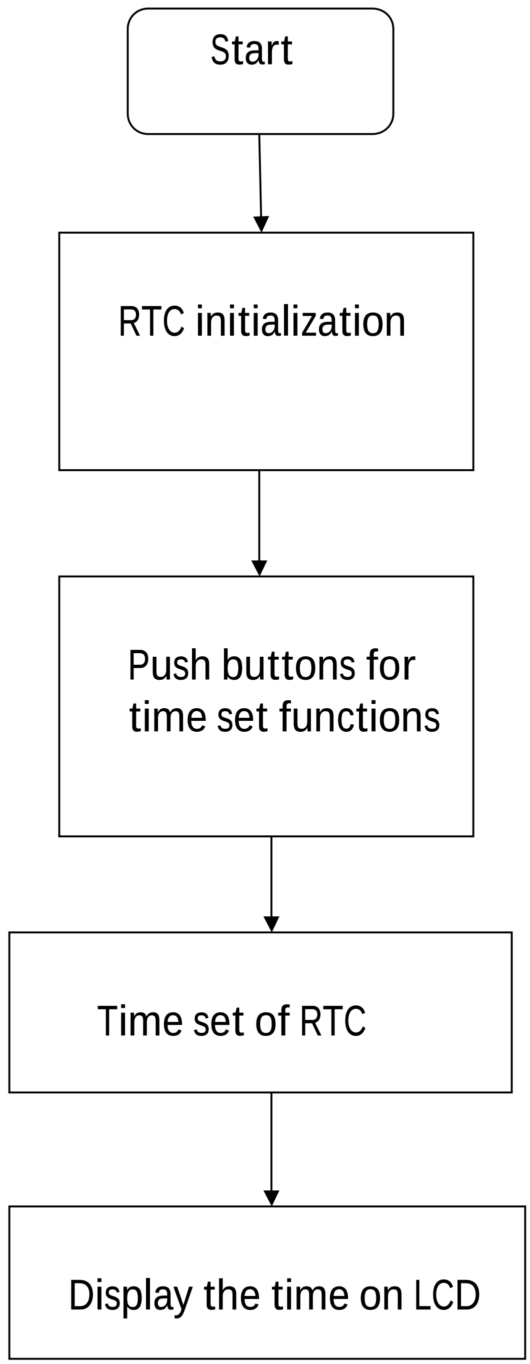


- **Single pin connecting wires**

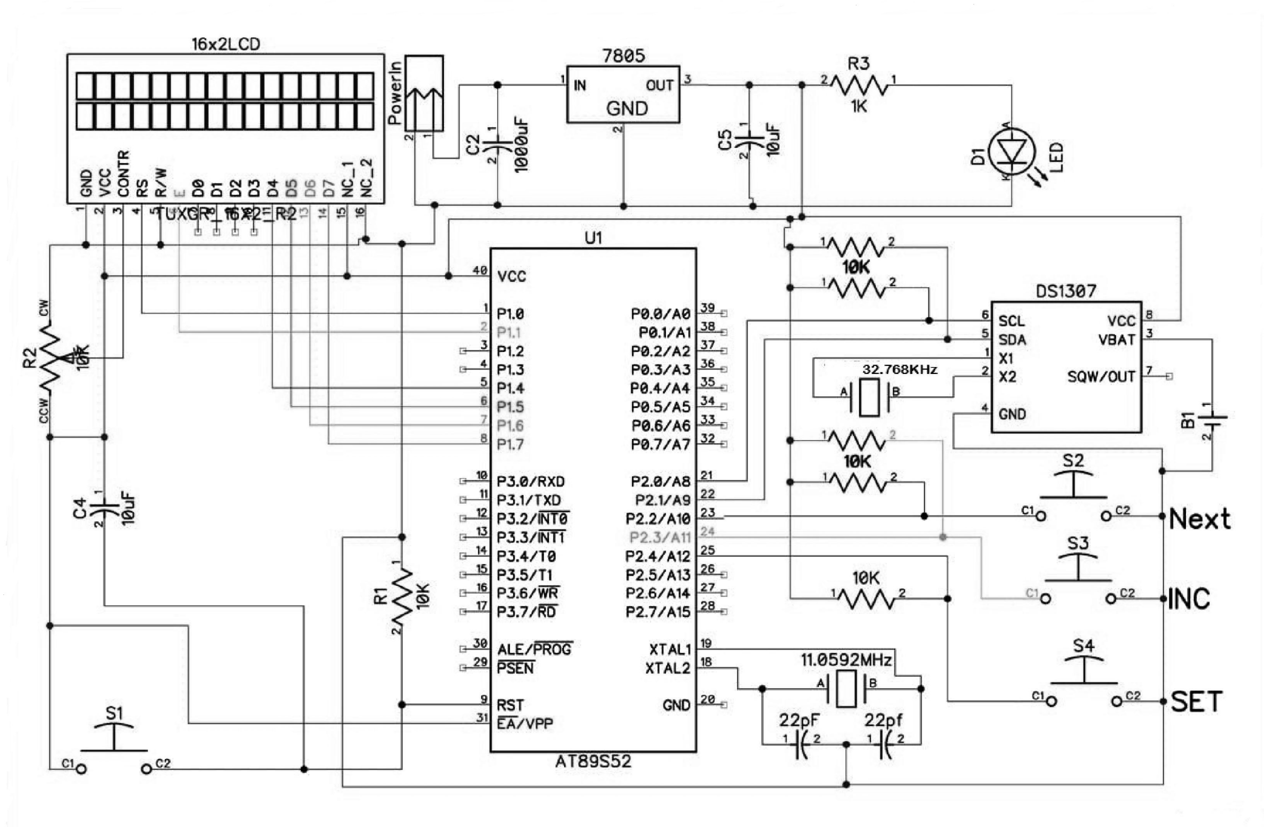
BLOCK DIAGRAM



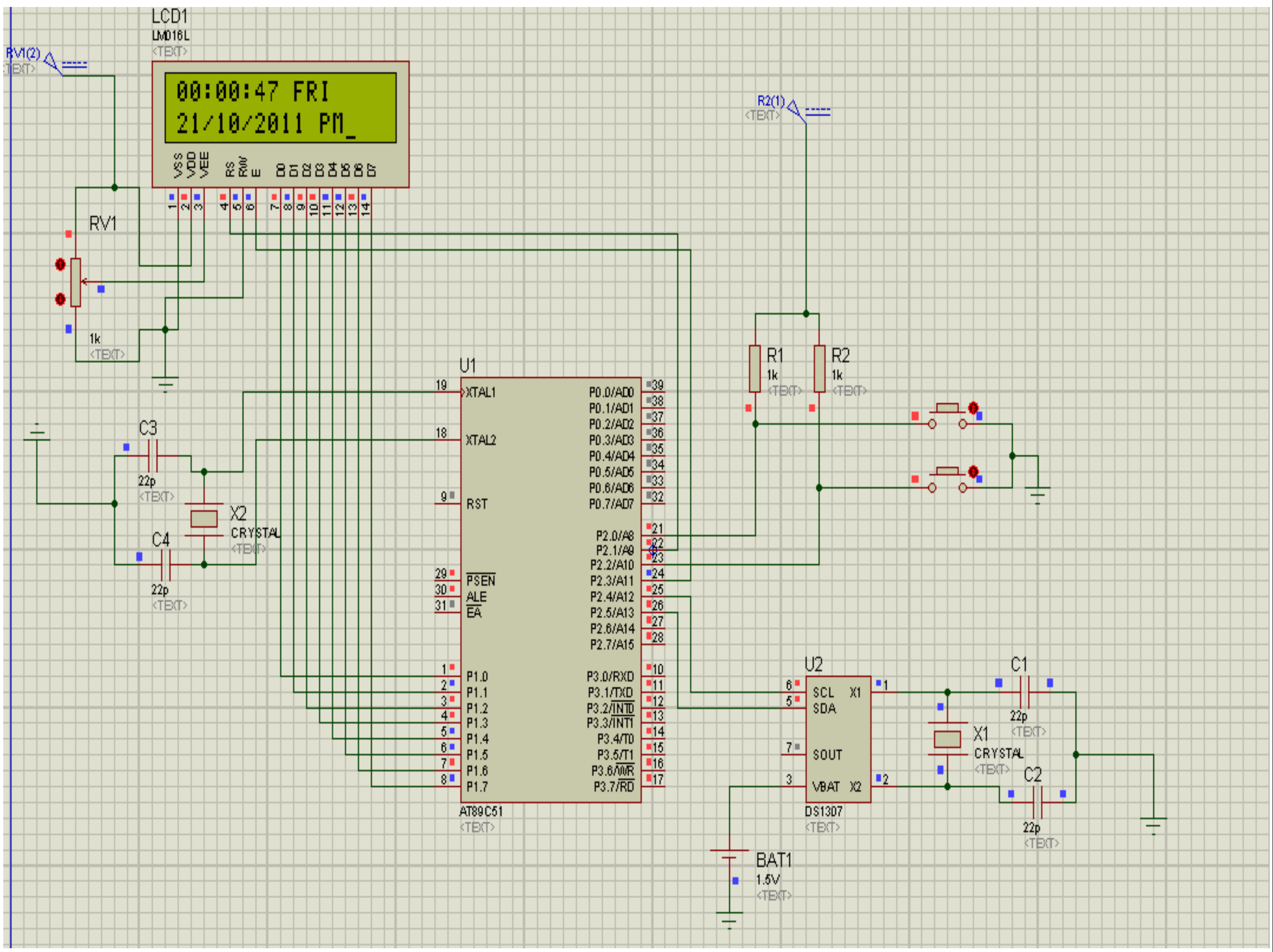
FLOWCHART


Start
RTC initialization
Push buttons for time set functions
Time set of RTC
Display the time on LCD

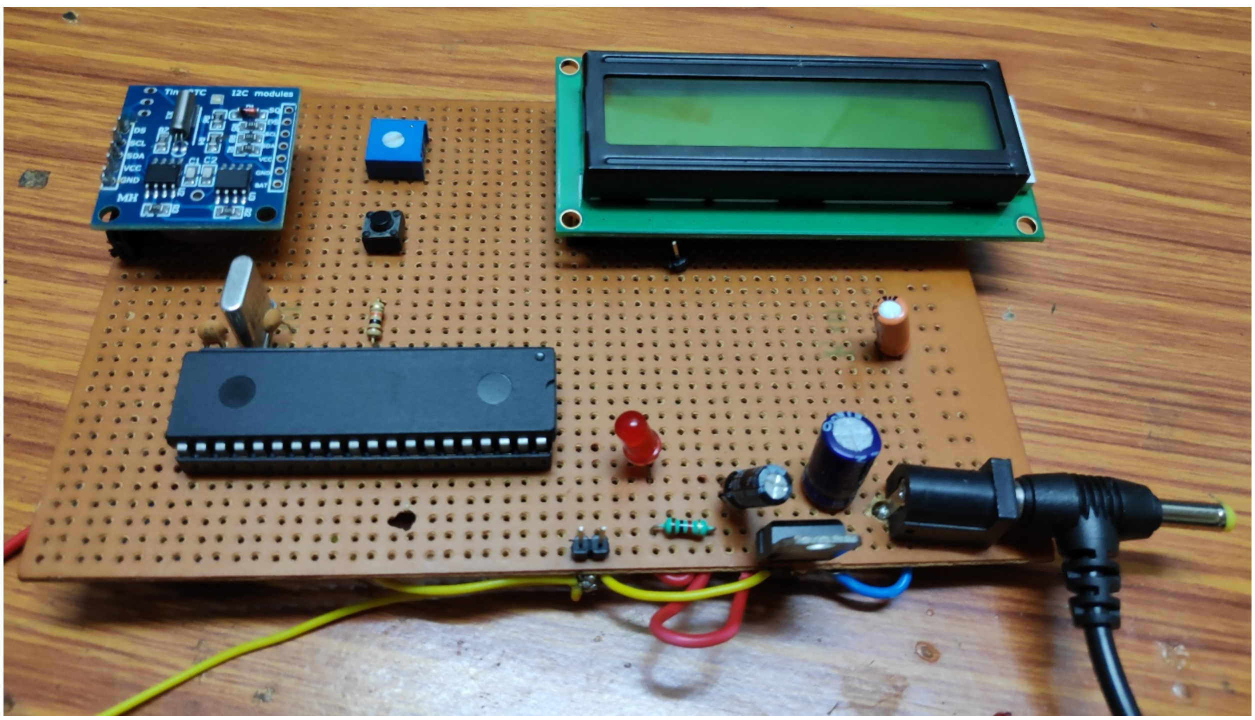
CIRCUIT DIAGRAM



<u>SOFTWARE SIMULATION</u>



<u>HARDWARE</u>



CONCLUSION

We completed our project successfully with the 16*2 LCD Display showing the desired output of Time(hh:mm:ss) ,Date(DD/MM/YYYY) and Day.

REFERENCES

- www.wikipedia.org/wiki/digitalclock
- www.circuitdigests.com
- Nptel lectures on digital clock circuits
- www.elprocus.com
- Youtube.in

ANNEXURE

A. CODE

```
#include<reg51.h>
#include<stdio.h>
#define lcdport P1
sbit rs=P1^0;
sbit en=P1^1;
sbit SDA=P2^1;
sbit SCL=P2^0;
sbit next=P2^2;                 //increment digit
sbit inc=P2^3;                  //increment value
sbit set=P2^4;                  //set time
char ack;
unsigned char day1=1;
unsigned char k,x;
unsigned int date=1, mon=1, hour=0, min=0, sec=0;
int year=0;
 void delay(int itime)
{
   int i,j;
   for(i=0;i<itime;i++)
   for(j=0;j<1275;j++);
}
void daten()
{
   rs=1;
   en=1;
   delay(1);
   en=0;
}
void lcddata(unsigned char ch)
{
   lcdport=ch & 0xf0;
   daten();
   lcdport=(ch<<4) & 0xf0;
   daten();
}
void cmden(void)
{
   rs=0;
   en=1;
   delay(1);
```

```
    en=0;
}
void lcdcmd(unsigned char ch)
{
    lcdport=ch & 0xf0;
    cmden();
    lcdport=(ch<<4) & 0xf0;
    cmden();
}
void lcdprint(char *str)
{
    while(*str)
    {
        lcddata(*str);
        str++;
    }
}
void lcd_init(void)
{
    lcdcmd(0x02);
    lcdcmd(0x28);
    lcdcmd(0x0c);
    lcdcmd(0x01);
}
void I2CStart(){SDA=1;SCL=1,SDA=0,SCL=0;}          //"start" function for communicate
with ds1307 RTC
void I2CStop(){SDA=0,SCL=1,SDA=1;}                 //"stop" function for communicate wit
ds1307 RTC

unsigned char I2CSend(unsigned char Data)          //send data to ds1307
{
char i;
char ack_bit;
for(i=0;i<8;i++)
{
if(Data & 0x80) SDA=1;
else SDA=0;
SCL=1;
Data<<=1;
SCL=0;
}
SDA=1,SCL=1;
ack_bit=SDA;
SCL=0;
return ack_bit;
```

```
}

unsigned char I2CRead(char ack)                    //receive data from ds1307
{
unsigned char i, Data=0;
SDA=1;
for(i=0;i<8;i++)
{
 Data<<=1;
 do{SCL=1;}
 while(SCL==0);
 if(SDA) Data|=1;
 SCL=0;
}
if(ack)SDA=0;
else SDA=1;
SCL=1;
SCL=0;
SDA=1;
return Data;
}
/*void day(char d)                          // Function for display day on LCD
{
switch(d)
{
  case 0:
  lcdprint("DAY");
  break;
  case 1:
  lcdprint("SUN");
  break;
  case 2:
  lcdprint("MON");
  break;
  case 3:
  lcdprint("TUE");
  break;
  case 4:
  lcdprint("WED");
  break;
  case 5:
  lcdprint("THU");
  break;
```

```
 case 6:
 lcdprint("FRI");
 break;
 case 7:
 lcdprint("SAT");
 break;
}
}    */
int BCDToDecimal(char bcdByte)
{
     char a,b,dec;
   a=(((bcdByte & 0xF0) >> 4) * 10);
   b=(bcdByte & 0x0F);
   dec=a+b;
   return dec;
}
char DecimalToBCD (int decimalByte)
{
 char a,b,bcd;
 a=((decimalByte / 10) << 4);
 b= (decimalByte % 10);
 bcd=a|b;
 return bcd;
}


 void show_time()                          //function to display time/date/day on LCD
{
 char var[5];
 lcdcmd(0x80);
 lcdprint("Date:");
 sprintf(var,"%d",date);
 lcdprint(var);
 sprintf(var,"/%d",mon);
 lcdprint(var);
 sprintf(var,"/%d",year+2000);
 lcdprint(var);
 lcdprint("   ");
 lcdcmd(0xc0);
 lcdprint("Time:");
 sprintf(var,"%d",hour);
 lcdprint(var);
 sprintf(var,":%d",min);
 lcdprint(var);
 sprintf(var,":%d",sec);
 lcdprint(var);
```

```
 lcdprint(" ");
 // day(day1);
  lcdprint("   ");
 }
 void set_time()                                     //time set function
{
 lcdcmd(0x0e);
 while(k<7)
 {
  while(k==3)                                  //set date
  {
   x=year%4;
   if(inc==0)
   {date++;while(inc==0);
   if(x==1 && mon==2 && date==28){date=1;}               //check for 28 day febuary
   if(x==0 && mon==2 && date==29){date=1;}               //check for 29 day febuary
   if((date==31) && (mon==4) || (mon==6) || (mon==9) || (mon==17)){date=1;}        // check for
30 day month
   if(date==32){date=1;}                                        // check for 31 day month
   show_time();}
   if(next==0)
   {
     k=5;

     while(next==0);
     }                                  //check for next digit
   lcdcmd(0x85);
  }
  while(k==2)                                  //set month
  {
   if(inc==0)
   {mon++;while(inc==0);
   if(mon==13){mon=1;}                          //check for end of year
   show_time(); }
   if(next==0){k=3;
   while(next==0);
   }
   lcdcmd(0x88);
  }
  while(k==1)                                //set year
  {
   if(inc==0)
   {year++;while(inc==0);
   if(year==30){year=0;}
```

```
  show_time();     }
  if(next==0){k=2;
  while(next==0);}
  lcdcmd(0x8d);
 }
 while(k==5)                              //set hour
 {
  if(inc==0)
  {hour++;while(inc==0);
  if(hour==24){hour=0;}
  show_time();}
  if(next==0){k=6;
  while(next==0);}
  lcdcmd(0xc5);
 }
 while(k==6)                               //set min
 {
  if(inc==0)
  {min++;while(inc==0);
  if(min==60){min=0;}
  show_time();}
  if(next==0){k=10;
  while(next==0);}
  lcdcmd(0xc8);
 }}}
void main()
{
   lcd_init();
   lcdprint("Digital Clock");
   lcdcmd(0xc0);
   lcdprint(" Using 8051  ");
   delay(400);
   lcdcmd(1);
   lcdprint("Circuit Digest");
   lcdcmd(192);
   lcdprint("Saddam Khan");
   delay(400);
   while(1)
 {
 if(set==0)                             // check time set button press
 { I2CStart();
 I2CSend(0xD0);
 I2CSend(0x00);
 I2CSend(0x00);
 I2CSend(0x00);
```

```
 I2CSend(0x00);
 I2CSend(0x01);
 I2CSend(0x01);
 I2CSend(0x01);
 I2CSend(0x00);
 I2CSend(0x80);
 I2CStop();
  k=1;
  set_time();                    // call time set function
     min=DecimalToBCD(min);
   sec=DecimalToBCD(0);
      hour=DecimalToBCD(hour);
      year=DecimalToBCD(year);
      mon=DecimalToBCD(mon);
   date=DecimalToBCD(date);
  I2CStart();
  I2CSend(0xD0);
  I2CSend(0x00);
  I2CSend(0x00);
  I2CSend(min);
  I2CSend(hour);
  I2CSend(day1);
  I2CSend(date);
  I2CSend(mon);
  I2CSend(year);
  I2CSend(0x80);
  I2CStop();
  lcdcmd(1);
  lcdcmd(0x0c);}
  I2CStart();
  I2CSend(0xD0);
  I2CSend(0x00);
  I2CStart();
  I2CSend(0xD1);
  sec=BCDToDecimal(I2CRead(1));
  min=BCDToDecimal(I2CRead(1));
  hour=BCDToDecimal(I2CRead(1));
  day1=BCDToDecimal(I2CRead(1));
  date=BCDToDecimal(I2CRead(1));
  mon=BCDToDecimal(I2CRead(1));
  year=BCDToDecimal(I2CRead(1));
  I2CStop();
   show_time();                              //display time/date/day
   delay(1);
 }
}
```

B. DATASHEET FOR RTC1307

PIN DESCRIPTION-

C. DATASHEET FOR 16*2 LCD DISPLAY