

I. Introduction:

It is important in some industrial as well as experimental setup to monitor and control temperature continuously. Earlier data loggers are used to monitor temperature manually. The data logger was done through manual measurements from analog instruments such as thermometers and manometers. For today's technology this type of data logger can't fulfill time and accuracy. From 1990 a further development in data logging took place as people begin to create PC-based data logging systems Goswami *et al* (2009). In later stage of development it has been found that microcontrollers (integration of microprocessors and certain peripherals including memory on single chip) are more reliable as well as efficient. Use of microcontrollers in embedded design is not only increased but brought a revolutionary change. At the same time competitive pressures require manufacturers to expand their product functionality and provide differentiation while maintaining or reducing the cost Baruah.J, Zaman.S and Islam.B. (2014)

Goswami *et al* (2009) have proposed an Embedded System for Monitoring and Controlling Temperature and Light. In this system microcontroller AT 89S52 is used which is a 40 pin IC. The temperature measurement and light intensity from the channels of ADC 0809 are taken. We have used a microcontroller AT 89S52 which is a 40 pin IC, temperature sensor chip, the DS1621 which acts as a sensor as well as functions as an analog to digital converter. The DS1621 chip senses the temperature and converts it into a digital output. The output is displayed on a LCD module. The program for the microcontroller is written in C language. Science C program has well defined syntax.

R. A. Eigenberg *et al* (2002) have developed a system for Rugged Environmental Monitoring Units for Temperature and Humidity. This system has complexity in construction and calibration in harsh environment. The system also does not have any hardware control unit to meet specific conditions.

M Ramu and CH. Rajendra prasad *et al* (2013) have discussed about Cost Effective Atomization of Indian Agricultural System using 8051 Microcontroller and GSM technologies. This system finds application in domestic and agricultural field. This can be used to ensure moisture level of soil in a particular area.

G. Saidu *et al* (2013) have designed a Temperature Monitoring and Logging System suitable for use in Hospitals, incorporating GSM Text Messaging. Their system design using AT Mega16 helps to manage the temperature of a patient. Such as preservation of food, drugs, etc. the LM35 sensor needed to be attached to the body of the patient which has been found to be very inconvenient.

II. Implementation Of The Temperature Monitoring System

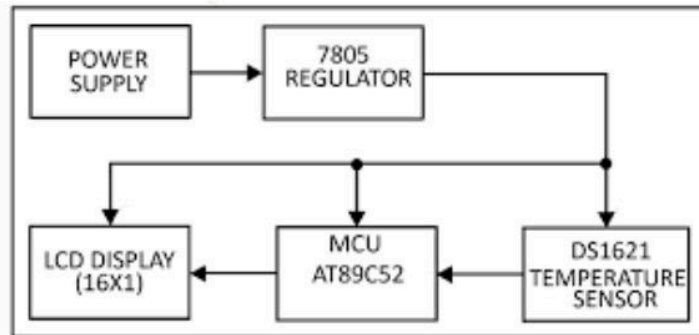


Figure 1: Block Diagram of Temperature Indicator Using AT89C52

Fig1. shows the block diagram of the temperature indicator using micro controller AT89C52. The power supply for the circuit is regulated by IC 7805 and supplied to different parts of the unit. DS1621 is the temperature sensor chip. The micro controller unit (MCU) reads the temperature from the sensor. The temperature data is compared with certain user-defined temperature values and processed inside the MCU as per the program and then sent to the LCD for display.

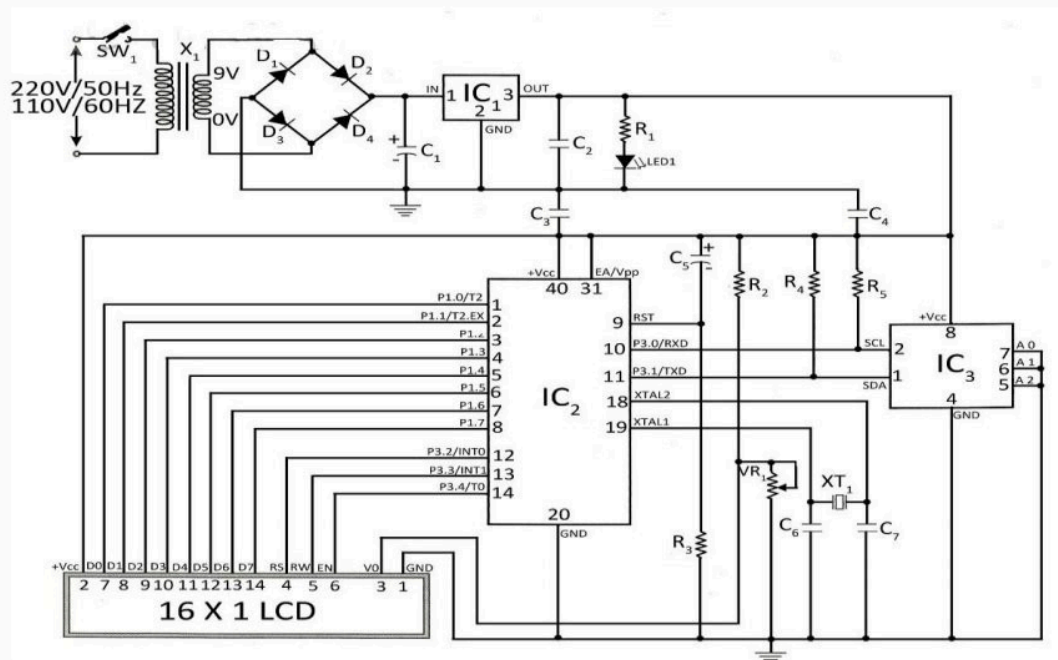


Figure2: Circuit of temperature indicator using micro controller AT89C52.

III. Hardware Implementation

Power supply. The power supply unit consists of a step-down transformer (230V AC primary to 0-9V, 250mA secondary), bridge rectifier and voltage regulator. The output of the transformer is fed to bridge rectifier diodes D1 through D4 (each 1N4007). The ripple from the output bridge rectifier is filtered by capacitor C1 and fed to regulator IC 7805. The regulated output is given to the temperature sensor, micro controller unit and LCD module, respectively. When switch S1 is closed, LED1 glows to indicate the presence of power in the system.

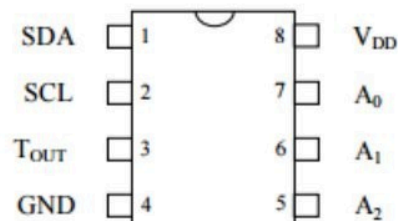


Fig 3: pin details of IC DS1621

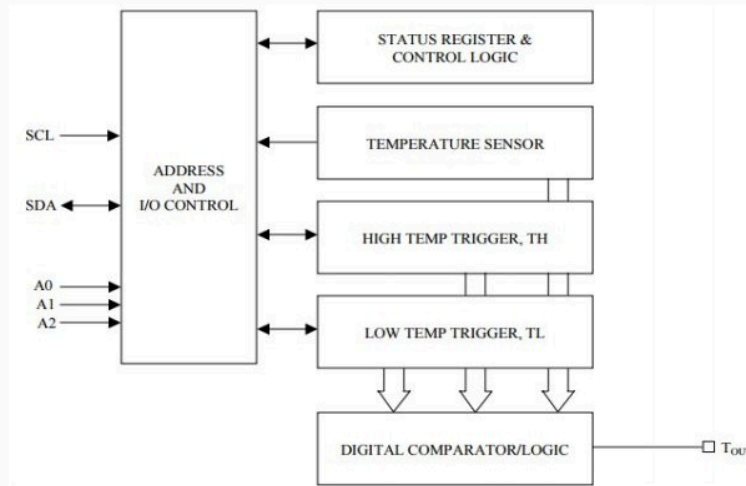


Fig 4: internal block diagram of IC DS1621

Temperature sensor.

Temperature sensor chip DS1621 (IC3) is an 8-pin DIP IC. Its pin details are shown in Fig. 3 and the internal block diagram in Fig. 4. The chip can measure temperatures from -55°C to $+125^{\circ}\text{C}$ in 0.5°C increments, which are read as 9-bit values. It can operate from 2.7V to 5.5V. Data is read/written via 2-wire serial interface. Pins 1 and 2 of the temperature IC are connected to pins 11 and 10 of the micro controller, respectively.

The thermal alarm output (T_{out}) of IC DS1621 temperature exceeds user defined high high temperature TH. The output remains active until the temperature drops below user-defined low temperature TL. User-defined temperature settings are stored in the non-volatile memory.

Temperature settings and temperature readings are all communicated to/from IC DS1621 over a 2-wire serial cable. The most significant bit (MSB) of the data is transmitted first and the last significant bit (LSB) is transmitted last.

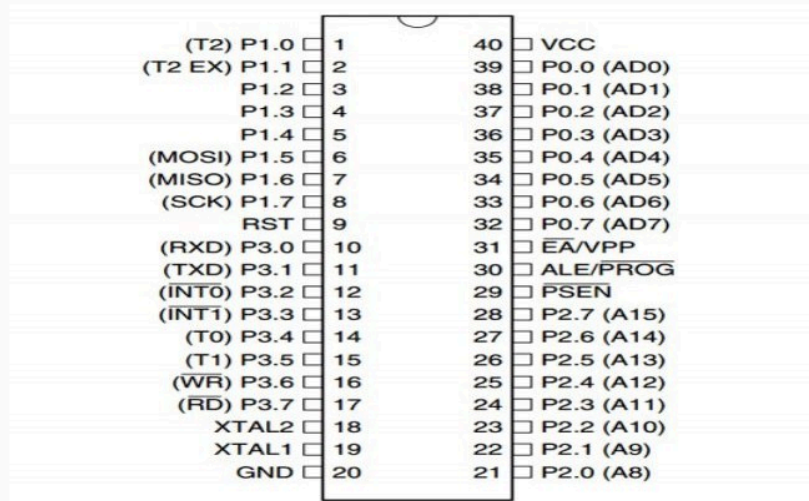


Fig 5: pin details of Microcontroller AT89C52

Microcontroller unit:

Microcontroller AT89C52 (IC2) is a 40 pin IC from Atmel. Its pin details are shown in Figure 5. Like AT89C51, it also belongs to the 8031 / 8051 family. Microcontroller AT89C52 has a 256 X 8 bit internal random access memory, eight interrupt sources and 4KB of flash memory in At 89C51. By combining a versatile 8 bit CPU with flash memory on a monolithic chip, Atmel 89C52 is a powerful, highly flexible and cost effective solution to many embedded control applications.

Ports 0 and 2 are 8 – bit bidirectional input / output (I/O) ports. These ports have been used in this temperature indicator.

Port 1 is an 8 – bit bidirectional I/O port with internal pull – ups. Ports 1.0 through 1.7 are connected to pins 7 through 14 of the LCD. Port – 1 output buffers can sink / source four TTL inputs.

Port 3 is an 8 – bit bidirectional I/O port with internal pull – ups. Port 3.0 and 3.1 of IC2 are connected to serial clock line (SCL) and serial data line(SDA) of IC3, respectively. Ports 3.2 through 3.4 are connected to pins 4 through 6 of the LCD, respectively. Port – 3 output buffers can sink/ source four TTL inputs.

A 12MHz crystal oscillator is connected to X_{TAL1} and X_{TAL2} pins for operation of the microcontroller. A high pulse on RST pin (pin 9) while the oscillator is running resets the microcontroller. In this circuit, this pin is connected to +Vcc for internal program executions. This pin also receives the 12V programming enable voltage (V_{pp}) during flash programming when 12V programming is selected.

Addressing: The chip address of DS1621 comprises internal preset code nibble 1001 (binary) followed by externally configurable address pins/bits A2, A1 and A0. The eighth bit of the address byte is determined by the type of operation (either read or write) that is to be performed. For writing to the device the eighth bit is zero and for reading from the device the eighth bit is 1. In this case the pins A2, A1 and A0 are grounded and hence device address for writing is 1001 0000 (90Hex) and for reading, the device address is 1001 1001 (91Hex).

Configuration/ status register: This register can be accessed for reading or writing by issuing command byte AC (hex) from the master (89C52). This register is particularly required if DS1621 is used for thermostat control. Since it contains flag bits THF (high temperature flag) and TLF (low temperature flag) which are set to '1' when temperature crosses the respective limits earlier written in to TH and TL registers. It also contains the flag bit which is set to '1' when results of conversion are available after issuing of start conversion command EE (hex). The other bits configuration register are determined below.

DONE	THF	TLE	NVB	1	0	PCL	1 SHOT
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“NVB” is the non volatile memory busy flag, ‘1’ is write to an E² memory cell in progress, ‘0’ indicates that the non volatile memory is not busy, ‘POL’ is non volatile output polarity bit (‘1’ = active high and ‘0’ = active low) and ‘1SHOT’ is one – shot mode. A copy to E² may take up to 10ms. If ‘1SHOT’ is ‘1’, DS1621 will perform one temperature conversion upon reception of the start convert T protocol. If ‘1SHOT’ is “0”, DS1621 will continuously perform temperature conversions. This bit is non volatile.

LCD: For display, a Lampex make 16 X 1 LCD (model GDM1601A) was used. Pins 15 and 16 haven't been used. Pin 3 is connected to the circuit ground through a 1 kilo – ohm preset that is used to control the light intensity of the LCD.

IV. Software Implementation

The C language program for microcontroller AT89C52 is compiled using cross – compiler C51 version 7.10 from Keil software. It can compile programs up to 2KB only, which is sufficient for writing most programs.

For temperature indication, the program temp52⁰C is used. The communication interface between the temperature sensor and the microcontroller chip follows the I²C (inter Integrated Circuit) standard, which is implemented in C here. I²C is a simple master/ slave type interface. Simplicity of the I²C system is primarily due to the bidirectional 2 wire (SDA and SCL) design and the protocol format. Bidirectional communication is through 2 wire lines (which are either active low or passive high). In the program, the i2C_stop, i2C_start, i2C_write and i2C_read functions are used for communicating clock and data from DS1621 to P3.0 and P3.1 of AT89C52, respectively. Functions such as command, ready and display in the program are used for driving the LCD.

V. Hardware Description

Microcontroller:

A microcontroller (or MCU) is a computer – on – a-chip. It is a type of microprocessor emphasizing self-sufficiency and cost-effectiveness, in contrast to a general-purpose microprocessor. The only difference between has three parts – ALU, Control Unit and registers (like memory), but the microcontroller has additional elements like ROM, RAM etc.

Embedded design:

The majority of computer systems in use today are embedded in other machinery. Such as telephones, clocks, appliances, vehicles, and infrastructure. An embedded system usually has minimal requirements for memory and program length and may require simple but unusual input/output systems. For example, most embedded systems lack keyboards, screens, disks, printers, or other recognizable I/O devices of a personal

computer. They may control electric motors, relays or voltages, and read switches, variable resistors or other electronic devices.

Higher Integration:

In contrast to general-purpose CPUs, microcontrollers may not implement an external address or data bus, because they integrate RAM and non-volatile memory on the same chip as the CPU. Because they need fewer pins, the chip can be placed in a much smaller, cheaper package.

Integrating the memory and other peripherals on a single chip and testing them as a unit increases the cost of that chip, but often results in decreased net cost of the embedded system as a whole. Even if the cost of a CPU that has integrated peripherals is slightly more than the cost of a CPU + external peripherals, having fewer chips typically allows a smaller and cheaper circuit board, and reduces the labor required to assemble and test the circuit board.

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

Central processing unit – ranging from small and simple 4 – bit processors to sophisticated 32 or 64 – bit processors

Input/output interfaces such as serial ports (UARTs)

Other serial communications interfaces like I²C, Serial peripheral interface and controller Area Network for system interconnect

Peripherals such as timers and watchdog

RAM for data storage

ROM, EPROM, EEPROM or Flash memory for program storage

Clock generator –often an oscillator for a quartz timing crystal, resonator or RC circuit

Many include analog-to-digital converters

This integration drastically reduces the number of chips and the amount of wiring and PCB space that would be needed to produce equivalent systems using separate chips and have proved to be highly popular in embedded systems since their introduction in the 1970s.

Microcontroller architectures are available from many different vendors in so many varieties that each instruction set architecture could rightly belong to a category of their own. Chief among these are the 8052, Z80 and ARM derivatives.

VI. Conclusion

The “Embedded based temperature monitoring system” is designed to monitor the temperature of any devices or any place. The system is developed using DS1621 temperature sensor, AT89C52 microcontroller and LCD. The output of temperature sensor is fed to the microcontroller which converts it to an appropriate digital value according to the set of pre defined values stored in its memory and displays it in the LCD. This system is designed to monitor temperature from -55°C to 125°C. Real time temperature measurements ensure that today's smaller and faster systems operate in the safe thermal zone.

Hence this system is useful for the industries to monitor temperature during manufacturing process, for calibrating thermostats and it can also be used as fire warning system by using a buzzer.