DESIGN AND SIMULATION OF DIGITAL INPUT BOARD FOR REACTOR APPLICATION

A PROJECT REPORT

Submitted by

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BONAFIDE CERTIFICATE

Certified that this project report **" DESIGN AND SIMULATION OF DIGITAL INPUT BOARD FOR REACTOR APPLICATION"** is the bonafide work of **" ABHISHEK. B. SHARMA"** who carried out the project work under my supervision.

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INTERNAL EXAMINER **EXTERNAL EXAMINER**

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ABSTRACT

Power plants in our country play a very important role in the field of power generation. In that list, nuclear plants play a very important role. As the fuels used in the reactors are Uranium-235 (^{235}U) and Plutonium-239 (^{239}Pu), nuclear process takes place by the nuclear fission process. Even though nuclear science deals with the production of energy, Electronics plays an important role in the nuclear power plant. Steam which is produced in the power plant helps in running of turbines which thereby generates electricity. These process takes place automatically, however there is some maintainance required for such process.

Digital Input Board plays an important role in nuclear plant as steam and coolant that run in the pipes are fixed to valves are used to detect the their flow. The digital input board detects the status of the valves which is useful for the maintainance purpose. As the valves detects the flow of coolant or steam, it opens or closes automatically in the power plant system. This status of valves can be detected using the digital input board using 0's and 1's. So incase, if the valves are open or closed the respective outputs can be seen through the computer connected to the digital input board, so that the operator can confirm the status of the valves and the operation of the reactor in the power plant.

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LIST OF ABBREVIATIONS

ATMEL - Atmospheric Electricity Measurements

VCC - Power supply

GND - Ground

Hz - Hertz

RxD - Receive Data pin

TxD - Transmit Data pin

WR - Write

RD - Read

RST - Reset

ALE - Address Latch Enable

PSEN - Program Store Enable

EA - External Access Enable

SEROUT - Serial Out

SERIN - Serial In

LED - Light Emitting Diode

ADC - Analog to Digital Converter

Vin+ - Positive input voltage

Vin- - Negative input voltage

CLK - Clock

Vref - Voltage reference

Vout - Output voltage

CHAPTER 1

INTRODUCTION

1.1 GENERAL

Computer Based Systems (CBS) are employed in safety critical and safety related systems of Indian Nuclear Plants; for protection, control and monitoring purpose. These systems should meet the target reliability figures. These CBS are configured using a family of microcomputer boards. For calculating the system reliability metrics, failure rates of microcomputer boards used in system are required. For forthcoming CBS, a new standardized Versa Module European (VME) bus based family of microcomputer boards is developed by Reactor Control Division, IGCAR. The family has CPU board, Ethernet communication board, analog input and output board, digital input board, digital output board, relay output board, protocol translator board, signal conditioning board, bus extender boards and motherboards. These boards are compact, low power, high speed, and intelligent modules designed as per latest state of the art technology. These boards and the systems configured using these boards need to be qualified to stringent requirements of nuclear industry. The paper briefly outlines the microcomputer boards' description and qualification tests carried out on these boards. Board failure rate estimation is done by summing the component failure rates. This board failure rate is then modified by various factors corresponding to process, environment, reliability growth and infant mortality characteristics.A design and development programme for a future monitoring and control system applied to a small, high-integrity nuclear reactor is postulated. An overview is given of a user-centred approach to the design, from initial conceptual studies to full-scope simulation. The approach allows due consideration to be given to the use of human factors techniques, and use of computer aided design tools in the full design process. Many of the problems and difficulties frequently encountered can be addressed during a user-centered approach, leading to greater assurance that the design will be safer to operate, and well received Such an approach would be applicable to any complex plant employing computer-based systems

1.2 BACKGROUND

Since a nuclear power plant needs some maintenance work, there are various boards used in the system.Analog input board, Analog output board, Synchronising board, Speed sensor board, Signal board and many boards are used in the group panel. A common power supply of 24V is given to all the boards in the panel via the power supply cable and each board has its own functions and applications.

1.3 OBJECTIVE

A Digital input board must be designed for the reactor application to check the status of the valves in the plant operation using a suitable microcontroller.

1. The board must have the capacity to accept 64 inputs and so, totally 128 pins have to be designed in the input section (sync type)

2. The board must have a on board temperature monitoring circuit.

3. The board must have a Field protection circuit and a Field isolation circuit.

4. A debouncing circuit has to be added to the circuit.
5. Forcing ‘0’ and Forcing ‘1’ test ability (Impulse testing)
6. Power supply monitoring circuit
7. Cable open detection circuit.

1.4 PROPOSED WORK

Digital board is one such board designed in this project, in addition to the various boards used in the panel. This makes the work of the operator more easier as it detects the status of the valves fixed to steam and coolant pipes.

Compared to other boards, this board has a temperature sensor circuit which avoids the board from getting heated up. It has an isolation circuit and power supply monitoring circuit which helps in the protection purposes. Hence, this board has an excellent application as for the power plant system as well as has protection system for the board. It also has a deboucing circuits which is satisfied using the transients and filters. Most importantly, this digital input board has the capacity to give 64 inputs and that can be connected to the valves of the steam and coolant pipes.

1.5 LITERATURE SURVEY

This project reckoned from the basic idea of implementing the concept of digital electronics in the safety systems in the most efficient way and also to use its applications for specific purposes. The next goal is to use this concept in our power plant during the operation and make the human work more easy.

S.V.Shrikandhe, BARC, Mumbai (2010) presented a paper in a conference (IEGUCTR) on hardware reliability prediction of Computer based safety systems in Indian nuclear power plant which involved the computer equipment testing, fault trees, microcomputers and design on power engineering computing and statistical analysis for safety and system recovery for military standards.

T. F. Mayfield ; Rolls-Royce & Associates Ltd., London, UK presented a paper in (1989) on Nuclear safety using the computing systems using the programming applications with safety systems which includes fission reactor control and monitoring, power system computer and control, surveillance control and system design for high-integrity nuclear reactor.

J.Aparna and B.S.V.G Sharma in (2006) presented in the First paper conference on the design and development of robotic automation and process controls for water jet lancing systems for nuclear plant steam generator which includes the controlled index for the boilers, manipulators, pipes fixed to the valves of coolants and steam, sludge treatment and water jet cutting, corrosion and thermal management.

CHAPTER 2

OVERVIEW OF THE PROJECT

In our project we have decided to design and digital input board and we are going to use those components that are much needed for our system as well as enhance the efficiency of the digital board and also our objectives.

ATMEL AT89C51 microcontroller is a master controller, controlling the board operation by receiving the information from the sensor. 74LS540 is a octal buffer/line driver with 3 state outputs and then 74LS137 decoder is used which is a 3-to-8 line device which is used to select the address lines. A Temperature sensor LM35 is used to used to select the temperature limit. And a buffer latch 74LS373 is used which is used to present the output and is used in the impulse testing system.

Optocoupler (pc817) is a device used to isolate the input system of the digital input board and the power supply system.

74LS540 is a octal buffer/line driver with 3 state outputs which is has 8 inputs and 8 inverted outputs. There will be a total of 8 buffers, because of 8 channels present in the digital input board.

74LS137 is a decoder which is used to select the address lines of the input system.There are 3 pins for the input values and 8 address lines for the input.So, each buffer is connected to one address line.

AT89C51 is a microcontroller belonging to the 8051 family. This device is used for the controlling process. The inputs of the buffers are connected to port 1. -The output is obtained through port 2. Again the port

2 is used as the input to the impulse testing to obtain the result. Port 3 is given to the temperature sensor through ADC.

ADC0804 is a 8-bit successive approximation converter, which converts the analog voltage produced by the temperature sensor to the digital form.

Differential analog voltage inputs allow increasing the common-mode rejection and offsetting the analog zero input voltage value. In reference the input voltage can be adjusted to a certain limit to the full 8-bit coding.

LM35 is a temperature precision grade sensor which is used to accept the temperature input of the digital input board. Its value ranges from -55 degree centigrade to 150 degree centigrade. In the digital input board, we are setting the voltage limit to 65 degree centigrade.

74LS373 is a 8-bit buffer latch that is used to produce output in the board. This is also used to give the input for the impulse testing.

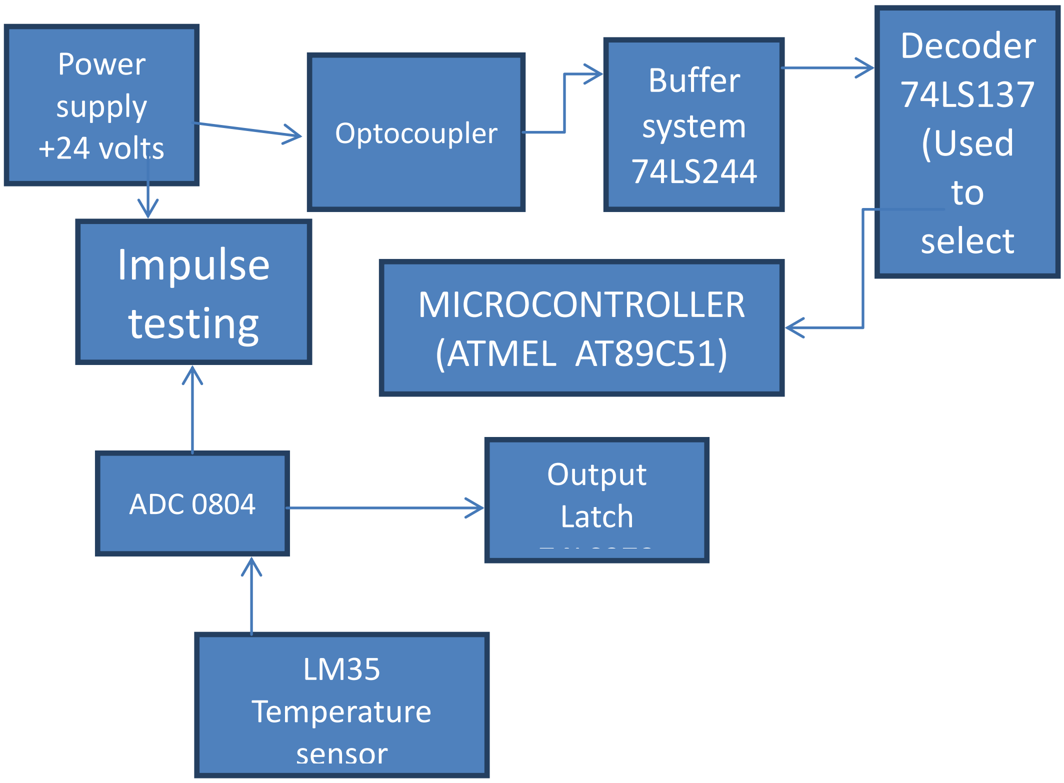


Figure 3.1.F- Block diagram of Digital input board

CHAPTER 3

COMPONENTS USED

3.1 MICROCONTROLLER AT89C51

3.1.1 Description

The AT89C51 is a low power, high performance CMOS 8-bit microcontroller with 4 kilobytes of in-system programmable flash memory. This device is manufactured using Atmel's high density non-volatile memory technology and is compatible with industry-standard 80C51 instruction set and pin out. The on-chip flash allows the program to be reprogrammed in-system or by a conventional non-volatile memory programmer. By combining a versatile 8-bit CPU with in-system programmable flash on a monolithic chip, the ATMEL AT89C51 is a powerful microcontroller which provides a highly flexible and cost effective solution to many embedded control applications. The AT89C51 is also designed with a state 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 ports and interrupt system to continue functioning.

3.1.2 Features

- 4V to 5.5V operating range.
- Fully static operation 0Hz to 33MHz.
- Three-level program memory lock.
- 32 programmable I/O lines.
- Two 16-bit counters/timers.

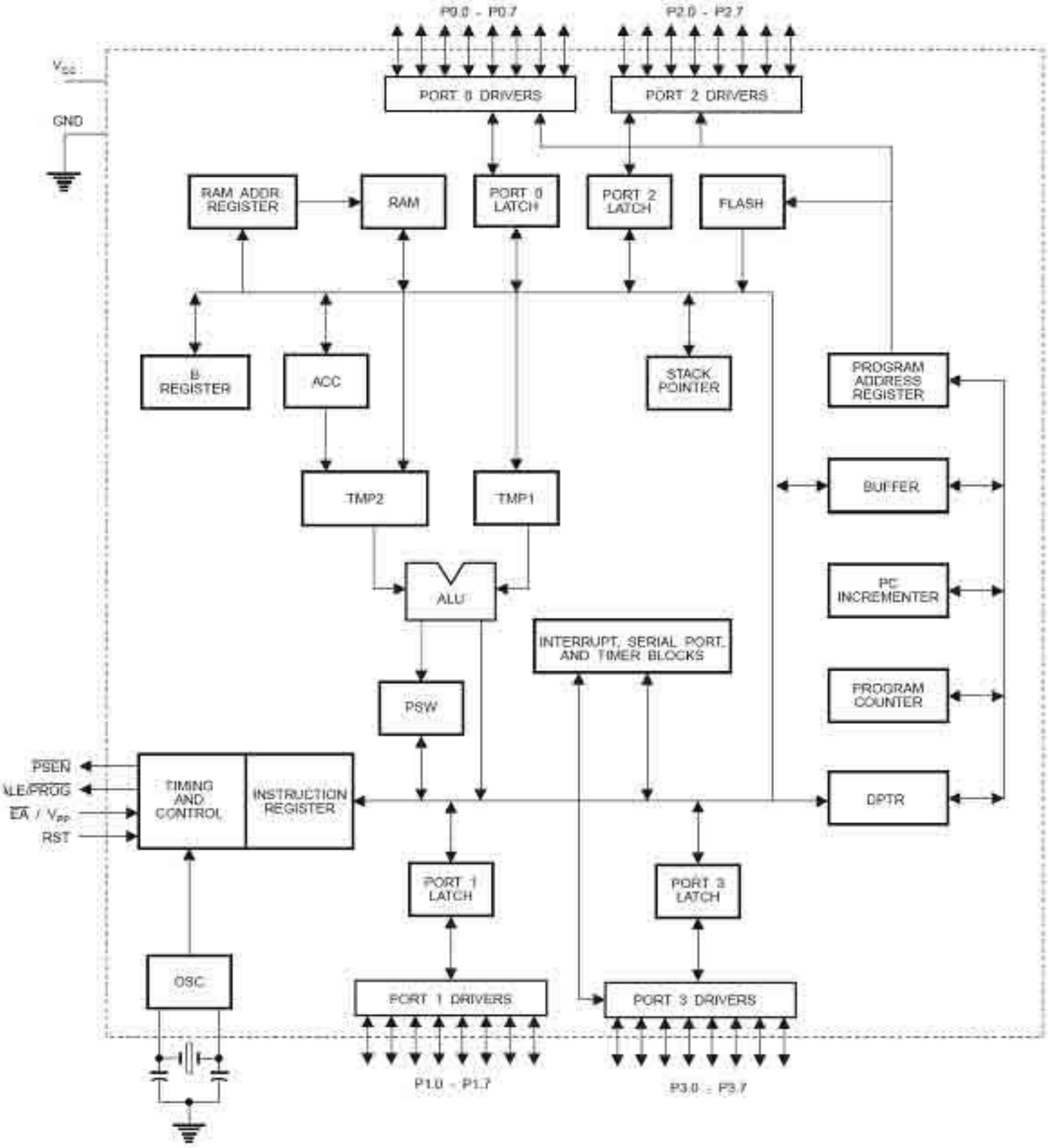


Figure 3.1Block diagram of AT89C51

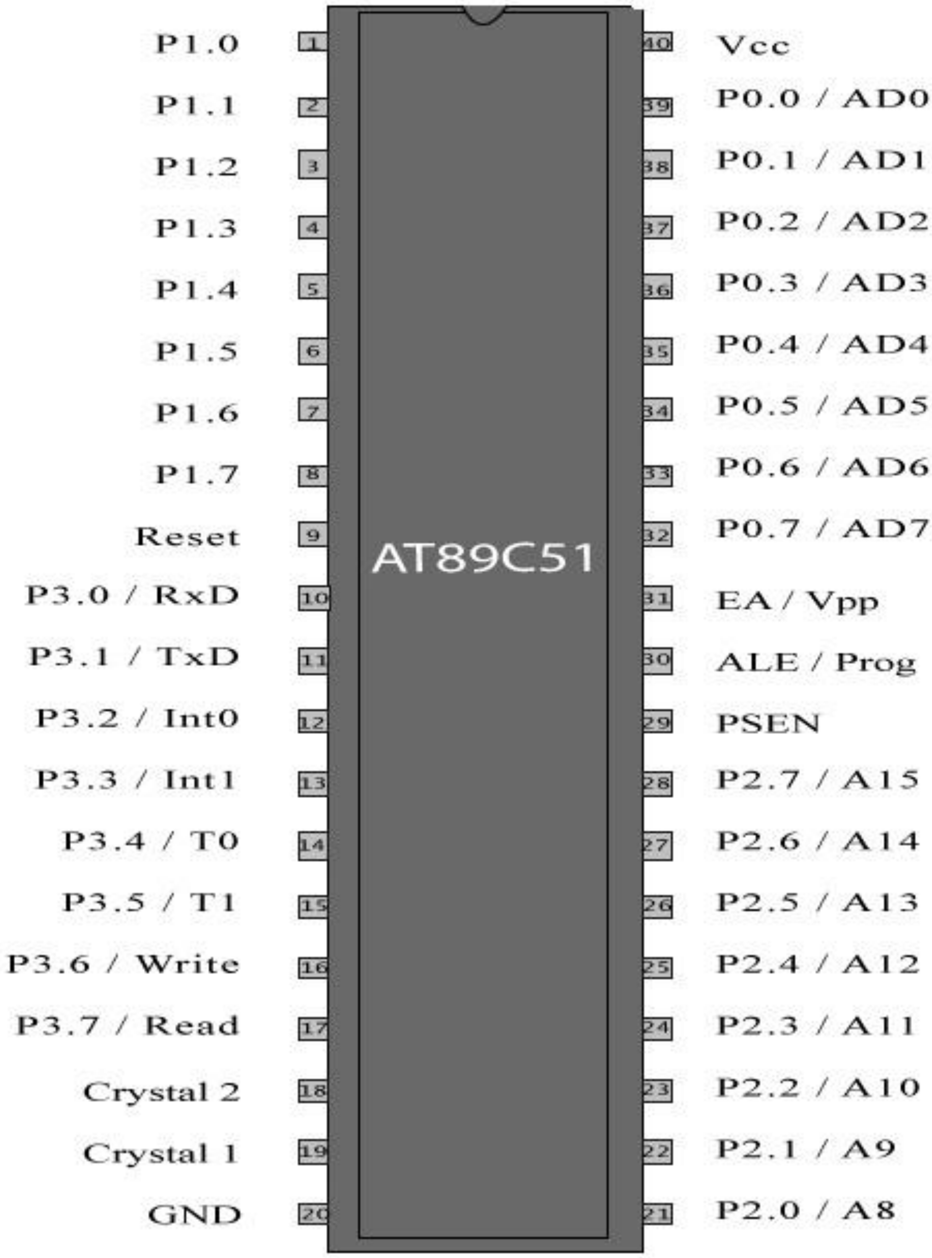


Figure 3.2Pin Diagram of AT89C51

3.1.3 Pin Description

VCC - Supply voltage.

GND –Ground.

PORT 0

Port 0 is an 8-bit open-drain bi-directional 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 may also be configured to be the multiplexed low order address/data bus during accesses to external program and data memory. In this mode P0 has internal pull-ups. 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 bi-directional 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 1 also receives the low-order address bytes during Flash programming and verification.

PORT 2

Port 2 is an 8-bit bi-directional 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 (IIL) because of the internal pull-ups.

Port 2 emits the high-order address byte during fetches from external program memory and during accesses to external data memory that use 16-bit addresses (MVOX @DPTR). In this application, it uses strong internal pull-ups when emitting 1s. During accesses to external data memory that use 8-bit addresses (MOVX @ RI), 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 bi-directional 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 (IIL) because of the pull-ups.

Table 3.1 Port Pin Alternate Functions

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

ALE/PROG

Address Latch Enable 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. Note, however, that one ALE pulse is skipped during each access to external Data.

MEMORY

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 the microcontroller is in external execution mode.

PSEN

Program Store Enable is the read strobe to external program memory. When the AT89C51 is executing code from external program memory, PSEN is activated twice each machine cycle, except the two PSEN activations are skipped during each access to external data memory.

EA/VPP

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. This pin also receives the 12-volt programming enable voltage (VPP) during Flash programming, for parts that require 12-volt VPP.

XTAL 1 AND XTAL 2

XTAL 1 gives input to the inverting oscillator amplifier and input to the internal clock operating circuit and XTAL 2 gives output from the inverting oscillator amplifier.

3.2 OCTAL BUFFER 74LS540

3.2.1 Description

These octal buffers and line drivers are designed to have the performance of the popular SN54LS240/SN74LS240 series and, at the same time, offer a pinout having the inputs and outputs on opposite sides of the package. This arrangement greatly enhances printed circuit board layout.

The three-state control gate is a 2-input NOR such that if either G1\ or G2\ are high, all eight outputs are in the high-impedance state.

The 'LS540 offers inverting data and the 'LS541 offers true data at the outputs.

The SN54LS540 and SN54LS541 are characterized for operation over the full military temperature range of -55°C to 155°C. The SN74LS540 and SN74LS541 are characterized for operation from 0°C to 70°C.

3.2.2 Features

- 3-State Outputs Drive Bus Lines or Buffer Memory Address Registers.
- P-N-P Inputs Reduce D-C Loading.
- Hysteresis at Inputs Improves Noise Margins.
- Data Flow-through Pinout (All Inputs on Opposite Side from Outputs).

Figure 3.3 Image of a octal buffer

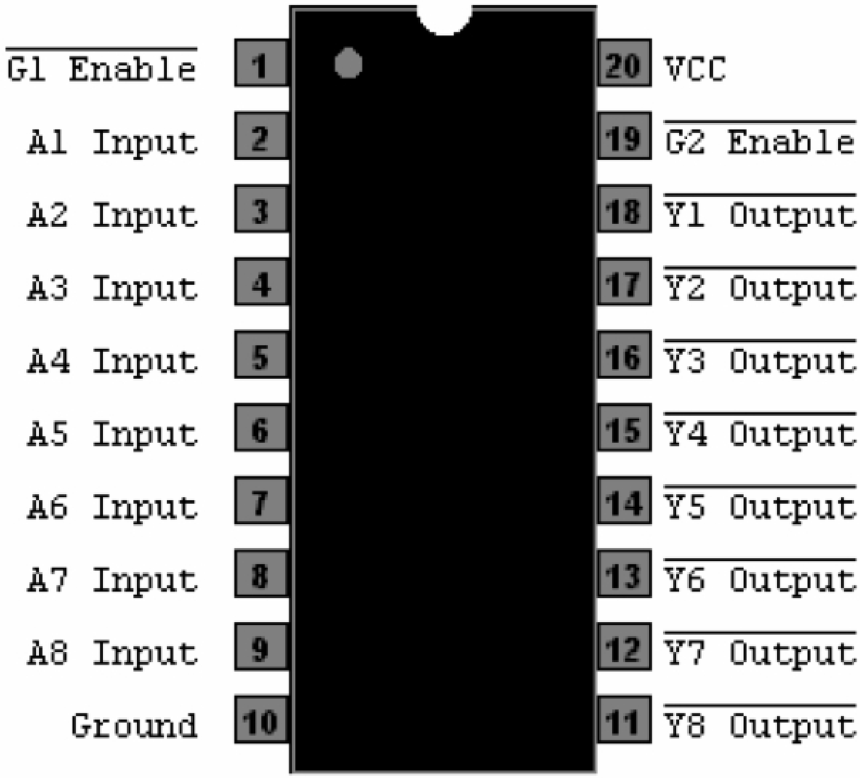


Figure 3.4 PIN DIAGRAM OF 74LS540

3.3 74LS137 DECODER

3.3.1 Description

The 74LS137 is a three-line to eight-line decoder/demultiplexer with latches on the three address inputs. When the latch-enable input (GL\) is low, the 'LS137 acts as a decoder/demultiplexer. When GL\ goes from low to high, the address present at the select inputs (A, B, and C) is stored in the latches. Further address changes are ignored as long as GL\ remains high. The output enable controls, G1 and G\2, control the state of the outputs independently of the select or latch-enable inputs. All of the outputs are high unless G1 is high and G\2 is low. The 'LS137 is ideally suited for implementing glitch-free decoders in strobed (stored-address) applications in bus-oriented systems.

In digital electronics, a binary decoder is a combinational logic circuit that converts a binary integer value to an associated pattern of output bits. They are used in a wide variety of applications , including data demultiplexing, seven segment displays, and memory address decoding. There are several types of binary decoders, but in all cases a decoder is an electronic circuit with multiple data inputs and multiple outputs that converts evety unique combination of data input states into a specific combination of output states. In addition to its data inputs, some decoders also have one or more “enable” inputs. When the enable input is negated (disabled), all decoder outputs are forced to their inactive states. Depending on its function, a binary decoder will convert binary information from n input signals to as many as unique output signals. Some decoders have less output lines. In such cases, at least one output pattern wil be repeated for different input valves. A 3-to-8 line decoder activates one of eight output bits for each input value from 0 to 7- the range of integer values that can be expressed in three bits.

3.3.2 Features

- Combines Decoder and 3-Bit Address Latch.
- Incorporates 2 Enable Inputs to Simplify Cascading.
- Low Power Dissipation of 65 mv Typically.

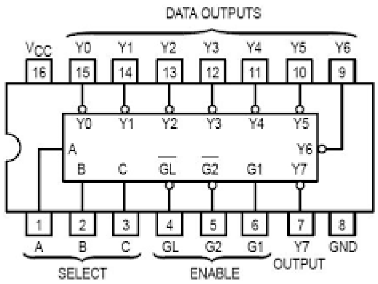


Figure 3.5 PIN DIAGRAM OF 74LS137

3.4 OPTOCOUPLER PC817

3.4.1 Description

The PC817 series of devices each consist of an infrared emitting diodes, DIP package and available in Wide-lead spacing and SMD option. It contains an IRED optically coupled to a phototransistor. It is packaged in a 4 pin DIP, available in wide-lead spacing option isolation voltage (rms) is 5.0kV. Collector-emitter voltage is 80V and CTR is 50% to 600% at input current of 5mA. It is a component that transfers electrical signals between two isolated circuits by using light. Opto-isolator prevent high-voltages from affecting the system receiving the signal. A common type of opto-isolator of an LED and a phototransistor in the same opaque package. Other types of source-sensor combinations include LED-photodiode, LED-

Lascr, and lamp-photoresistor pairs. Usually opto-ioslators transfer digital (on-off) signals, but some techniques allow them to be used with analog signals.

An opto-isolator contains a source (emitter) of light, almost always an near infrared light-emitting diode (LED), that converts electrical input signal into light, a closed optical channel (also called dielectrical channel), and a photosensor, which detects incoming light and either generates electric energy directly, or modulates electric current flowing from an external power supply. The sensor can be a photoresistor, a photodiode, a phototransistor, a silicon-controlled rectifier (SCR) or a triac. Because LEDs can sense light in addition to emitting it, construction of symmetrical, bidirectional opto-isolators is possible. An optocoupled solid state relay contains a photodiode opto-isolator which drives a power switch, usually a complementary pair of MOSFETs. A slotted optical switch contains a source of light and a sensor, but its o[tical channel is open, allowing modulation of light by external objects obstructing the path of light or reflecting light into the sensor.

3.4.2 Features

- Current transfer ration.
  (CTR: MIN. 50% at I=5mA, V=5V)
- High isolation voltage between input and output (V : 5000V)
- Compact dual-in-line voltage package which has 4 channel types.

3.4.3 Applications

- Computer terminals.
- System appliances, measuring instruments.
- Registers, copiers, automatic vending machines.

- Electric home appliances, such as fan, heaters etc.
- Signal transmission between circuits of different potentials and impedances.

3.5 ANALOG TO DIGITAL CONVERTER 0804

3.5.1 Description

Analog to digital converters find huge application as an intermediate device to convert the signals from analog to digital form. These digital signals are used for further processing by the digital processors. Various sensors like temperature, pressure, force etc. convert the physical characteristics into electrical signals that are analog in nature.

ADC0804is a very commonly used 8-bit analog to digital convertor. It is a single channel IC, *i.e.*, it can take only one analog signal as input. The digital outputs vary from 0 to a maximum of 255. The step size can be adjusted by setting the reference voltage at pin9. When this pin is not connected, the default reference voltage is the operating voltage, *i.e.*, Vcc. The step size at 5V is 19.53mV (5V/255), *i.e.*, for every 19.53mV rise in the analog input, the output varies by 1 unit.

To set a particular voltage level as the reference value, this pin is connected to half the voltage. For example, to set a reference of 4V (Vref), pin9 is connected to 2V (Vref/2), thereby reducing the step size to 15.62mV (4V/255).

3.5.2 Features

- Compatible with 8080 Microprocessors derivatives – No interfacing logic needed – access time 135ns.

- Easy interface to all microprocessors, or operates as a stand-alone device.
- Differential Analog Voltage Inputs.
- Logic inputs and outputs meet both MOS and TTL voltage level specifications.
- Works with 2.5V (LM35) Voltage reference.
- On-chip clock generator.
- 0V to 5V Analog Input Voltage range with single 5V supply.
- No Zero adjust required.
- 0.3 inch standard width 20-pin DIP package
- 20-pin molded chip carrier or small outline package
- Operates ratiometrically or with 5V DC, 2.5V DC or Analog span adjusted voltage reference.

3.5.3 Applications

- Operates with any 8-bit microprocessors or as a stand-alone device.
- Interface to temperature sensors, voltage sources and transducers.

Figure 3.6 Image of ADC0804.

3.5.4 Pin Diagram

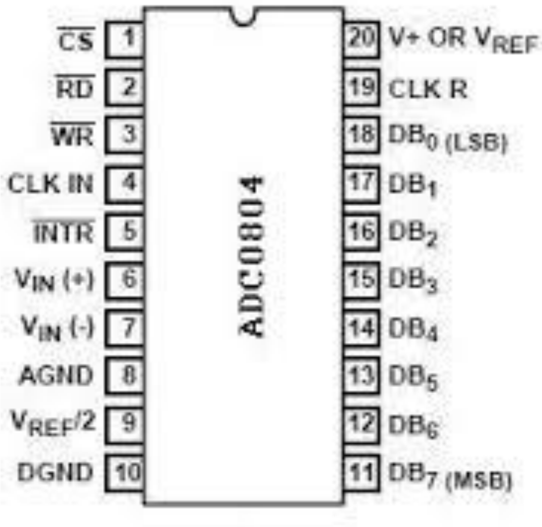


Figure 3.7 Pin diagram of ADC0804.

3.5.5 Pin Description

Table 3.2 Pin details of ADC0804.

Pin No	Function	Name
1	Activates ADC; Active low	Chip select
2	Input pin; High to low pulse brings the data from internal registers to the output pins after conversion	Read
3	Input pin; Low to high pulse is given to start the conversion	Write
4	Clock Input pin; to give external clock.	Clock IN
5	Output pin; Goes low when conversion is complete	Interrupt
6	Analog non-inverting input	Vin(+)
7	Analog inverting Input; normally ground	Vin(-)
8	Ground(0V)	Analog Ground
9	Input pin; sets the reference voltage for analog input	Vref/2
10	Ground(0V)	Digital Ground
11	8 bit digital output pins	D7
12		D6
13		D5
14		D4
15		D3
16		D2
17		D1
18		D0
19	Used with Clock IN pin when internal clock source is used	Clock R

3.6 TEMPERATURE SENSOR LM35

3.6.1 Description

LM35 is a precision IC temperature sensor with its output proportional to the temperature (in °C). The sensor circuitry is sealed and therefore it is not subjected to oxidation and other processes. With LM35**,** temperature can be measured more accurately than with a thermistor. It also possess low self heating and does not cause more than 0.1 °C temperature rise in still air. The operating temperature range is from -55°C to 150°C. The output voltage varies by 10mV in response to every °C rise/fall in ambient temperature, *i.e.*, its scale factor is 0.01V/ °C. LM35 are precision integrated-circuit temperature devices with an output voltage linearly proportional to the centigrade temperature. The LM35 device 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.

The LM35 device does not require any external calibration or trimming to provide typical accuracies of one fourth of degree Celsius at room temperature range. Lower cost is assured by trimming and calibration at the water level. The low-output impedance, linear output and precise inherent calibration of the LM35 device makes interfacing to readout or control circuitry especially easy. The device is used with single power supplies, or with plus and minus supplies. As the LM35 device makes interfacing to readout or control circuity especially easy. The device is used with single power supplies, or with plus and minus supplies. As the LM35 device draws only 60 microampere from the supply, it has very low self-heating of less than 0.1 centigrade in still air. The LM35 device is rated to operate over a -55 degree centigrade to 150 degree centigrade temperature range, while the LM35C device is rated for a -40 degrees to 110 degrees range (-10 degrees with improved accuracy). The LM35-series devices are available packaged in hermetic to transistor packages, while the LM35C, LM35CA, and LM35D devices are available in the plastic TO-92 transistor package. The LM35D device is available in an 8-lead surface-mount small-outline package and a plastic TO-220 package.

3.6.2 Features

- Calibrated directly in Celsius (Centigrade).
- Linear +10-mv/degrees centigrade scale factor.
- 0.5 degree centigrade ensured accuracy (at 25 degrees centigrade).
- Rated for full -55 degree centigrade to 150 degree centigrade range.
- Suitable for Remote applications.
- Low-cost due to wafer-level trimming.
- Operates from 4V to 30V.
- Less than 60 microampere current drain.
- Low self-heating, 0.08 degrees Celsius in still air.
- Non-linearity only typically.
- Low-impedance output, 0.1 ohms for 1-mA load.

3.6.3 Applications

- Power supplies.
- Battery management.
- HVAC.
- Appliances.

3.6.4 Pin Diagram

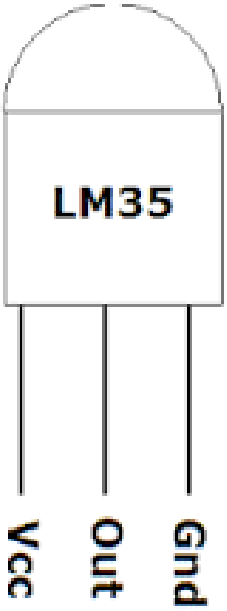


Figure 3.8   Pin diagram of Temperature sensor.

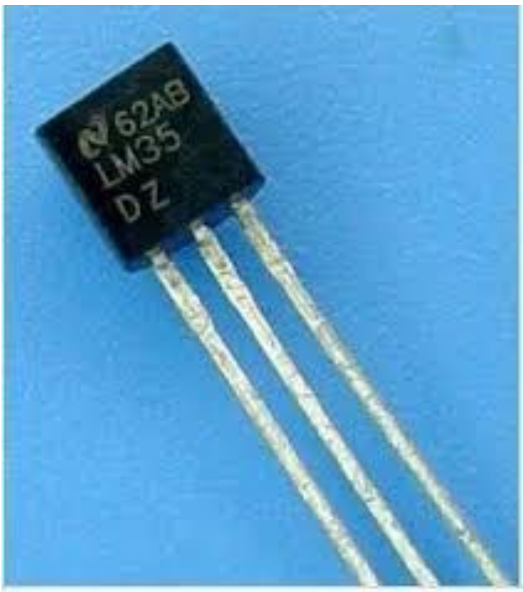


Figure 3.9   Image of Temperature sensor.

Figure 3.10 Pin configuration for Temperature sensor.

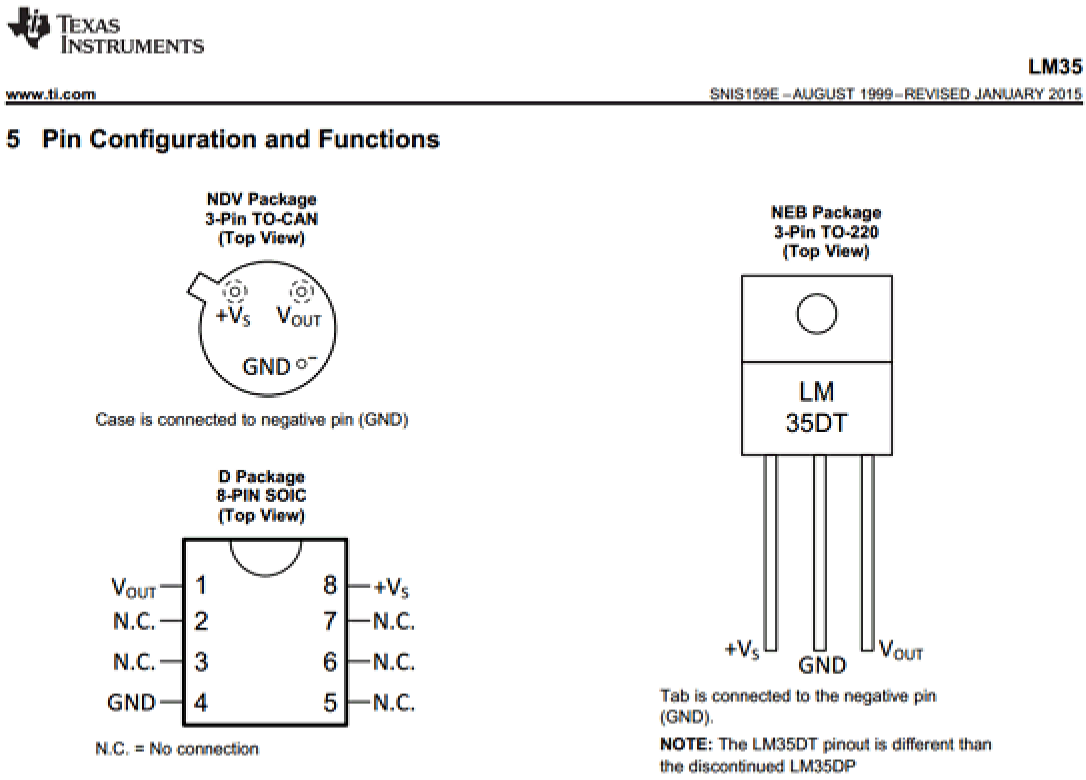


Figure 3.11 Functions of Temperature sensor.

3.7 BUFFER LATCH 74LS373

3.7.1 Description

These 8-bit registers feature totem-pole TRI-STATE outputs designed specially for driving highly capacitive or relatively low-impedance loads. The high-impedance state and increased high-logic level drive provide these registers with the capability of being connected directly to and driving bus lines in a bus-organized system without need for interface or pull-up components. They are particularly attractive for implementing buffer registers, I/O ports, bidirectional bus drivers, and working registers. The eight latches of the 74LS373 are transparent D-type latches meaning that while the enable(G) is high the Q outputs will follow the data (D) inputs. When the enable is taken low the output will be latched at the level of the data that was set up.

The eight flip-flops of the 74LS373 are edge-triggered D-type flip flops. On the positive transition of the clock, the Q outputs will be set to the logic states that were set up at the D inputs. A buffered output control input can be use to place the eight outputs in either a normal logic state (high or low logic levels) or a high-impedance state. In the high-impedance state the outputs neither load nor drive the bus lines significantly. The output control does not affect the internal operation of the latches or flip-flops. That is, the old data can be retained or new data can be entered even while the outputs are off.

3.7.2 Features

- Choice of 8 latched or 8 D-type flip-flops in a single package.
- TRI-STATE bus-driving outputs.
- Full parallel-access for loading.
- Buffered control inputs.
- P-N-P inputs reduce D-C loading on data lines.

3.7.3 Working of Latch IC 74LS373

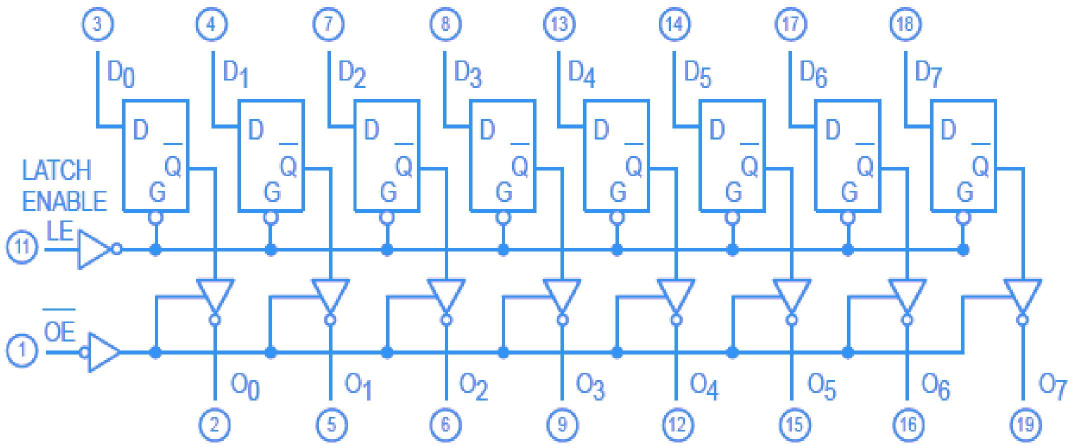


Figure 3.12 Working of 74LS373

The IC 74LS373 comprises eight D flip flops through which the input was given to the each pins of the IC.The Flip flops data changes asynchronously when the Latch enable (LE) is in High state.As we all know the operation of flip flop that any input to the D pin at the present state will be given as output in next clock cycle.But when the Latch Enable Pin was pulled low, the data will be latched so that the data appears instantaneously providing a Latching action.

The Output Enable pin also plays an important role in the working of this 74LS373 IC.When the (OE) pin is low input data will appear in the output.But when the OE is high the output will be in a high impedance state.This IC operates with maximum of 5 V and widely used in many kinds of electronic appliances.

3.7.4 Pin Diagram

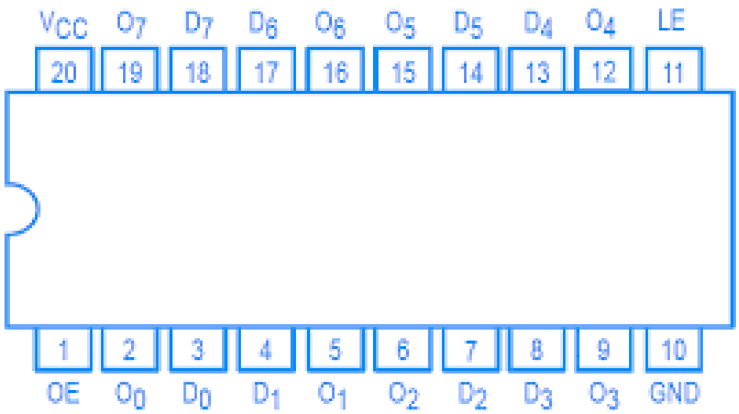
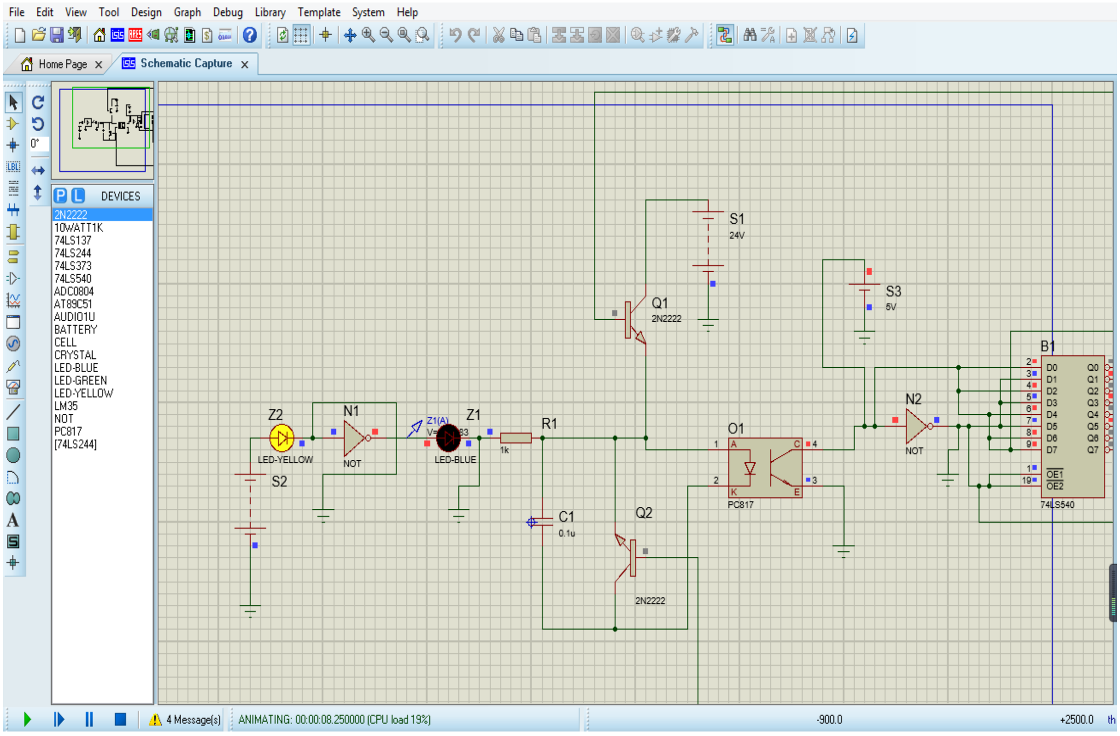


Figure 3.13 Pin diagram of 74LS373

CHAPTER 4

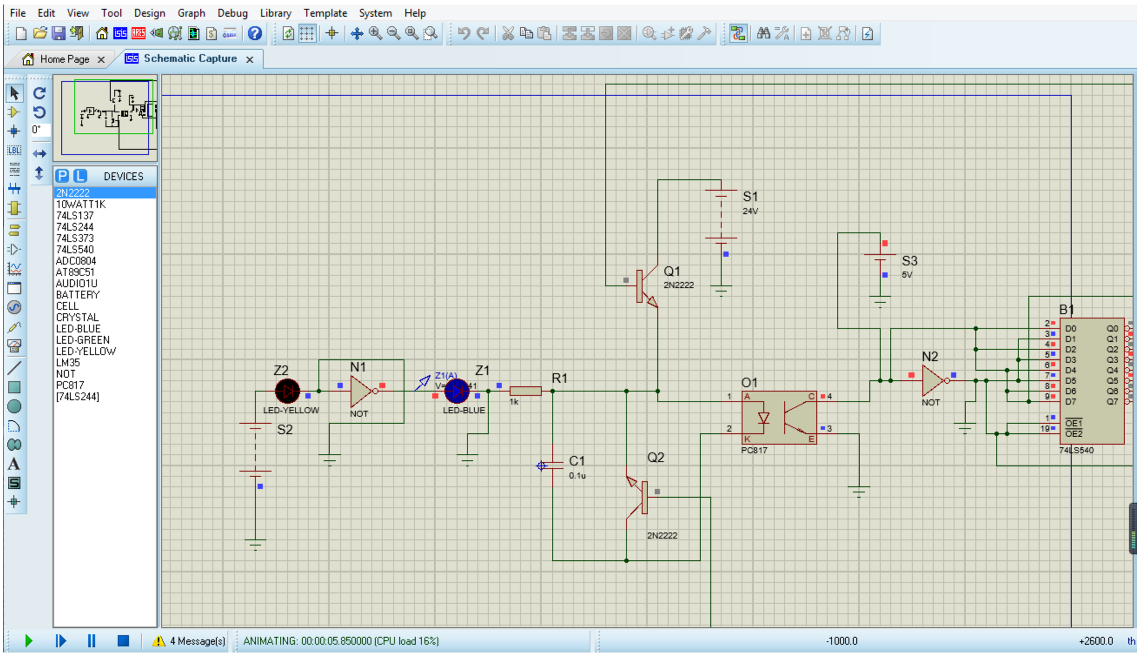
SIMULATION AND RESULTS

4.1 SIMULATION FOR NORMAL OPERATION



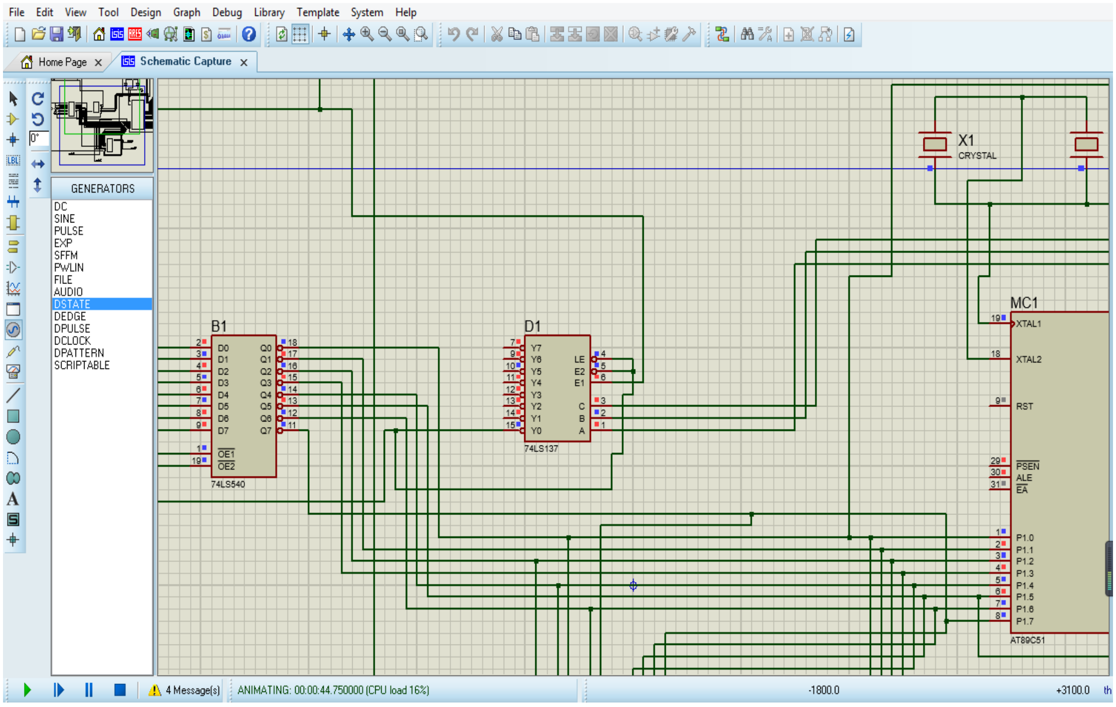
Under the normal operation of the digital input board, the power supply has to be +24V. This is notified using the Z2 LED in the digital input board. So, from this we can identify that the system is working properly without any disturbance in the power supply. Here optocouler PC817 is also used so that the input system can be isolated from the power supply system in case of any errors in the system.

4.2 SIMULATION FOR CABLE OPEN DETECTION



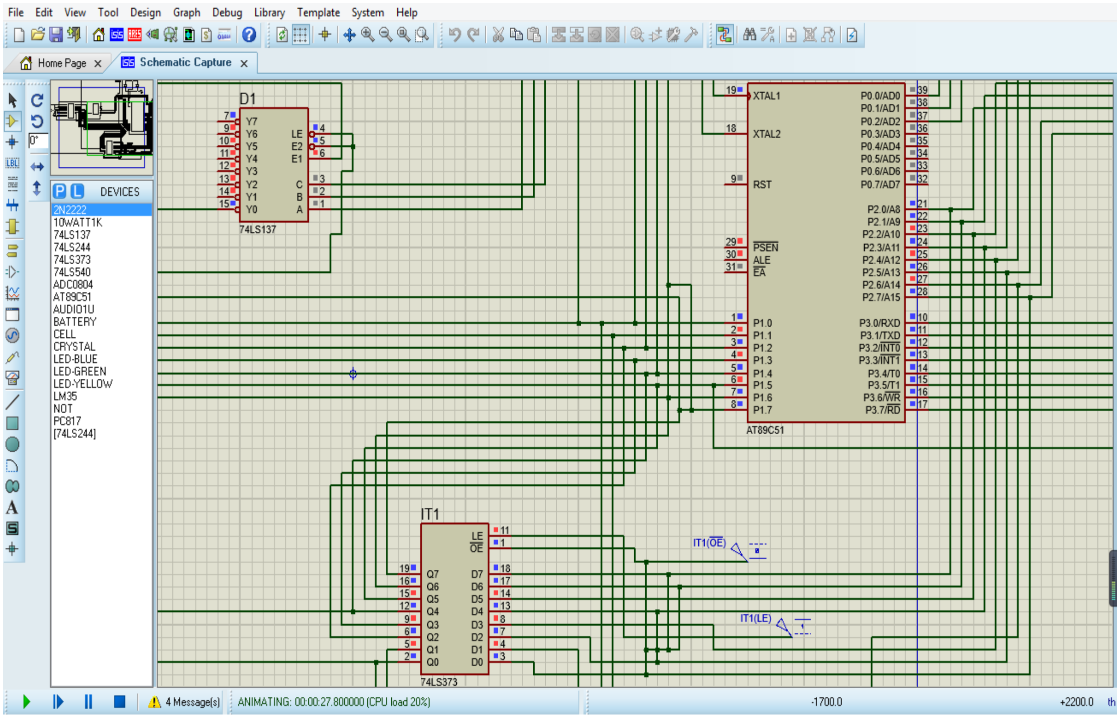
Under the system of cable open detection, the input system detects incase any line of the valves is open or not connected properly. Here LED Z1 is used so that the cable open detection can be identified. In case if the required voltage of +24V is not given to the system, then again this system plays a very important role in the input system. This means the power supply must be checked again.

4.3 SIMULATION FOR BUFFER AND DECODER



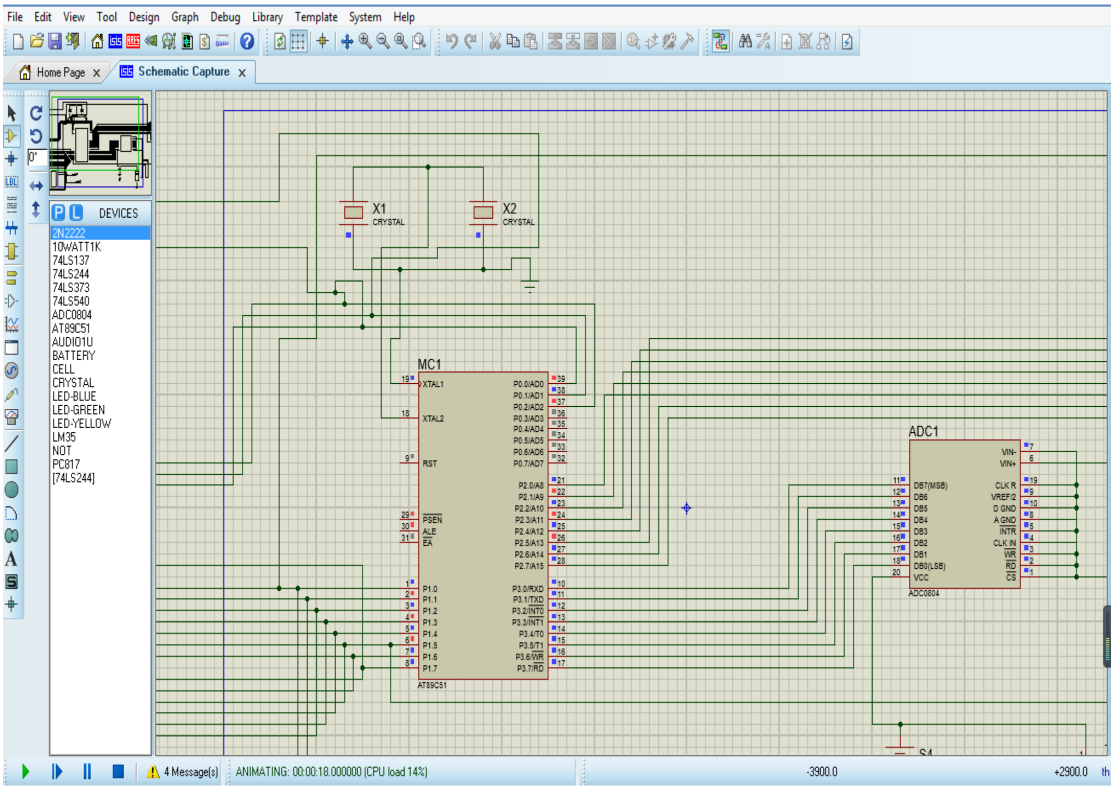
The Buffer 74LS540 is used in the input system where the valve inputs are given to it. And the input of this is given to the Port 1 of the microcontroller AT89C51 represented by MC1. And the OE is connected to the one of the channel in the address line of the 3-to-8 line decoder which is represented by D1. And the three inputs A, B, C is given to one of the ports of the microcontroller.

4.4 SIMULATION FOR FORCED 0'S AND FORCED 1'S



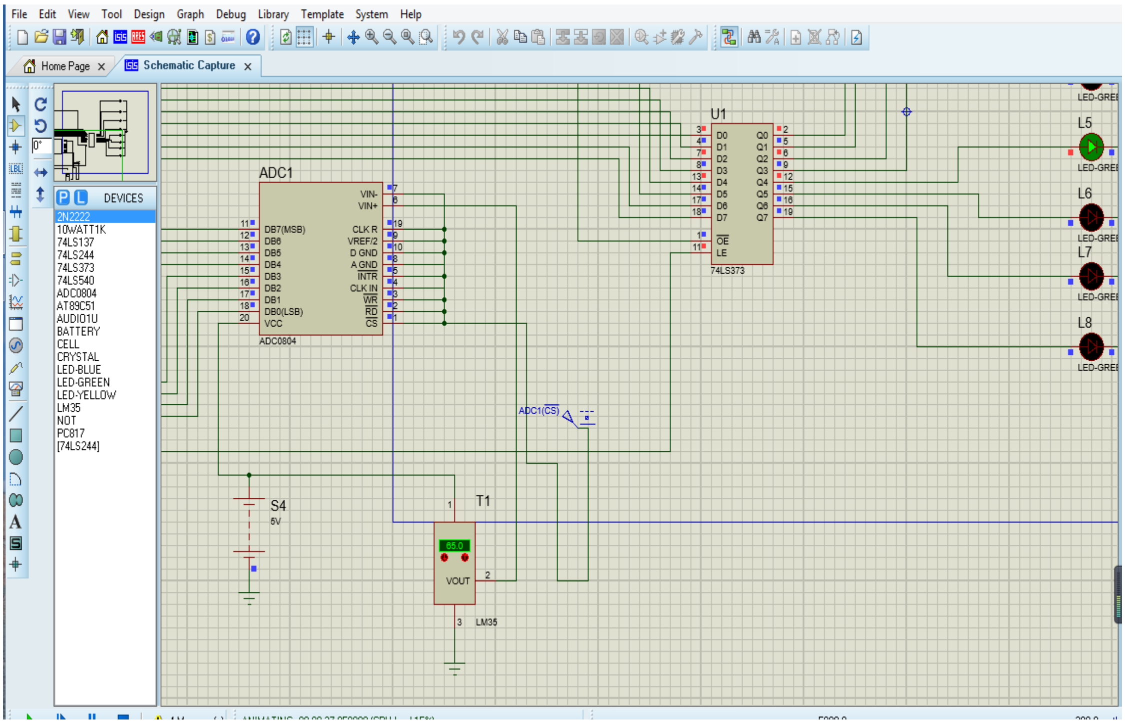
This type of system is called Impulse testing which is done by the forced 0's and forced 1's. The input is taken from the one of the ports from the microcontroller. Here the input is taken from port 1 of the microcontroller and the inputs for the buffer latch 74LS373 is given through the mixed signals. And hence, the same is produced in the output of the buffer latch and it is given as the forced 0's and forced 1's to the respective BJT switches respectively. And from there on, the values are sent to the port 2 of the microcontroller which now acts an input and the output is obtained through the Ethernet ports.

4.5 SIMULATION FOR THE MICROCONTROLLER



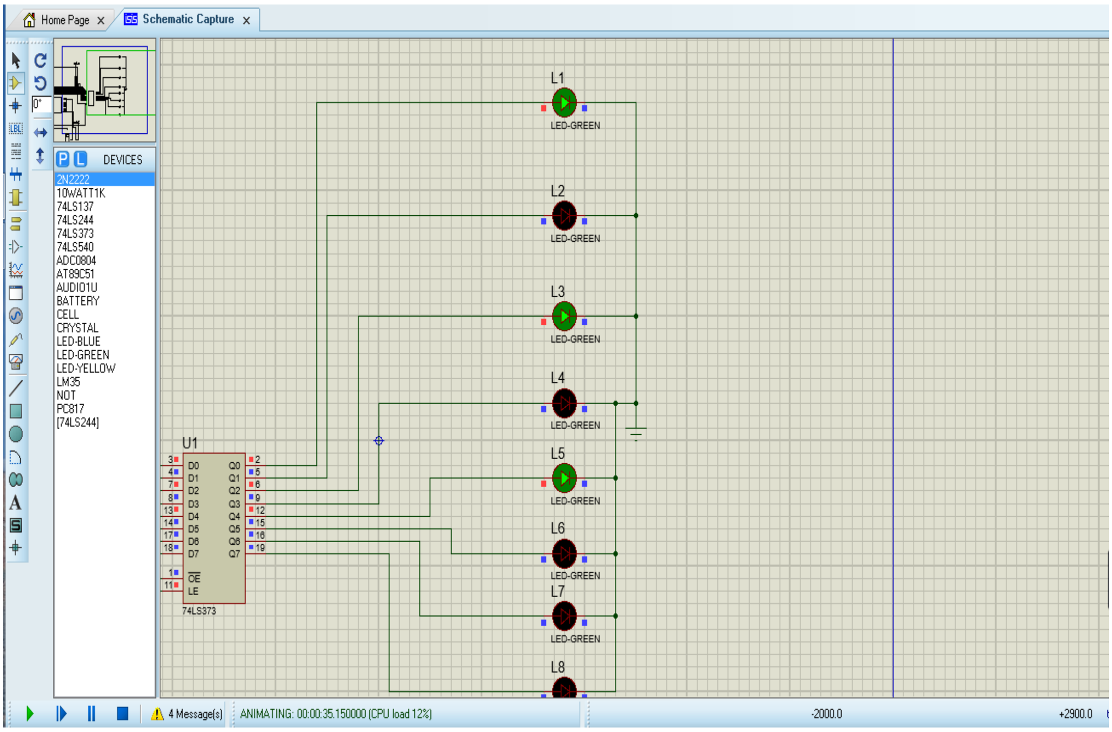
As we see the simulation, the input of the buffer and the input of the impulse testing is given to port 1 of the microcontroller and the output is given to the port 2 of the microcontroller. The address lines A, B, C is given to port 0 of the microcontroller and the input of ADC which is given negative signal in this system is given to port 3 of the microcontroller. The Vin+ of the ADC is given to temperature sensor LM35.

4.6 SIMULATION FOR ADC AND TEMPERATURE SENSOR



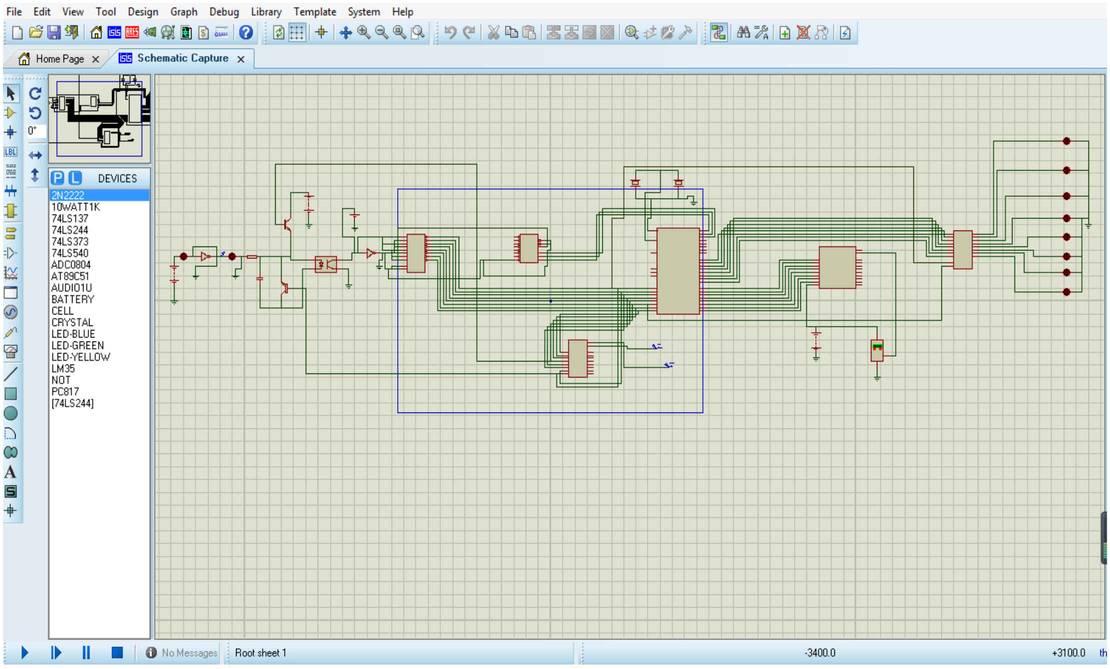
The negative signal is given to ADC for low power application of the system. And we are fixing a limit to the temperature sensor to 65 degree centigrade. Above which the normal board would get heated up. However, the panel of boards are fixed with the cooler fans, we take a safety measure for digital input board. And we can also see from the above simulation that the the input to the output buffer latch 74LS373 is connected to port 2 of the microcontroller.

4.7 SIMULATION FOR THE VALVE OUTPUTS



We can see that, the buffer latch output 74LS373 is used in the output system of the digital input board. We can see that there are 8 LEDs that are connected to each output pin of the buffer latch. So, the LEDs that are glowing or switched ON are representing 1's and those LEDs that are OFF are represented as 0's in the digital input board. This is the output for one channel of input that contains 8 inputs for a buffer, similarly there would be 8 more buffers and there will be 8 LED outputs for every channel. The original digital input board might not contain LEDs for outputs, instead it would be connected to the computer used by the operator through the Ethernet port of the digital input board.

4.8 VIEW OF ONE WHOLE SINGLE CHANNEL



The above representation is the whole view of one single channel that is given as input and obtained as output. Similarly, there would be 7 more channel that would satisfy the input for 64 valves of the digital input board.

CHAPTER 5

CONCLUSION

5.1 SUMMARY OF PROPOSED WORK

The Digital input board for reactor application, proposed in this project has more applications than the other boards in the existing system. This is designed in such a way that it gives the status of the valves of the pipes coming out from the reactor. This has numerous applications, as the output obtained from the digital input board is connected to a computer through a Ethernet port. And the operator who is working on the computer can identify the status of the valves as Open or Close.

5.2 FUTURE SCOPE

Status are obtained only through the computer, these status are recorded in it. So, in case of any error in the power plant reactor, the time of Opening or Closing of the valves are compared to the heat or steam produced by the reactor at that particular time. This helps in reasoning out the error in the reactor system and thus can be rectified.

APPENDIX – I

CODING FOR THE MICROCONTROLLER AT89C51

```
#include <Reg51.h>
sbit A=P0^0;
sbit B=P0^1;
sbit C=P0^2;
{
return();
A=0;
B=0;
C=0;
}
sbit wr();
sbit rd();
sbit cs1=D1;
sbit cs2=D2;
sbit cs3=D3;
sbit cs4=D4;
sbit cs5=D5;
sbit cs6=D6;
sbit cs7=D7;
sbit cs8=D8;
sbit cs=return();
sbit rd=P3^0;
```

```
sbit wr=P3^6;
sbit INTR0=P3^2;
sbit INTR1=P3^3;
sbit F=P3^4;
sbit L=P3^5;
{
void force();
void temp();
void main();
{
while(1)
{
read();
{
force();
void temp();
}}
void read()
{
unsigned char X;
cs1=1;
wr=0;
{
A=0;
B=0;
C=0;
```

```
X=P1;
P2=X;
return();
}
{
cs2=1;
wr=0;
A=1;
B=0;
C=0;
X=P1;
P2=X;
return();
}
{
cs=1;
wr=0;
A=0;
B=0;
C=0;
return();
}
{
cs4=1;
```

```
wr=0;
A=0;
B=0;
C=1;
return();
}
{
cs5=1;
wr=0;
A=1;
B=0;
C=1;
return();
}
{
cs6=1;
wr=0;
A=1;
B=2;
C=0;
return();
}
{
```

```
ws7=1;
wr=0;
A=0;
B=1;
C=1;
return();
}
{
cs8=1;
wr=0;
A=1;
B=1;
C=1;
return();
}
void force()
{
force 0();
force 1();
{
cs1=1;
wr=0;
A=0;
```

```
B=0;
C=0;
return force();
}
{
cs2=1;
wr=0;
A=1;
B=0;
C=0;
return force();
}
{
cs3=1;
wr=0;
A=0;
B=1;
C=0;
return force();
}
{
cs4=1;
wr=0;
```

```
A=0;

B=0;

C=1;

return force();

}

{

cs5=1;

wr=0;

A=0;

B=1;

C=0;

return force();

}

{

cs6=1;

wr=0;

A=1;

B=1;


C=1;

return force();

}

{
```

```
cs7=1;

wr=0;

A=0;

B=1;

C=1;

return force();

}

{

cs8=1;

wr=0;

A=1;

B=1;

C=1;

return force();

}}

void force 0()

{

unsigned char F0;


F=0;

F0=P2;

B=0*00;

if (F0=B)
```

```
{
L=0;
}}
void force 1()
{
unsigned char F1;
F=1;
F1=P1;
B=0*FF;
if (F0=B)
{
L=0;
}
void force 1()
{
F1=1;
F1=P2;
if (F1=B);
{
L=0;
}
}
void temp()
```

```
{
unsigned char X;
cs=0;
wr=0;
while (INTR == 1)
{
}
rd=0;
X=P0;
if (X>0*0F)
L=0;
INTR=1;
CALL STOP;
}
}
}
```

CHAPTER – 6

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