ANALOG TO DIGITAL CONVERTOR INTERFACE WITH 8051 MICROCONTROLLER

DEBANAND MAJHI (109EE0278)

BRAJESH ANAND (109EE0638)

SAKSHAM MISHRA (109EE0639)

Department of Electrical Engineering
National Institute of Technology Rourkela

ANALOG TO DIGITAL CONVERTOR INTERFACE WITH 8051 MICROCONTROLLER

A Thesis submitted in partial fulfillment of the requirements for the degree of

Bachelor of Technology in "Electrical Engineering"

By

DEBANAND MAJHI (109EE0278)

BRAJESH ANAND (109EE0638)

SAKSHAM MISHRA (109EE0639)

Under guidance of

Prof. SUPRATIM GUPTA

Department of Electrical Engineering
National Institute of Technology
Rourkela-769008 (ODISHA)
May-2013

DEPARTMENT OF ELECTRICAL ENGINEERING

NATIONAL INSTITUTE OF TECHNOLOGY, ROURKELA

ODISHA, INDIA-769008

CERTIFICATE

This is to certify that the thesis entitled "**Analog to Digital Convertor Interface with 8051 Microcontroller**", submitted by **Debanand Majhi (Roll. No. 109EE0278), Brajesh Anand (Roll. No. 109EE0638) and Saksham Mishra (Roll. No. 109EE0639)** in partial fulfilment of the requirements for the award of **Bachelor of Technology** in **Electrical Engineering** during session 2012-2013 at National Institute of Technology, Rourkela. A bonafide record of research work carried out by them under my supervision and guidance.

The candidates have fulfilled all the prescribed requirements.

The Thesis which is based on candidates' own work, have not submitted elsewhere for a degree/diploma.

In my opinion, the thesis is of standard required for the award of a bachelor of technology degree in Electrical Engineering.

Place: Rourkela

Dept. of Electrical Engineering
National institute of Technology
Rourkela-769008

Prof. Supratim Gupta

ACKNOWLEDGEMENTS

We would like to articulate our deep gratitude to our project guide **Prof. SUPRATIM GUPTA** who has always been source of motivation and firm support for carrying out the project. We would also like to convey our sincerest gratitude and indebtedness to all other faculty members and staff of Department of Electrical Engineering, NIT Rourkela, who showed their great efforts and guidance at required times without which it would have been very difficult to carry out our project work. Moreover , an assemblage of this nature could never have been attempted with our reference to the works of others whose details are mentioned in the references section at the last. We acknowledge our indebtedness to all of them. Furthermore, we would like to take the name of our parents and God who directly or indirectly encouraged and motivated us during this dissertation.

ABSTRACT

In this paper we shall study how a 8051 microcontroller is interfaced with an analog to digital convertor(ADC). An ADC is a real world device which converts real time continuous quantities into digital values that represent the amplitude of the quantity. An ADC converts input analog signals by quantizing it. Higher the sampling rate used to discretize the values more will be the accuracy with which the output from ADC is obtained. ADCs may be used in Digital Signal Processing, in commercial applications as well as in music industries to convert the data from analog to digital in order to create the data that will be used in compact disks. Further the circuit has been simulated using PROTEUS Demo version.

CONTENTS

CHAPTER 3

SIMULATION AND OUTPUT

CHAPTER 4

CONCLUSION

LIST OF FIGURES

LIST OF TABLES

CHAPTER 1

Introduction

1.1 MOTIVATION:

In embedded system, it is essential that microcontrollers take analog input. Sensors and transducers used in industry are analog in nature. We need to convert the analog output from the sensors to digital so that the corresponding signal can be processed by the controller. These are generally used in control operation and instrumentation in industries. ADCs are used everywhere when we have to process, store or transmit an analog signal in digital form. ADCs are used in TV tuner cards and for digital data processing in microcontrollers in the form of on chip 8 bit, 10 bit ADCs. Commercial ADCs are also used as integrated circuits. Convertors with a resolution of 8 to 24 bits are used and its sample frequency is in order of some KHz, Mega and Giga sample analog to digital convertors are also used. They may be required in digital video cameras. Digital to Analog Convertors may also be required in applications such as CD players, data which will be stored in binary form may be converted into analog form by the digital to analog convertors[1]. Here ADC 0808 is used. It is a 8-channel multiplexer, 8-bit analog to digital converter and microprocessor compatible control logic.

1.2 MICROCONTROLLER ARCHITECTURE:

The 8051 microcontroller is an 8-bit microcontroller introduced by Intel corporation. this microcontroller has 128 bytes of Random Access Memory(RAM), 4K bytes of on-chip Ream Only Memory(ROM), two timers, one serial port and four port(each 8-bits wide) all on a single chip. The Central Processing Unit(CPU) can work only on 8-bit of data at a time. The 8051 has four I/O ports, each 8-bits wide[2].

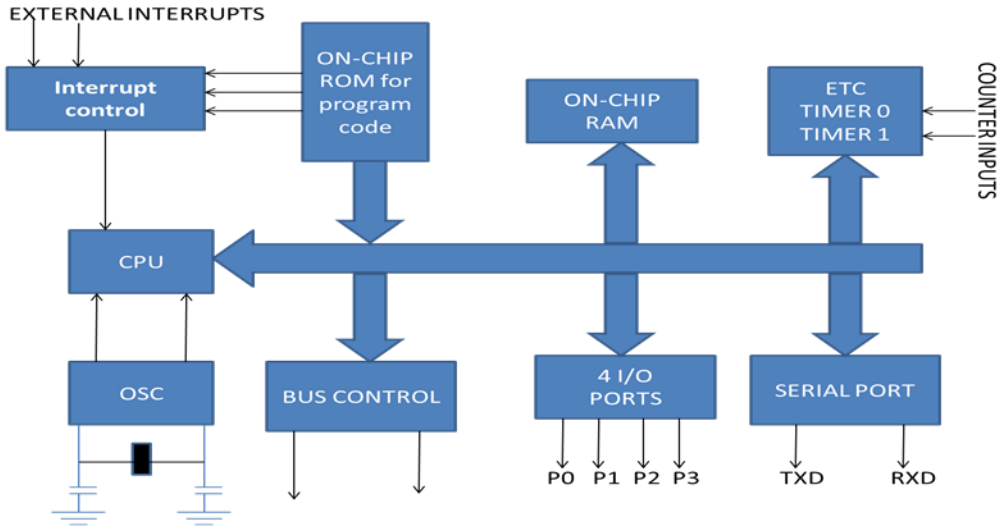

Fig 1: 8051 microcontroller block diagram[5]

1.2.1 Features of 8051[3]:

Feature	Quantity
ROM	4K bytes
RAM	128 bytes
Timer	2
I/O pins	32
Serial port	1
Interrupt sources	6

Table No.1 Features of 8051[3]

1.2.2 Registers:

Registers are used to store information temporarily. The vast majority of 8051 registers are 8-bit registers. With an 8 bit data type, any data larger than 8 bits must be broken into 8-bits chunks before it is processed. Commonly used registers of the 8051 are A(accumulator), B, R0, R1, R3, R4, R5, R6, R7, DPTR(data pointer), PC(program counter).

Some special purpose registers are:

Program Status Word(PSW)

Stack Pointer(SP)

Data Pointer(DPTR)

Accumulator(ACC)

B Register(B)

Timer/Counter mode control(TMOD)

Timer/Counter control(TCON)

Serial Control(SCON)

Power Control(PCON)

1.2.3 Pin Description of 8051:

8051 microcontroller has 40 pins which perform functions such as input/output, read/write, address, data interrupts. Out of the 40 pins, 32 pins are for the four ports namely: P0, P1, P2, P3. $V_{CC,}$ GND, XTAL1, XTAL2, $\overline{EA}$, $\overline{PSEN}$, ALE and RST are the other 8 pins available on microcontroller chip.

V_{CC} (Pin 40)

Voltage input is +5V, purpose of V_{CC} is to supply voltage to microcontroller.

GND(Pin 20)

Ground is also provided in 8051.

XTAL1 AND XTAL 2(Pins 18 and 19)

An external clock is required to run 8051. Two capacitors of 33pF are connected in addition to a quartz crystal oscillator to XTAL1 and XTAL2. The crystal oscillator used in our circuit has been set at 11.0592 MHz.

RST(Pin 9)

It is normally low, when a high pulse is applied to this pin, microcontroller will terminate all activities and reset all register values.

$\overline{EA}$(Pin 31)

It is an input pin and should be connected to $V_{CC.}$ It is known as External Access.

$\overline{PSEN}$(Pin 29)

$\overline{PSEN}$(Program Store Enable pin) is an output pin.

ALE(Pin 30)

It is an output pin and stands for Address Latch Enable.

P0(Port 0)(Pins 32 to 39)

Port 0 can be used for address as well as data. If ALE=1, P0 has address A0-A7 and if ALE=0, P0 provides data D0-D7. Port 0 needs pull-up resistors of value 10K-ohm to be connected externally because P0 has no inbuilt pull-up resistors like P1, P2 and P3.

P1(Port1)(Pins 1 to 9) and P2(Port2)(Pins 21 to 28)

They are used as input/output pins.

P3(Port3)(Pins 10 to 17)

It is used as input as well as output port. No pull-up resistors are required in P3. Apart from input/output it also provides interrupts.

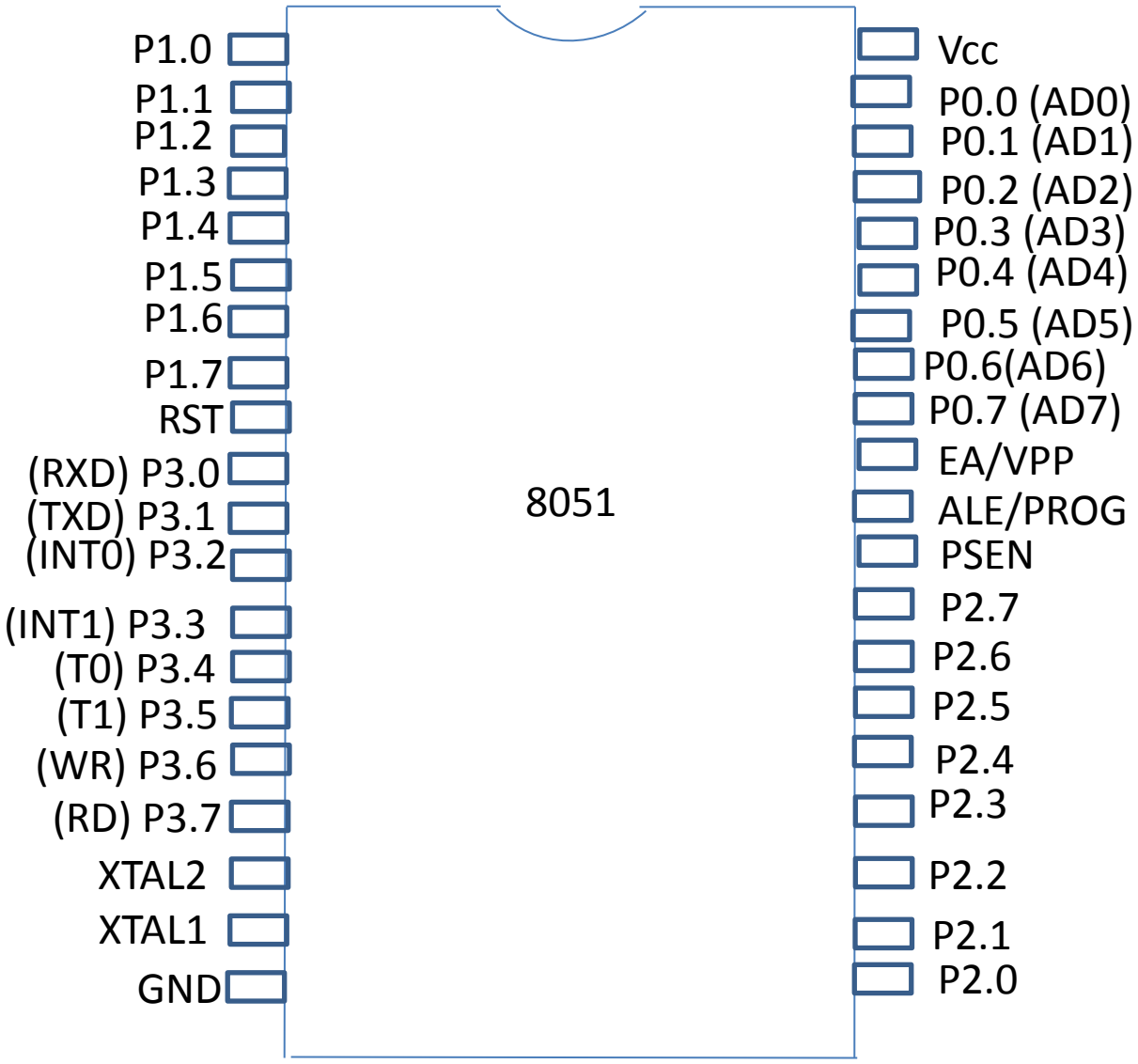

Fig 2: 8051 microcontroller[5]

1.3 ADC ARCHITECTURE

The ADC used in the interfacing is ADC 0808. It has 28 pins, and can handle upto 8 analog signals using one chip. It has got an 8-bit data output. The 8 input channels are IN0-IN7, and Vref(+)=5V; Vref(-) has been grounded. In order to select the inputs IN0-IN7; A, B and C addresses are used[4].

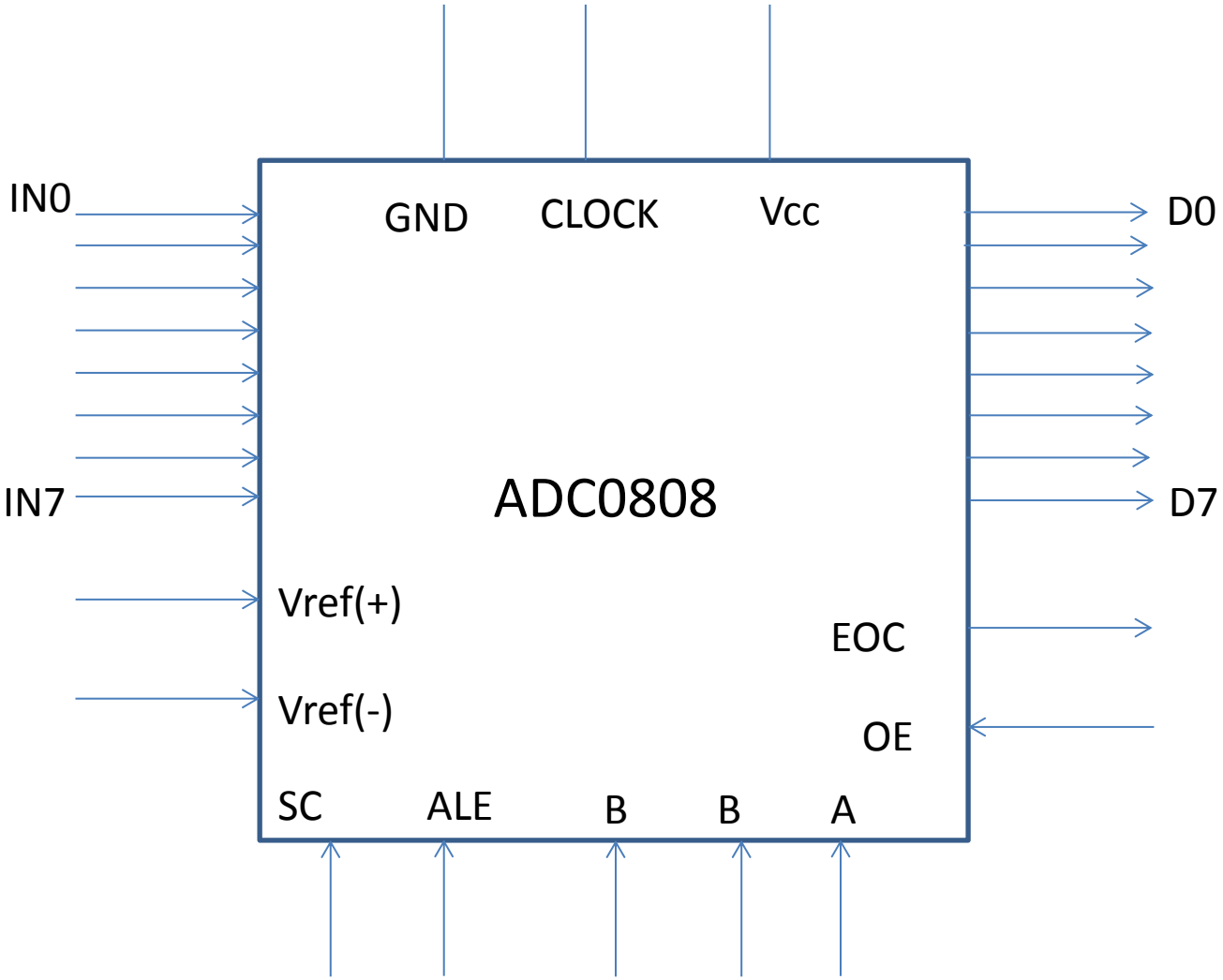

Fig 3: ADC0808[5]

CHAPTER 2

8051 MICROCONTROLLER WITH ADC

ADC receives analog signal from the source. This analog signal is received from one of the 8 input channels of ADC0808. Then this signal is processed accordingly and converted to corresponding digital signal. This signal is then sent to the microcontroller and the output is displayed using Light Emitting Diode (LED)[5].

Fig 4: block diagram for interfacing ADC with 8051 microcontroller

2.1 ALGORITHM FOR PROGRAMMING ADC

i) An analog channel is selected by giving bits to A, B, C addresses.

ii) ALE(Address Latch Enable) is activated by a low to high pulse in order to latch in the address.

iii) SC(Start Conversion) is activated by a low to high pulse in order to start the conversion.

iv) If a high to low output is obtained at EOC(End of Conversion), it indicates that the data conversion is finished and the data is ready.

v) OE(Output Enable) is activated to read output data from the ADC chip. In order to bring the digital data out of the chip a low to high pulse is is given to the OE pin.

2.2 ASSEMBLY PROGRAM TO INTERFACE ADC WITH 8051

```
ORG 000AH

SJMP MAIN

ADC_DATA EQU P1                    ;Give Name To Port Pins

ADC_SC BIT P3.0

ADC_EOC BIT P3.1
```

```
ADC_ALE BIT P3.2

ADC_OE BIT P3.3

ADD_A BIT P3.4

ADD_B BIT P3.5

ADD_C BIT P3.6

MAIN:

        MOV ADC_DATA,#0FFH              ;Port 1 is input port

        SETB ADD_A                      ;select channel

        SETB ADD_B

        CLR ADD_C                       ;for channel 3 selection

        ACALL DELAY1

        ACALL ADC_COUNT

        MOV P0,A

;ADC Programming Start

ADC_COUNT:

        SETB ADC_EOC                     ;it is made as input Port

        CLR ADC_ALE

        CLR ADC_SC

        CLR ADC_OE

BACK:
```

```
        SETB ADC_ALE            ;High To Low Pulse is given to ALE
        ACALL DELAY1
        SETB ADC_SC             ;High To Low Pulse is given to SC
        ACALL DELAY1
        CLR ADC_ALE
        CLR ADC_SC
LOOP1:
        JB ADC_EOC,LOOP1        ;Wait for conversion to finish
LOOP2:
        JNB ADC_EOC,LOOP2       ;Output becomes high
        SETB ADC_OE             ;Set OE High to covert data on controller
        ACALL DELAY1            ;For Further delay
        CLR ADC_OE              ;digital converted data is saved in memory
        MOV B,#05H
        DIV AB      ;amplify with  gain in place of 05H for obtaining real digital data
        RET                     ;Return To Main Routine
Delay
;App. 1.3643 Sec. Delay
DELAY:
        MOV R3,#3
```

```
LOOP3:
        MOV R1,#254
LOOP4:
        MOV R2,#254
LOOP5:
        DJNZ R2,LOOP5
        DJNZ R1,LOOP4
        DJNZ R3,LOOP3
        RET
;Approximately 435 µsec
DELAY1:
        MOV R3,#1
LOOP6:
        MOV R1,#10
LOOP7:
        MOV R2,#10
LOOP8:
        DJNZ R2,LOOP8
        DJNZ R1,LOOP7
        DJNZ R3,LOOP6
```

```
RET

END
```

CHAPTER 3

SIMULATION AND OUTPUT

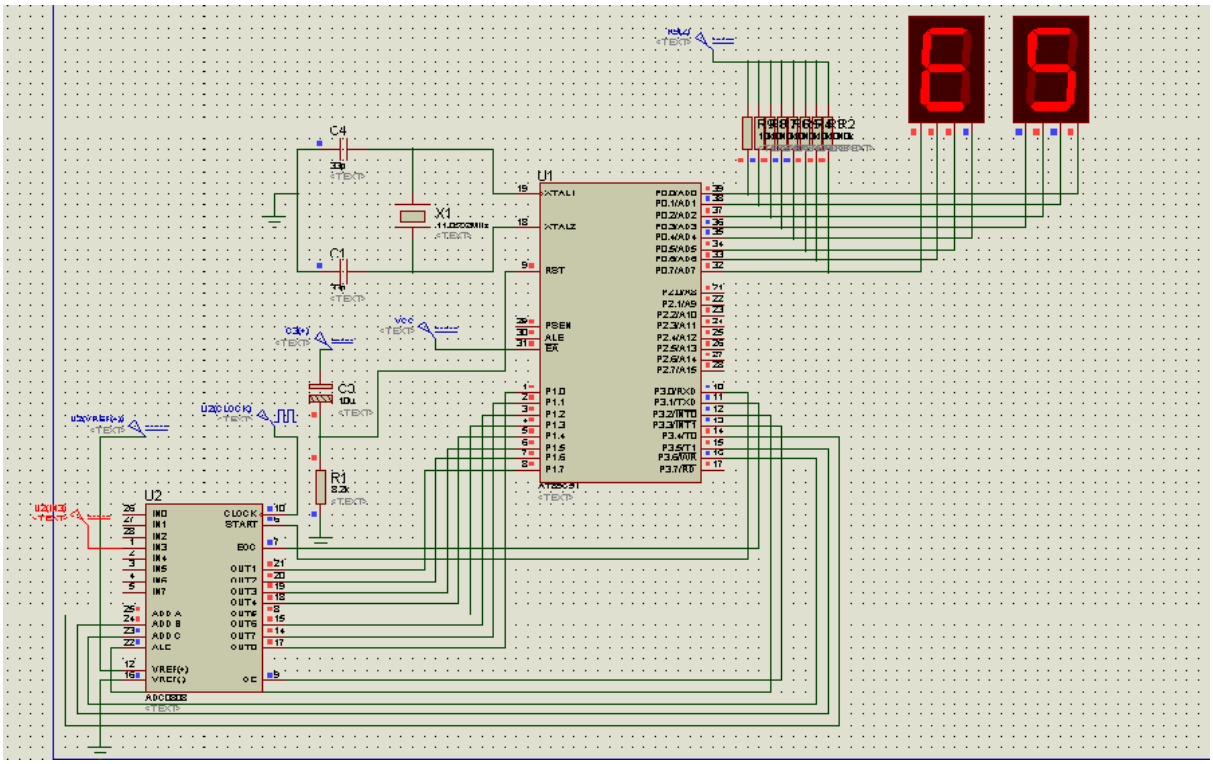

Fig. 5 Circuit Diagram for interfacing ADC with 8051

3.1 OUTPUT

Sl.No	Voltage Input	Digital output(in hexadecimal)
1	.5 V	1A
2	1 V	33
3	1.5 V	4D
4	2 V	66
5	2.5 V	7F
6	3 V	99
7	3.5 V	B2
8	4 V	CC
9	4.5 V	E5
10	5 V	FF

Table No. 2 Output

3.2 OUTPUT ANALYSIS

As ADC 0808 is a 8-bit ADC, so the numbers of steps is 256. Correspondingly the step size(smallest change that can be detected by an ADC) becomes equal to

$$5/256=19.53mV$$

So, the smallest change in voltage that can be detected by the ADC is 19.53mV.

CHAPTER 4

CONCLUSION

Simulation of interfacing of ADC and 7 segment display has been done using Proteus Demo Version. Input is given as DC voltage with a step increase of 0.5V and is increased till 5V. The corresponding digital values of the signals have been obtained.

REFERENCES

[1] S.K, Mandal, "Digital Electronics Principles and Applications," 2nd Edition, Tata McGraw Hill, 2011.

[2] Predko Myke., "Programming and Customizing the 8051 Microcontroller, TATA McGraw Hill Production", January 1999, Second Edition.

[3] ADC 0808/0809 8-bit µP compatible A/D converters with 8-channel Multiplexer, National Instruments, October 1999 Revised March 2013.

[4] Kenneth J. Ayala., "The 8051 Microcontroller: Architecture, Programming, and Applications", Thomson Delmer Learning, July 2004, Third edition.

[5] Mazidi Muhammad Ali, "The 8051 Microcontroller And Embedded Systems Using Assembly And C", Pearson Education, September 2007, Second edition.