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Design and construction of simple I/O card for IBM PC

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In the present days of computer trend, in many applications it is quite often necessary to transmit or receive parallel data from devices that are external to IBM PC. For the purpose to interface any device to a PC a digital input – output (DIO) interface card is designed and tested and described in present paper. DIO is a programmable address input/output PC add on card flexible enough to interface to almost all Input/output devices without a need of external logic. This is TTL compatible input/output card compatible to all IBM PC, XT and AT's.

1 Introduction

Those were the days when you could use commodore C-64 acron atom or ZX-81 computer to control the hardware intelligently. Transducers and other types of recorder device enable a computer to measure and store physical quantities from the 'real world' around us. Temperature control systems, Green house watering, model train systems and robots, etc. All are now-a-days within the easy reach of the keen programmer with a little or no knowledge of computer hardware. All it needs is the PC interfacing card. Unfortunately, these cards are pretty expensive. Therefore a low cost fully buffered insertion card has been designed and described in this paper which forms a versatile, safe and simple link between PC (XT, AT, 386/486) based machine and your hardware.

2 Principle of Working

The interface card uses the signals available on the IBM PC extension slot on the motherboard. The DIO card seeks eight unique addresses for which it is set. Ones address decoder logic finds a match, it activates the respective control logic, data bus buffer and I/O ports. This card can be driven using the software written in any higher level language.

3 Functional Description

The block diagram of the DIO card and the detailed circuit is depicted in Figs 1 and 2 respectively. The heart of this circuit is the address decoding logic designed around the eight-bit digital word comparator IC1 (74LS688). Address decoding logic compares the part of the PC address with address selected by DIP (Dual in line Package) switch block S_1. The circuit acts as a buffer between the computer and external hardware. It is set to operate at a unique address in a small area in the PC's I/O range. The actual address setting is accomplished with the help of three DIP switch block S1. In all cases, a free base address must be used so that the interface card must not share an I/O address with any other card in the PC.

The three switch determines the logic level at inputs P0, P1, P7 of IC1. The pull up resistor connected to these inputs provide a logic high level when the switches are opened. The relative IC input is kept at logic low by closing the respective switch. All other P inputs of IC1 are held at fixed logic levels. The possible base addresses associated with different switch settings are listed in Table 1.

Address lines A2 to A9 on the expansion bus are connected to the input Q0-Q6 address compactor IC1. The AND gate IC3d combines address lines A8 and A9 at input Q6, this frees input Q7 for use by AEN, the address enable signal that indicates DMA (direct mem-

Table 1 — Switch settings for different base address

Address	300H	304H	308H	30CH	310H	314H	318H	31C
Switch								
S1	ON	OFF	ON	OFF	ON	OFF	ON	OFF
S2	ON	ON	OFF	OFF	ON	ON	OFF	OFF
S3	ON	ON	ON	ON	OFF	OFF	OFF	OFF

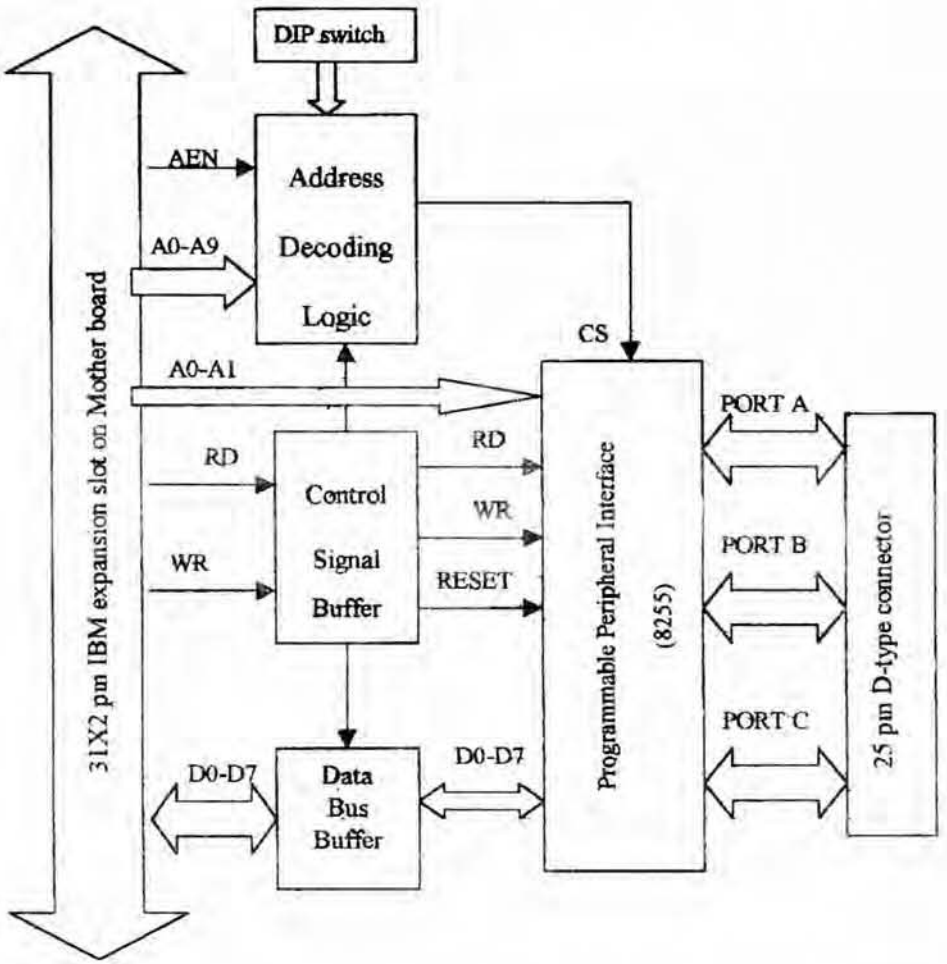

Fig. 1 — Block diagram of the interface card for IBM PC

ory access) activity without an I/O address being decoded. Gate IC3c ensure that IC1 is enabled during a read or write operation only. When binary code input at P input equals that at Q inputs P=Q goes LOW. This signal is used to enable Chip selection (CS) input of Programmable Peripheral Interface (PPI) IC4 (8255). The P=Q output also activates the G input of IC2 (74LS245) which enables the PC data bus to be connected to the Data bus input of PPI.

The Control block provides the control signal to DIO card. The level of read (RD) signal determines the direction of flow of data between the PC and the external hardware. A LOW level signal means that data is transferred from connector K1 to PC while HIGH level indicates the transfer of data from PC to PPI. Both RD and WR signals are buffered using a gate IC3a and IC3b respectively.

The PC's data bus is buffered by IC2 (74LS245). Since all the PC signals are buffered, the risk of cross effect between the PC and external hardware is reduced to a minimum.

The two address lines A0-A1 are used to select the control word register (CWR) and the three ports of PPI. The PPI consist of four registers as port A, port B, port C and CWR. Data written in control word register decides the function of PPI device and provides 8-bit port A, port B and port C [in all 24 I/O lines]. These are brought on 25 pin D-type female connector K1. The base address for the interface card is selected from Table 1. In order to select the four registers of PPI, the necessary addresses are as follows:

[base + 0]	PA0 - PA7	PORT A
[base + 1]	PB0 - PB7	PORT B
[base + 2]	PC0 - PC7	PORT C

[base +3] Control Register PORT CWR

The computers 5V-supply rail is used for this circuit so no separate power supply is needed. The double-sided printed circuit board is used for constructing this circuit. The photograph of the constructed interface card is shown in Fig. 3.

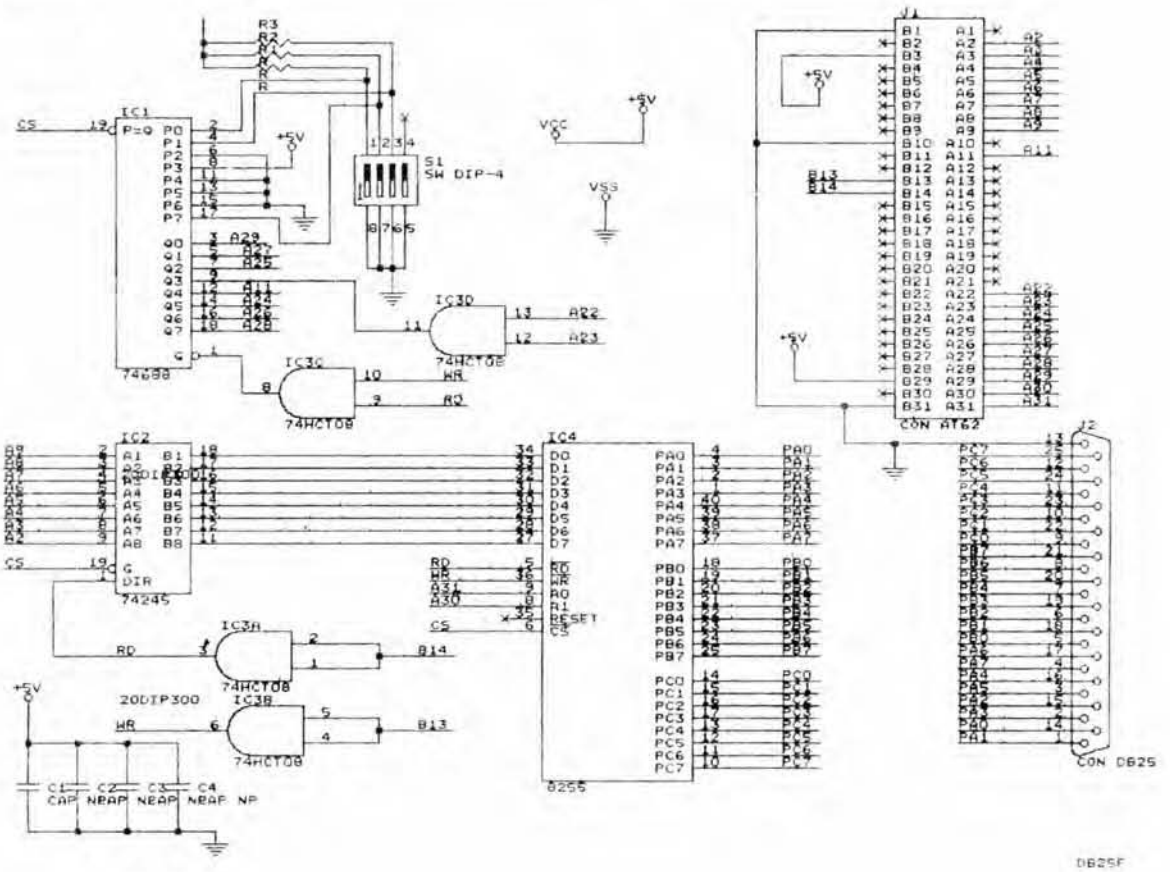

Fig. 2 — Circuit diagram of the interface card for IBM PC

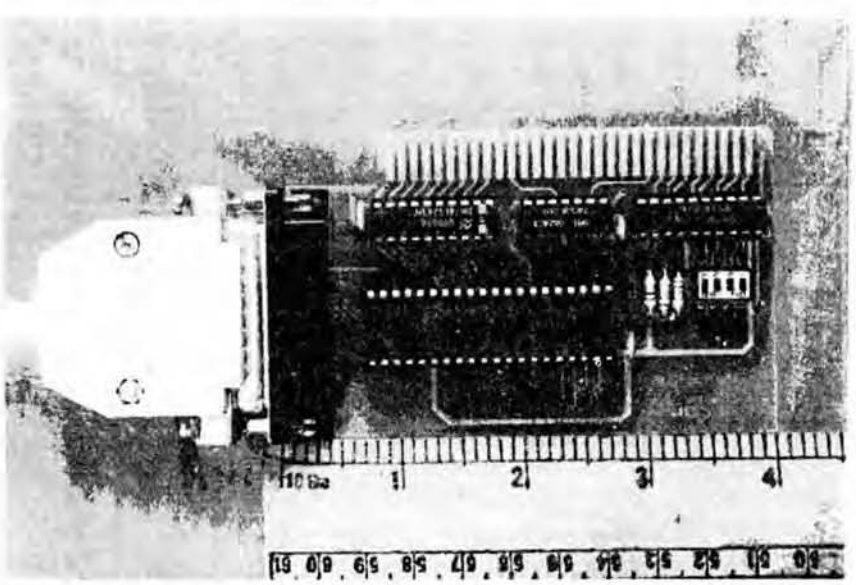

Fig. 3 — Photograph of constructed interface card for IBM PC

This DIO card has the following features:

(i) It provides 24 I/O lines in three 8-bits ports ; (ii) Base address selection through DIP switch; (iii) IBM - PC/XT/AT compatibility; (iv) Buffered data bus, hence no loading; (v) The interface card can be used in different modes such as mode -0 (Basic input/output), Mode-1 (Strobed input/output), Mode-2 (bi-directional strobed input/output).

5 Testing of DIO Card

For the testing of designed card, it is interfaced with the analogue to digital converter circuit as shown in Fig. 4. The ADC is linked with designed DIO card using connector K1 of DIO card via 25 D type connector provided on rear side of the card with a flat FRC cable.

The ADC chosen is the economical, not-too fast device, the National ADC0804, which can convert the analogue signal into the digital form in 100 microseconds. Using this IC we can take up to 8000 samples in one second. The higher conversion speed is also possible with ADC chip like AD574.

The ADC works with an internal clock, for which resistor R4 (10- kilo ohm) and capacitor C5 (150 pF) are provided on pin 4 and 19 respectively, for clock generation. In the present case the PPI (8255) is used in mode 0 with port A and port C (upper) as input ports and port C (lower) as the output port. The corresponding control word is 98H. The data pins D7-D0 pins of ADC are connected to 8 bit port A via connector K1. The Pin 5 of-ADC, which indicates the end of conversion (that is the analogue input at the current instant has been converted into digital value), is read via pin 25 of 'D' type connector K1 at bit PC7 of port C- upper. The port line PC1 is connected to WR pin of ADC, which activates start of conversion of analogue data. Making pin PC0 low enables the output data latch of ADC. The flow chart for testing of the ADC circuit is shown in Fig. 5. The coding of the flow chart using C language is given in Fig. 6.

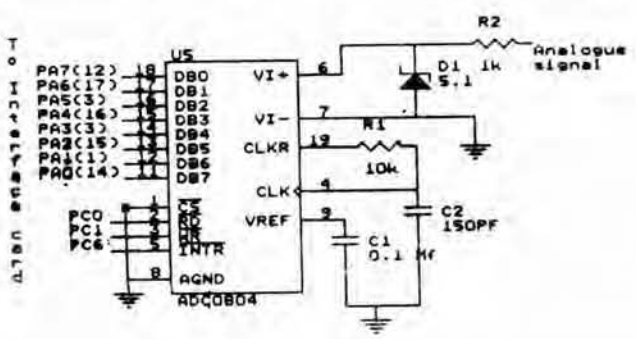

Fig. 4 — Circuit diagram of ADC circuit interfaced with the designed card

6 Conclusion

From the working of ADC circuit it is seen that the DIO card is activated only when proper base address is given on address bus. The base address can be selected by changing the setting of the DIP switch and avoids puzzle with the other cards present on motherboard. The analogue data can be effectively converted into digital

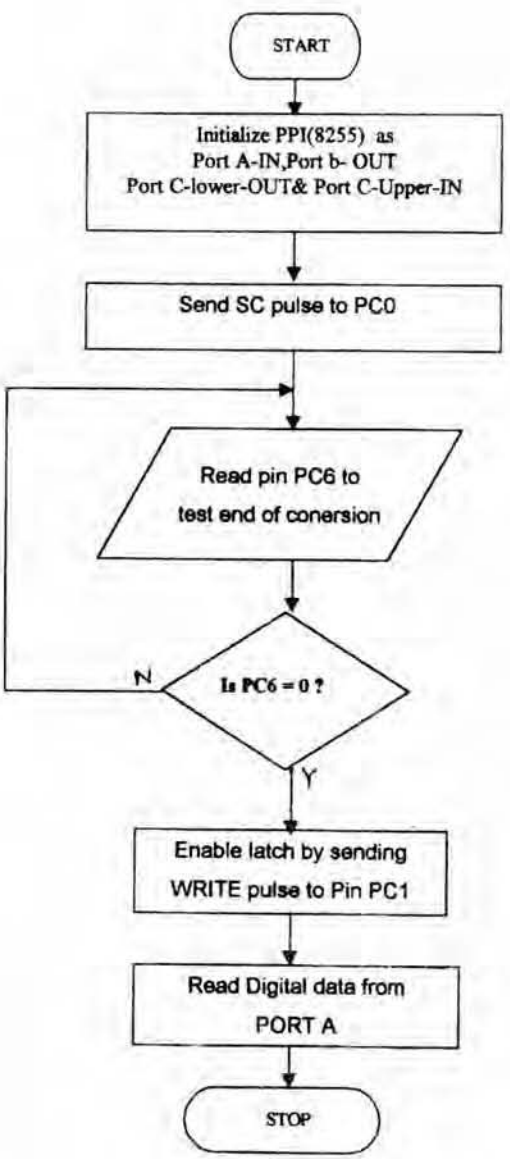

Fig. 5 — Program flow chart for ADC interfacing

```
/* Program test.c for interfacing card*/
/* PROGRAM FOR ADC interfacing*/
/* written by V.V.Killedar & Surve A.A.*/
/* At Dept.of Physics A.A.College,Manchar*/
#include<stdio.h>
#include<conio.h>
#include<dos.h>
#define portA 0x300
#define portC 0x302
#define portcwr 0x303
void main(void)
{
    int eoc,eoc1,data;
    clrscr();
    outportb(portcwr,0x98);
    gotoxy(30,10);
    printf("Data acquisition using interfacing card");
    gotoxy(30,20);
    printf("Press any key to exit....");
    gotoxy(30,14);
    printf(" Digital data: ");
while(!kbhit())
  {
   outportb(portC,0x01);/* send start of conversion pulse */
   delay(0.1);
   outportb(portC,0x03);
   delay(0.1);
   scan:
   eoc=inportb(portC);/* get EOC */
   eoc1=eoc & 0x80;/* remove unwanted bits */
   if(eoc1!=00) /* test PC7 */
   goto scan ;/* PC7 high scan again*/
   outportb(portC,0x02);/* enable latch */
   data=(inportb(portA)*15)/255; /* get data */
   gotoxy(45,14);printf("%d",data);
   }/* end while */
} /* end main */
```

Fig. 6 — C language program for ADC interfacing

form by using ADC circuit. Thus we infer that the designed interface cards act as a effective link between users hardware and the PC. This card can be used in various applications in industrial sector.

Acknowledgement

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