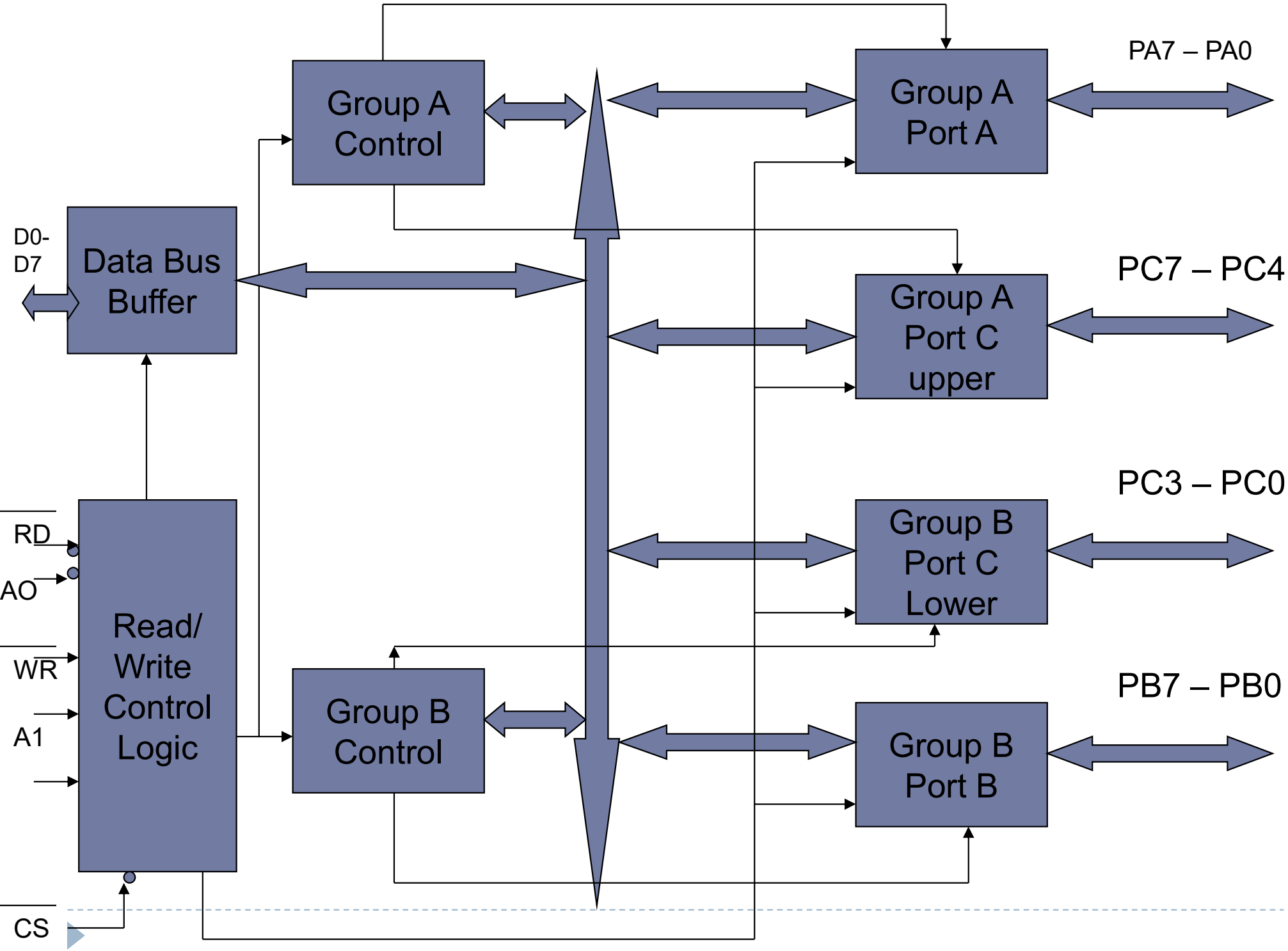
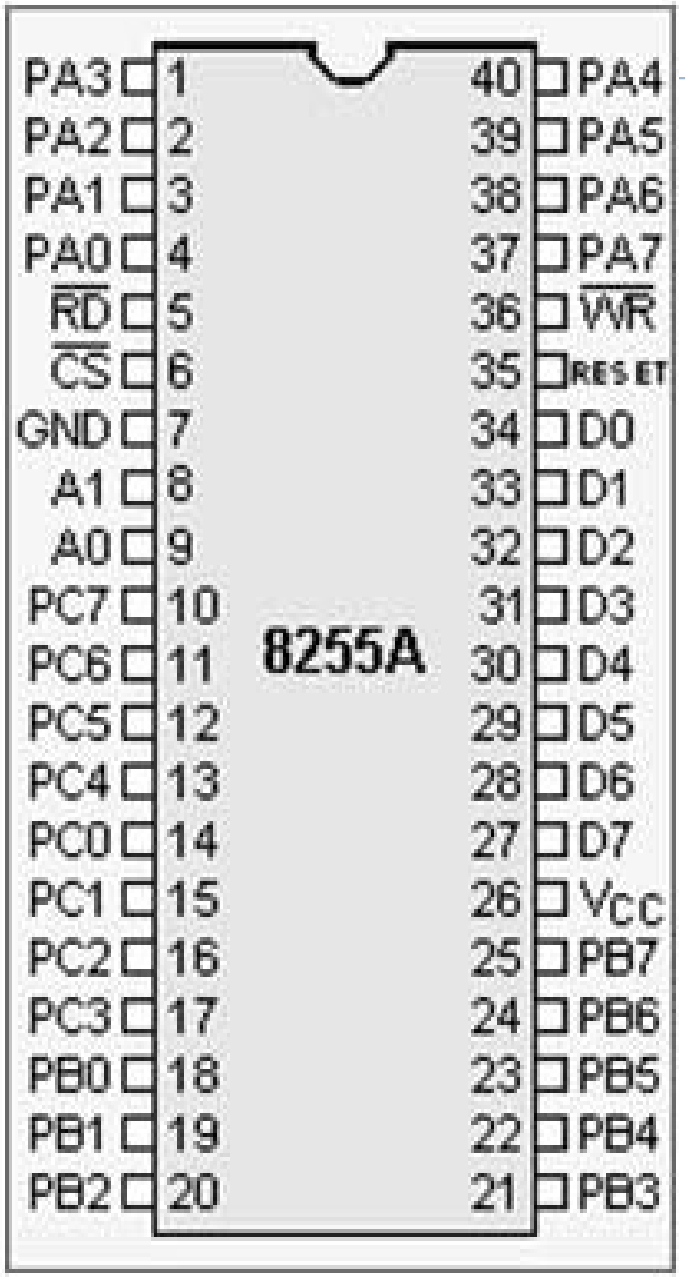
Architecture of Programmable I/O Port 8255


Group A Control
Group A Port A
PA7 – PA0
D0-
D7
Data Bus Buffer
PC7 – PC4
Group A Port C upper
PC3 – PC0
Group B Port C Lower
RD
AO
Read/ Write Control Logic
WR
A1
Group B Control
PB7 – PB0
Group B Port B
CS

8255 Programmable I/O Port

- The 8255 is a Programmable peripheral interface device which is used to control the communication between microprocessor and i/o devices through programming using i/o ports.
- 8255 contains 3 ports named as port A, port B and port C.
- A port is used to communicate between external i/o device and microprocessor.
- Each port can be used as a input /output port.this can be achieved by programming the bits of a register is called control word register.The three ports are combined into 2 groups.

PIN DIAGRAM OF 8255



Pin Description

PA(0-7): Port A is an I/O port. Its an 8- bit data output latch/buffer and an 8-bit data input latch.

RD': Read Control is an Active low input pin. RD is LOW when CPU reads data.

CS': Chip Select is an Active low input pin. A LOW on this pin selects 8255.

GND: This provides the ground for the IC

A0,A1: These pins along with RD',WR', CS' pins control the operation of 8255. User needs to use these 5 pins to program 8255. following table indicates the operation of 8255 by using pins A0,A1, RD',WR', CS'.

Pin Description (Accessing 8255 using A0, A1 ,RD ,WR ,CS pins)

A1	A0	RD	WR	CS	Operation Performed
X	X	X	X	1	Chip Disabled i.e. Chip not Selected
Chip is selected when CS = 0					
Input(Read) Operation.					
0	0	0	1	0	Read Port A- Data bus
0	1	0	1	0	Read Port B- Data bus
1	0	0	1	0	Read Port C- Data bus
1	1	0	1	0	Control Word Register- Data bus
			Output(write) Operation.		
0	0	1	0	0	Write Port A-data bus
0	1	1	0	0	Write Port B-data bus
1	0	1	0	0	Write Port C-data bus
1	1	1	0	0	Data bus-Control

Pin Description

PC(0-7): Port C is an 8-bit I/O port. Its lower 4-bits can be programmed to work in conjunction with PortB and the upper 4-bits can be programmed to work in conjunction with Port A separately.

PB(0-7): Port B is an 8-bit I/O port used for 8-bit output data latch/buffer or input data buffer

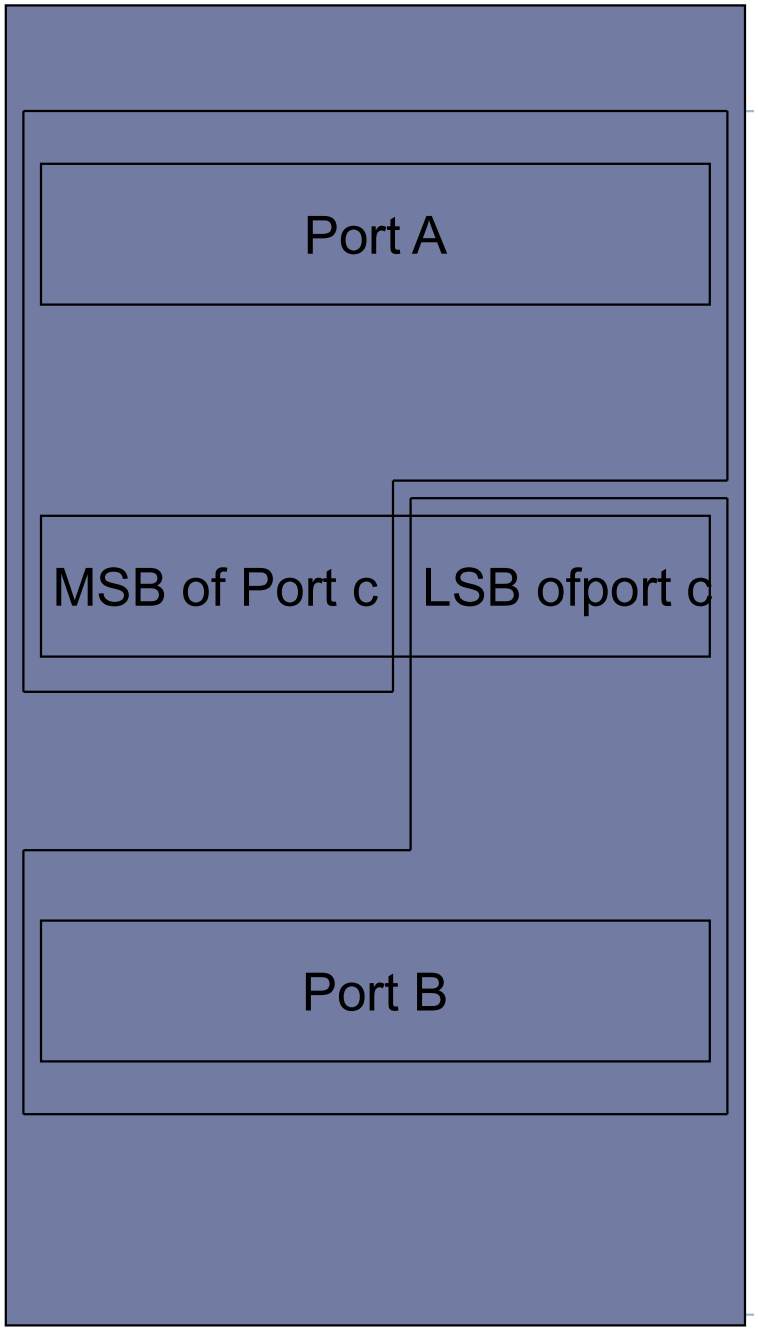
Vcc: +5V power supply.

D7-D0: Data bus, bidirectional, tristate lines connected to system data lines

RESET: input pin which resets the control word register.

WR': Write Enable is an active low input pin.it indicates the write operation.

8255 Ports



Group A = port A + MSB of port C

Group B = port B + LSB of port C

Modes of Operation in 8255

- There are two basic modes of operation of 8255.

  1.I/O mode

  2.Bit set-reset mode: Bit set/reset mode is used to set resets the port-c bits.

- In the I/O mode, 8255 ports works as programmable I/O ports, while in BSR mode only port-c(pc0-pc7) cab be used to set or reset its individual port bits.
- Under the I/O mode of operation, further there are three modes. they are mode0,mode1,mode2.

Modes of Operation in 8255

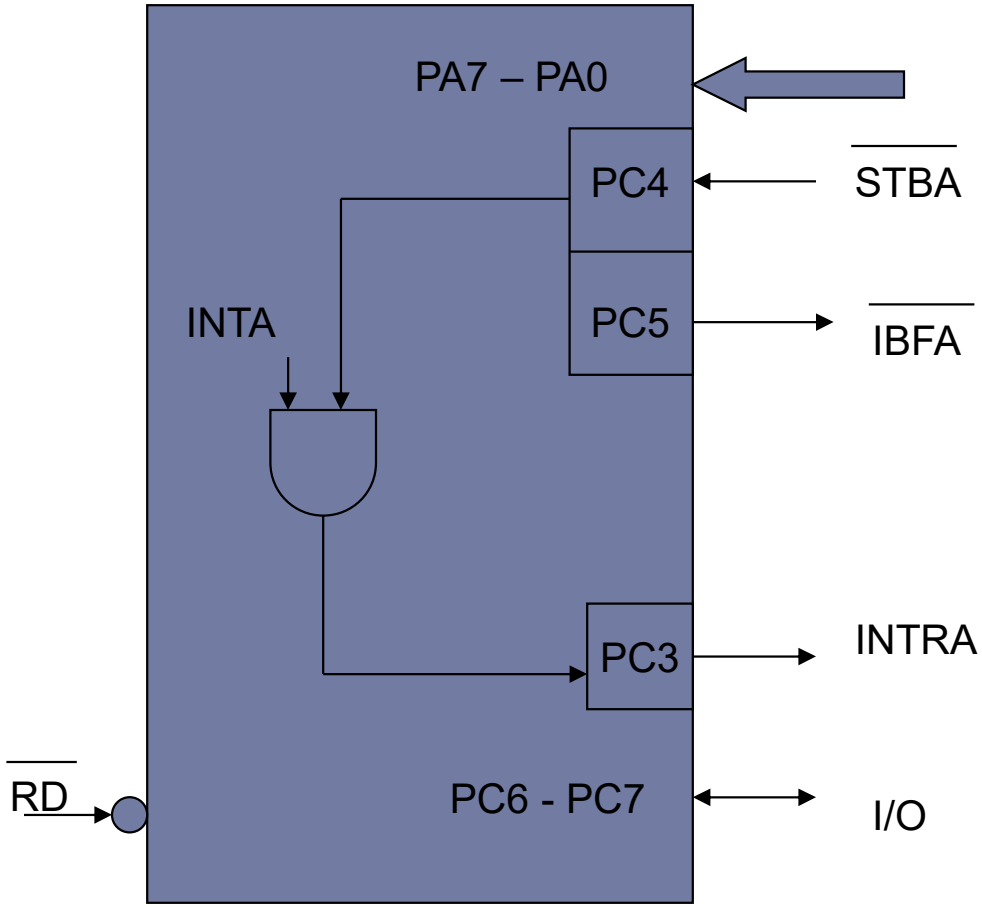
- 8255 supports three different Modes mode 0, mode 1 and mode 2.
- Mode 0 (simple I/O)
  - This is a simple i/o mode and it provides i/o capability for all the three ports.
  - Any port can be used as input or output port.
  - Two 8 bit ports (A&B) and two 4 bit ports (C Upper & lower) are available.port-c can be used as either single 8-bitport or two independent 4-bits.
  - O/P Ports are latched and I/P ports are not latched
  - All the modes can be selected by programming control word.

Modes of Operation in 8255 Contd..

- Mode 1
  - This mode is called strobed i/o mode. Only two ports port-a &b cab be operated in this mode.
  - The hand shaking signals controls i/o action of the specified port. Port C is used for this purpose
  - The Port C lines PC_0 – PC_2 provides hand shaking signals for port B .
  - The Port C lines PC_3 – PC_{75}provides hand shaking signals for port A .
  - Each group contains one 8 bit data I/O port and one 4 bit control / data port
  - 8 bit data port can be used as Input or output port
  - Both Input and Output are latched
  - PC0-PC2 generates control signals for port B, PC3-PC5 generates control signals for Port A and PC6, PC7 are used as a simple i/O operation.

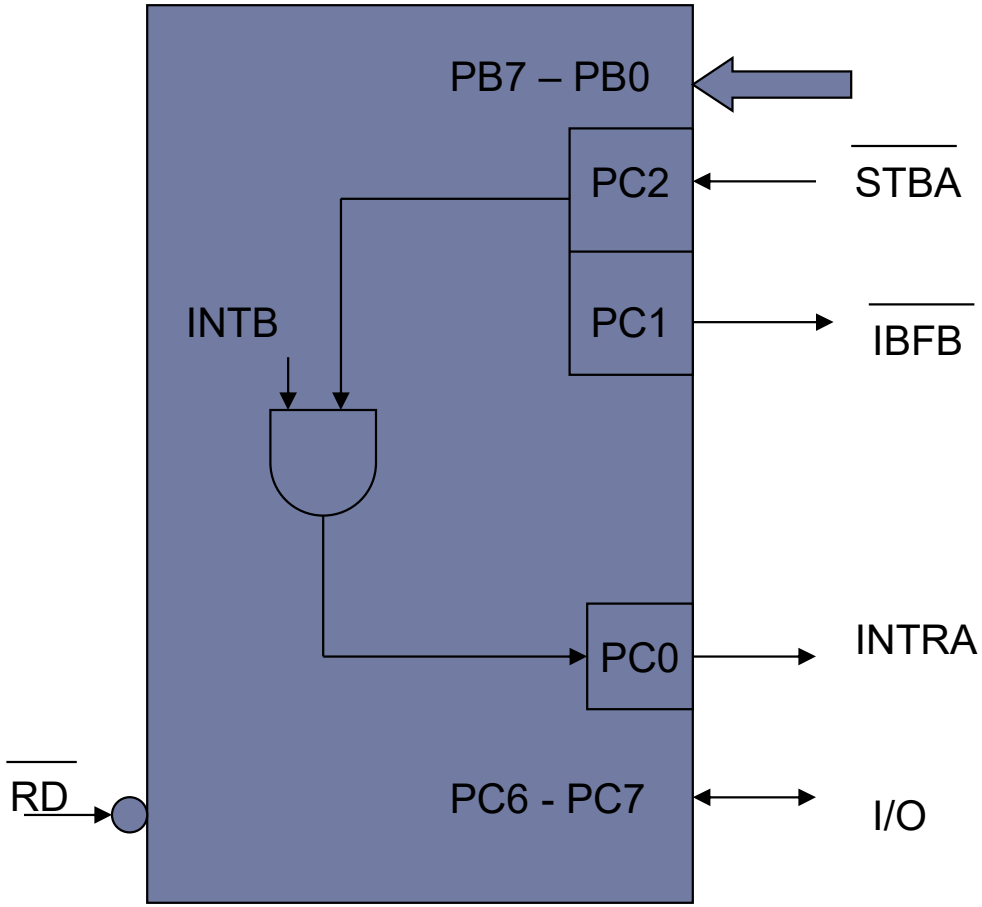
Mode 1 control word

When Group A is input



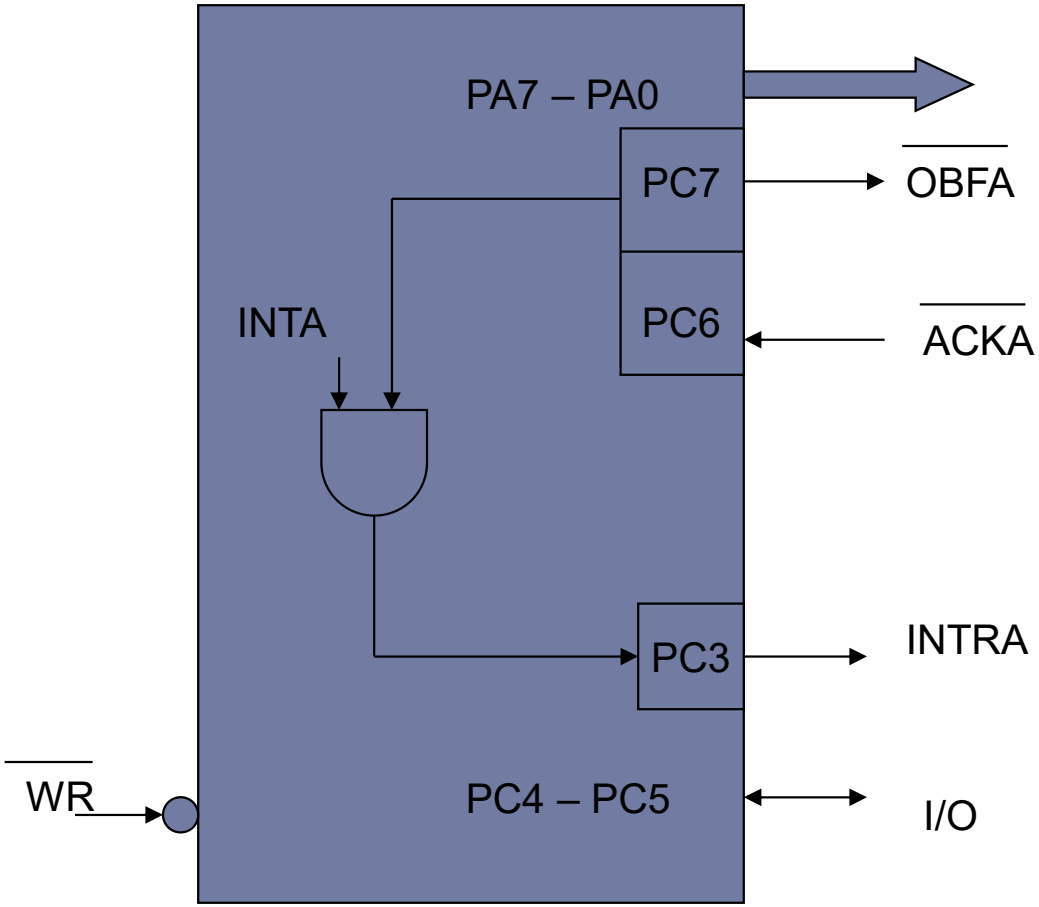
Mode 1 control word

When Group B is input



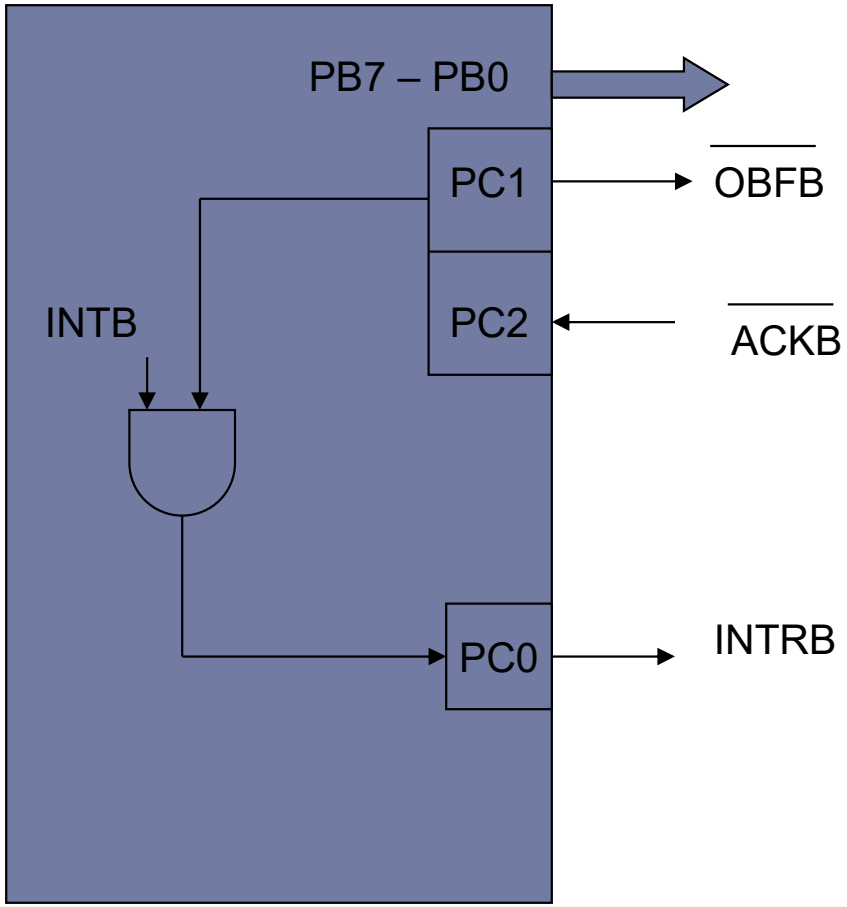
Mode 1 control word

When Group A is output



Mode 1 control word

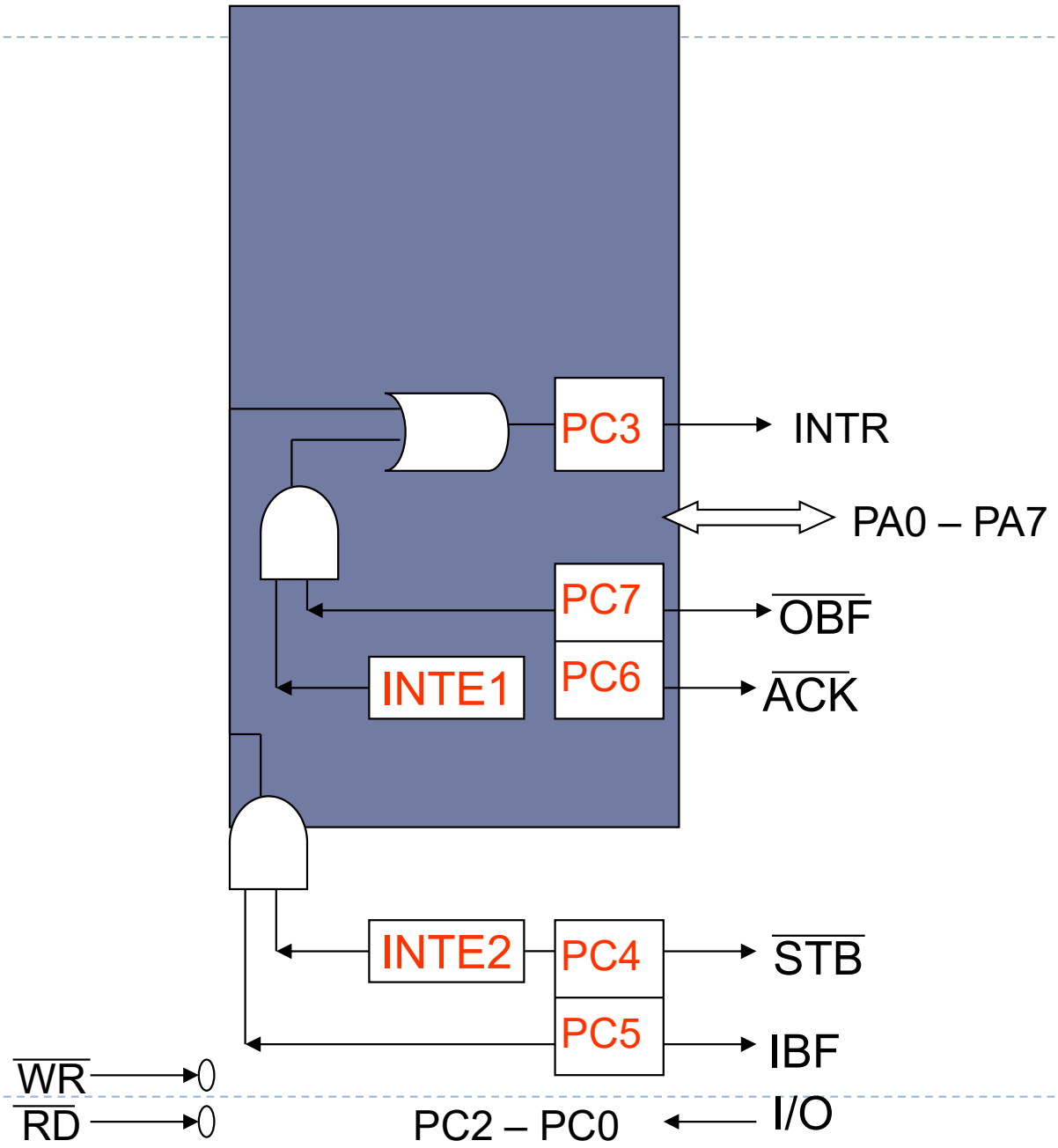
When Group B is output



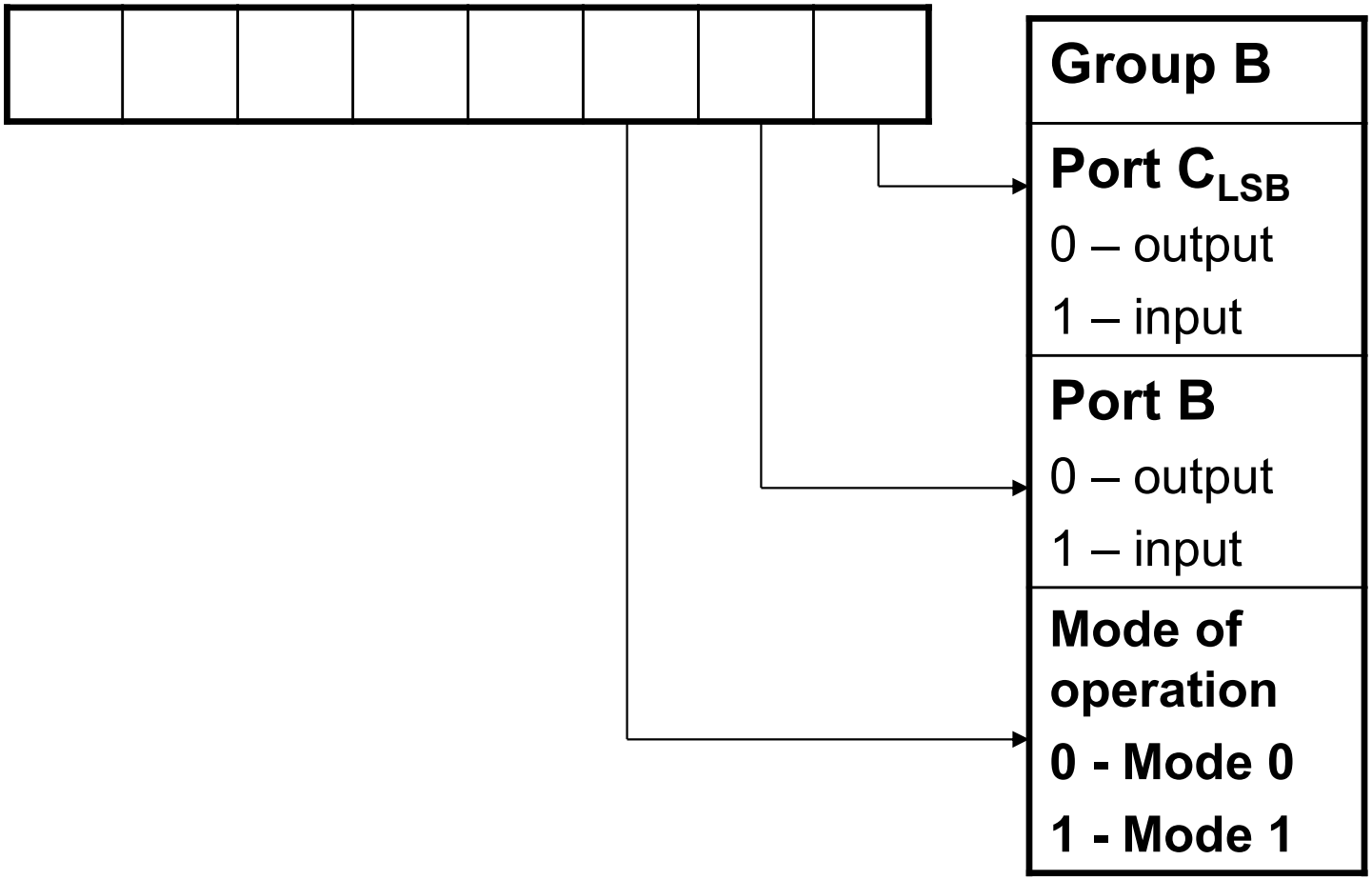
Modes of Operation in 8255 Contd..

- Mode2
  - This is a Strobed bidirectional mode.
  - Tha is data will be transmitted & received on an 8 bit data bus.
  - Handshaking signals are provided to maintain proper data flow and synchronization between data transmitter and receiver
  - In this mode 8-bit bidirectional port A and 5 bits of port C (PC_3 – PC_7) are available.
  - Three I/O lines are available at port C (PC2-PC0)
  - Input and Outputs are both latched
  - 5 bit control port C (PC3-PC7) is used for generating / accepting handshaking signals for 8 bit data transfer on port A.

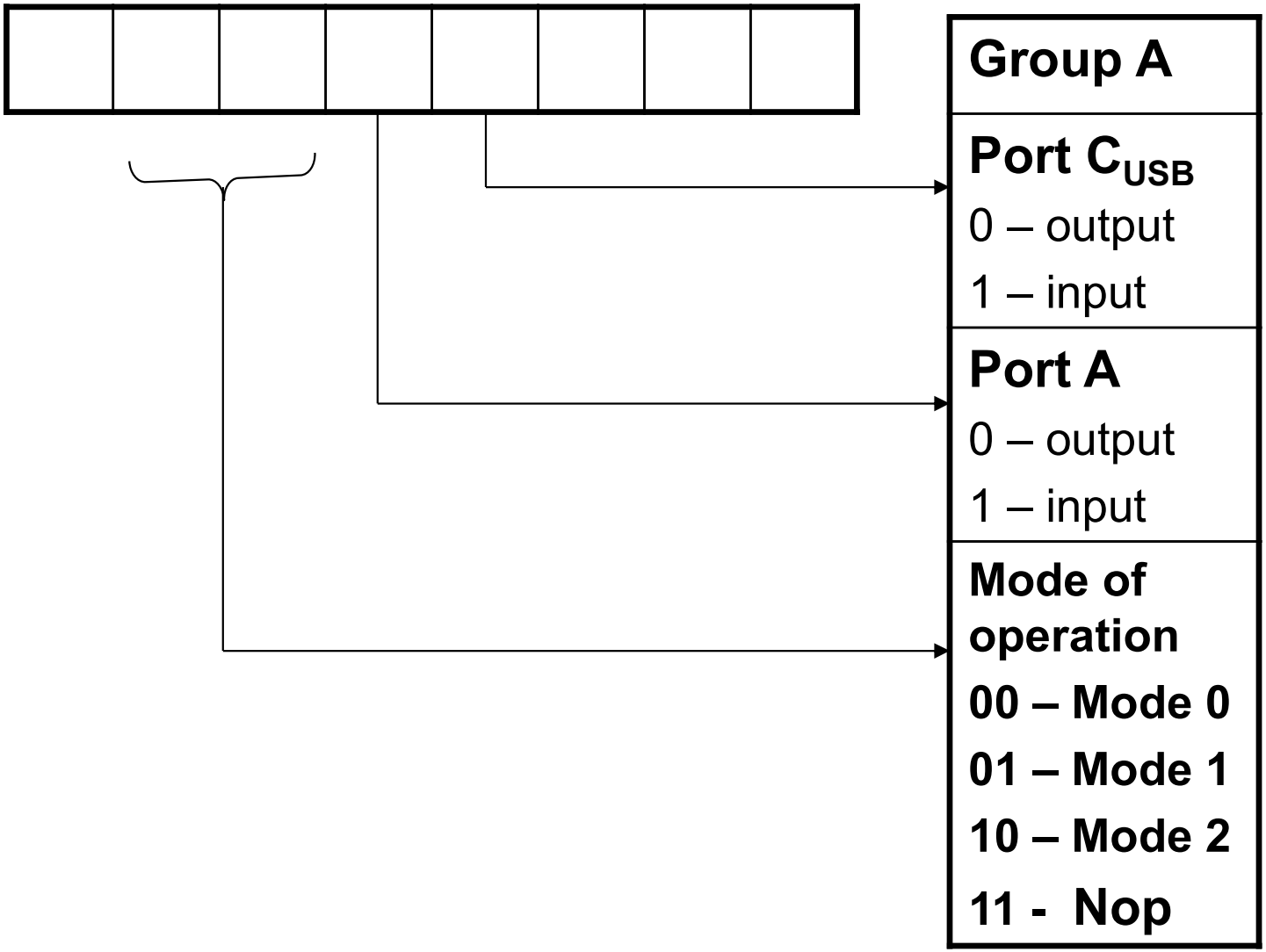
Mode 2


PC3
INTR
PA0 – PA7
PC7
OBF
INTE1
PC6
ACK
INTE2
PC4
STB
PC5
IBF
WR
RD
PC2 – PC0
I/O

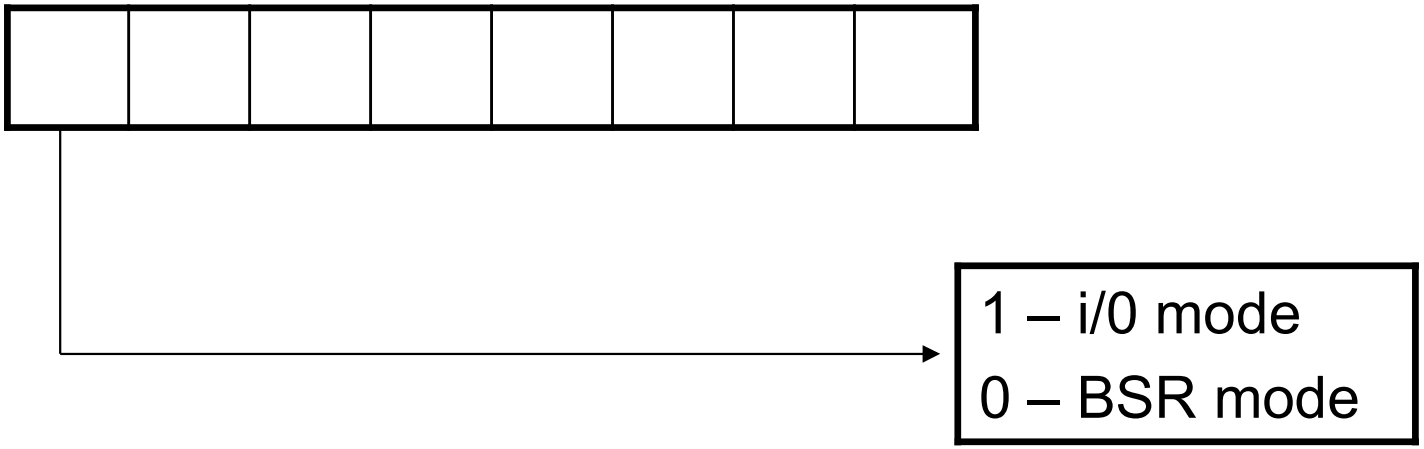
CONTROL WORD for I/O mode



CONTROL WORD for I/O mode



CONTROL WORD for I/O mode



Checking of the port status

Ex : Write a program to initialize port A and port C as output to send the data to external devices and port B as input to receive the data from input device.

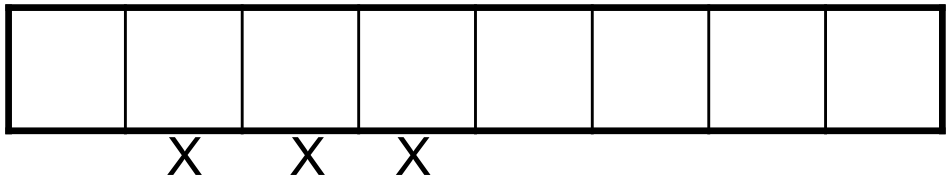
Ans :

1. Define Control word

1	0	0	0	0	0	1	0

= 82 H

CONTROL WORD FORMAT FOR BSR MODE



1 – Set

0 - Reset

0 – BSR mode

1 – I/O mode

			Port C
0	0	0	PC0
0	0	1	PC1
0	1	0	PC2
0	1	1	PC3
1	0	0	PC4
1	0	1	PC5
1	1	0	PC6
1	1	1	PC7

Applications of 8255

- Interfacing of Stepper motor
- Interfacing of ADC and DAC
- Interfacing of matrix Key board
- Interfacing of Seven segment LED
- Interfacing of sensors
- Interfacing of various home appliances and Industrial control elements

Interfacing Analog to Digital Data Converters

- In most of the cases, the PIO 8255 is used for interfacing the analog to digital converters with microprocessor.
- This section we will only emphasize the interfacing techniques of analog to digital converters with 8255.
- The analog to digital converters is treaded as an input device by the microprocessor, that sends an initializing signal to the ADC to start the analogy to digital data conversation process. The start of conversation signal is a pulse of a specific duration.
- The process of analog to digital conversion is a slow process, and the microprocessor has to wait for the digital data till the conversion is over. After the conversion is over, the ADC sends end of conversion EOC signal to inform the microprocessor that the conversion is over and the result is ready at the output buffer of the ADC.

Interfacing Analog to Digital Data Converters

- General algorithm for ADC interfacing contains the following steps:

1. Ensure the stability of analog input, applied to the ADC.
2. Issue start of conversion pulse to ADC
3. Read end of conversion signal to mark the end of conversion processes.
4. Read digital data output of the ADC as equivalent digital output.

Interfacing Analog to Digital Data Converters

ADC 0808/0809 :

- The analog to digital converter chips 0808 and 0809 are 8-bit CMOS, successive approximation converters.
- This technique is one of the fast techniques for analog to digital conversion.
- The conversion delay is 100μs at a clock frequency of 640 KHz, which is quite low as compared to other converters.
- These converters internally have a 3:8 analog multiplexer so that at a time eight different analog conversion by using address lines -ADD A, ADD B, ADD C.
- Using these address inputs, multichannel data acquisition system can be designed using a single ADC.
- The CPU may drive these lines using output port lines in case of multichannel applications.
- There are unipolar analog to digital converters, i.e. they are able to convert only positive analog input voltage to their digital equivalent.

Interfacing Analog to Digital Data Converters

Analog I/P selected	Address lines		
	C	B	A
I/P_0	0	0	0
I/P_1	0	0	1
I/P_2	0	1	0
I/P_3	0	1	1
I/P_4	1	0	0
I/P_5	1	0	1
I/P_6	1	1	0
I/P_7	1	1	1

Interfacing Analog to Digital Data Converters

Example: Interfacing ADC 0808 with 8086 using 8255 ports. Use port A of 8255 for transferring digital data output of ADC to the CPU and port C for control signals. Assume that an analog input is present at I/P2 of the ADC and a clock input of suitable frequency is available for ADC.

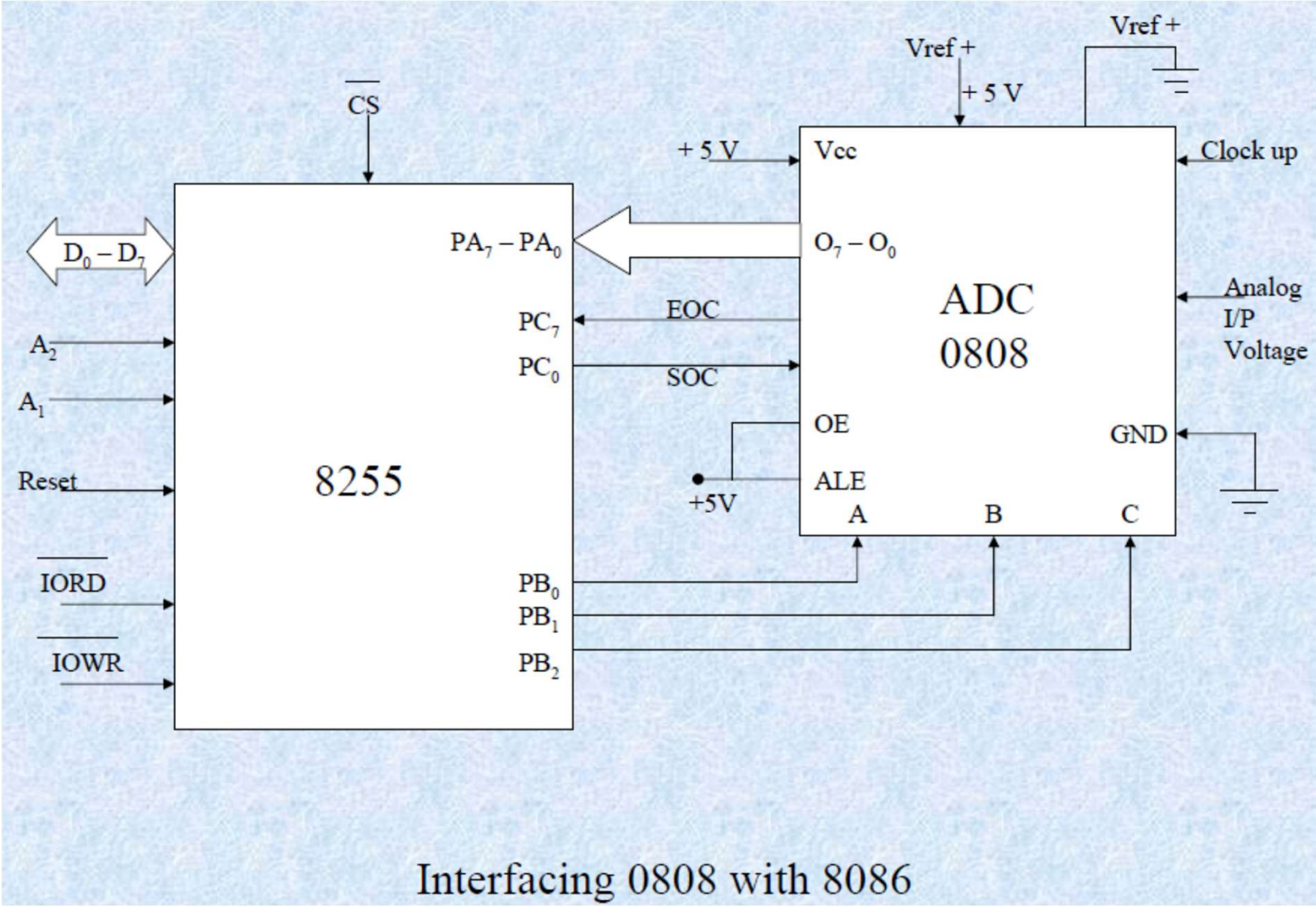
Solution: The analog input I/P2 is used and therefore address pins A,B,C should be 0,1,0 respectively to select I/P2. The OE and ALE pins are already kept at +5V to select the ADC and enable the outputs. Port C upper acts as the input port to receive the EOC signal while port C lower acts as the output port to send SOC to the ADC.

Port A acts as a 8-bit input data port to receive the digital data output from the ADC. The 8255 control word is written as follows:

D7 D6 D5 D4 D3 D2 D1 D0

1 0 0 1 1 0 0 0

Interfacing Analog to Digital Data Converters



Interfacing 0808 with 8086

Interfacing Analog to Digital Data Converters

The required ALP is as follows:

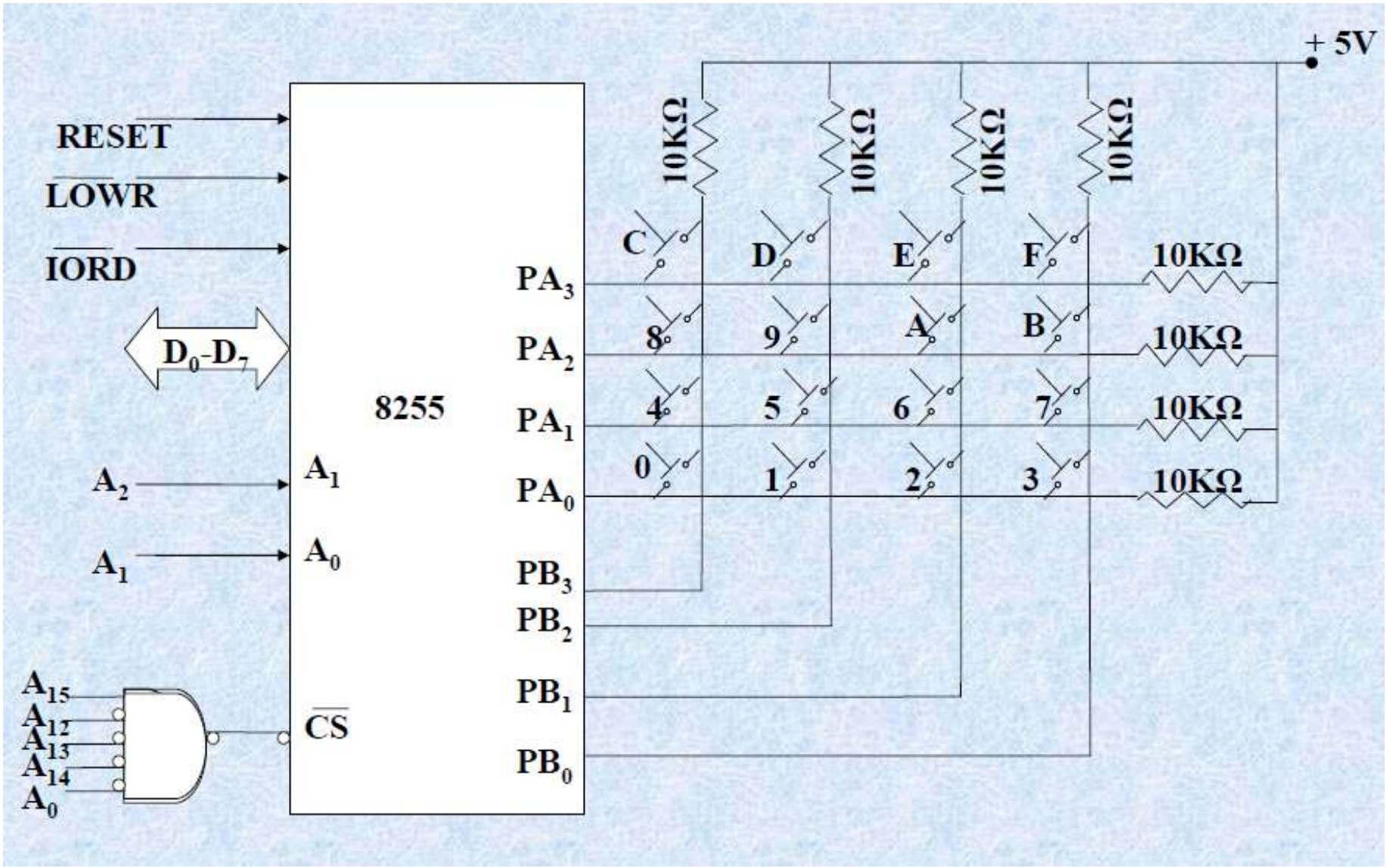
```
MOV AL, 98h ;initialize 8255 as
OUT CWR, AL ;discussed above.
MOV AL, 02h ;Select I/P2 as analog
OUT Port B, AL ;input.
MOV AL, 00h ;Give start of conversion
OUT Port C, AL ; pulse to the ADC
MOV AL, 01h
OUT Port C, AL
MOV AL, 00h
OUT Port C, AL
WAIT: IN AL, Port C ;Check for EOC by
RCR ; reading port C upper and
JNC WAIT ;rotating through carry.
IN AL, Port A ;If EOC, read digital equivalent in AL
HLT ;Stop.
```

Interfacing Keyboard with 8086

Interface a 4 * 4 keyboard with 8086 using 8255 an write an ALP for detecting a key closure and return the key code in AL. The debounce period for a key is 10ms. Use software debouncing technique. DEBOUNCE is an available 10ms delay routine.

Solution: Port A is used as output port for selecting a row of keys while Port B is used as an input port for sensing a closed key. Thus the keyboard lines are selected one by one through port A and the port B lines are polled continuously till a key closure is sensed. The routine DEBOUNCE is called for key debouncing. The key code is depending upon the selected row and a low sensed column.

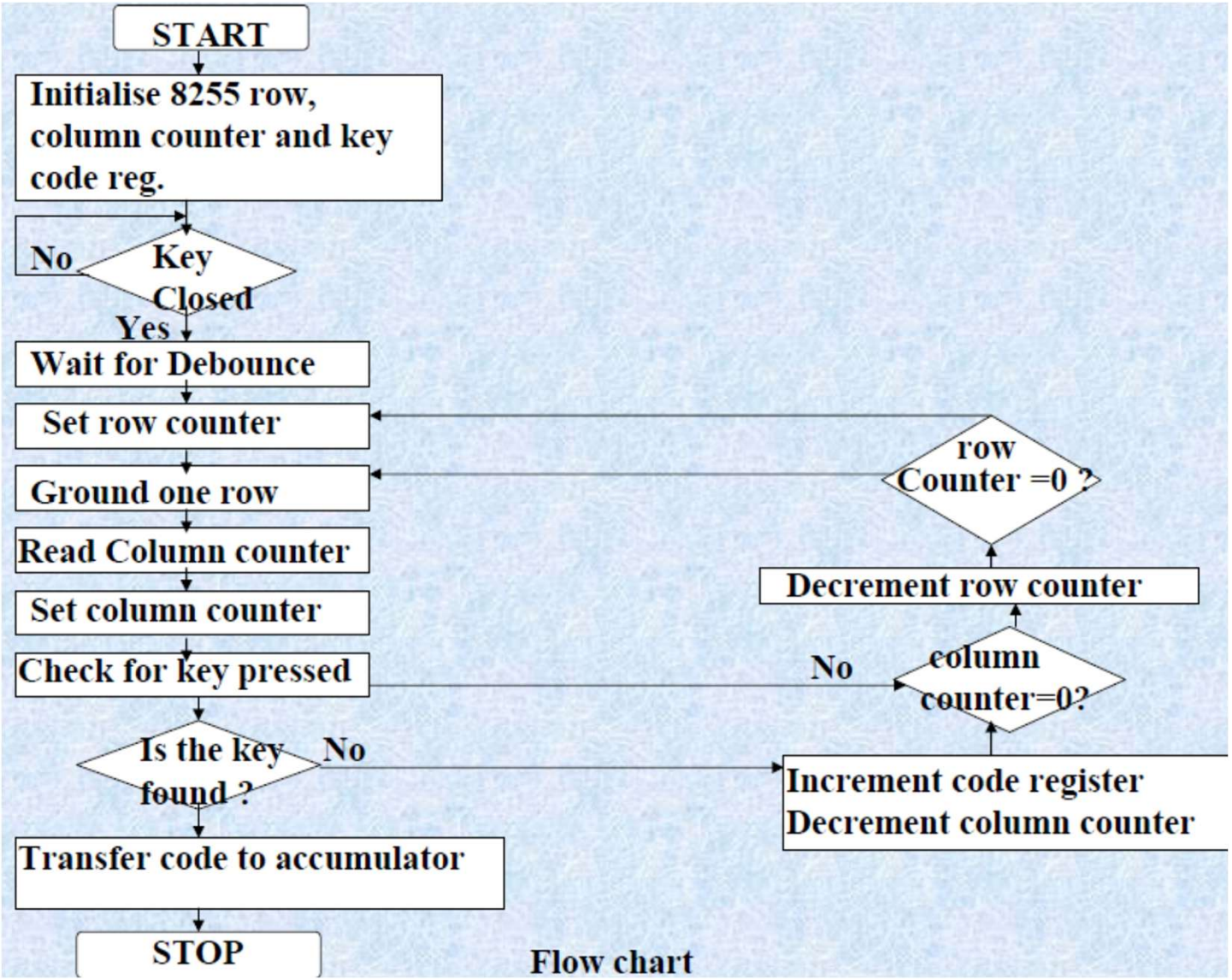
Interfacing 4*4 Keyboard



Interfacing 4*4 Keyboard

- The higher order lines of port A and port B are left unused. The address of port A and port B will respectively 8000H and 8002H while address of CWR will be 8006H. The flow chart of the complete program is as given. The control word for this problem will be 82H. Code segment CS is used for storing the program code.
- **Key Debounce** : Whenever a mechanical push-button is pressed or released once, the mechanical components of the key do not change the position smoothly, rather it generates a transient response .

Interfacing 4*4 Keyboard

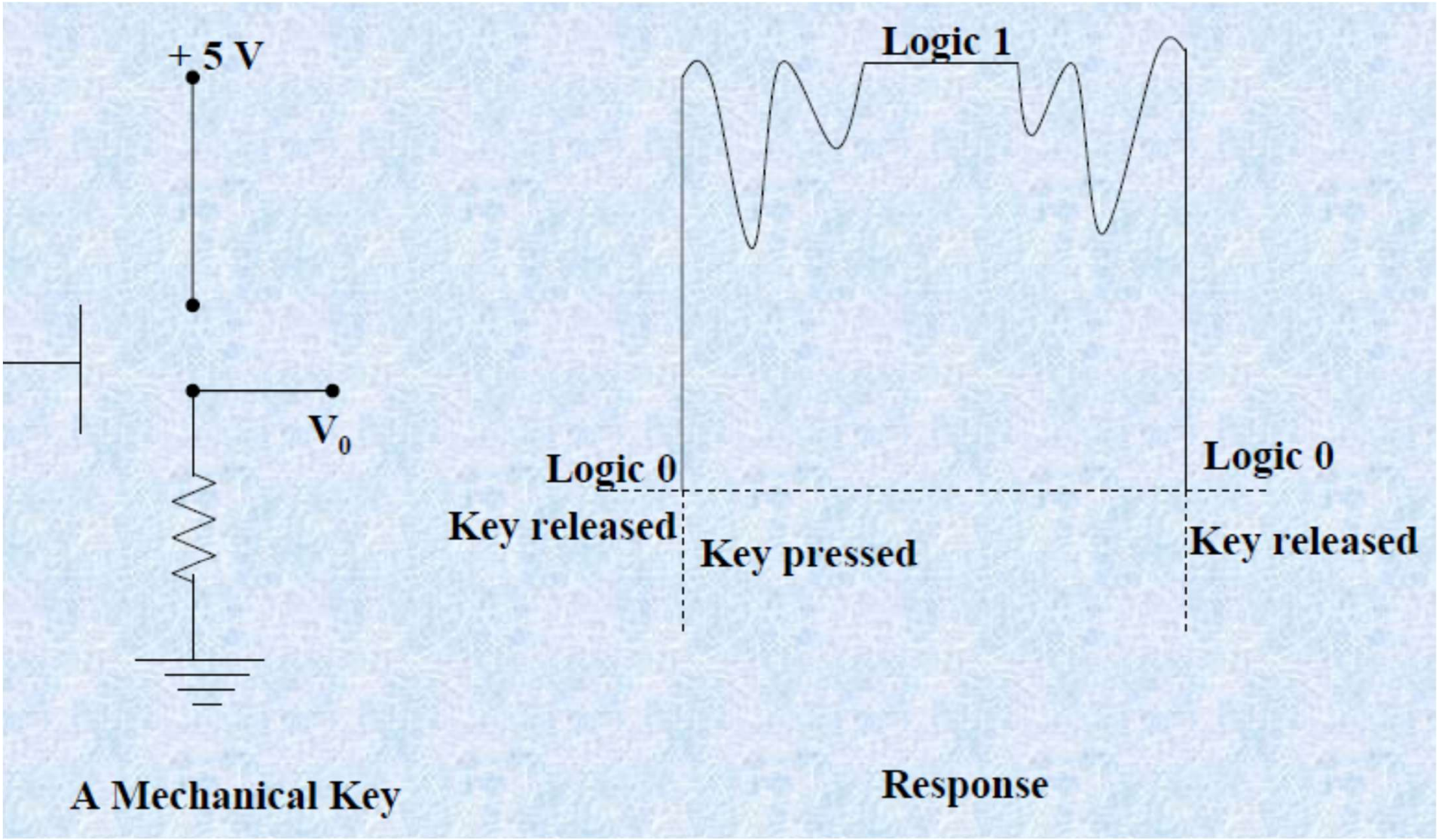


Flow chart

Interfacing 4*4 Keyboard

- These transient variations may be interpreted as the multiple key pressure and responded accordingly by the microprocessor system.
- To avoid this problem, two schemes are suggested: the first one utilizes a bistable multivibrator at the output of the key to debounce .
- The other scheme suggests that the microprocessor should be made to wait for the transient period (usually 10ms), so that the transient response settles down and reaches a steady state.
- A logic ‘0’ will be read by the microprocessor when the key is pressed.
- In a number of high precision applications, a designer may have two options- the first is to have more than one 8-bit port, read (write) the port one by one and then from the multibyte data, the second option allows forming 16-bit ports using two 8-bit ports and use 16-bit read or write operations.

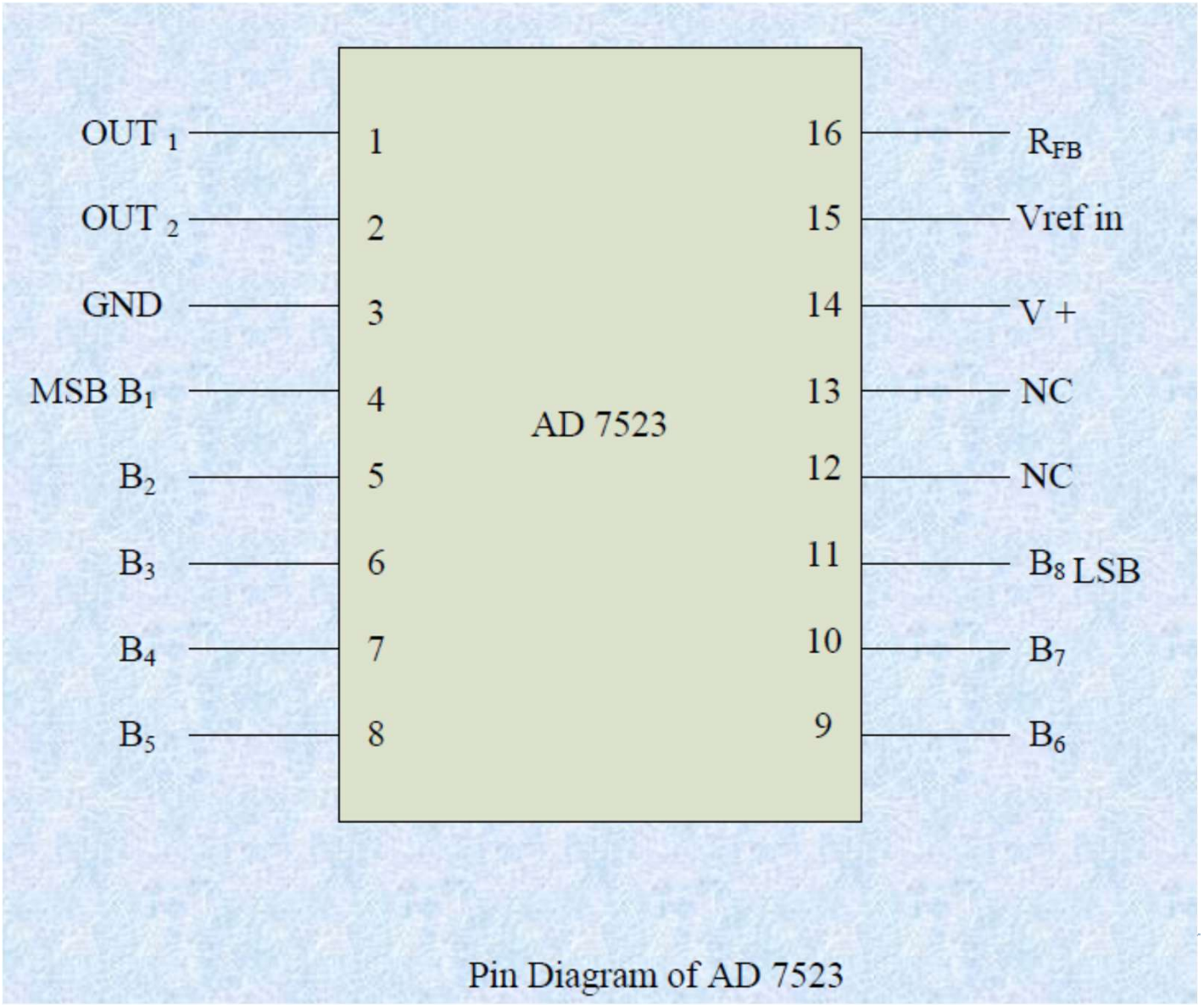
Interfacing 4*4 Keyboard



Interfacing Digital to Analog Data Converters

- The digital to analog converters convert binary number into their equivalent voltages. The DAC find applications in areas like digitally controlled gains, motors speed controls, programmable gain amplifiers etc.
- AD 7523 8-bit Multiplying DAC : This is a 16 pin DIP, multiplying digital to analog converter, containing R-2R ladder for D-A conversion along with single pole double thrown NMOS switches to connect the digital inputs to the ladder.

Interfacing Digital to Analog Data Converters



Pin Diagram of AD 7523

Interfacing Digital to Analog Data Converters

- The pin diagram of AD7523 is shown in fig the supply range is from +5V to +15V, while Vref may be any where between -10V to +10V. The maximum analog output voltage will be any where between -10V to +10V, when all the digital inputs are at logic high state.
- Usually a zener is connected between OUT1 and OUT2 to save the DAC from negative transients. An operational amplifier is used as a current to voltage converter at the output of AD to convert the current out put of AD to a proportional output voltage.
- It also offers additional drive capability to the DAC output. An external feedback resistor acts to control the gain. One may not connect any external feedback resistor, if no gain control is required.

Interfacing Digital to Analog Data Converters

EXAMPLE: Interfacing DAC AD7523 with an 8086 CPU running at 8MHZ and write an assembly language program to generate a sawtooth waveform of period 1ms with Vmax 5V.

SOLUTION: Fig shows the interfacing circuit of AD 74523 with 8086 using 8255. program gives an ALP to generate a sawtooth waveform using circuit.

```
ASSUME CS:CODE
CODE SEGMENT
START: MOV AL,80h ;make all ports output
OUT CW, AL
AGAIN: MOV AL,00h ;start voltage for ramp
BACK : OUT PA, AL
INC AL
CMP AL, 0FFh
JB BACK
JMP AGAIN
CODE ENDS
```

Interfacing Digital to Analog Data Converters

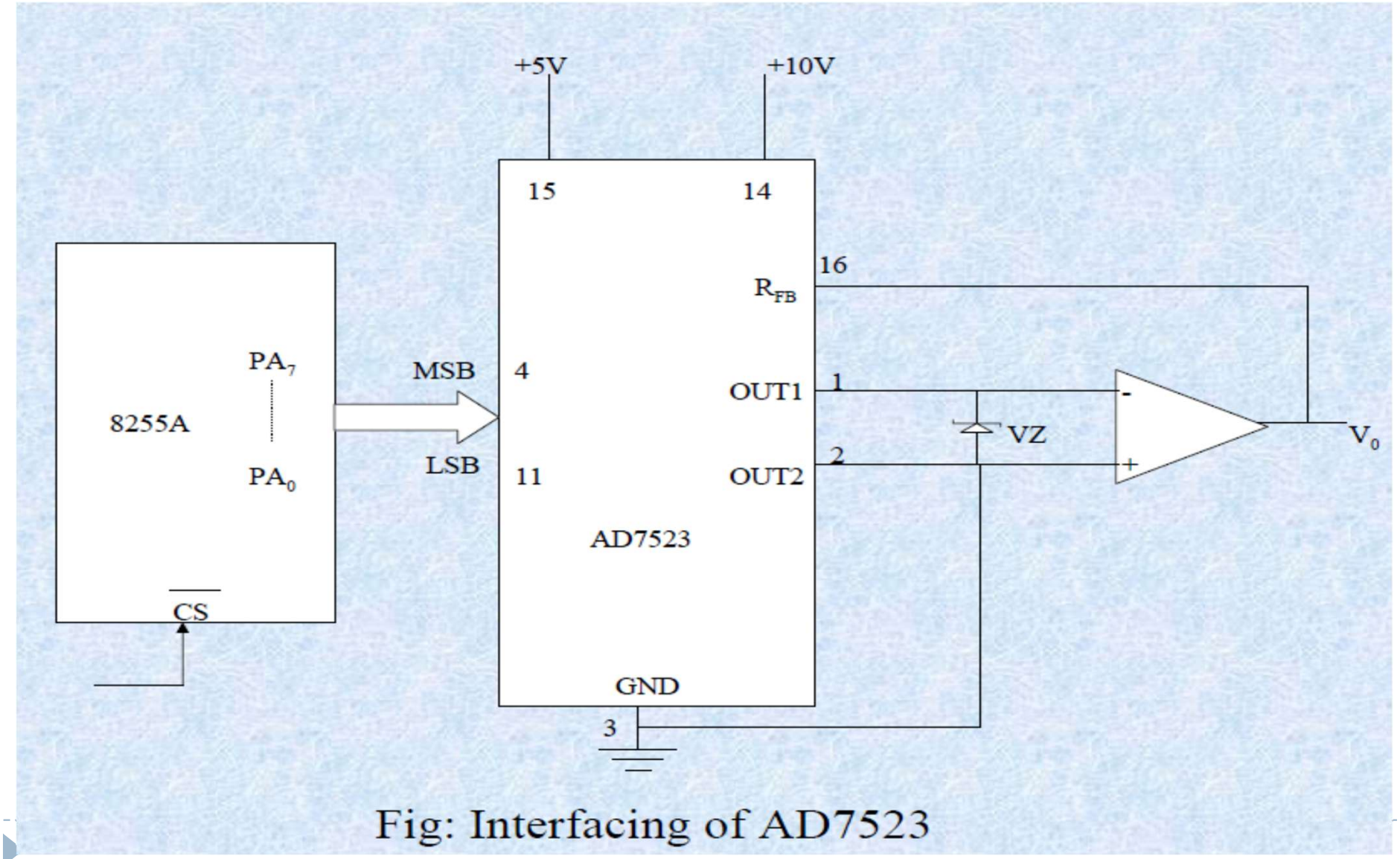
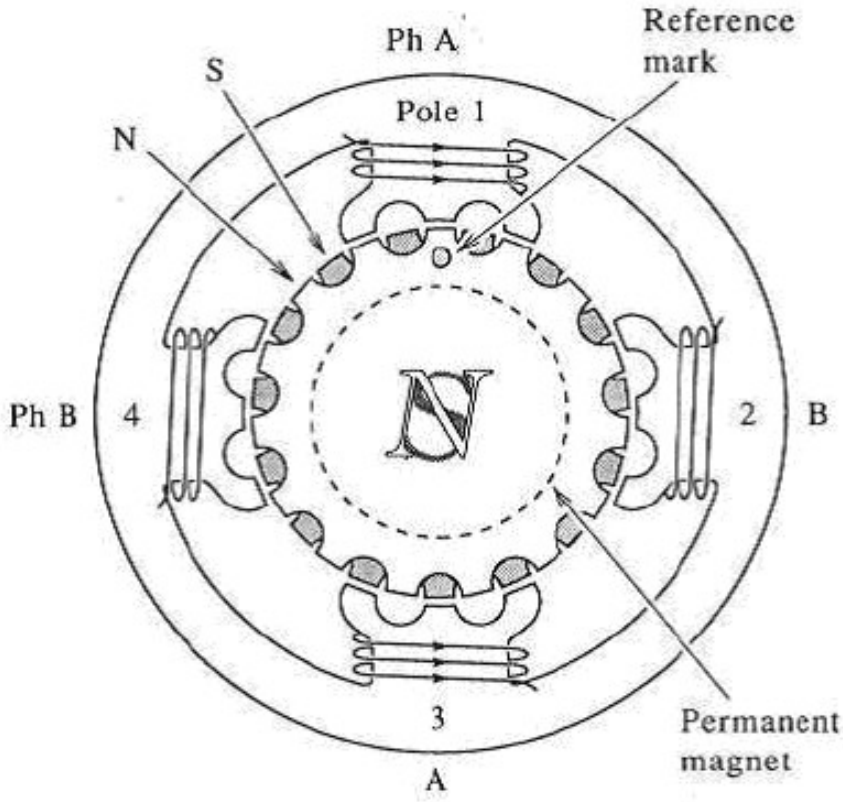


Fig: Interfacing of AD7523

Interfacing with a Stepper Motor

- Stepper motor is a device used to obtain an accurate position control of rotating shafts.
- A stepper motor employs rotation of its shaft in terms of steps, rather than continuous rotation as in case of AC or DC motor.
- To rotate the shaft of the stepper motor, a sequence of pulses is needed to be applied to the windings of the stepper motor, in proper sequence.
- The numbers of pulses required for complete rotation of the shaft of the stepper motor are equal to the number of internal teeth on its rotor.
- The stator teeth and the rotor teeth lock with each other to fix a position of the shaft.
- With a pulse applied to the winding input, the rotor rotates by one teeth position or an angle x. the angle x may be calculated as.
  x = 3600 / no. of rotor teeth
- After the rotation of the shaft through angle x, the rotor locks it self with the next tooth in the sequence on the internal surface of the stator.

Internal Schematic of a Four Winding Stepper Motor



Cross-section of a two-phase hybrid motor.

Interfacing with a Stepper Motor

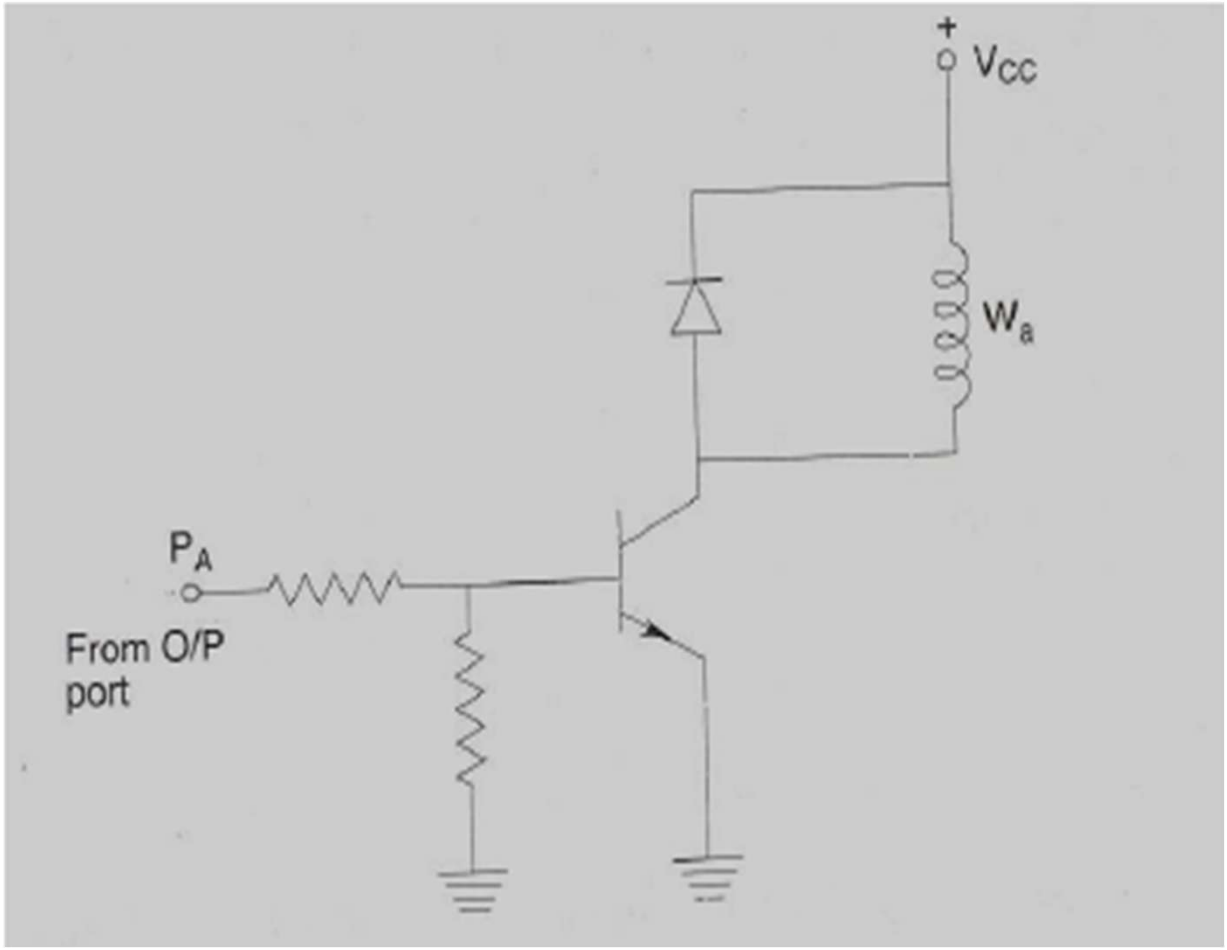
- The stepper motors have been designed to work with digital circuits. Binary level pulses of 0-5V are required at its winding inputs to obtain the rotation of the shafts. The sequence of the pulses can be decided, depending upon the required motion of the shaft. By suitable sequence of the pulses the motor can be used in three modes of operation.
  - One phase ON (medium torque)
  - Two phase ON (high torque)
  - Half stepping (low torque)
- A Typical stepper motor may have parameters like torque 3Kg-Cm, Operating voltage 12V, current rating 0.2A and a single step angle 1.8degrees i.e., steps/revolution

Interfacing with a Stepper Motor

- A simple scheme for rotating the shaft of a stepper motor is called a wave scheme
- In this scheme the windings Wa, Wb, Wc, Wd are applied with required voltage pulses, in a cyclic fashion
- By reversing the sequence of excitation, the direction of the rotation of the shaft of the stepper motor can be reversed as shown in the figure
- **Working:**
  - 8255 is interfaced with 8086 in I/O mapped I/O. port C (PC0, PC1, PC2, PC3) is used to give pulse sequence to stepper motor. The 8255 provides very less current which will not be able to drive stepper motor coils so each of the winding of a stepper motor needs to be interfaced using high speed switching Darlington transistors with max 1A, 80V rating with heat sink, with the output port of 8255. Output the sequence in correct order to have the desired direction to rotate the motor.

Excitation sequences of a stepper motor using wave switching scheme

Motion	Step	A	B	C	D
Clockwise	1	1	0	0	0
	2	0	1	0	0
	3	0	0	1	0
	4	0	0	0	1
	5	1	0	0	0
Anticlock wise	1	1	0	0	0
	2	0	0	0	1
	3	0	0	1	0
	4	0	1	0	0
	5	1	0	0	0


+
Vcc
Wa
PA
From O/P
port

Example: To Rotate the stepper motor 180 degrees right and left immediately and settle down at initial position.

```
CODE SEGMENT
 ASSUME CS:CODE
 START: MOV AL,80H
        OUT CWR,AL
        MOV AL,88H
        MOV CX,100

AGAIN1:OUT PORTA,AL
        CALL DELAY
        ROR AL,1
        DEC CX
        JNZ AGAIN1
```

```
        MOV CX,100

AGAIN2:OUT PORTA,AL
        CALL DELAY
        ROL AL,1
        DEC CX
        JNZ AGAIN2
        INT 3

DELAY: NOP
        NOP
        MOV BX,0FFFFH
L1:     DEC BX
        JNZ L1
        RET
CODE ENDS
END START
```