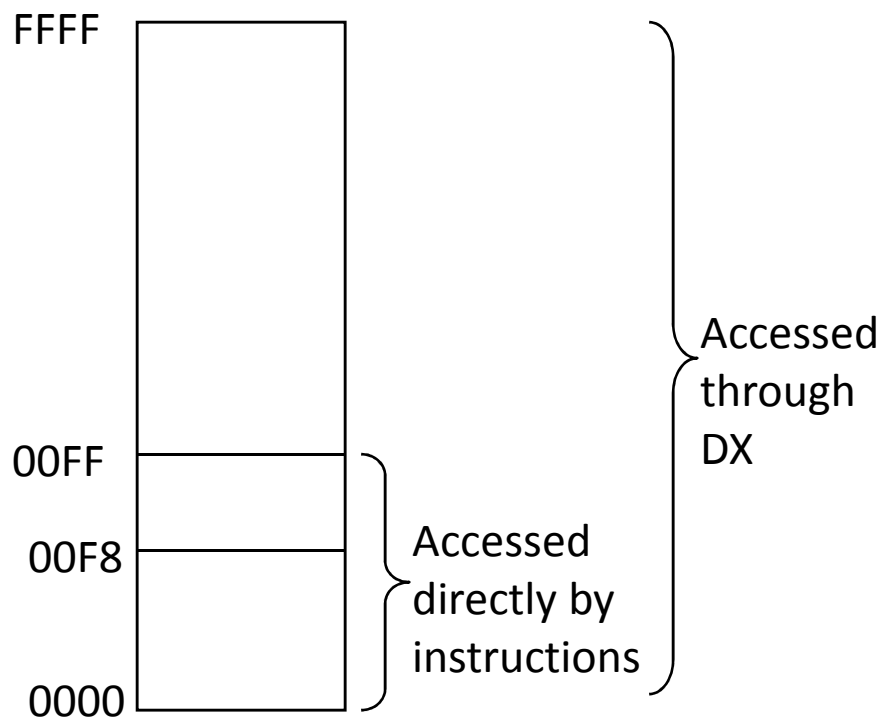


8086 Port Addressing Space

□ Addressing Space



□ Accessing directly by instructions

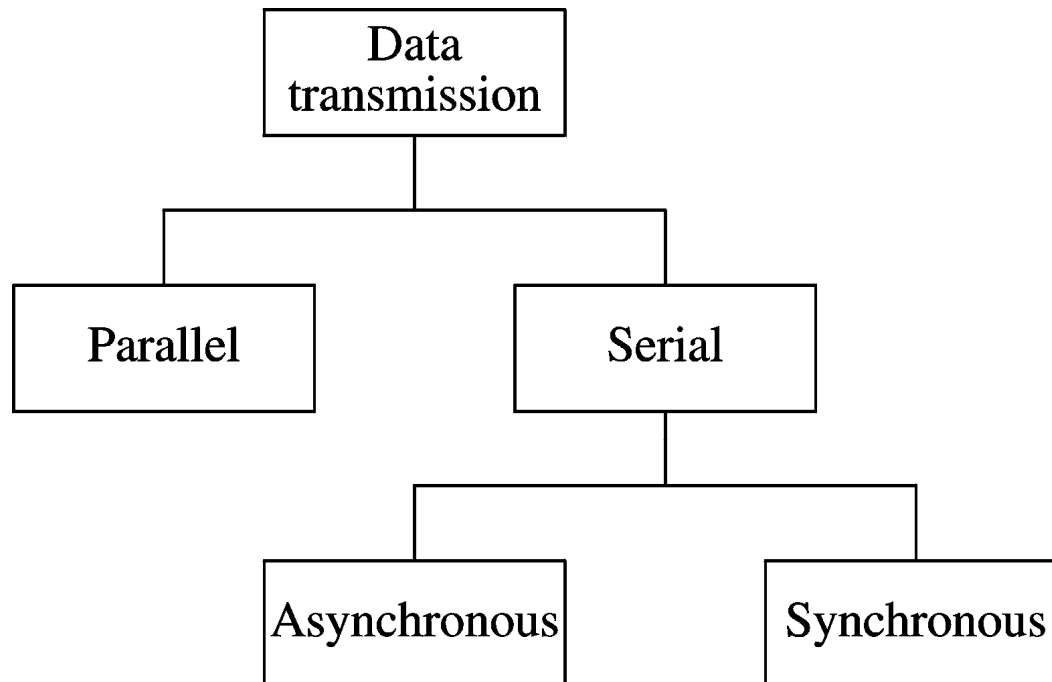
```
IN    AL,    80H
IN    AX,    6H
OUT   3CH,   AL
OUT   0A0H,  AX
```

□ Accessing through DX

```
IN    AL,    DX
IN    AX,    DX
OUT   DX,    AL
OUT   DX,    AX
```

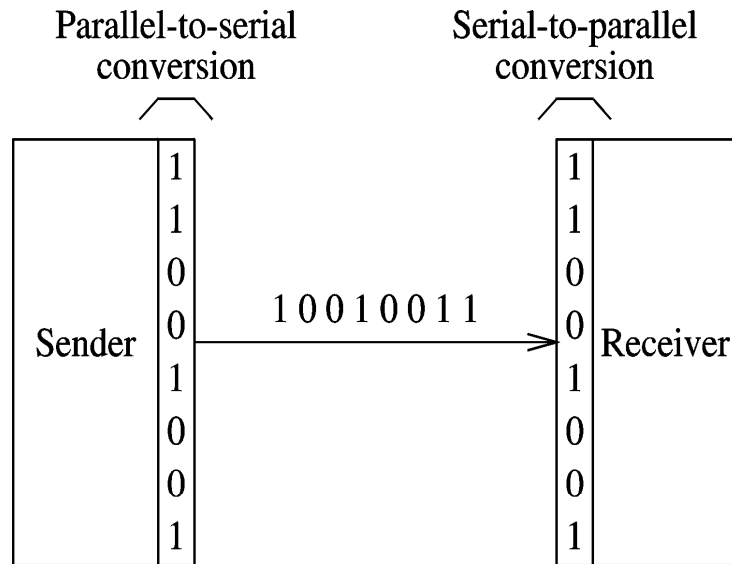
External Interface

- Two ways of interfacing I/O devices

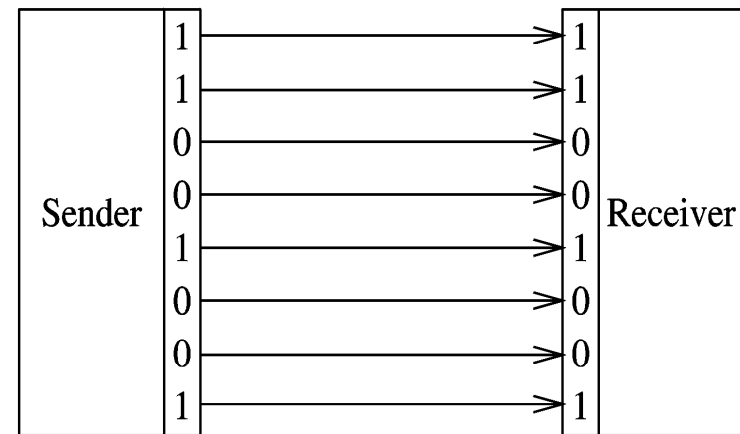


External Interface (cont'd)

Two basic modes of data transmission



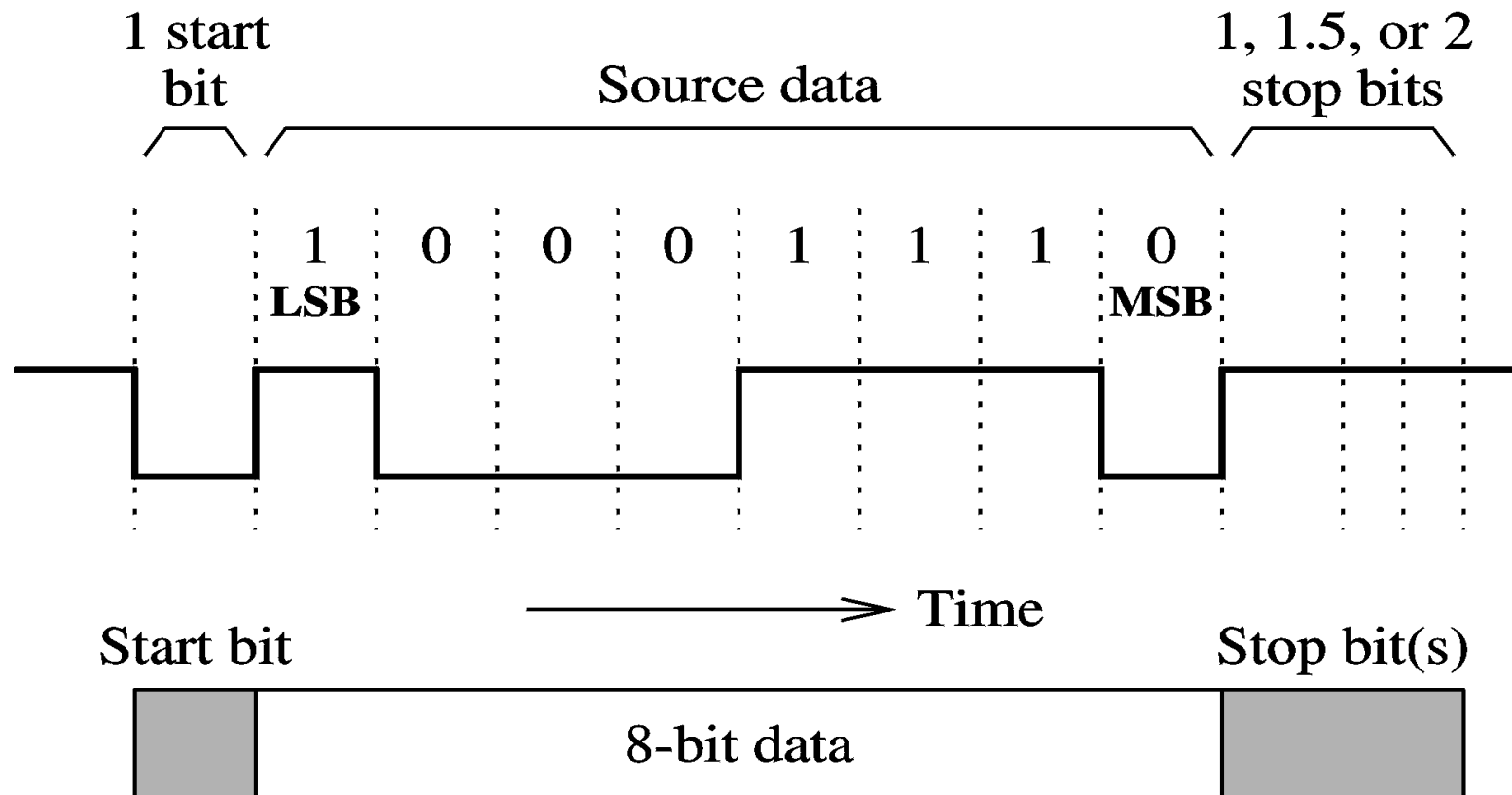
(a) Serial transmission



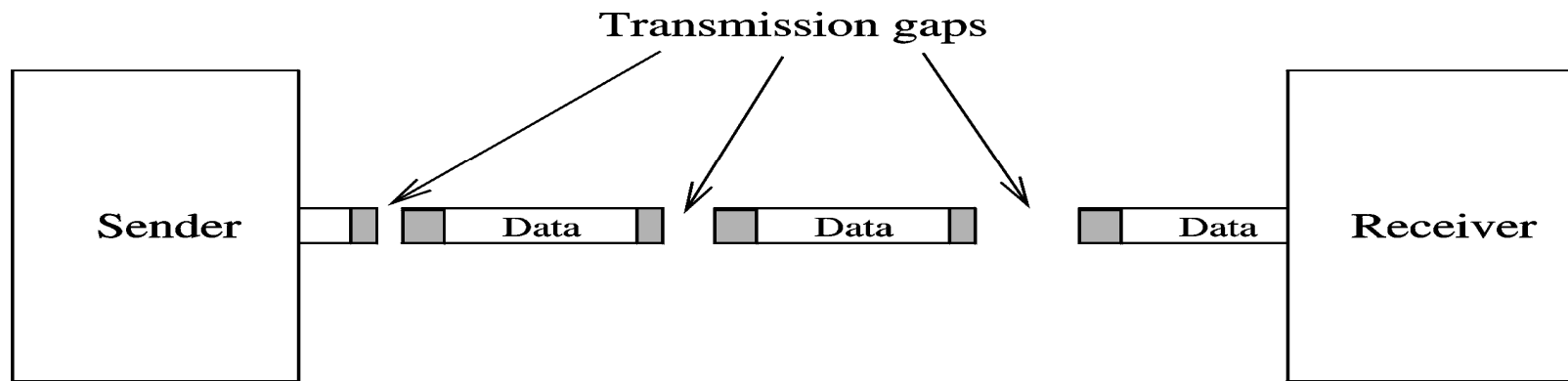
(b) Parallel transmission

External Interface (cont'd)

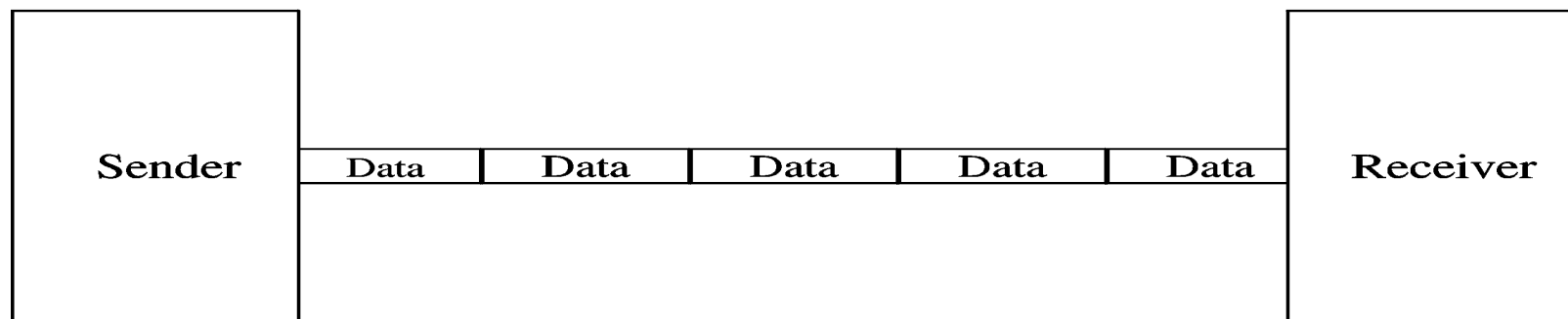
Asynchronous transmission



External Interface (cont'd)



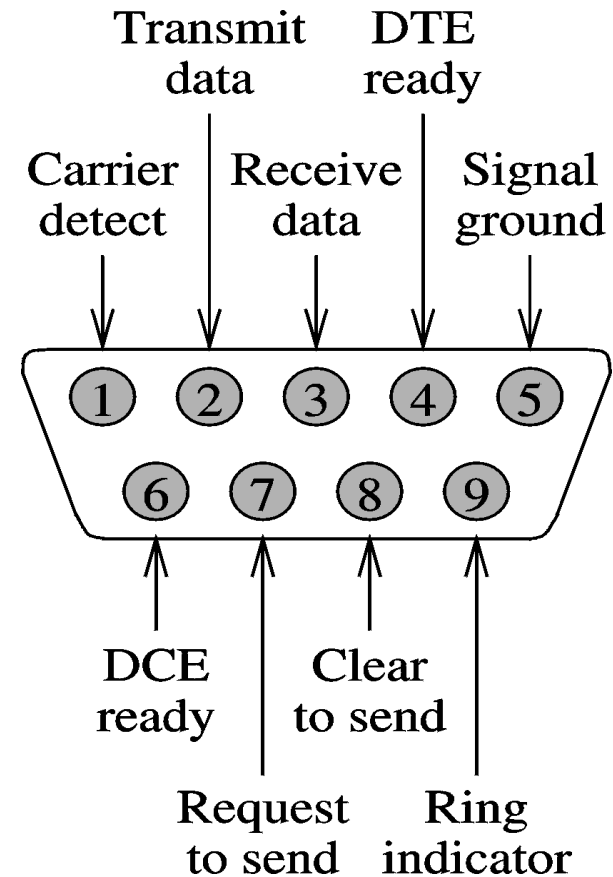
(a) Asynchronous transmission



(b) Synchronous transmission

External Interface (cont'd)

- EIA-232 serial interface
 - Low-speed serial transmission
 - Adopted by Electronics Industry Association (EIA)
 - Popularly known by its predecessor RS-232
 - It uses a 9-pin connector DB-9
 - Uses 8 signals
 - Typically used to connect a modem to a computer



External Interface (cont'd)

Table 19.3 Parallel printer interface signals

Pin #	Signal	Signal direction	Signal function
1	STROBE	PC \Rightarrow printer	Clock used to latch data
2	Data 0	PC \Rightarrow printer	Data bit 0 (LSB)
3	Data 1	PC \Rightarrow printer	Data bit 1
4	Data 2	PC \Rightarrow printer	Data bit 2
5	Data 3	PC \Rightarrow printer	Data bit 3
6	Data 4	PC \Rightarrow printer	Data bit 4
7	Data 5	PC \Rightarrow printer	Data bit 5
8	Data 6	PC \Rightarrow printer	Data bit 6
9	Data 7	PC \Rightarrow printer	Data bit 7 (MSB)
10	ACK	printer \Rightarrow PC	Printer acknowledges receipt of data
11	BUSY	printer \Rightarrow PC	Printer is busy
12	POUT	printer \Rightarrow PC	Printer is out of paper
13	SEL	printer \Rightarrow PC	Printer is online
14	AUTO FEED	printer \Rightarrow PC	Autofeed is on
15	FAULT	printer \Rightarrow PC	Printer fault
16	INIT	PC \Rightarrow printer	Clears printer buffer and resets printer
17	SLCT IN	PC \Rightarrow printer	TTL high level
18–25	Ground	N/A	Ground reference

GENERAL PURPOSE PROGRAMMABLE PERIPHERAL DEVICES

- 8255 Programmable peripheral interface
- 8254 programmable interval timer
- 8259 Programmable interval timer
- 8237 DMA Controller
- 8251 USART

An Example I/O Device

- Keyboard
 - Keyboard controller
 - Scans and reports Key depressions and releases
 - Supplies key identity as a scan code
 - Interfaced through an 8-bit parallel I/O port
 - Originally supported by 8255 programmable peripheral interface chip (PPI)
- Keyboard scan code and status can be read from port 60H
 - 7-bit scan code is available from
 - PA0 – PA6
 - Key status is available from PA7
 - PA7 = 0 – key depressed
 - PA0 = 1 – key released

An Example I/O Device (cont'd)

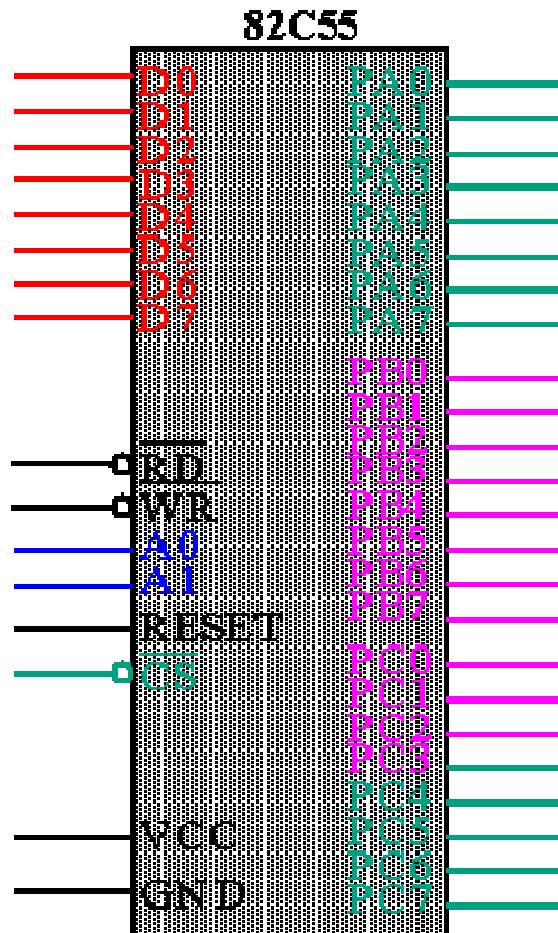
- 8255 PPI has three 8-bit registers
 - Port A (PA)
 - Port B (PB)
 - Port C (PC)
- These ports are mapped as follows

8255 register	Port address
PA (input port)	60H
PB (output port)	61H
PC (input port)	62H
Command register	63H

8255 Programmable peripheral interface

- It can be programmed to transfer data under various conditions.
- It has 24 I/O pins.
- The function of 8255A classified acc to two modes.
- BSR mode
- I/O mode

8255 Programmable Peripheral Interface



Group A

Port A (PA7-PA0) and upper half of port C (PC7 - PC4)

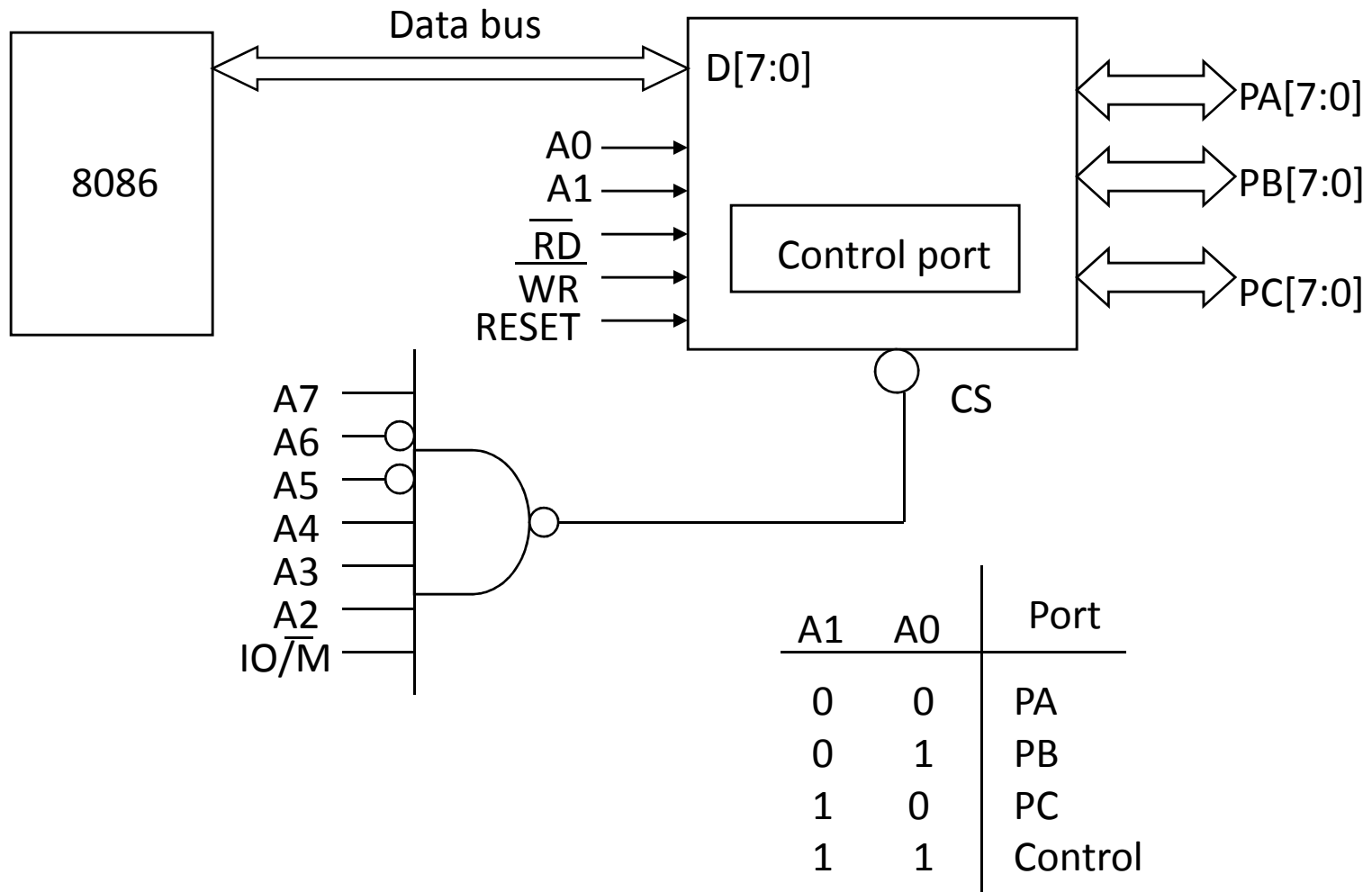
Group B

Port B (PB7-PB0) and lower half of port C (PC3 - PC0)

I/O Port Assignments

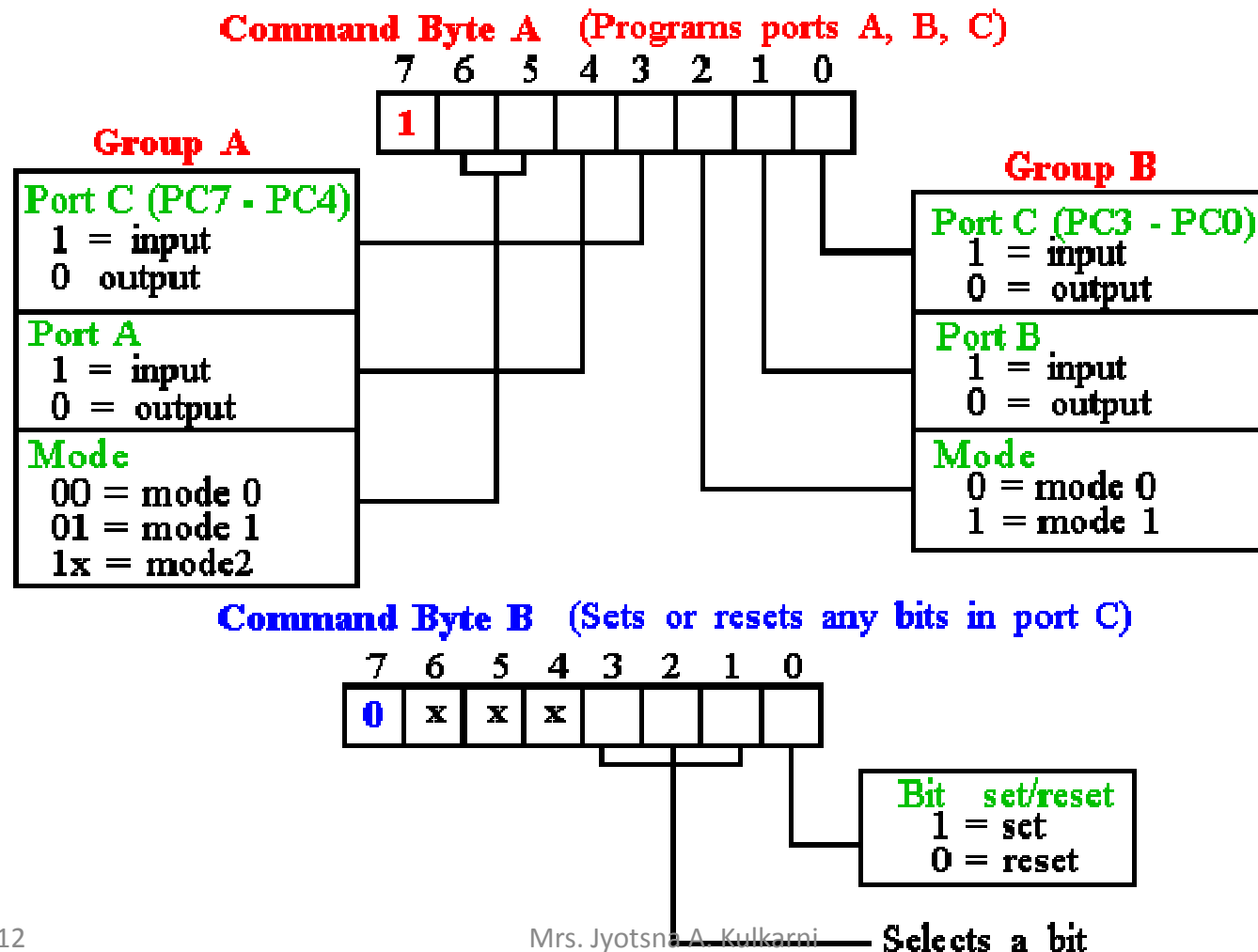
A ₁	A ₀	Function
0	0	Port A
0	1	Port B
1	0	Port C
1	1	Command Register

8255 Programmable Peripheral Interface



Programming 8255

- 8255 has three operation modes: *mode 0*, *mode 1*, and *mode 2*



8255 control word

- D7 D6 D5 D4 D3 D2 D1 D0
0/1

BSR Mode

I/O Mode

For port C

Mode0 Mode 1 Mode2

No effect on mode 0

Simple I/O

Handshake I/O

for ports
A,B,C

for ports A and or B

•

Port C bits

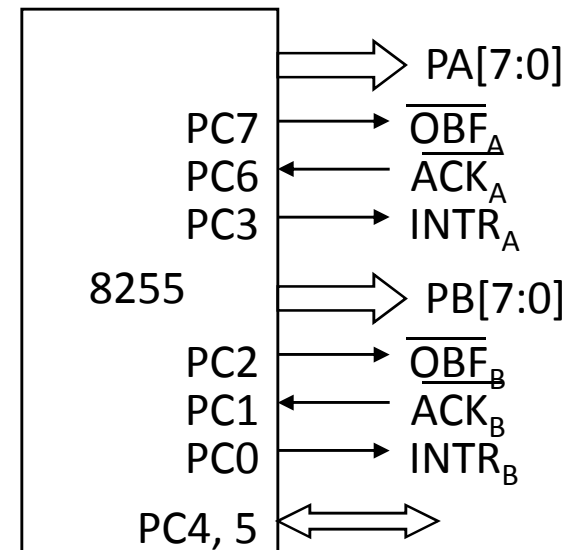
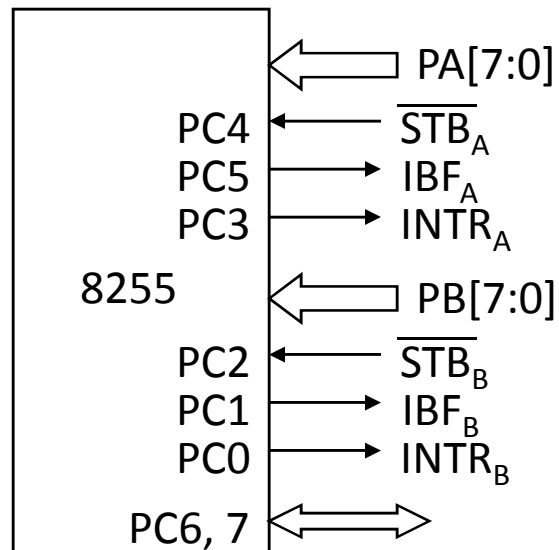
Programming 8255

❑ Mode 0:

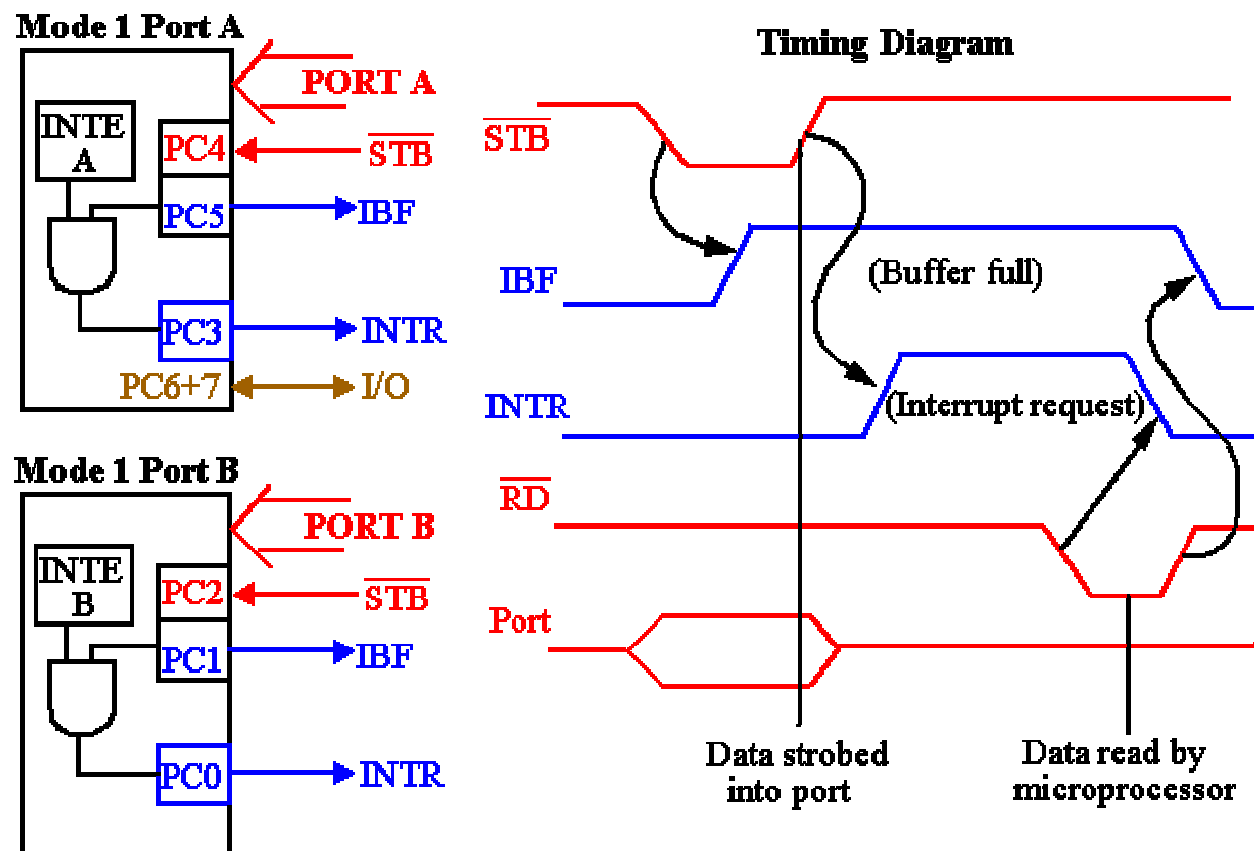
- Ports A, B, and C can be individually programmed as input or output ports
- Port C is divided into two 4-bit ports which are independent from each other

❑ Mode 1:

- Ports A and B are programmed as input or output ports
- Port C is used for handshaking



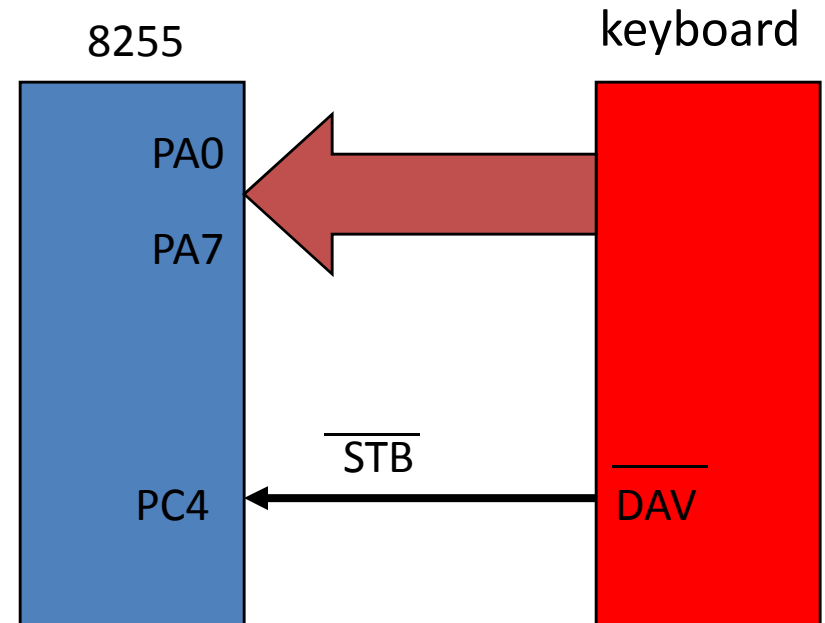
- \overline{STB}** The strobe input loads data into the port latch on a 0-to-1 transition
- IBF** Input buffer full is an output indicating that the input latch contain information
- INTR** Interrupt request is an output that requests an interrupt
- INTE** The interrupt enable signal is neither an input nor an output; it is an internal bit programmed via the PC4(port A) or PC2(port B) bits.
- PC7,PC6** The port C pins 7 and 6 are general-purpose I/O pins that are available for any purpose.



Example: Mode 1 Input

- BIT5 EQU 20H
- PORTC EQU 22H
- PORTA EQU 20H

- READ PROC NEAR
- Read:
 - IN AL, PORTC ; read portc
 - TEST AL, BIT5 ;test IBF
 - JZ Read ;if IBF=0
 - IN AL, PORTA ;Read Data
- READ ENDP



$\overline{\text{OBF}}$ Output buffer full is an output that goes low when data is latched in either port A or port B. Goes low on $\overline{\text{ACK}}$.

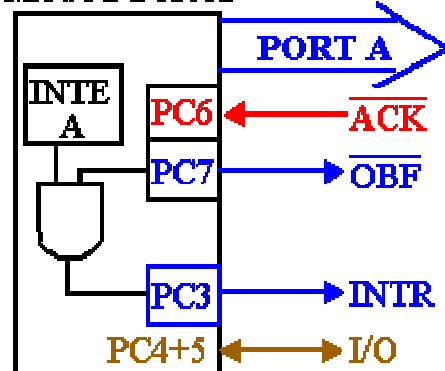
$\overline{\text{ACK}}$ The acknowledge signal causes the $\overline{\text{OBF}}$ pin to return to 0. This is a response from an external device.

INTR Interrupt request is an output that requests an interrupt

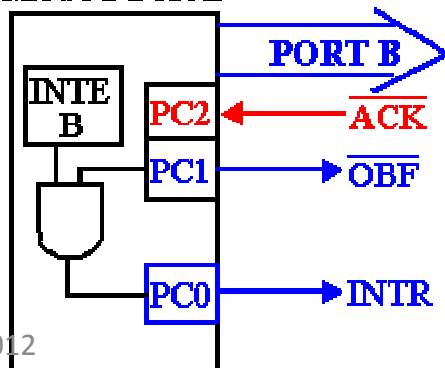
INTE The interrupt enable signal is neither an input nor an output; it is an internal bit programmed via the PC6(port A) or PC2(port B) bits.

PC5,PC4 The port C pins 5 and 4 are general-purpose I/O pins that are available for any purpose.

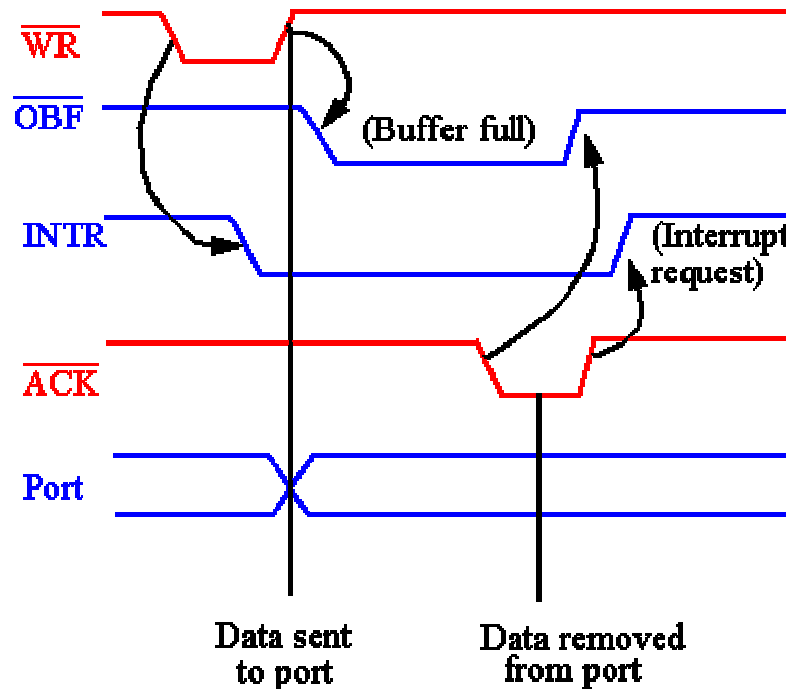
Mode 1 Port A



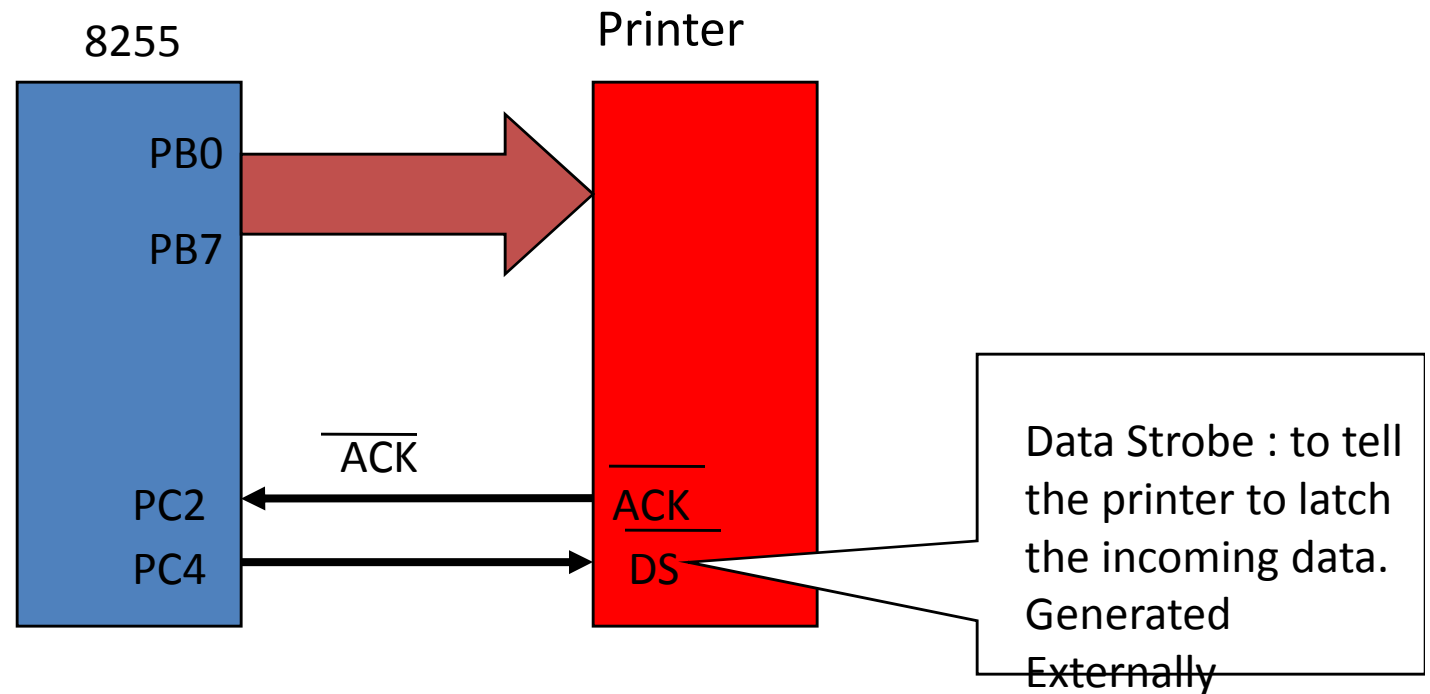
Mode 1 Port B



Timing Diagram



Example: Mode 1 output



Example: Mode 1 output

```
BIT1    EQU    2
PORTC EQU    62H
PORTB EQU    61H
CMD     EQU    63H
PRINT  PROC  NEAR

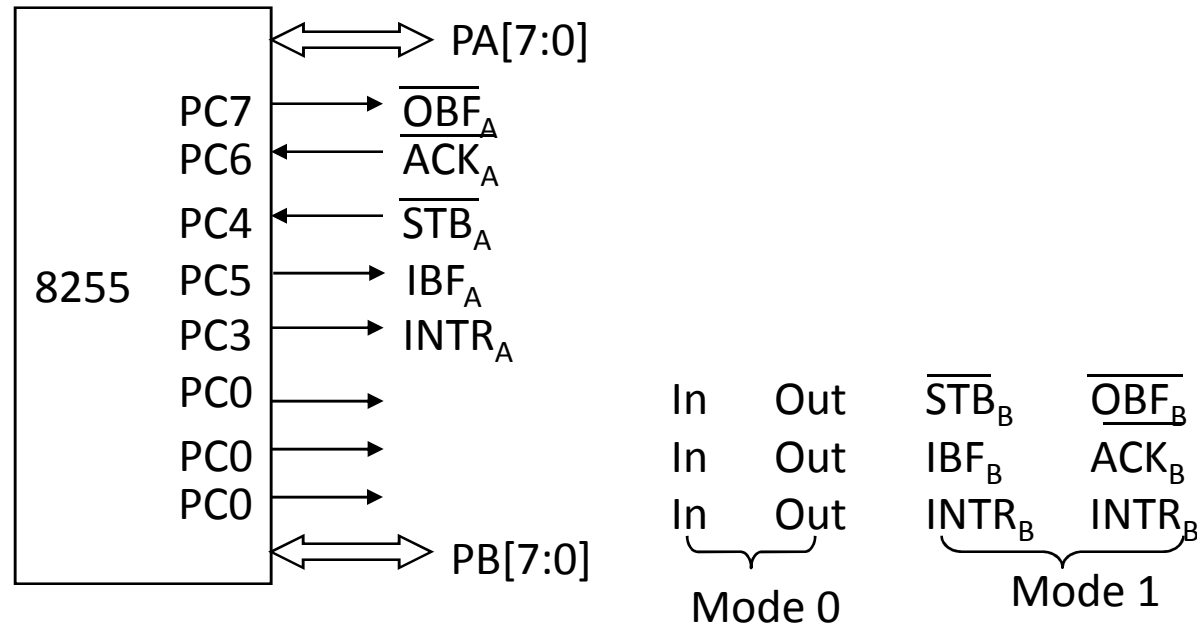
    ; check printer ready?
    IN AL, PORTC ;get OBF
    TEST AL, BIT1 ;test OBF
    JZ PRINT ;if OBF=0 buffer is full

    ;send character to printer
    MOV AL, AH ;get data
    OUT PORTB, AL ;print data
    ; send data strobe to printer
    MOV AL, 8 ;clear DS
    OUT CMD, AL
    MOV AL, 9 ;clear DS
    OUT CMD, AL
    ;rising the data at the positive
    ;edge of DS
    RET
PRINT ENDP
```

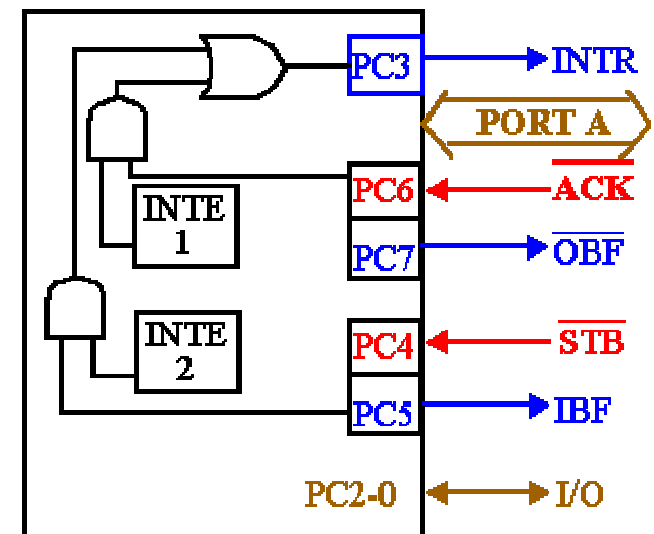
Programming 8255

□ Mode 2:

- Port A is programmed to be bi-directional
- Port C is for handshaking
- Port B can be either input or output in mode 0 or mode 1



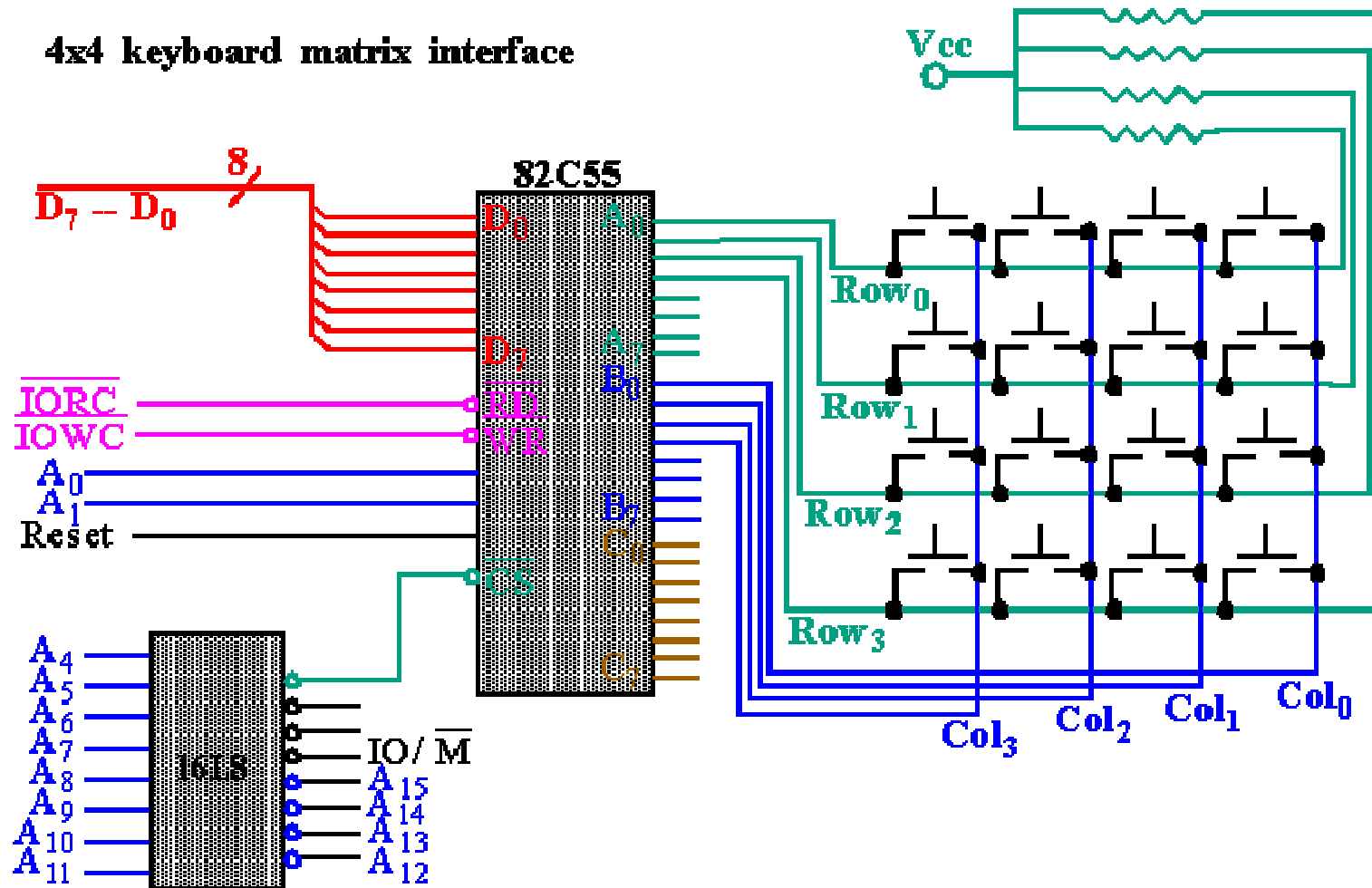
INTR	Interrupt request is an output that requests an interrupt
$\overline{\text{OBF}}$	Output buffer full is an output indicating that the output buffer contains data for the bi-directional bus
$\overline{\text{ACK}}$	Acknowledge is an input that enables tri-state buffers which are otherwise in their high-impedance state
$\overline{\text{STB}}$	The strobe input loads data into the port A latch
IFB	Input buffer full is an output indicating that the input latch contains information for the external bi-directional bus
INTE	Interrupt enable are internal bits that enable the INTR pin. Bit PC6(INTE1) and PC4(INTE2)
PC2,PC1 and PC0	Theses port C pins are general-purpose I/O pins that are available for any purpose.



Timing diagram is a combination of the Mode 1 Strobed Input and Mode 1 Strobed Output Timing diagrams.

Keyboard example 1/2

4x4 keyboard matrix interface



I/O Data Transfer

- Data transfer involves two phases
 - A data transfer phase
 - It can be done either by
 - Programmed I/O
 - DMA
 - An end-notification phase
 - Programmed I/O
 - Interrupt
- Three basic techniques
 - Programmed I/O
 - DMA
 - Interrupt-driven I/O