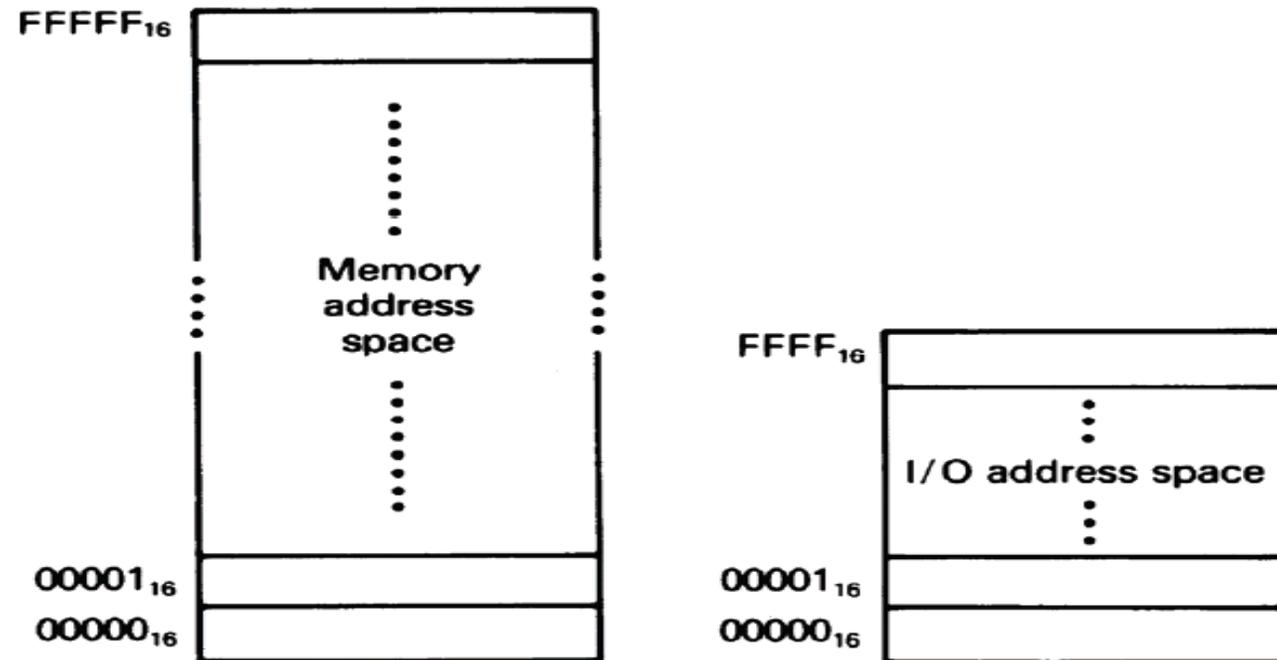# Input-Output Devices

The 8086 Input/output Interface

- When using isolated I/O in a microcomputer system, the I/O device are treated separate from memory.

- The memory address space contains 1M consecutive byte address in the range 00000_{16} through $FFFFF_{16}$ and the I/O address space contains 64K consecutive byte addresses in the range 0000_{16} through $FFFF_{16}$.

- All input and output data transfers must take place between AL or AX register and I/O port.

■ Isolated input/output

Figure (1)

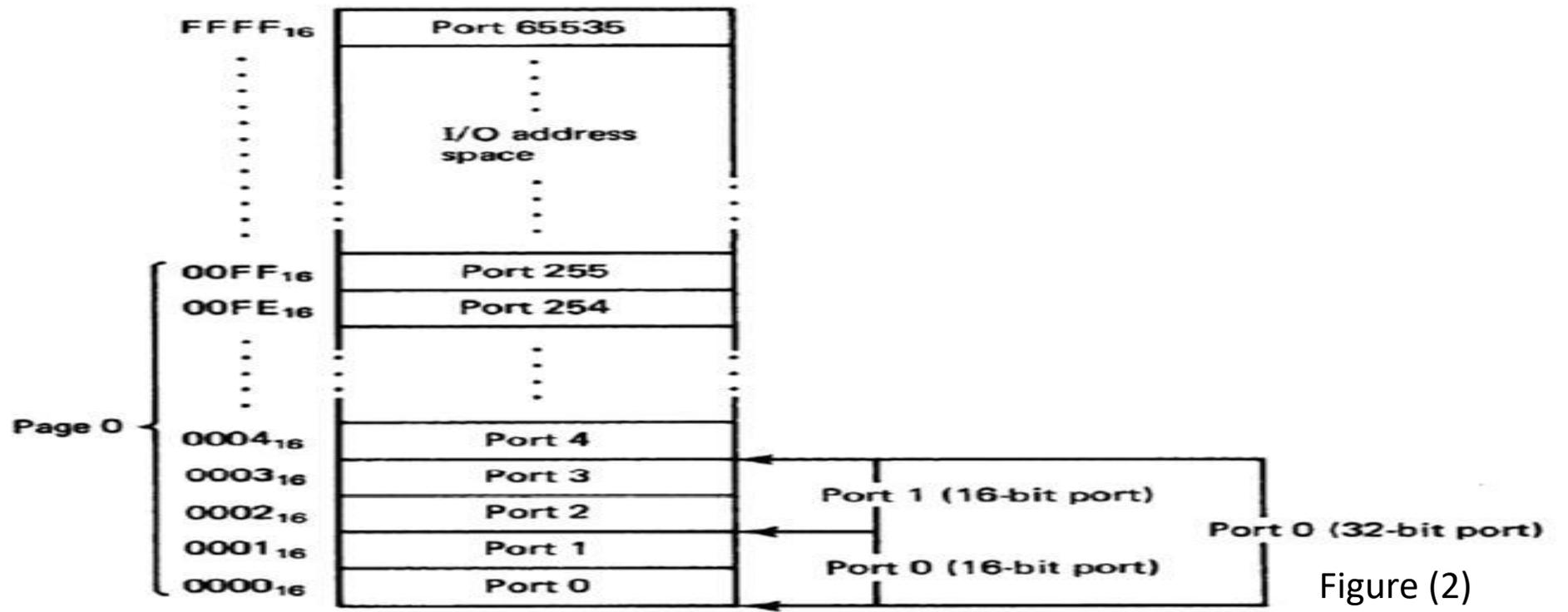**8086 memory and I/O address spaces**

Figure (2)

Isolated I/O ports

Memory-mapped input/output

- In the case of memory-mapped I/O, MPU looks at the I/O port as though it is a storage location in memory.

- Some of the memory address space is dedicated to I/O ports.

- Instructions that affect data in memory are used instead of the special I/O instructions.

- The memory instructions tend to execute slower than those specifically designed for isolated I/O.
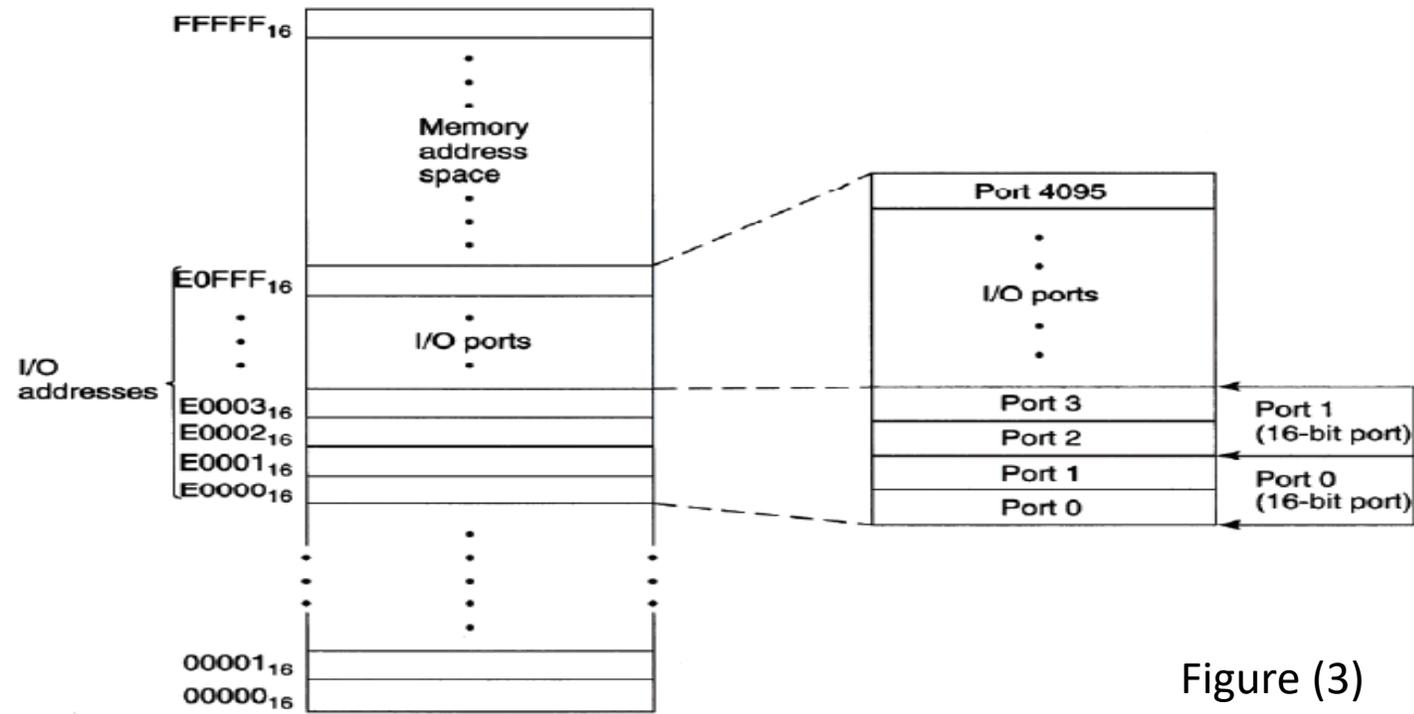
Memory-mapped input/output

Figure (3)

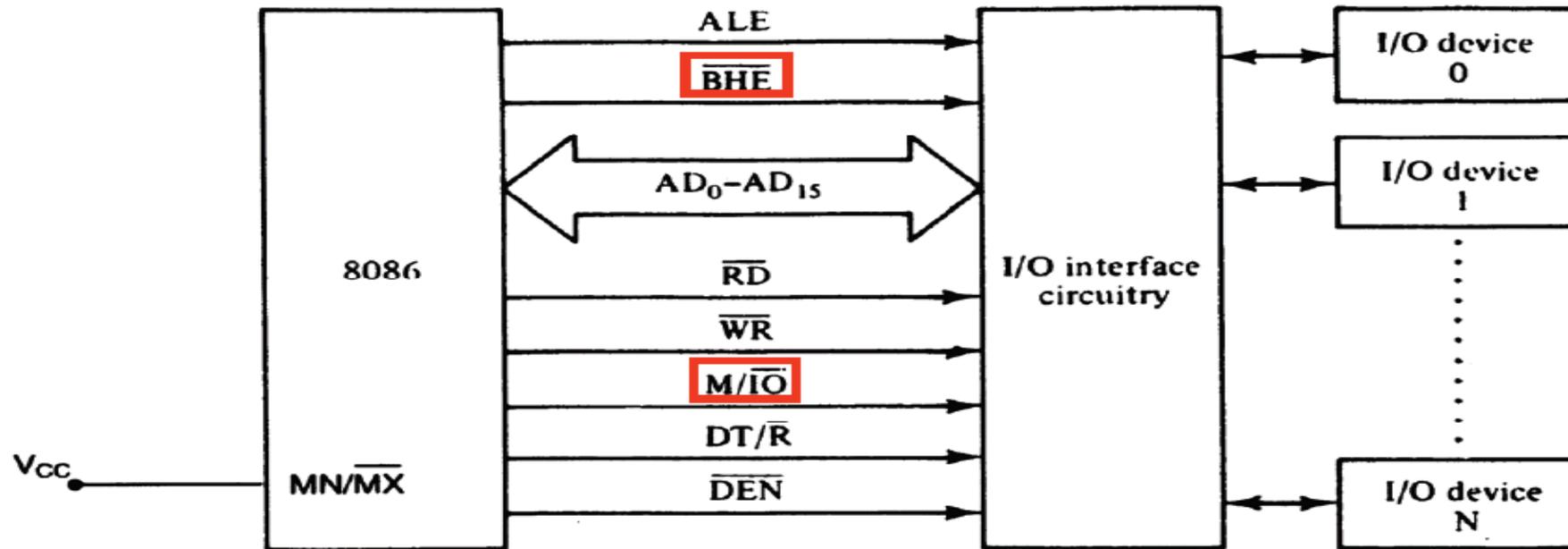**Memory mapped I/O ports**

Minimum-mode interface

Figure (4)

Minimum-mode 8086 system I/O interface
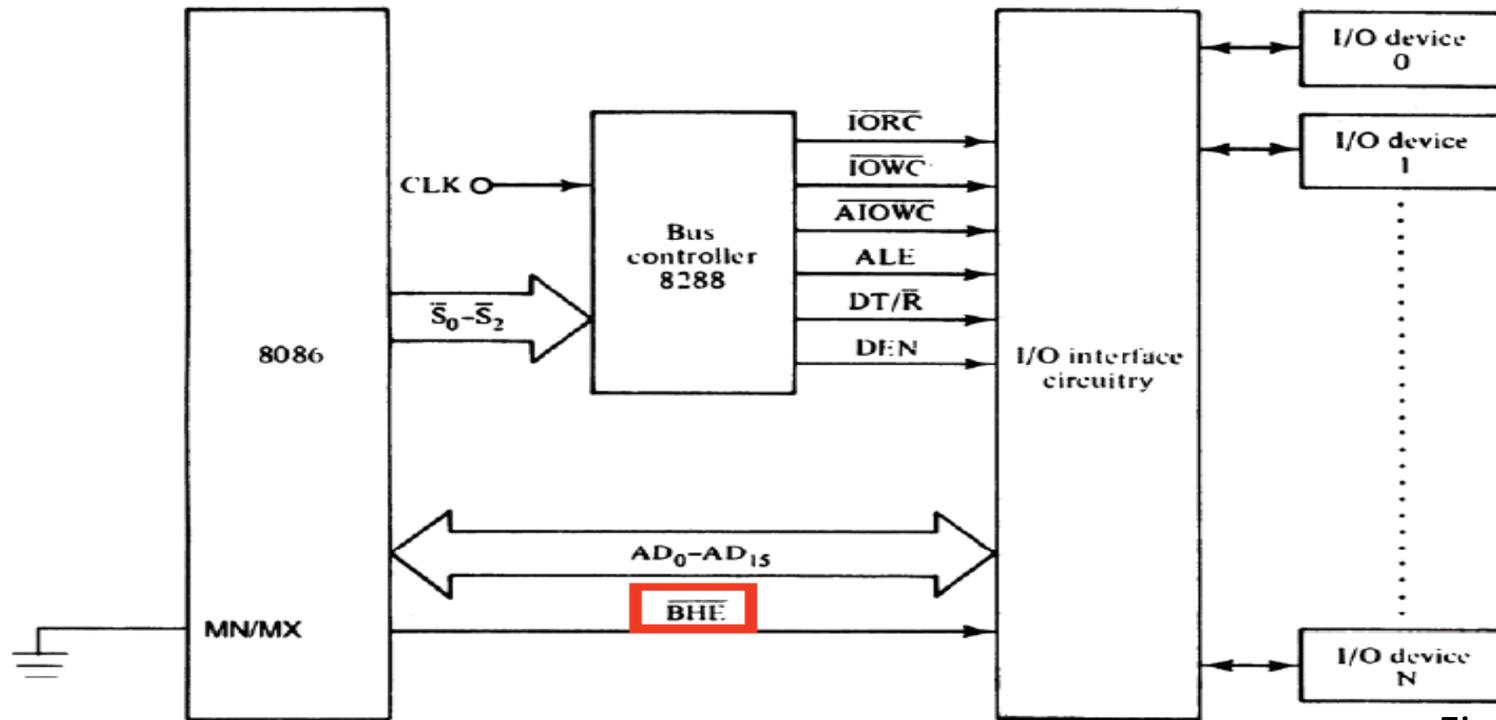
Maximum-mode interface

Figure (5)

Maximum-mode 8086 system I/O interface

- Input/ Output Instructions

Mnemonic	Meaning	Format	Operation
IN	Input direct	IN Acc, Port	$(ACC) \leftarrow (Port)$ Acc = AL or AX
	Input indirect (variable)	IN Acc,DX	$(ACC) \leftarrow ((DX))$
OUT	Output direct	OUT Port,Acc	$(Port) \leftarrow (Acc)$
	Output indirect (variable)	OUT DX,Acc	$((DX)) \leftarrow (ACC)$

Example:-

Write a sequence of instructions that will output the data FF_{16} to a byte-wide output port at address AB_{16} of the I/O address space.

Solution:

First , the AL register loaded with FF_{16} as an immediate operand in the instruction

   MOV AL, 0FFH

Now the data in AL can be output to the byte-wide output port with the instruction.

   OUT 0ABH,AL

- ## Example

Write a series of the instruction that will output FF_{16} to an output port located at address $B000_{16}$ of the I/O address space.

Solution:

The DX register must first be loaded with the address of the output port. This is done with the instruction.

MOV DX,0B000H

Next, the data that are to be output must be loaded into AL with the instruction

MOV AL,0FFH

Finally, the data are output with instruction

OUT DX,AL

Example

Data are to be read in from two byte-wide input ports at addresses AA_{16} and $A9_{16}$ and then output as a word-wide output port at address $B000_{16}$. Write a sequence of the instructions to perform this input/output operation.

Solution:-

First read in the byte at address AA_{16} into AL and move into AH.

IN AL,0AAH

MOV AH,AL

Now the other byte can be read into AL by the instruction

IN AL,0A9H

And to write out the word of data

MOV DX,0B000H

OUT DX,AL