Microprocessor System Design Input / Output Peripheral Interfacing

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Outline

- **Peripheral devices**

  - **Input devices**

  - **Output devices**

- **8 bit / 16-bit IO**

- **Simple Output device - interfacing LEDs**

- **Simple Input device - interfacing switches**

Peripheral

- is an input and/or output device

- like a memory chip, it is mapped to a certain location (called the port address)

- unlike a memory chip, a peripheral is usually mapped to a single location

Output Device

- **like a memory chip, you can write to an output device**

- **You can write to a memory chip using the command `mov [bx], al`**

- **You can write to an output device using the command `out dx, al`**

Input Device

- like a memory chip, you can read from an input device

- You can read from a memory chip using the command `mov al, [bx]`

- You can read from an input device using the command `in al, dx`

Memory mapped vs. peripheral

- **Same instruction vs. independent instruction**

- **Entire address bus vs. part of address bus**

- **Same control signals vs. independent**

- **More IO ports vs. 65536 ports**

- **More commands and operations**

- **Uses memory space**

Two formats for IN / OUT

Format 1

- **IN AL, port#**

Or

- **OUT port#, AL**

- **Example:**
  - BACK: IN AL,22H
                 CMP AL, 100
                 JNZ BACK

Format 2

- **MOV DX,port#
  IN AL, DX**

Or
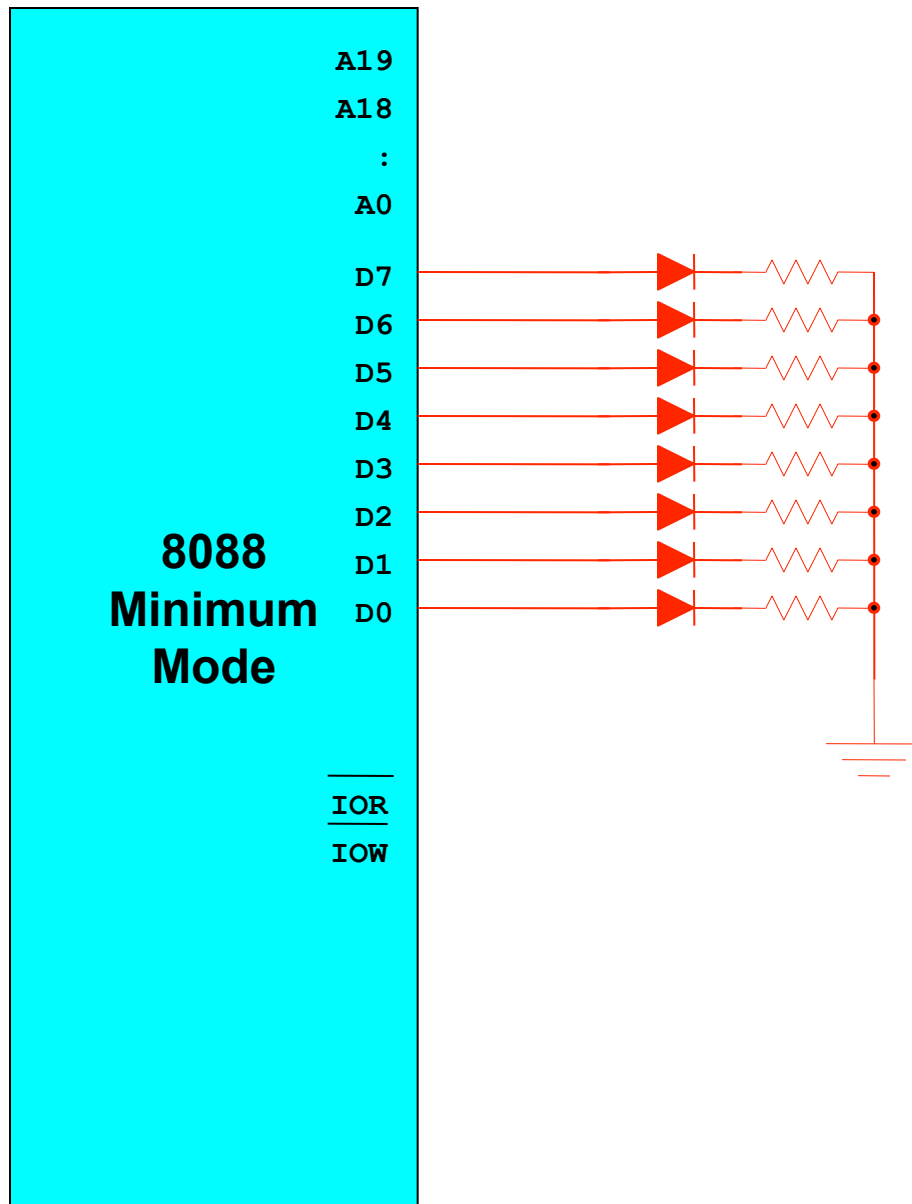
- **MOV DX, port#
  OUT DX, AL**

8bit vs 16bit IO

- **8088 case:**
- **MOV DX, 648H
OUT DX, AX** ;AX = 76A9H

- **Address bus and ALE**
- **Low byte (A9), IOW**
- **Setup time**
- **Address (649) and ALE**
- **High byte (76), IOW**
- **Setup time**

- **8086 case:**
- **MOV DX, 648H
OUT DX, AX** ;AX = 76A9H

- **Address bus and ALE**
- **Word (76A9), IOW**
- **Setup time**

Creating a Simple Output Device

- **Use 8-LED's**

Use 8 LED's

8088 Minimum Mode

A19
A18
:
A0

D7
D6
D5
D4
D3
D2
D1
D0

$\overline{IOR}$
$\overline{IOW}$
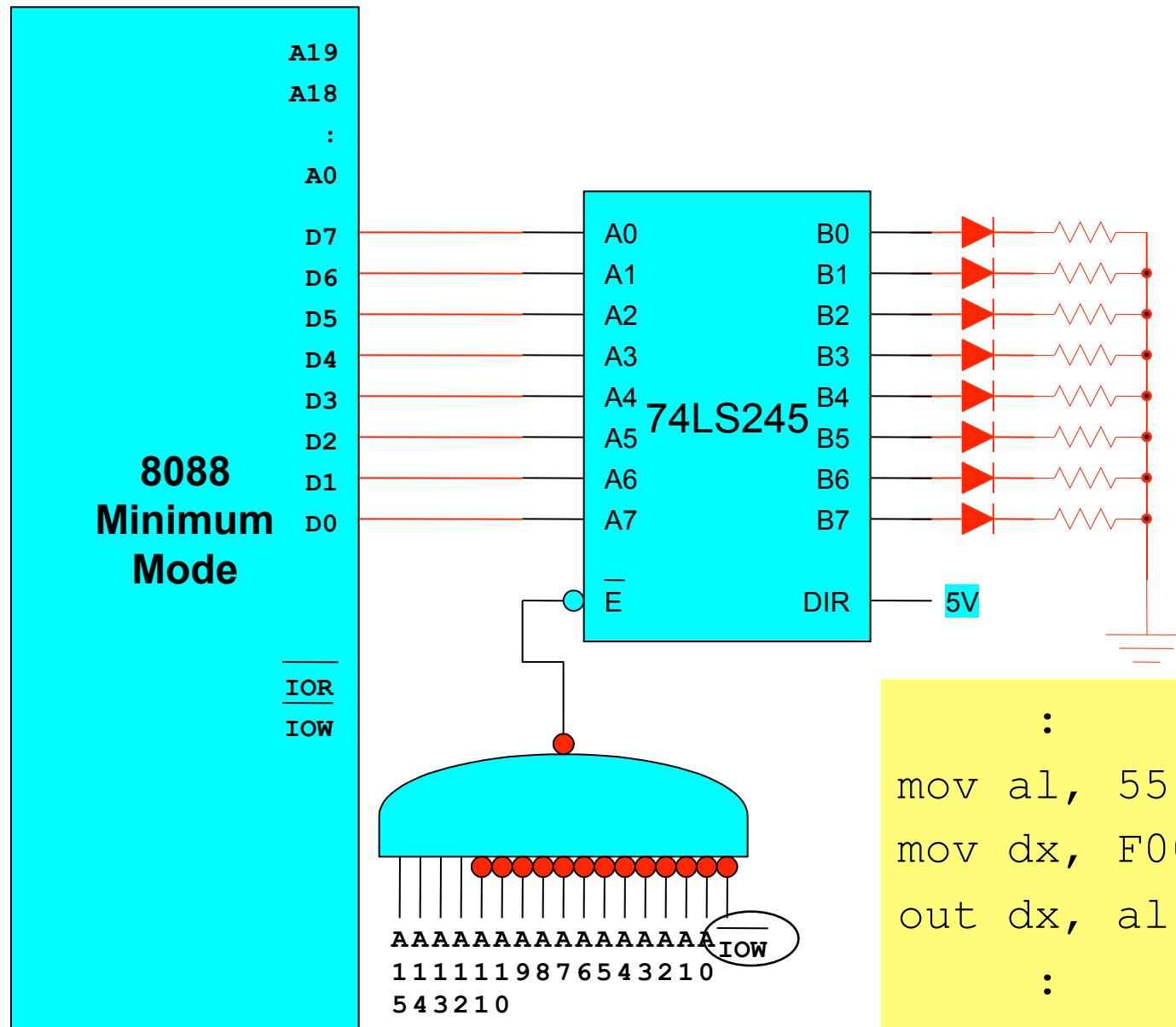
:

mov al, 55
out dx, al

:

:

:

Creating a Simple Output Device

- **Use 8-LED's**

- **Use a chip and an address decoder such that the LED's will respond only to the command `out` and a specific address (let's assume that the address is `F000`)**
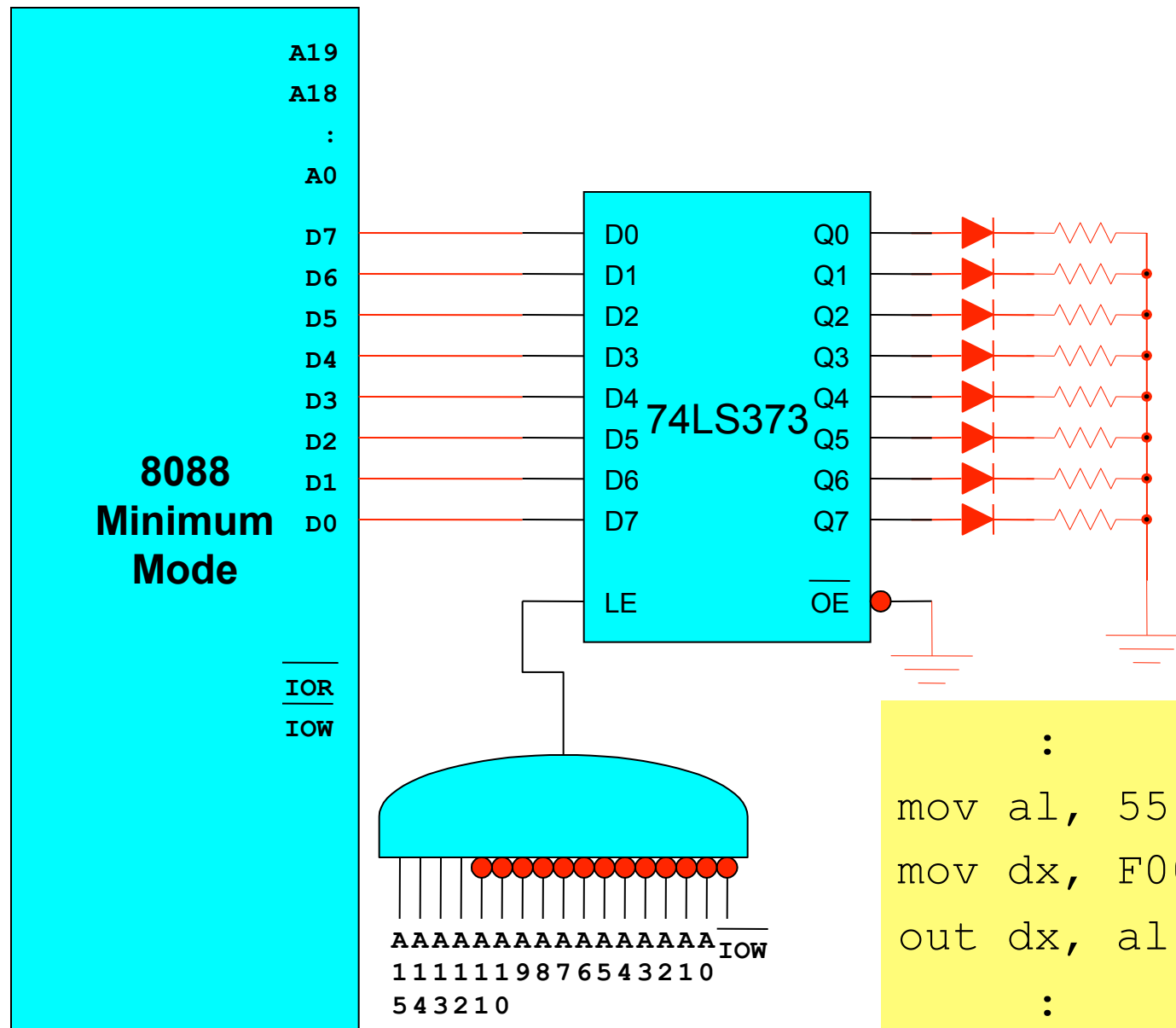
Use of 74LS245 and Address Decoder

8088 Minimum Mode

A19
A18
:
A0

D7
D6
D5
D4
D3
D2
D1
D0

IOR
IOW

74LS245

A0 B0
A1 B1
A2 B2
A3 B3
A4 B4
A5 B5
A6 B6
A7 B7

E̅ DIR — 5V

A A A A A A A A A A A A A A A A I̅O̅W̅
1 1 1 1 1 1 9 8 7 6 5 4 3 2 1 0
5 4 3 2 1 0

```
       :
mov al, 55
mov dx, F000
out dx, al
       :
```

Creating a Simple Output Device

- **Use 8-LED's**

- **Loses the data**

- **Solution?**

- **Use a chip and an address decoder such that the LED's will not only respond to the command `out` and a specific address (let's assume that the address is `F000`) but will also latch the data**
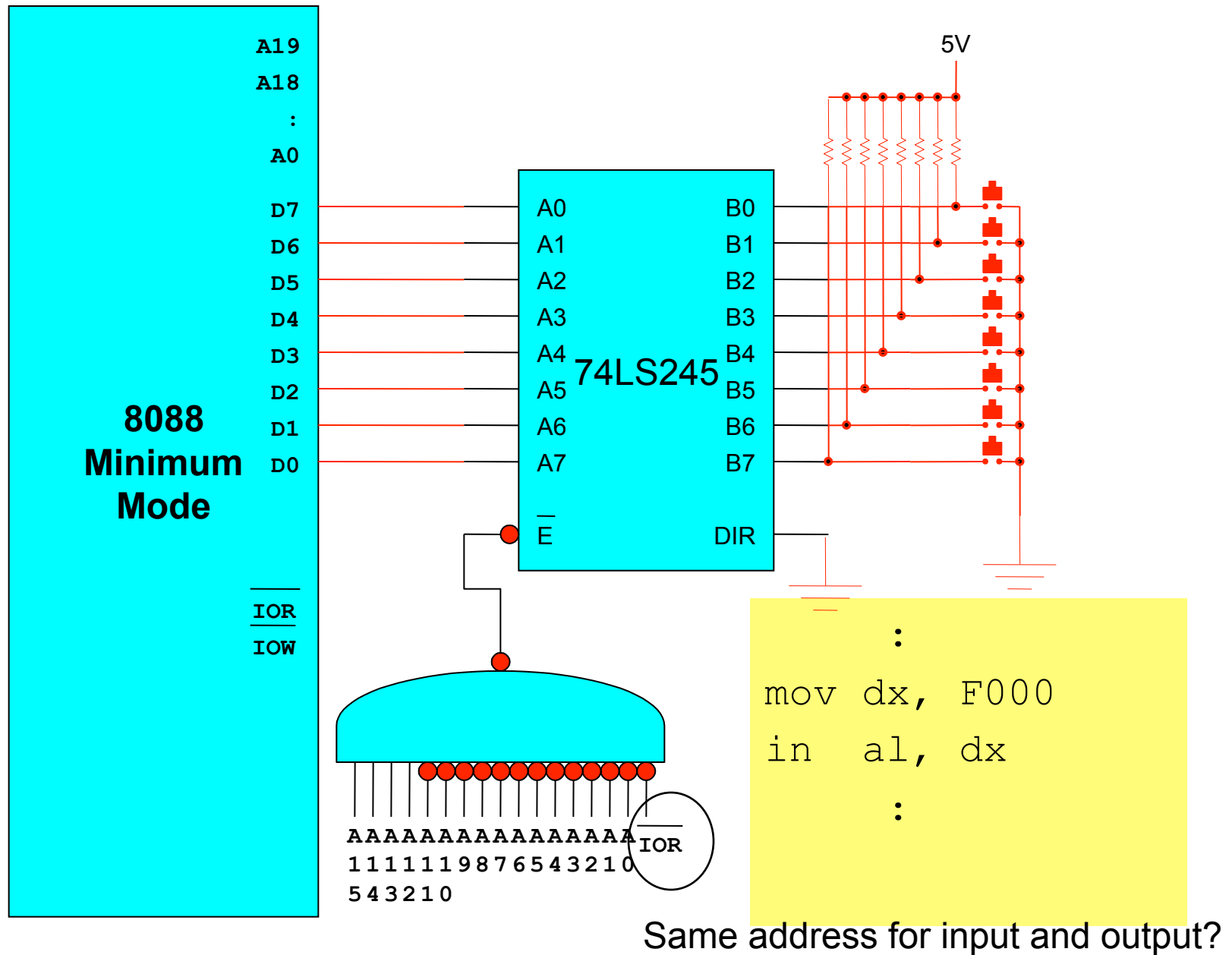
Use of 74LS373 and Address Decoder


```
     :
mov al, 55
mov dx, F000
out dx, al
     :
```

Creating a Simple Input Device

- **Use 8-Switches (keys)**

- **Use a chip and an address decoder such that the keys will be read only to the command `in` and a specific address (let's assume that the address is `F000`)**

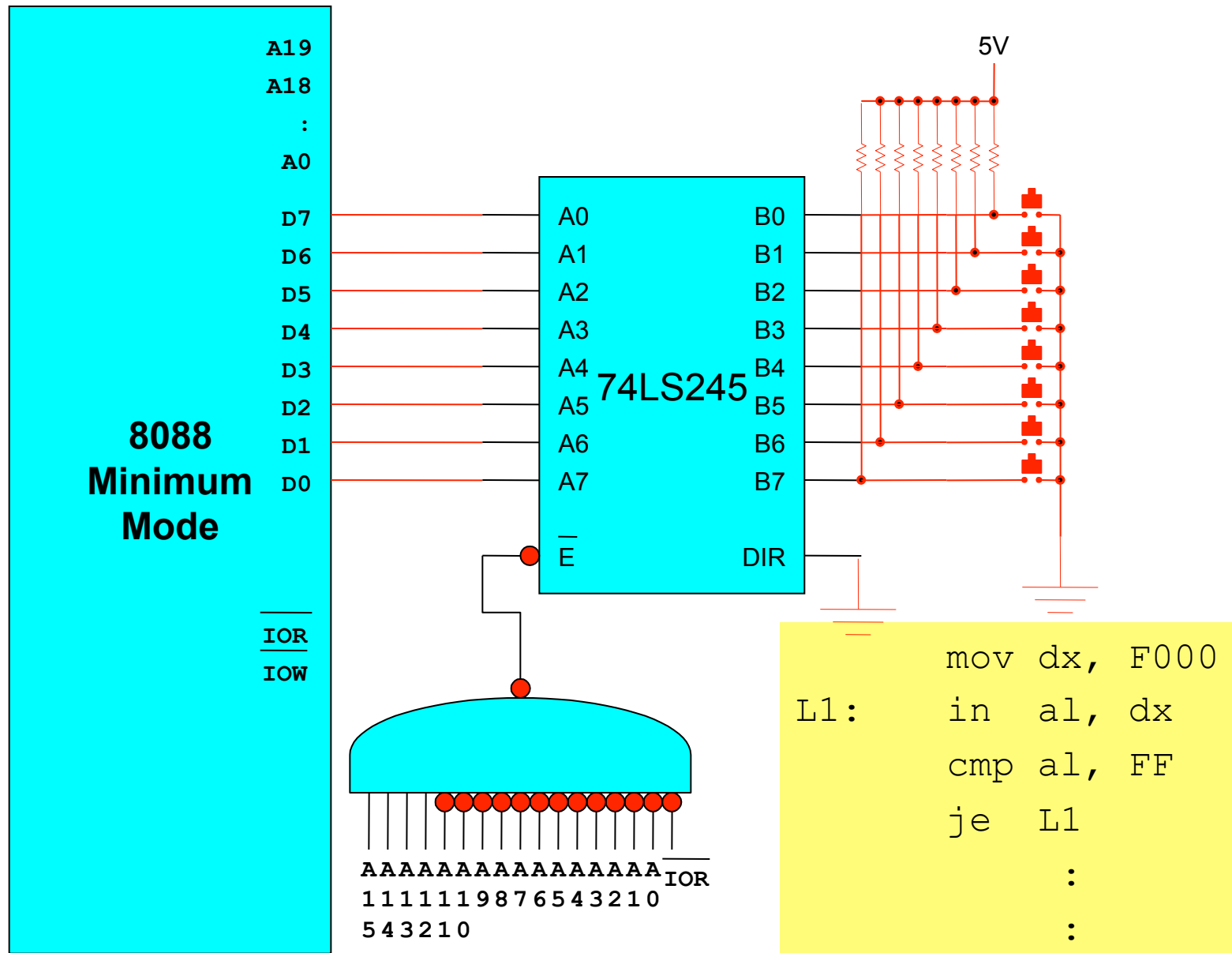- **How to interface a switch to computer?**

Use of 74LS245 and Address Decoder

5V

8088
Minimum
Mode

A19
A18
:
A0

D7
D6
D5
D4
D3
D2
D1
D0

$\overline{IOR}$
$\overline{IOW}$

74LS245

A0   B0
A1   B1
A2   B2
A3   B3
A4   B4
A5   B5
A6   B6
A7   B7

$\overline{E}$ DIR

A A A A A A A A A A A A A A A A A A
1 1 1 1 1 1 9 8 7 6 5 4 3 2 1 0
5 4 3 2 1 0

$\overline{IOR}$

```
        :
mov dx, F000
in  al, dx
        :
```

Same address for input and output?

How do you know if a user has pressed a button?

- **By Polling**
- **By Interrupt**

Polling


```
         mov dx, F000
L1:      in  al, dx
         cmp al, FF
         je  L1
         :
         :
```

8088 Minimum Mode

A19
A18
:
A0

D7
D6
D5
D4
D3
D2
D1
D0

IOR
IOW

74LS245

A0   B0
A1   B1
A2   B2
A3   B3
A4   B4
A5   B5
A6   B6
A7   B7

E̅   DIR

5V

A A A A A A A A A A A A A A A A A A IOR
1 1 1 1 1 1 9 8 7 6 5 4 3 2 1 0
5 4 3 2 1 0

Output Port Design
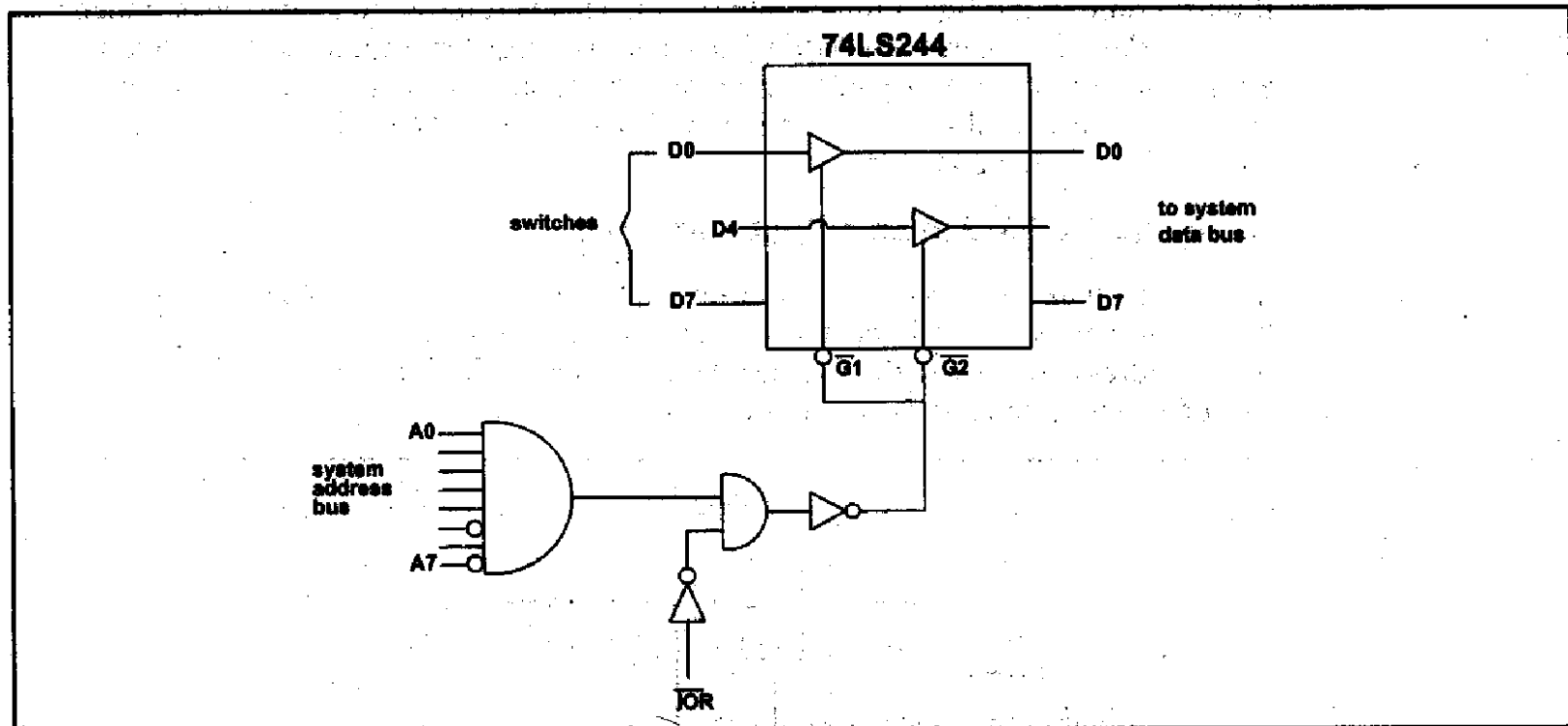

Design for "OUT 99H,AL"
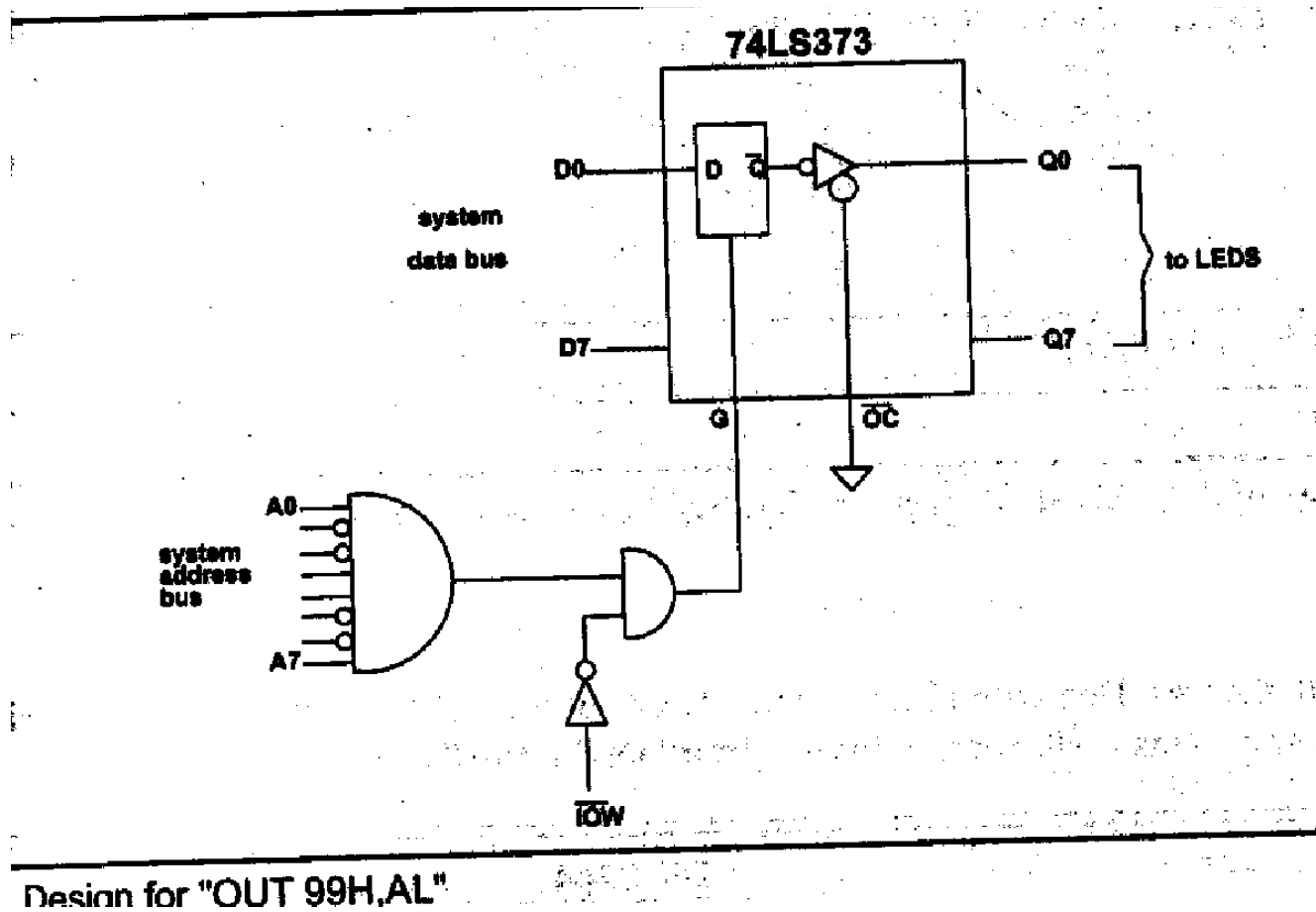
T1 – T4 of OUT 99H, AL ?

Input Port Design

Figure 4-2. Design for "IN AL,5FH"

T1 – T4 of IN AL, 5FH ?