INPUT/OUTPUT

To enable the microcomputer system to output data or to receive data from outside world. This allow the CPU to communicate with outside world. The way data is sent or received is either in the form of parallel data or serial data. Parallel data transmission requires **handshaking** in order to make sure the data sent is received, whereas serial data transmission requires the sender and receiver to use a certain agreeable **transmission protocol**.

Such devices used for the communication is :-

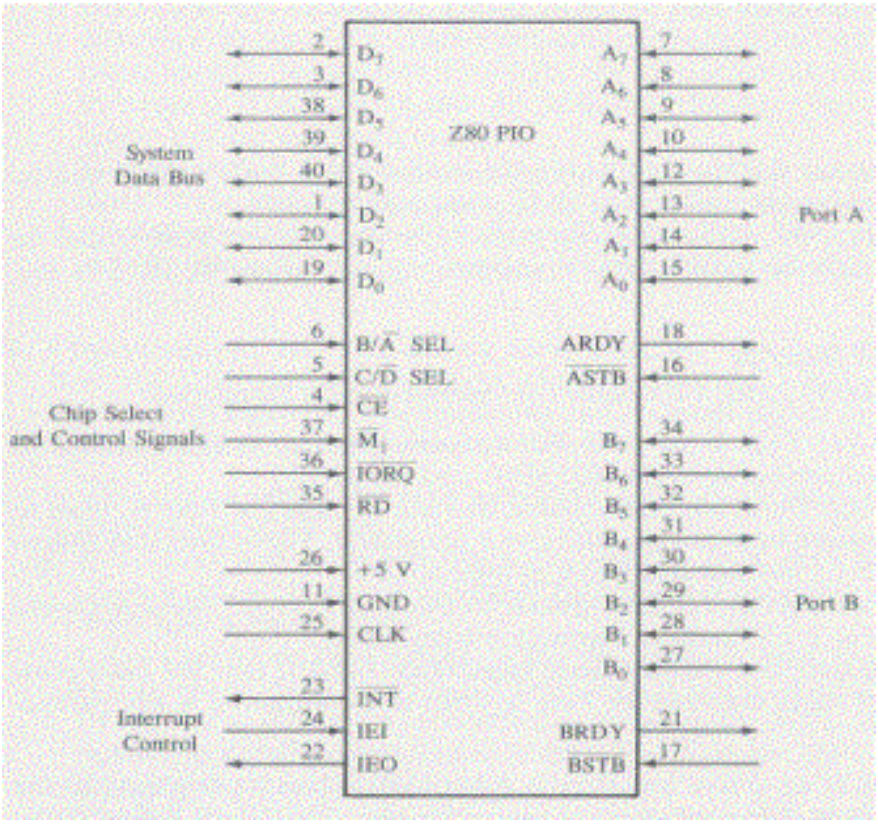
1. parallel I/O i.e. Z80-PIO, 8255A
2. serial I/O i.e. Z80-SIO, UART
3. Counter Timer Circuit (CTC)
4. Direct Memory Access (DMA)

THE Z80 PROGRAMMABLE INPUT/OUTPUT (Z80-PIO)

The Z80 PIO is a programmable interfacing device, specially designed to work with Z80 CPU only. It has two 8-bit I/O ports, named **port A** and **port B.**

These ports can be programmed to work in three modes:- Mode 0 (output mode), Mode 1 (input mode) and Mode 3 (bit I/O). Only Port A can be programmed to work in Mode 2 (bidirectional mode).

In Modes 0 or 1, ports A and B can be used either as **simple I/O** without handshake or **interrupt I/O** with handshake signals. Each port has two handshake signals, **Strobe** (STB*) and **Ready (RDY)**.



Registers in Z80 PIO

In the Z80 PIO, there are two register for each port. The registers are called **Control register** and **Data register**.

Control reg. is where the **control word** must be written, which causes the PIO port to work in the corresponding mode. The port must not be used until the control reg. has been set-up.

The Data reg. is the reg. where the data must be placed in output mode, or where the data is to be found (read) when in input mode.

Instructions associated with I/O

OUT means loading data from register to I/O and IN means reading data from I/O to a register. The register is reg. A (accumulator)

eg. OUT (80H), A and IN A, (80H)

The Control reg. and Data reg. are accessed by the CPU using as 8-bit addresses. For example, a Z80 PIO may have the addresses as follows :-

Data reg. A - 80H

Data reg. B - 81H

Control reg. A - 82H

Control Reg. B - 83H

Initializing the Z80-PIO

Before the PIO can be used, it must first be initialized to the corresponding mode. Initializing the PIO is done by writing the proper control word to the Control reg.

Control Word - $M_1M_2XX1111_2$ where XX is don't care values and

M_1M_2 are the mode select code

If M_1M_2 = 00 then Mode 0 is selected.

Mode 0 or Output mode will cause the ports to act as an output port. All the 8 port lines becomes output lines and can be used to sent out data.

If M_1M_2 = 01 then Mode 1 is selected

Mode 1 or Input mode will cause the ports to act as an input port. All the 8 port lines becomes input lines and can be used to receive data.

If M_1M_2 = 10 then Mode 2 is selected

Mode 2 or Bidirectional mode will cause port A to act as a bidirectional port. All the 8 port A lines becomes bidirectional lines and can be used to sent out or receive data (simplex operation). Port B cannot be programmed in Mode 2 since all the handshake lines for port B is used by port A in this mode.

If M_1M_2 = 11 then Mode 3 is selected

Mode 3 or Control or Bit mode will cause the ports lines able to be programmed as an output line or input line (mixing of output and input lines on the same port). This mode also support Z80 interrupt system.

Examples:

1. To send out the data 72H to port A

```
                    ORG   1800H
1800   3E 0F        LD A, 0FH       ;set reg. A with control word
1802   D3 82        OUT (82H),A     ;send reg. A to control reg.
                                     ;port A is now output port
1804   3E 72        LD A, 72H
1806   D3 80        OUT (80H),A     ;port A now has data 72H
```

2. To read the data at port A

```
                    ORG   1800H
1800  3E 4F         LD A, 4FH       ;set reg. A with control word
1802  D3 82         OUT (82H),A     ;send reg. A to control reg.
                                     ;port A is now input port
1804  DB 80         IN A, (80H)     ;Acc. A now has data read from port A
```

Note: The data must be ready at the port before the IN instruction.

3. To light up LEDs connected at the port.

4. To light up seven segment display unit connected to the port.

5. To read the key or switch setting connected to the port.

Exercises :

1. Name 2 common types of data format used in I/O transmission.

2. Explain what is a programmable I/O device.

3. What kind of data transfer that can be carried out by an I/O device?

4. Why is it important to initialize an I/O device before data can be transferred?

5. What are handshake signals? Why are they important?

6. Explain the instructions OUT and IN. How they differ from load (LD) instructions?

7. Explain the functions of the Control and Data registers found in an I/O device.

8. Study the program below which is written for Z80 PIO. Explain what it does.

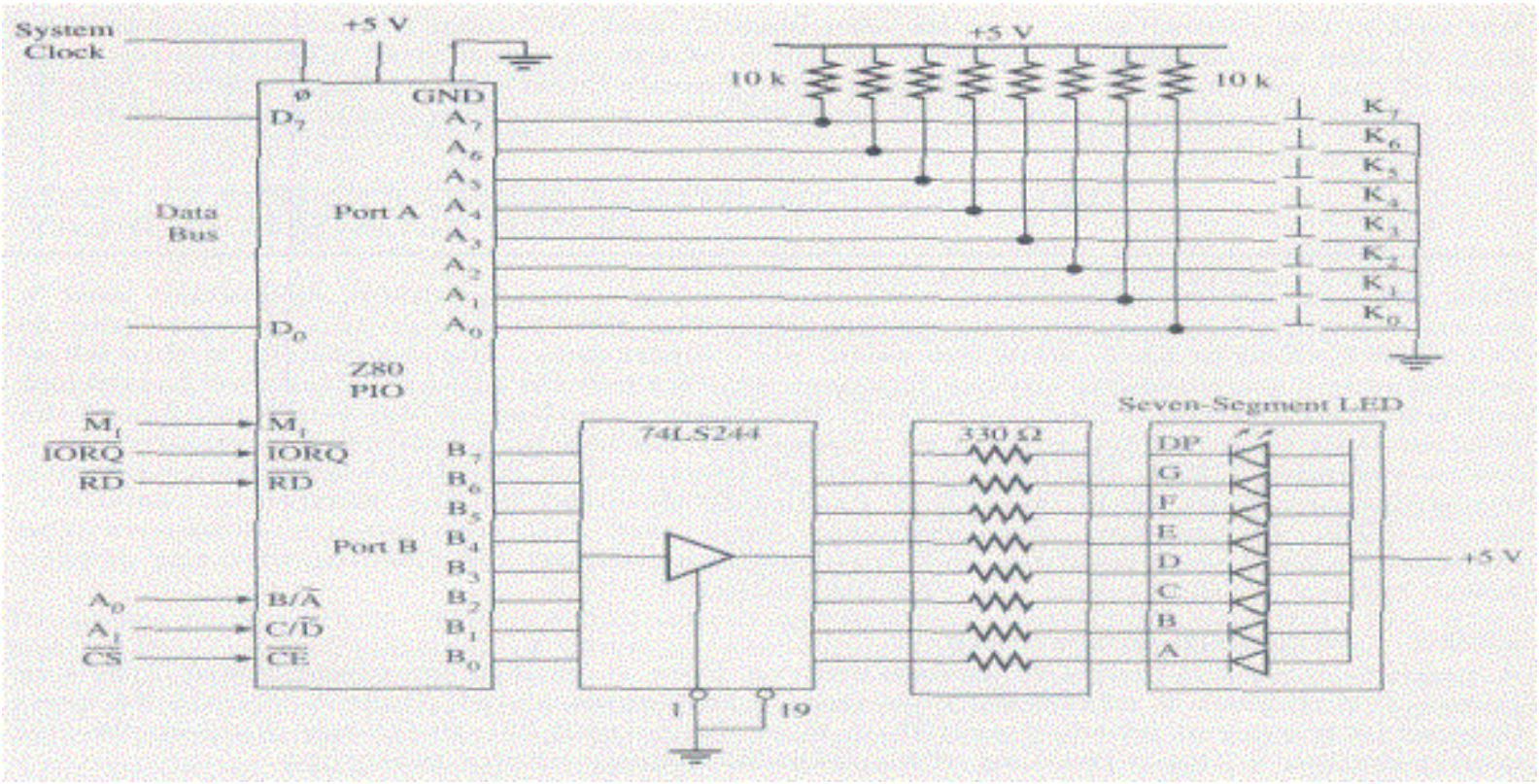
```
LD    A, 0FH
OUT   (81H),A      ;Control reg. A is 81H
LD    A, 85H
OUT   (80H),A      ;Data reg. A is 80H
```

9. Write an assembly language program that sent out the data 34H, 89H, 56H and 21H via port A. There must be a 1 second delay between each data sent.

10. Write an assembly language program that read the data at port B and store it in memory address 1900H.

11. Refer to the diagram below. Port A has 8 push button switches (K0-K7) and port B has a 7-segment display unit connected. The 74LS244 is the driver for the 7-segment display unit.

Write a program that reads any key pressed at port A and display its corresponding decimal value on the 7-segment display unit.



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