LAB 7: I/O programming with PPI Chip

Objective

1. Introduction to PPI (8255) Chip and understand its modes of operation, ports and design.
2. Practice I/O Programming with I/O Experiment Board (Module No. 8806)
In the previous experiment, we learnt how to input and output data to external device. We have examined a simple I/O interface circuit as implemented in BGC8008 in its connection to the status port lights and speaker. Could you recall the two important software elements in accessing the external device?

We continue to enhance our understanding I/O interface with device 8255, which is known as PROGAMMBABLE PERIPHERIAL INTERFACE.

We use 8255 for an easy implementation and design of I/O Ports. The intention is to provide the whole I/O implementation in 1 IC. Using 8255 will eliminate the use of 74LS374 octal latches and 74F244 octal buffers in a hard wired and fixed I/O interface circuit. 8255 gives us a total of 24 I/O pins in 3 different ports and all this are in one simple IC packet.

- PA0 - PA7: input, output, or bi-directional port
- PB0 - PB7: input or output
- PC0 - PC7: This 8 bit port can be all input or output. It can also be split into two parts, CU (PC4 - PC7) and CL (PC0 - PC3). Each can be used for input and output.
- RD or WR
  - IOR and IOW of the system are connected to these two pins
- RESET
- A0, A1, and CS
  - CS selects the entire chip whereas A0 and A1 select the specific port (A, B, or C)

As the 8255 is connected directly to data bus of the our, microprocessor, we can program on how to use the ports. Ports must be initialized whether to be an input port or an output port.
**Port Selections**
The following table explains A0 and A1 assignments for port selection

<table>
<thead>
<tr>
<th>To Select</th>
<th>A1</th>
<th>A0</th>
</tr>
</thead>
<tbody>
<tr>
<td>Port A</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Port B</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Port C</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Control Register</td>
<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>

**Control Group**
When Port C lower is used with Port B for I/O port selection, its known as Group B while using Port A with Port C upper is known as Group A.

**Modes of Operation**
There are 3 modes of operation for Group A and Group B.

Mode 0 is known as Unconditional I/O, where it provides for Basic Input and Output operation. Termed as unconditional microprocessor input and output data without any regard for I/O BUSY/READY status.

Mode 1 or Strobbed I/O. Unlike mode 0, sometimes I/O device might have a special line to indicate that it is busy right now and thus cannot accept or provide data for other operations. In interfacing such device, the microprocessor must check for BUSY/READY flag. In this mode port A and B are used for data paths (input or output ports) but port C is used to generate BUSY/READY signal.

Mode 2: Bi Directional Bus. Only port A can be configured to work this way.

*Note: In this experiment, we use mode 0 operation only.*

**Control Word**
As mentioned above, the 8255 must be initialized before being used. Initialization means to set the readily available ports as Input or Output, which ports to be used, and what mode of operation is going to perform by the microprocessor. In order to do this, we must select the control register by assigning A0 and A1 appropriately and load the control data to the control register. For example, if the control register is loaded with 82 H, following configuration is achieved.

\[
82 \, H \rightarrow \begin{array}{c}
1000 \\
0010 \\
\end{array} \, B
\]

- D0 = : Lower 4 bits of port C are outputs
- D1 = : Port B are inputs
- D2 = : Mode 0 operation for both port B and the lower 4 bits of port C
- D3 = : Upper four bits of ports C are outputs
- D4 = : Port A are outputs
- D6, D5 = : Mode 0 operation for both port A and the upper part of port C
- D7 = : Mode set flag
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Addressing the 8255.

In our system the 8255 is wired as shown in figure below. You can determine the address from the figure below. The concept and principals are the same as we did in our last lab.

![Diagram of 8255 wiring](image)

**Equipment**

Besides BGC8088, you also need board EDS8086 and cable for 50 Pins Connections for this experiment.

In board EDS 8086, identify following components:

- 50 pins PCI connector
- LEDs of Port A
- 7 segment LEDs
- Thumbwheel Switch
- 8p dip Switch
- Tact Switch
- Jumper for Signal Selections
Step 1: Addressing the ports

By referring to figure 1, fill in the possible addresses for ports A, B and C

<table>
<thead>
<tr>
<th>Ports</th>
<th>Possible addresses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Port A</td>
<td>FF10, ______, ______, ______</td>
</tr>
<tr>
<td>Port B</td>
<td>FF11, ______, ______, ______</td>
</tr>
<tr>
<td>Port C</td>
<td>FF12, ______, ______, ______</td>
</tr>
<tr>
<td>Control</td>
<td>FF13, ______, ______, ______</td>
</tr>
</tbody>
</table>

Step 2 Initialization

Before start any program using 8255, this device must be initialized. Meaning of initialization is setting the PPI for the specific I/O configuration. Initialization is done by loading the Control Word into Control Registers of 8255. Ex:

```
MOV DX, address_of_control_port
MOV AL, control_word_configuration
OUT DX, AL
```

Initialize the PPI for following conditions:

- Mode of operation = 0
- Port A and Port C lower to be input port
- Other Ports to be output Ports
Step 3:
   a) Below is the command in assembler to **input data from Port A of PPI**

   MOV DX, FF10
   IN AL, DX

   Question: Rewrite the commands for accessing Port B and Port C

   ____________________________________________
   ____________________________________________
   ____________________________________________

   b) Below is the command in assembler to **output data to Port A of PPI**

   MOV DX, FF10
   MOV AL, data
   OUT DX, AL

   Question: Rewrite the commands for accessing Port B and Port C

   ____________________________________________
   ____________________________________________
   ____________________________________________

Step 4
   a) Wire your EDS8086 to BGS 8088, set the mini jumper to position of right one. Assemble
   and execute the following program:

   ;Initialize the PPI to mode 0 and all the ports to output ports

   ____________________________________________
   ____________________________________________
   ____________________________________________

   MOV DX, __________; address_of_port_A
   start
   MOV AL, 01
   MOV BX, 8
   Add 1 OUT DX, AL
   MOV CX, 4FFF
   Add 2 LOOP Add 2
   SHL AL, 1
   DEC BX
   JNZ Add 1
   MOV AL, 80
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MOV BX, 8
Add 3 OUT DX, AL
MOV CX ,4FF
Add 4 LOOP Add 4
SHR AL,1
DEC BX
JNZ Add 1
JMP start

What you observe. Explain the program

**Step 5.**
Write a program that switch on LED 1 to 4 & Off LED 5 to 8. And switch alternatively LED 1 to 4 OFF and on LED 5 to 8.
Step 5

Change the position of mini jumper to position of right three, 3. Assemble and execute the following program.

```
// Initialize the PPI to mode 0 and all the ports to output ports
                      
                      
                      
MOV DX, ______________ // address_of_port_A 
MOV AL, 0

Add1 OUT DX,AL
      MOV CX, FFFF
Add2 LOOP Add2
      INC AL
      DAA
      JMP Add 1
```

What you observe? Explain the program. Change the jumper's position-to-position one, change the instruction DAA to NOP and execute. What should you observe?
Step 6

Set the jumper to position 2

Write a program to read the value of binary from 8 Dipswitch and store the number in a memory location number.

Hints: Initialize the Port A to be input port.

Questions

1. Figure 8.18 is modified that A0 and A1 of 8255 is supplied from A3,A2 of Microprocessor. Determine A4 till A15 from the diagram and A1 and A2 are don’t care state. List the addresses for port A, B, C and Control Register
2. Describe Mode 0, Mode1 and Mode 3 operations
3. Fill in the table below for each of the control word

<table>
<thead>
<tr>
<th>TABLE 3: 8255 (CONTROL) MODE CONFIGURATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>CONTROL WORD (HEX)</td>
</tr>
<tr>
<td>80</td>
</tr>
<tr>
<td>82</td>
</tr>
<tr>
<td>85</td>
</tr>
<tr>
<td>87</td>
</tr>
<tr>
<td>88</td>
</tr>
<tr>
<td>8A</td>
</tr>
<tr>
<td>8C</td>
</tr>
<tr>
<td>8F</td>
</tr>
</tbody>
</table>
4. Examine the figure above; there could be some invertors in between the NAND Gate. The A0 till A7 is the control word for the 8255.

a. Suppose a 8255 PPI chip is connected to the system address bus as shown above. Which of the following port addresses cannot be assigned to Port A of the PPI chip and why?
   i. 32 H   ii. BA H   iii. 24 H

b. Show the NAND gate decoding circuitry with inverters appropriately inserted if we want port A to have address 68 H

c. Suppose the Port A has address 68H, what will be the port addresses of port B, Port C and Control register

5. In an 8255 design, Port A is given as F640H, Port B is F642H, Port C is F644H and Control register is F648H. Design the interface circuit.

6. If value A4 is written into the control register, what is the mode and I/O Configuration of 8255?
7.