Lecture 5 : Personal Computer Systems III

8253 Timer and Music

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Outline

- PC I/O Map
- 8253 Timer
- Speaker Interface
- I/O Instruction
- Generating Sound
8253 Timer

Block diagram
## Addressing 8253 Port

<table>
<thead>
<tr>
<th>CS</th>
<th>A1</th>
<th>A0</th>
<th>Port</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0</td>
<td>0</td>
<td>Counter 0</td>
</tr>
<tr>
<td>0</td>
<td>0</td>
<td>1</td>
<td>Counter 1</td>
</tr>
<tr>
<td>0</td>
<td>1</td>
<td>0</td>
<td>Counter 2</td>
</tr>
<tr>
<td>0</td>
<td>1</td>
<td>1</td>
<td>Control register</td>
</tr>
<tr>
<td>1</td>
<td>x</td>
<td>x</td>
<td>8253/54 is not selected</td>
</tr>
</tbody>
</table>
8253 Control Register

![Diagram of 8253 Control Register]
Example:
- Suppose that control register is programmed as 10110110b (b6h).
- Then
  - Select counter 2.
  - Read LSB first, then MSB.
  - Select mode 3.
  - Select binary counting.
PC 8253 Connection
PC 8253 Connection (2)

8253

(40h) Clock 0
TIM0
Gate0
Out 0 (18.2 Hz 中斷訊號)

(41h) Clock 1
TIM1
Gate1
Out 1 (DRAM)

(42h) Clock 2
TIM2
Gate2
Out 2 (SPEAKER)

(43h) 控制輸入
TIM_CTR

1190000 Hz CLOCK
Speaker Interface

1.9318 MHz  bit 1 of port 6h
bit 0 of port 6h

CLOCK  GATE2
Channel 2 of 8253 Timer

16-bit COUNT  CONTROL

OUT2

SPEAKER DATA

to Speaker

to bit 5 of port 62h

port 42h  Ch. 2 Control byte (via port 43h)
Frequency Number

- Frequency Number = 1190000 / Frequency
- Example:
  - Frequency of Middle C = 261.63
  - Then Frequency Number of Middle C = 1190000 / 261.63 = 4560 = 11d0h
I/O Instruction

- in ax/al, port/dx
- out port/dx, ax/al

Example:
- in al, 61h
- out 42h, al
Generating Sound

1. Send value 182 to port 43h.
2. Send frequency number to port 42h.
3. Set bits 1 and 0 of port 61h.
Generating Sound (2)

Example:

- `mov al, b6h`
- `out 43h, al`
- `mov ax, 11d0h; frequency number for middle C`
- `out 42h, al`
- `mov al, ah`
- `out 42h, al`
- `in al, 61h`
- `or al, 00000011b`
- `out 61h, al`
Sound Duration

- PC makes bit 4 of port 61H toggle every 15.085 µs.
- A fixed time delay can be obtained by BIOS WAITF procedure, where register cx holds the number of 15.085 µs time delays needed.
- A half-second delay created by WAITF:
  - mov cx,33144
  - call WAITF
Sound Duration (2)

- BIOS WAITF Procedure:
  - push ax
  - waitf1: in al,61h
  - and al,10h
  - cmp al,ah
  - je waitf1
  - mov ah,al
  - loop waitf1
  - pop ax
  - ret
Turn Off Sound

- Reset bits 1 and 0 of port 61h.

**Example:**

- `in al, 61h`
- `and al, 11111100b`
- `out 61h, al`