I/O - 3
8255 PPI
PHY 4635/5635
Spring 2009

82C55 Programmable Peripheral Interface (PPI)
- Three I/O ports: A, B, C
  - Selected via

<table>
<thead>
<tr>
<th>A1</th>
<th>A0</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0</td>
<td>Port A</td>
</tr>
<tr>
<td>0</td>
<td>1</td>
<td>Port B</td>
</tr>
<tr>
<td>1</td>
<td>0</td>
<td>Port C</td>
</tr>
<tr>
<td>1</td>
<td>1</td>
<td>Command Register</td>
</tr>
</tbody>
</table>

To read / write, drop CS and either RD or WR low. Select port.

82C55 Programmable Peripheral Interface (PPI)
- Low-cost, popular component for parallel I/O in 8086/8088.
- Can interface any TTL device to the CPU directly.
- 24 pins for I/O in two groups of 12.
- Three distinct modes of operation

- Here:
  - Port A = C0h
  - Port B = C2h
  - Port C = C4h
  - CR = C6h
- PC’s use 60h-63h
  - Speaker, timer, KB
8255 Control

- Two groups
  Group A = A0-A7 + C4-C7
  Group B = B0-B7 + C0-C3
- Three modes
  Mode 0, 1, 2

8255 Control

- MODE 0:
  - Simple I/O operation
  - Port pins are assigned to be
    level-sensitive inputs or
    latched outputs.
  CR = \(100xx0xx\)
  Where the “x” would define the
  directionality of each port via
  the last slide.

8255 Control

- If A0=A1=1, Data becomes
  control byte (write only to CR)
- MSB=1 : Mode control
  D0-D2: Group B control
  D3-D6: Group A control
  (2 mode select bits)
- MSB=0: Allows you to set or
  reset any port C bit.

8255 Control

Mode 0 control words and corresponding I/O configuration
Example

- What is the mode and I/O configuration for ports A, B, and C of an 8255 after its control register is loaded with
  90h?
  81h?
  82h?
Ports A & B are in mode 0 – simple latched outputs.
(CR = 80h)
Port A = 7 segment data inputs
Port B selects which segment of the bank will display.
I/O ports 0700h-0703h (via the PAL)
WR pin is strobed by the PAL output as well (not shown)

MOV AL,80h
MOV DX,703h
OUT DX,AL ;Set CRC
CALL DISP

PROC DISP NEAR
PUSHF
MOV BX,8 ;Load count
MOV AH,7fh ;Load selection pattern
MOV SI, OFFSET MEMLOC-1 ;Data address
MOV DX,701h ;Address port B
DISP1: MOV AL, [BX+SI] ;Address port A
        OUT DX,AL ;Get data to display
        DEC DX ;Address next digit
        INC DX ;Address port B
        DEC BX ;Adjust count
        JNZ DISP1
        POPF
        RET
DISP ENDP

74LS85
- 4-bit magnitude comparator
- Per truth table, only when 
  A=B and IN(pin 3)=1 does pin 6 = 1
• Addresses align as 8255 ports…
  FF00h = A
  FF01h = B
  FF02h = C
  FF03h = Control Reg.
• Without the NAND gate here, these become:
  0300h = A
  0301h = B
  0302h = C
  0303h = Control Reg.

Recall from Lab…
• Switch bank and LED bank, we did this…
  MOV DX, 303h
  MOV AL, 90h
  The “90h” to CR = 1001 0000 (see previous example) forces
  Port A (300) to be input (Switches)
  Port B (301) to be output (LEDs)
  Port C (302) to be output (we didn’t use it on our breakout board)

Recall from Lab…
• Relay box, we did this…
  MOV DX, 303h
  MOV AL, 81h
  The “81h” to CR = 1000 0001 (see previous example) forces
  Port A (300) to be output (not used on relay box)
  Port B (301) to be output (not used on relay box)
  Port C (302)
    Bits C7-C4 = output (light bulbs and alarm)
    Bits C3-C0 = input (door sensor / temp. sensor circuit)
Parallel Printer Port – Recall…

Replace with 8255!

HW Assignment

• From previous slide, assume…
  – An 8088 in maximum mode and that a
    8288 bus controller is generating all
    necessary I/O control signals
  – The I/O port addresses have already
    been decoded to select the 8255 –
    assume it is at location 0378-037B
    • e.g. Port A = 0378h
    Port B = 0379h
    Port C = 037Ah
    CR = 037Bh
(a.) Connect the wires in the
    diagram at right
(b.) Modify the code in the following slide
    that will…
   - Define the CR per your wiring diagram
   - Print the ASCII character stored in BL

Recall our print sequence
based on the non-8255 implementation…

PRINT PROC NEAR
  MOV DX,8004h ;Go look at PORT 2
  IN AL,DX
  TEST AL,01h ;Is the printer busy?
  JNE PRINT
  JNE PRINT
  MOV AL,BL ; Assume BL holds ASCII
  character to be printed
  MOV DX,8000h ;Place character in buffer
  OUT DX,AL
  MOV DX,8002h ;Print buffer contents
  OUT DX,01h
RET
PRINT ENDP

NOTE: you only need to define CR once, prior to the procedure calls

Other examples…

• Please analyze the other Mode 0 examples in the
  book:
  – LCD interface
  – Stepper motor interface
  – Key matrix interface
Chapter 11, section 11-3
8255 Control

- **MODE 1:**
  - Strobed I/O
  - Groups A and B consist of byte-wide I/O ports, each with nibble-wide control ports.
  - **Group A:** I/O = A0-A7
  - **Group B:** I/O = B0-B7

Control port pin usage depends on Group and IN/OUT

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**Mode 1 - input**

- Input ports capture data when STB is sent low.
- This activates the IBF (input buffer full) pin (SW)
  - Recall keyboard INT 16h / 01 (Is buffer full?)
- It also activates the INTR (interrupt request) (HW) – more on interrupt handling later.
- An IN instruction sends a RD=0 which resets IBF and INTR.

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**Mode 1 – Input Example: Keyboard**

- STB is provided whenever a key is pressed.
  - DAV (Data available) is active for 1.0μs.
Code – INT 16h / 0

INT16.0 PROC NEAR
IN AL,22h ;Port C
TEST AL,20h ;Check IBF line
JZ READ ;If IBF=0
IN AL,20h ;Port A
IRET
INT16.0 ENDP

Here, the IBF line is coming from port C, pin 5 (see previous slides)…. 00x0 0000 = 20. If IBF is high, read in data.

Mode 1 - output

• When output latches hold data for external device, the OBF/OBF (output buffer full) line goes active.
• When the external device gets data, it strobes the ACK (acknowledge) line low.
• This, in turn, resets the OBF line.

Mode 1 – Output Example: Printer

• **Homework assignment:**
  Write a short paragraph that describes how this interface works – how it is programmed to use DS, ACK, and OBF to send a character to the printer.
  (see page 421, 6th edition)