UCS2502 – Microprocessors, Microcontrollers, and Interfacing
Assignment – 1

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The objective of this system is to design and implement an 8086 microprocessor-based control unit using the 8255 Programmable Peripheral Interface (PPI) to manage eight electric home appliances. The appliances can be switched ON/OFF through software instructions, their status can be monitored through LEDs and user inputs can be taken through switches. The design demonstrates both I/O mapped I/O and memory mapped I/O interfacing techniques.

The Intel 8086 microprocessor is a 16-bit processor widely used in embedded and computer systems. It has a 20-bit address bus, allowing it to access up to 1 MB memory space. It supports both memory-mapped I/O and I/O-mapped I/O methods for interfacing external devices. The 8255 Programmable Peripheral Interface (PPI) is a general-purpose I/O device used to connect the microprocessor to external devices like switches, LEDs, displays, and actuators.

Port Configuration:

- 8255 is connected in **Mode 0** (simple I/O).
- **Port A** (PA): Output - Controls 8 appliances (ON/OFF).
- **Port B** (PB): Input - Reads signals from 8 manual control switches.
- **Port C** (PC): Output – Controls 8 LEDs representing the ON/OFF status of appliances.
- Control Word Register (CWR): Used to configure the 8255.

Control Word Breakdown (for 8255):

1. Bit 7 = 1: Mode Set Flag (always 1 for mode configuration).
2. Bits 6–5 = 00: Port A in Mode 0 (simple I/O).
3. Bit 4 = 0: Port A is Output (to control 8 appliances).
4. Bit 3 = 0: Port C Upper (PC7–PC4) is Output (for LEDs).
5. Bit 2 = 0: Port B in Mode 0 (simple I/O).
6. Bit 1 = 0: Port B is Input (to read 8 switches).
7. Bit 0 = 0: Port C Lower (PC3–PC0) is Output (for LEDs).

Control Word used = 80H (1000 0000B)

Characteristics of Mode 0:

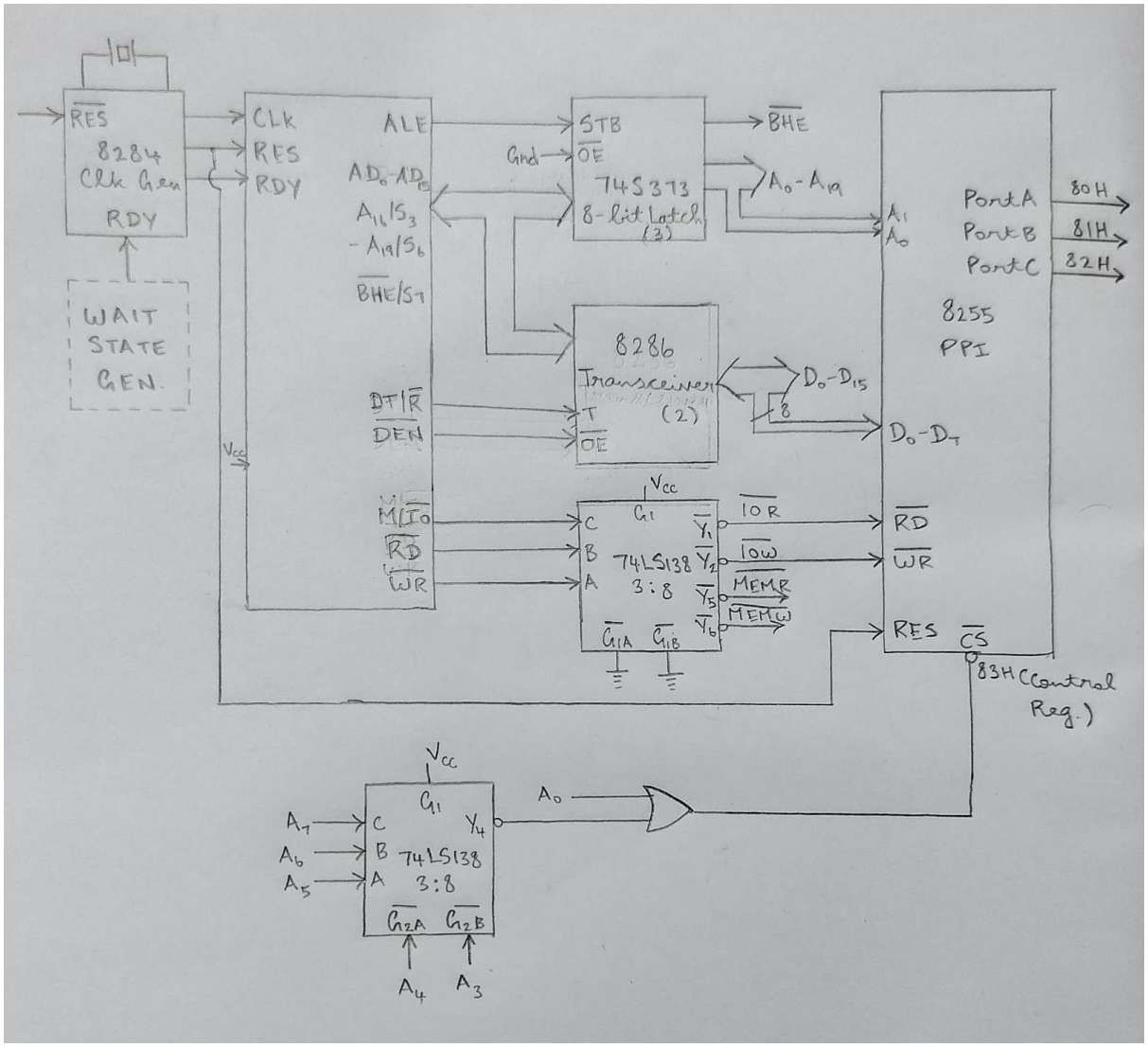
- In this mode, ports act as straightforward input or output lines.
- No strobe controls are required.
- Output data is stored (latched) until it is updated again.
- Input data is read directly from the pins, without being latched.
- Ideal for basic input/output operations in control systems.

Relevance of Mode 0 for Appliance control:

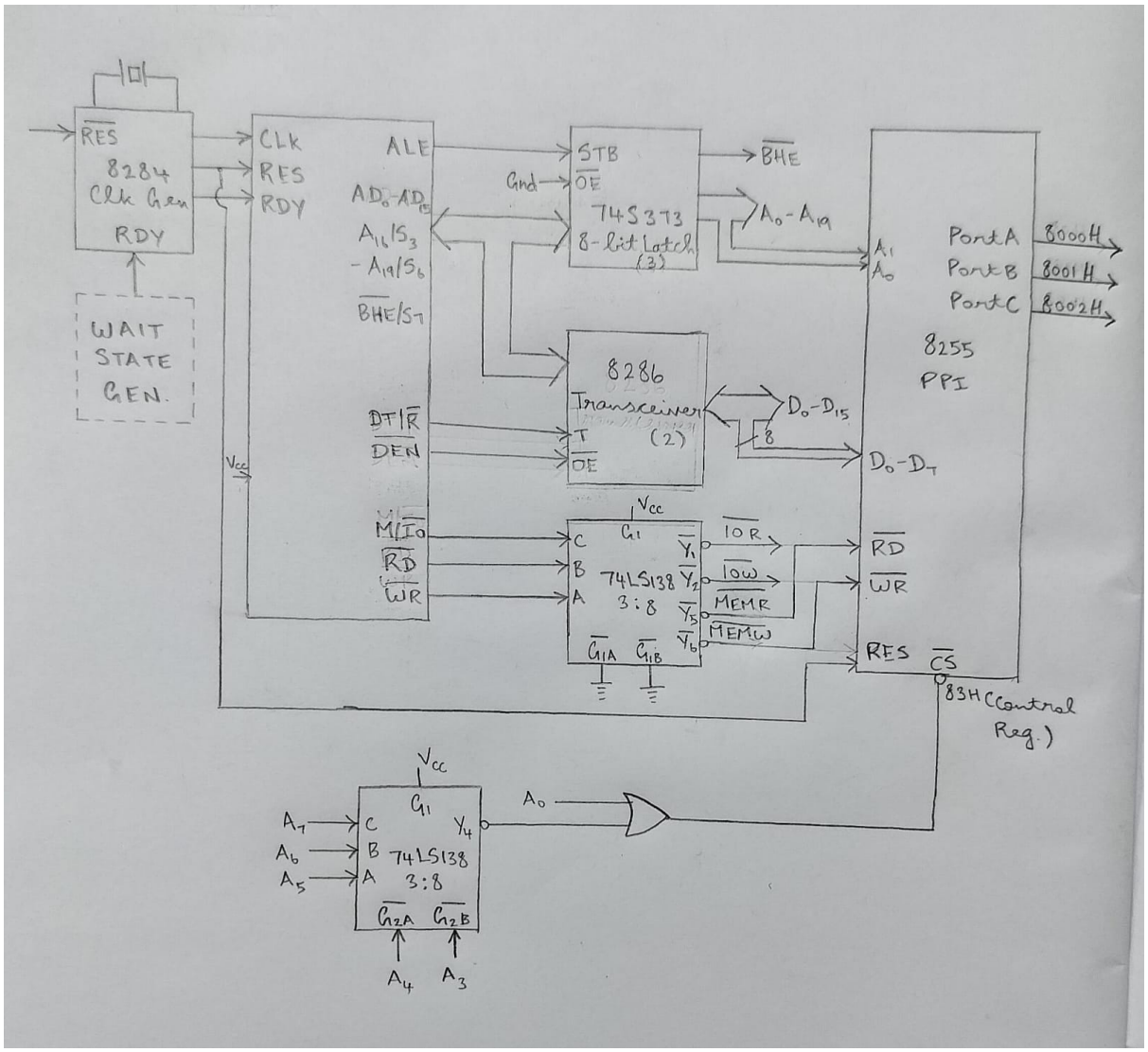
- Easy Appliance Control: Appliances only require simple ON/OFF commands.
- No Synchronization Needed: Since no timing is required, control is direct.
- Instant Response: Switch inputs are read immediately by the microprocessor.
- Clear Feedback: LEDs can directly show the ON/OFF status of appliances.
- Efficient Operation: Direct port access ensures fast and real-time performance.

1. System design diagrams using memory and I/O mapped I/O:

I/O Mapped I/O:



Memory Mapped I/O:



2. 8086 ALP for I/O mapped I/O and memory mapped I/O interfacing:

I/O Mapped I/O:

- The IN and OUT instructions are used.
- Each port and control register has an 8-bit port address.

Assumptions:

- Port A = 80H
- Port B = 81H
- Port C = 82H
- Control = 83H
- PA = Output (appliances), PB = Input (Switches), PC = Output (LEDs).
- Control word = 80H.

Working:

- In I/O mapped I/O, the 8086 communicates with 8255 using IN and OUT instructions.

- The 8255 ports are assigned addresses in the 64 KB I/O address space.
- Port A is used to control appliances by sending ON/OFF data.
- Port B is used to read the status of switches as input.
- Port C is used to drive LEDs to indicate appliance status.
- The Control Word Register is used to configure the operating modes of the ports.

Program:

```
; (Initialize 8255)
MOV AL, 80AH        ; Control Word: PA=Out, PB=In, PC=Out
MOV DX, 83H
OUT DX, AL

; (Turn OFF all appliances and LEDs initially)
MOV AL, 00H
MOV DX, 80H         ; Port A → Appliances OFF
OUT DX, AL
MOV DX, 82H         ; Port C → LEDs OFF
OUT DX, AL

MAIN_LOOP:
; (Read switches from Port B)
MOV DX, 81H
IN BL, DX           ; BL = switch inputs
CMP BL, 00H
JZ MAIN_LOOP        ; If no switch pressed, repeat

; (Toggle appliances)
MOV DX, 80H
IN AL, DX           ; Read current appliance state
XOR AL, BL          ; Toggle based on switch input
OUT DX, AL          ; Update appliances

; (Update LEDs on Port C)
MOV DX, 82H
OUT DX, AL

JMP MAIN_LOOP
```

Memory Mapped I/O:

- Normal MOV instructions with memory operands are used.
- Ports are treated as memory locations.
- Each port has a 16-bit address in memory space.

Assumptions:

- Port A = 8000H
- Port B = 8001H
- Port C = 8002H
- Control = 8003H
- PA = Output (appliances), PB = Input (Switches), PC = Output (LEDs).
- Control word = 80H.

Working:

- In memory mapped I/O, the 8255 ports are treated like memory locations in the 1 MB memory space of 8086.

- The microprocessor uses normal data transfer instructions like MOV to access ports.
- Specific memory addresses are assigned to Port A, Port B, Port C, and the Control Word Register.
- Writing data to the address of Port A switches the appliances ON or OFF.
- Reading from the address of Port B provides the switch inputs.
- Writing data to the address of Port C updates the LEDs to show the appliance status.

Program:

```
; (Initialize 8255)
MOV AL, 80AH        ; Control Word: PA=Out, PB=In, PC=Out
MOV BX, 8003H
MOV [BX], AL

; (Turn OFF all appliances and LEDs initially)
MOV AL, 00H
MOV BX, 8000H       ; Port A → Appliances OFF
MOV [BX], AL
MOV BX, 8002H       ; Port C → LEDs OFF
MOV [BX], AL

MAIN_LOOP:
; (Read switches from Port B)
MOV BX, 8001H
MOV BL, [BX]        ; BL = switch inputs
CMP BL, 00H
JZ MAIN_LOOP        ; If no switch pressed, loop again

; (Toggle appliances)
MOV BX, 8000H
MOV AL, [BX]        ; Read current appliance state
XOR AL, BL          ; Toggle based on switch input
MOV [BX], AL        ; Update appliances

; (Update LEDs on Port C)
MOV BX, 8002H
MOV [BX], AL

JMP MAIN_LOOP
```

3. Analysis of Design Differences:

Aspect	Memory Mapped I/O	I/O Mapped I/O
Address Space	Uses locations in the memory address space (e.g., F000:0000H–F000:0003H).	Uses separate I/O port addresses (e.g., 60H–63H).
Address Length	Requires full 20-bit decoding.	Only 16-bit addressing is required.
Instruction Usage	Uses standard memory instructions like MOV, INC, DEC, AND, OR etc.	Uses IN and OUT to control/ read appliances
Address Decoding	Decoder activates the device during memory cycles.	Decoder activates the I/O device only during I/O cycles using the M/$\overline{IO}$ signal.
Memory Space Impact	I/O device occupies part of the memory space, thus reducing RAM/ROM area.	Occupies I/O address space, leaving entire memory free for program/data.
Hardware Complexity	Slightly more complex hardware because of additional address decoding.	Simpler hardware design due to fewer address lines being decoded.