

MPI Design Project

P23 – AUTOMATIC WASHING MACHINE

SUBMITTED BY

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SUBMITTED IN

COMPLETE FULFILLMENT OF THE REQUIREMENTS OF THE COURSE
MICROPROCESSORS PROGRAMMING AND INTERFACING

PROBLEM STATEMENT

SYSTEM TO BE DESIGNED – AUTOMATIC WASHING MACHINE

Description: An Automatic washing machine with Dryer.

The Washing Machine can handle three different types of load: Light, Medium and Heavy.

The Washing Machine has three different cycles: Rinse, Wash and Dry.

Depending on the load the number of times a cycle is done and the duration of the cycle varies.

Light Load: Rinse- 2 mins, Wash- 3 mins, Rinse – 2 mins, Dry Cycle –2 mins

Medium Load: Rinse- 3 mins, Wash- 5 mins and Rinse – 3 mins Dry Cycle –4 mins

Heavy load: Rinse - 3 mins, Wash- 5 mins and Rinse – 3 mins, Wash- 5 mins and Rinse – 3 mins, Dry Cycle – 4 mins

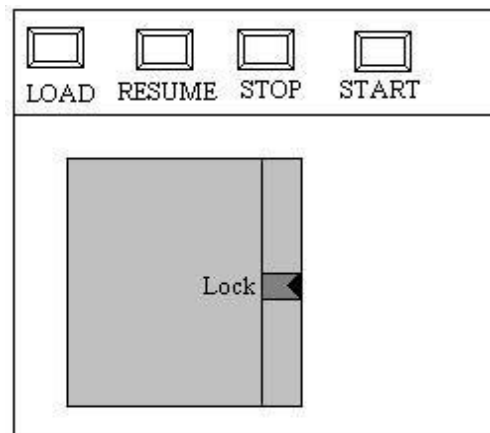
- ☐ The Washing Machine is a single tub machine.
- ☐ The Washing machine is made of a Revolving Tub and an Agitator. The Agitator is activated during the Rinse and Wash cycle; revolving tub is active only during the Dry cycle. The door of the washtub should remain closed as long as the agitator is active.
- ☐ Before each cycle the water level is sensed. At the beginning of the cycle the water level should be at the maximum possible level, the water should be completely drained during dry cycle. The cycle should begin only when the water level is correct.
- ☐ At the end of each cycle a buzzer is activated. The user should drain the water at the end of the rinse/wash cycle and refill the water for the next cycle; once this has been completed the user can press the resume button.
- ☐ At the beginning of the wash cycle the user should add the detergent.
- ☐ At the end of the complete wash process the Buzzer is sounded.
- ☐ User can turn off system by pressing STOP Button
- ☐ Different sounds are used for different events.
- ☐ Display the load selected using a seven-segment display.

User Interface: The User Interface is shown in fig below

The number of times the load button is pressed determines load: 1 press- light; 2 presses medium and 3 presses –heavy.

To begin washing process START is pressed.

Pressing STOP can stop the process.



COMPONENTS USED:

- ☐ 74LS138
- ☐ 74LS245
- ☐ 74LS273
- ☐ 2732
- ☐ 6116
- ☐ 74LS447
- ☐ 7404(Not gate)
- ☐ 7432(2 input OR gate)
- ☐ 4072(4 input OR gate)
- ☐ 4078 (8 input NOR gate)
- ☐ 8255
- ☐ Led
- ☐ Buzzer
- ☐ Button
- ☐ Resistor
- ☐ Agitator, Revolving Tub(Motor)
- ☐ Sw-spst
- ☐ 8086
- ☐ Sw-spdt-mom
- ☐ Relay

MEMORY MAPPING :

ROMchipused:2732

RAMchipused:6116

ROM:8KB = 4KB(even)+4KB(odd)

- ☐ ROM (Even Bank):00000H,00002H,,01FFCH,01FFEH
- ☐ ROM (Odd Bank):00001H,00003H,,01FFDH,01FFFH

RAM:4KB = 2KB(even)+2KB(odd)

- RAM (Even Bank):02000H,02002H, ,02FFCH,02FFEH
- RAM (Odd Bank):00001H,00003H, ,02FFDH,02FFFH

	A19- A16	A15	A14	A13	A12	A11	A10	A9	A8	A7	A6	A5	A4	A3	A2	A1	A0
ROM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1
RAM	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	1	0	1	1	1	1	1	1	1	1	1	1	1	1

I/O MAPPING :

8255(Programmable peripheral interface)- 00H to 06H

PORT	ADDRESS	INPUT/OUTPUT
PORT A	00H	Input Port
PORT B	02H	Output Port
PORT C	04H	Output port (both upper and lower ports)
CONTROL REGISTER	06H	

PORT A

PA0- Start Button
 PA1- Stop Button
 PA2- Load Button
 PA3- Resume Button
 PA4- Door Lock Switch
 PA5- Water Max Switch
 PA6- Water Min Switch

PORT B

PB0- Agitator
 PB1- Revolving tub
 PB2- Buzzer - Dry
 PB3- Buzzer - Wash
 PB4-Buzzer - Rinse

PORT C

PC0-PC3:input to BCD to 7 segment decoder.

ASSUMPTIONS:

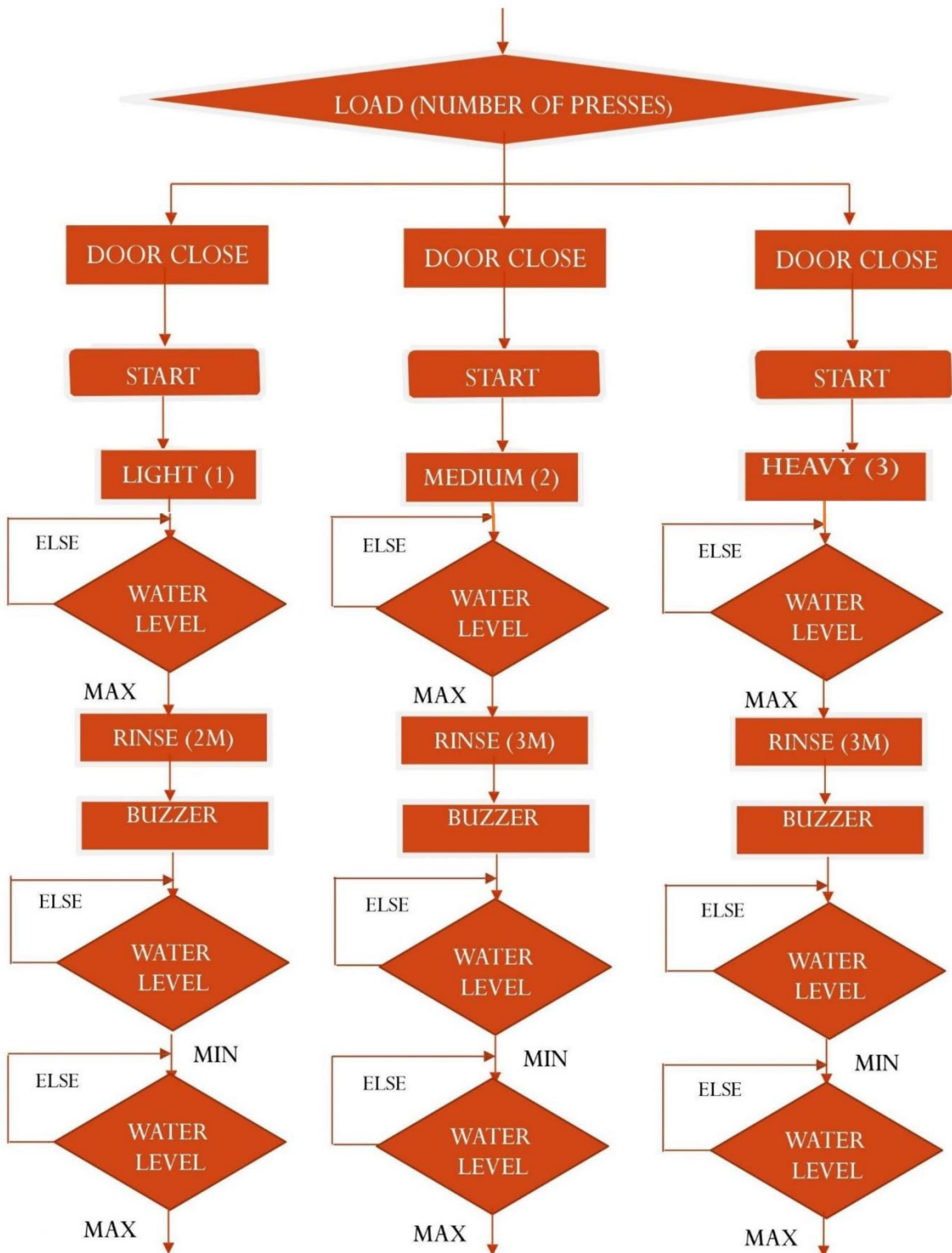
- ☐ Water level max or min is modelled using switches (SW-SPST). In reality they will be pressure sensitive switches (as water reaches max level the switch will automatically be pressed). Here we will be manually pressing the water - max/water - min switch.
- ☐ Before every wash cycle, the user is given 1 minute to put detergent.
- ☐ Assume that the door is locked when the agitator is running. Before the agitator starts running, the program checks if door is locked or not.
- ☐ Agitator and revolving tub are modelled by DC motors.

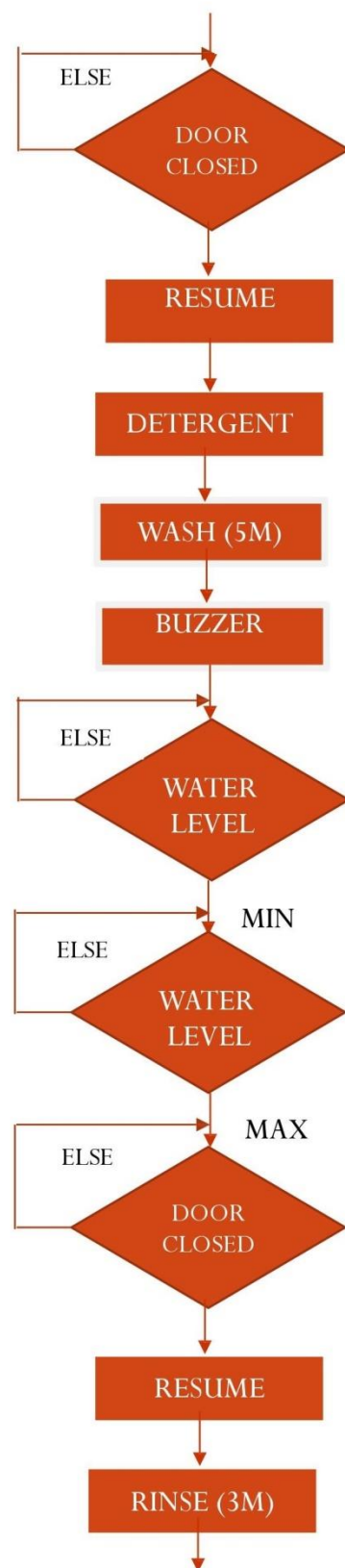
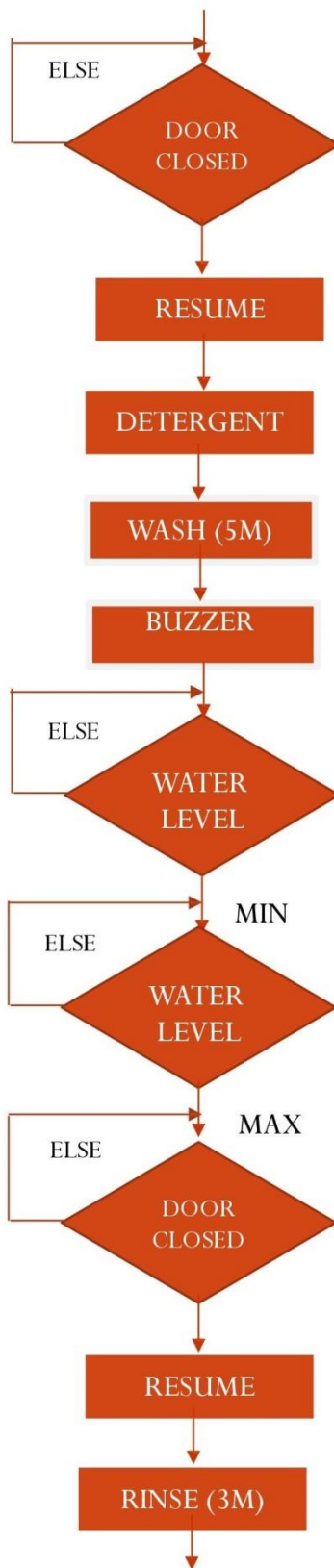
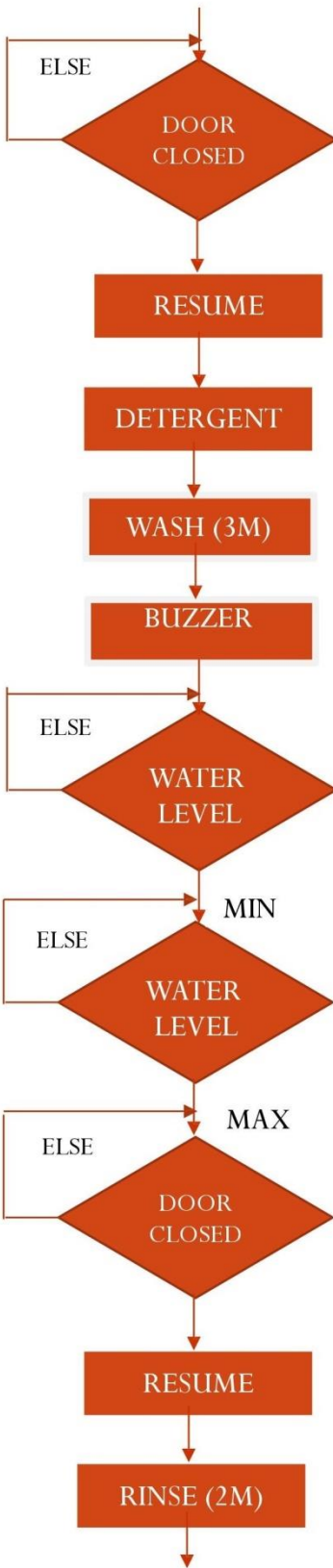
IVT:

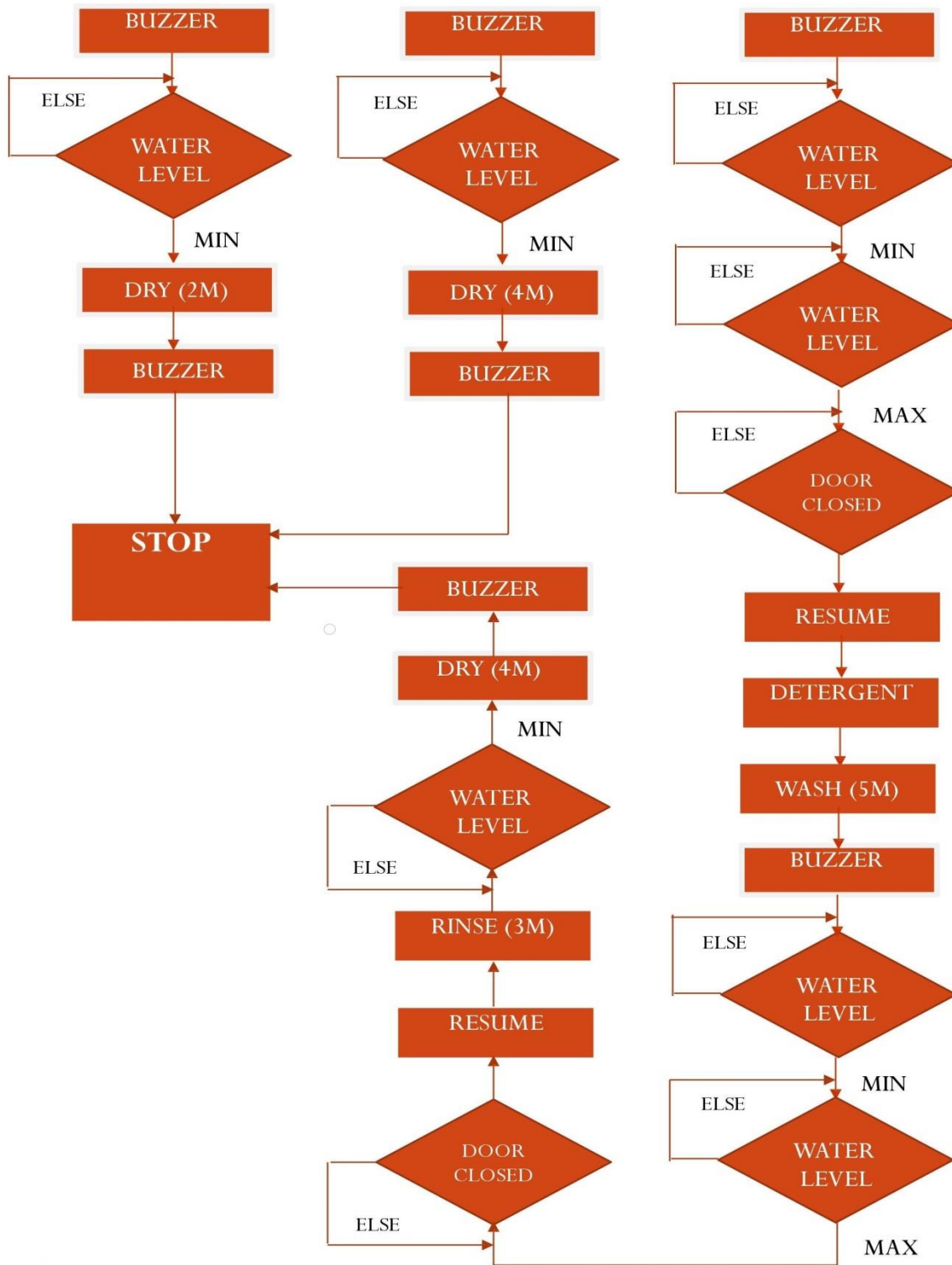
- ☐ INT 2H (NMI) is used.

ADDRESS	CONTENTS
00008H	IP (lower byte)
00009H	IP (higher byte)
0000AH	CS (lower byte)
0000BH	CS (higher byte)

FLOWCHART:







CODE:

```
.model tiny
.data
    STARTING_IP DW ?
    PA EQU 00H
    PB EQU 02H
    PC EQU 04H
    CR_8255 EQU 06H
    MODENO DB 00H
    STACK DW 100 DUP(?)
    TOP_STACK LABEL WORD
.code
.startup

    LEA SP, TOP_STACK ;---STORE THE ISR ADDRESS OF THE NMI(STOP) IN THE IVT
    MOV AX,0
    MOV ES,AX ;calculate vector address for interrupt 02H(NMI)
    MOV AL,02H
    MOV BL,04H
    MUL BL
    MOV BX,AX

    MOV SI,OFFSET [STOP_BUTTON]
    MOV ES:[BX],SI
    ADD BX,2

    MOV AX,0000
    MOV ES:[BX],AX

    MOV AL,10010000B ;programming the 8255 10010000b
    OUT CR_8255,AL
    MOV AH,00h
    MOV MODENO, AH

BEGIN:
    MOV AL, 00h
    OUT PC, AL
    MOV AL, 00h
    OUT PB, AL
    MOV AL, 00h
    MOV MODENO, AL

LOAD: ;polling the LOAD button and DOOR_LOCK switch
    MOV AL, MODENO
    OUT PC, AL
    IN AL, PA
    CMP AL, 11101110B
    JZ PRESTART
    CMP AL, 11111011B
    JZ INCR
    CMP AL, 11101011B
    JZ INCR
```

```

        JMP LOAD
    INCR: INC BYTE PTR MODENO ;if LOAD button is pressed increase the MODE
number
        MOV AH , MODENO
        CMP AH , 03H
        JA RSCNT
        CALL RELEASE_DELAY ;one press of LOAD button should only raise MODE
number by 1
        JMP LOAD
    RSCNT:MOV AH , 00H
        MOV MODENO , AH
        CALL RELEASE_DELAY
        JMP LOAD

    PRESTART: MOV AH , MODENO
                CMP AH , 00H
                JZ LOAD
                JMP OUT1

    OUT1:
        MOV AL, MODENO
        CMP AL, 01H                ;displaying on the 7 segment display
        JNE OUT2
        MOV AL, 01H
        OUT PC, AL
        JMP LIGHT

    OUT2:
        CMP AL, 02H
        JNE OUT3
        MOV AL, 02H
        OUT PC, AL
        JMP MEDIUM

    OUT3:
        MOV AL, 03H
        OUT PC, AL
        JMP HEAVY

    LIGHT:                                ;LIGHT MODE
        CALL WATER_MAX                ;sensing if water level is max

        MOV AL,01H                    ;rinse cycle
        OUT PB,AL                    ;activating the agitator
        MOV CX,2
    X1:  CALL DELAY_1m                ;rinse cycle runs for 2 minutes
        LOOP X1

        MOV AL,00H
        OUT PB,AL                    ;stop rinse cycle(i.e. stop agitator)
        CALL BUZZER_RINSE            ;play the buzzer for 1 minute
        CALL WATER_MIN                ;check if water has drained fully
        CALL WATER_MAX                ;check if water is at max level again for wash
cycle
        CALL CHECK_RESUME            ;check if resume button is pressed

```

```

CALL RELEASE_DELAY ;only when resume button comes up, proceed

cycle
MOV AL,01H          ;wash cycle
OUT PB,AL
MOV CX,3
X2: CALL DELAY_1m    ;wash cycle runs for 3 minutes
    LOOP X2

MOV AL,00H
OUT PB,AL
CALL BUZZER_WASH     ;play the buzzer for 1 minute
CALL WATER_MIN       ;check if water has drained fully
CALL WATER_MAX       ;check if water is at max level again for wash

    CALL CHECK_RESUME ;check if resume button is pressed
    CALL RELEASE_DELAY

MOV AL,01H          ;rinse cycle
OUT PB,AL          ;activating the agitator
MOV CX,2
X3:CALL DELAY_1m    ;rinse cycle runs for 2 minutes
    LOOP X3

MOV AL,00H
OUT PB,AL          ;stop rinse cycle(i.e. stop agitator)
CALL BUZZER_RINSE  ;play the buzzer for 1 minute
CALL WATER_MIN     ;check if water has drained fully
CALL CHECK_RESUME  ;check if resume button is pressed
CALL RELEASE_DELAY ;only when resume button comes up, proceed

MOV AL,02H          ;dry cycle
OUT PB,AL          ;activating the revolving tub

MOV CX,2
X4:
    CALL DELAY_1m    ;dry cycle runs for 2 minutes
    LOOP X4

MOV AL,00H
OUT PB,AL
CALL BUZZER_DRY
JMP DONE_WASHING

MEDIUM:
;MEDIUM MODE
CALL WATER_MAX     ;sensing if water level is max
MOV AL,01H         ;rinse cycle
OUT PB,AL          ;activating the agitator

MOV CX,3
X5:
    CALL DELAY_1m    ;rinse cycle runs for 3 minutes
    LOOP X5

```

```

cycle
MOV AL,00H
OUT PB,AL          ;stop rinse cycle(i.e. stop agitator)

CALL BUZZER_RINSE   ;play the buzzer for 1 minute
CALL WATER_MIN      ;check if water has drained fully
CALL WATER_MAX      ;check if water is at max level again for wash

cycle
CALL CHECK_RESUME   ;check if resume button is pressed
CALL RELEASE_DELAY ;only when resume button comes up, proceed

MOV AL,01H          ;wash cycle
OUT PB,AL

MOV CX,5
X6:
    CALL DELAY_1m    ;wash cycle runs for 5 minutes
    LOOP X6

MOV AL,00H
OUT PB,AL

CALL BUZZER_WASH    ;play the buzzer for 1 minute
CALL WATER_MIN      ;check if water has drained fully
CALL WATER_MAX      ;check if water is at max level again for wash

cycle
CALL CHECK_RESUME   ;check if resume button is pressed
CALL RELEASE_DELAY

MOV AL,01H          ;rinse cycle
OUT PB,AL          ;activating the agitator

MOV CX,3
X7:
    CALL DELAY_1m    ;rinse cycle runs for 3 minutes
    LOOP X7

MOV AL,00H
OUT PB,AL          ;stop rinse cycle(i.e. stop agitator)
CALL BUZZER_RINSE   ;play the buzzer for 1 minute
CALL WATER_MIN      ;check if water has drained fully
CALL CHECK_RESUME   ;check if resume button is pressed
CALL RELEASE_DELAY ;only when resume button comes up, proceed

MOV AL,02H          ;dry cycle
OUT PB,AL          ;activating the revolving tub

MOV CX,4
X8:
    CALL DELAY_1m    ;dry cycle runs for 4 minutes
    LOOP X8

MOV AL,00H
OUT PB,AL

```

```

CALL BUZZER_DRY
JMP DONE_WASHING

```

```

HEAVY:                                ;HEAVY MODE
CALL WATER_MAX                        ;sensing if water level is max
MOV AL,01H                            ;rinse cycle
OUT PB,AL                            ;activating the agitator

```

```

MOV CX,3
X9:
CALL DELAY_1m                        ;rinse cycle runs for 3 minutes
LOOP X9

```

```

MOV AL,00H
OUT PB,AL                            ;stop rinse cycle(i.e. stop agitator)
CALL BUZZER_RINSE                    ;play the buzzer for 1 minute
CALL WATER_MIN                       ;check if water has drained fully
CALL WATER_MAX                       ;check if water is at max level again for wash
cycle
CALL CHECK_RESUME                    ;check if resume button is pressed
CALL RELEASE_DELAY                   ;only when resume button comes up, proceed

```

```

MOV AL,01H                            ;wash cycle
OUT PB,AL

```

```

MOV CX,5
X10:
CALL DELAY_1m                        ;wash cycle runs for 5 minutes
LOOP X10

```

```

MOV AL,00H
OUT PB,AL
CALL BUZZER_WASH                    ;play the buzzer for 1 minute
CALL WATER_MIN                       ;check if water has drained fully
CALL WATER_MAX                       ;check if water is at max level again for wash
cycle
CALL CHECK_RESUME                    ;check if resume button is pressed
CALL RELEASE_DELAY
CALL WATER_MAX                       ;sensing if water level is max

```

```

MOV AL,01H                            ;rinse cycle
OUT PB,AL                            ;activating the agitator

```

```

MOV CX,3
X11:
CALL DELAY_1m                        ;rinse cycle runs for 3 minutes
LOOP X11

```

```

MOV AL,00H
OUT PB,AL                            ;stop rinse cycle(i.e. stop agitator)

```

```

cycle
CALL BUZZER_RINSE    ;play the buzzer for 1 minute
CALL WATER_MIN       ;check if water has drained fully
CALL WATER_MAX       ;check if water is at max level again for wash

CALL CHECK_RESUME    ;check if resume button is pressed
CALL RELEASE_DELAY   ;only when resume button comes up, proceed

MOV AL,01H           ;wash cycle
OUT PB,AL

MOV CX,5
X12:
    CALL DELAY_1m     ;wash cycle runs for 5 minutes
    LOOP X12

MOV AL,00H
OUT PB,AL
CALL BUZZER_WASH     ;play the buzzer for 1 minute
CALL WATER_MIN       ;check if water has drained fully
CALL WATER_MAX       ;check if water is at max level again for wash
cycle
CALL CHECK_RESUME    ;check if resume button is pressed
CALL RELEASE_DELAY   ;sensing if water level is max
CALL WATER_MAX

MOV AL,01H           ;rinse cycle
OUT PB,AL           ;activating the agitator

MOV CX,3
X13:
    CALL DELAY_1m     ;rinse cycle runs for 3 minutes
    LOOP X13

MOV AL,00H
OUT PB,AL           ;stop rinse cycle(i.e. stop agitator)
CALL BUZZER_RINSE    ;play the buzzer for 1 minute
CALL WATER_MIN       ;check if water has drained fully
CALL CHECK_RESUME    ;check if resume button is pressed
CALL RELEASE_DELAY   ;only when resume button comes up, proceed

MOV AL,02H           ;dry cycle
OUT PB,AL           ;activating the revolving tub

MOV CX,4
X14:
    CALL DELAY_1m     ;dry cycle runs for 4 minutes
    LOOP X14
MOV AL,00H
OUT PB,AL
CALL BUZZER_DRY
JMP DONE_WASHING

DONE_WASHING:
MOV AL, 0EH
OUT PC, AL

```

```

        CALL DELAY_1m
        MOV AL , 00H
        MOV MODENO , AL

        JMP BEGIN

;INF:
;JMP INF
STOP_BUTTON:                                ;this procedure is an ISR for NMI (STOP button)
        MOV BP,SP
        MOV AL,00H
        OUT PB,AL
        OUT PC,AL
        MOV AX,STARTING_IP ;this will put in stack the IP address of the
starting line of program
        MOV [BP],AX
        IRET                                ;now the IP address popped will be of the starting
line of program

        JMP DONE_WASHING

.exit

STORE_IP PROC NEAR                        ;this procedure will store the IP address
        MOV BP,SP                        ;of the label POLL_START
        MOV AX,[BP]
        MOV STARTING_IP,AX
        RET
STORE_IP ENDP

RELEASE_DELAY PROC NEAR                  ;this procedure checks all the buttons and
RELEASE:                                ;returns only if all the buttons are up
        IN AL,PA
        OR AL,11110000B
        CMP AL,11111111B
        JNZ RELEASE
        RET
RELEASE_DELAY ENDP

INITIALIZE_INT PROC NEAR
        MOV AX, 0
        MOV ES, AX
        CLI
        MOV WORD PTR ES:[320], OFFSET INT50H
        MOV WORD PTR ES:[322], CS
        STI
        MOV AX, 0
        RET
INITIALIZE_INT ENDP

INT50H PROC FAR
        ;int 3
        MOV AL, 08H

```

```

        OUT PC, AL
        IRET
INT50H ENDP

```

```

DELAY_1m PROC NEAR ;this procedure is used to generate a delay of 1 minute
        MOV DX , 001Fh
        P2 :
                MOV BX , 0FFFFh
                P1 :
                DEC BX
                NOP
                JNZ P1
        DEC DX
        JNZ P2
        RET
DELAY_1m ENDP

```

```

WATER_MAX PROC NEAR ;this procedure checks if water level is max
                    ;water level is max when the pressure sensitive
switch(WATER_MAX) is pressed
        CHECK1:
                IN AL,PA
                CMP AL,11001111B
                JNE CHECK1
        RET
WATER_MAX ENDP

```

```

WATER_MIN PROC NEAR ;this procedure checks if water level is min
                    ;water level is min when the pressure sensitive
switch(WATER_MIN) is pressed
        CHECK2:
                IN AL,PA
                CMP AL,10101111B
                JNE CHECK2
        RET
WATER_MIN ENDP

```

```

BUZZER_RINSE PROC NEAR ;this procedure activates a buzzer after rinse
cycle in complete
        MOV AL,10H
        OUT PB,AL
        CALL DELAY_1m
        MOV AL,00H
        OUT PB,AL
        RET
BUZZER_RINSE ENDP

```

```

BUZZER_WASH PROC NEAR ;this procedure activates a buzzer after wash
cycle in complete
        MOV AL,08H
        OUT PB,AL
        CALL DELAY_1m

```



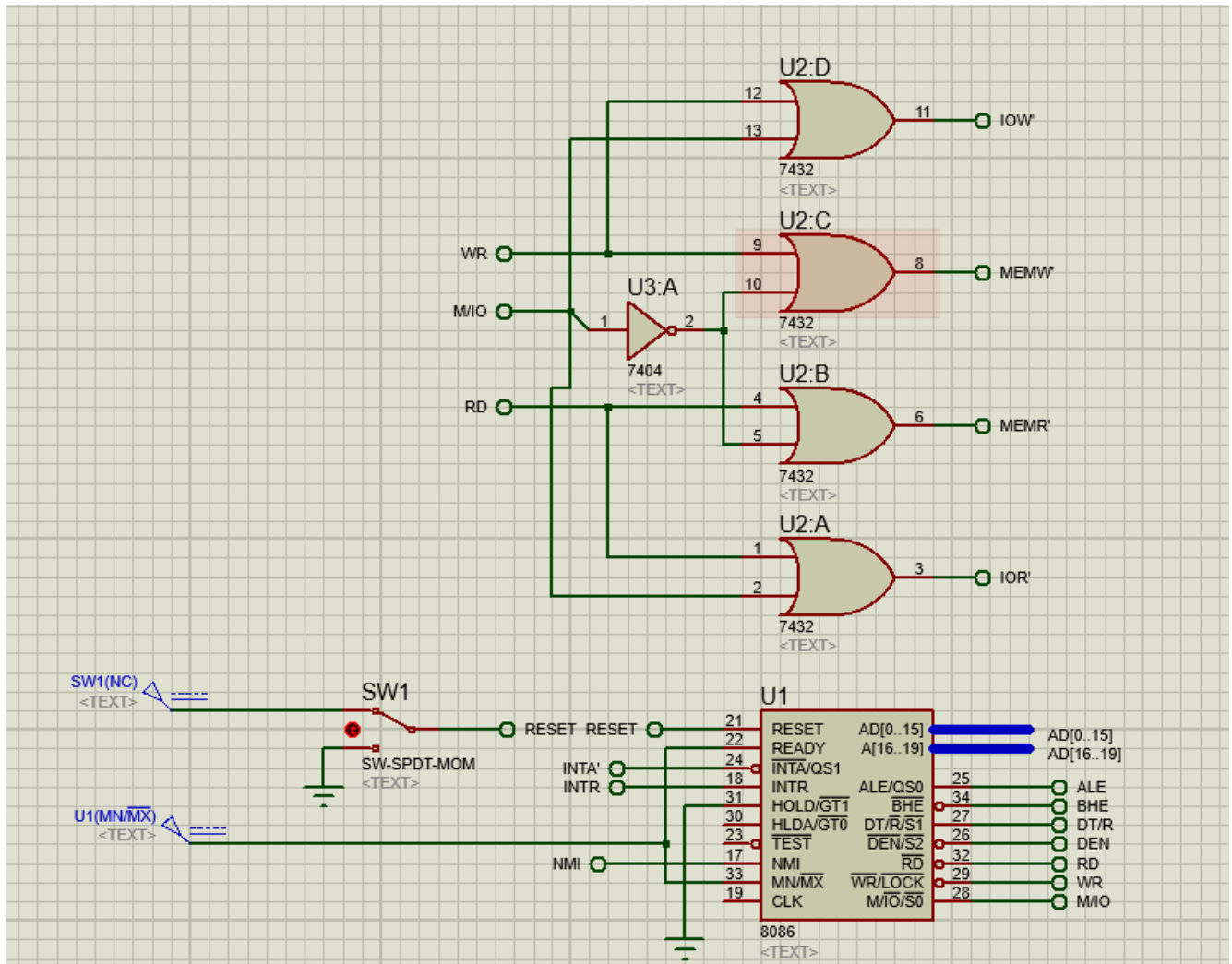
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    MOV AL,00H
    OUT PB,AL
    RET
BUZZER_WASH ENDP
```

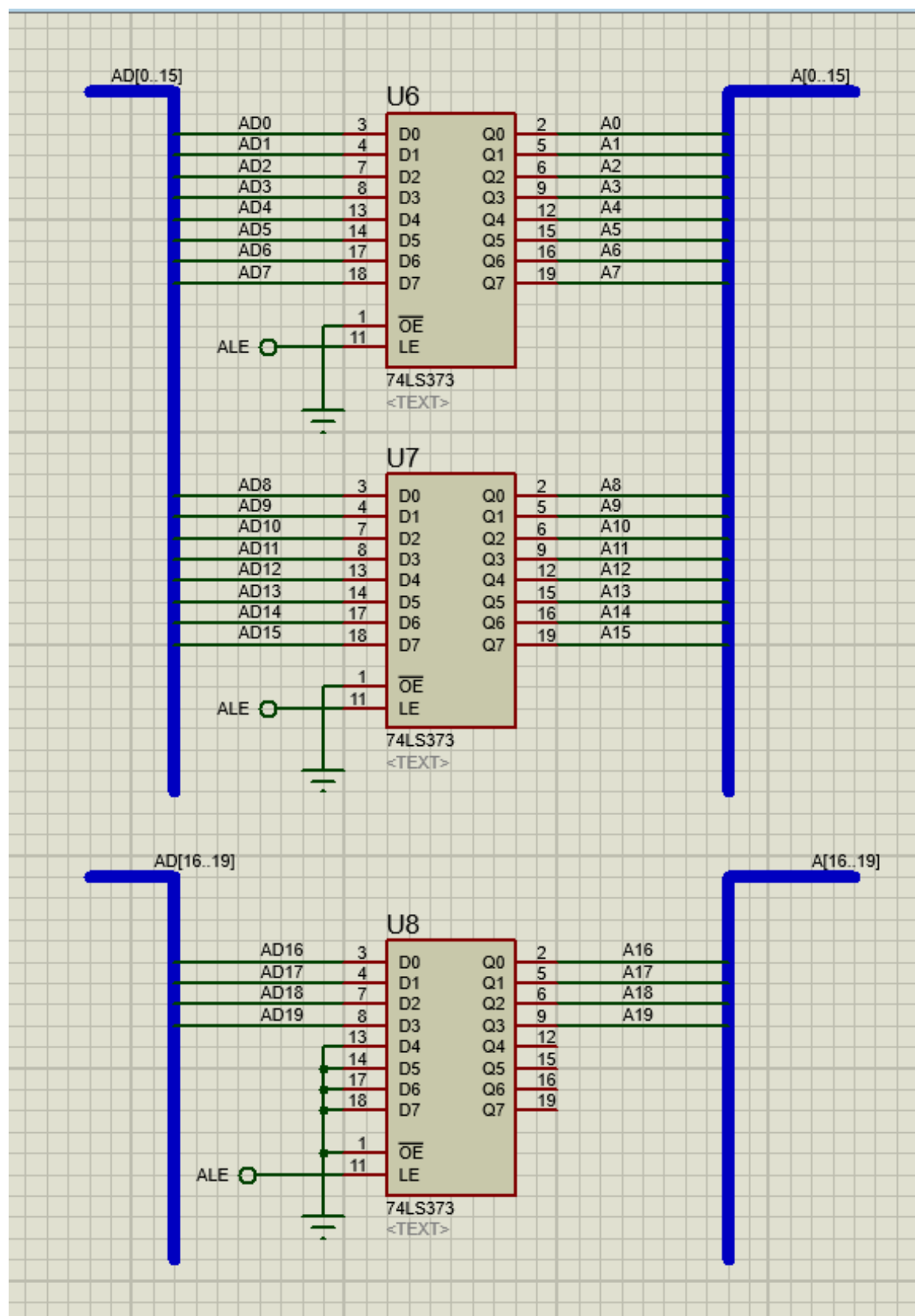
```
BUZZER_DRY PROC NEAR          ;this procedure activates a buzzer after dry cycle
in complete
    MOV AL,04H
    OUT PB,AL
    CALL DELAY_1m
    MOV AL,00H
    OUT PB,AL
    RET
BUZZER_DRY ENDP
```

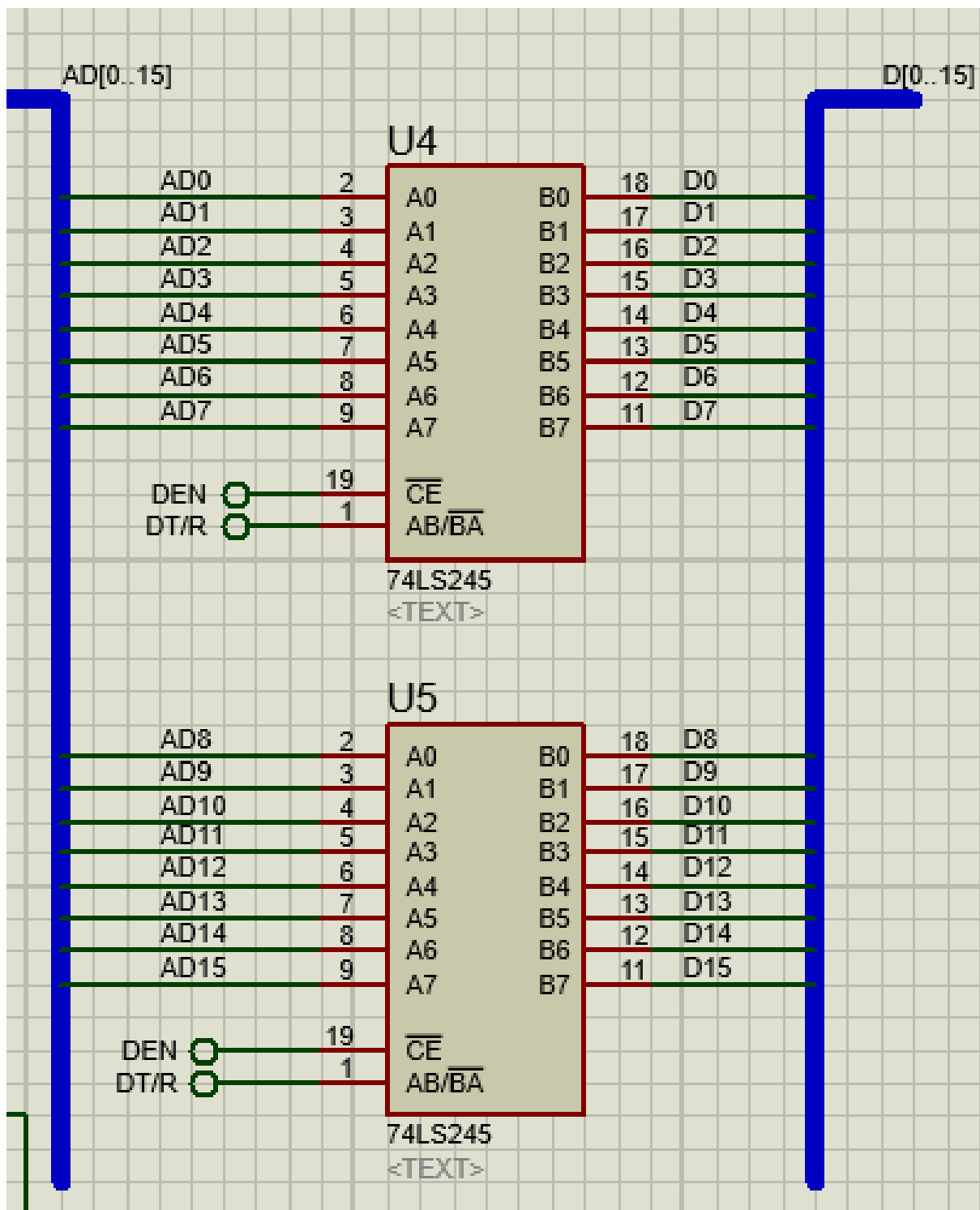
```
CHECK_RESUME PROC NEAR      ;this procedure checks if resume button is pressed
or not
```

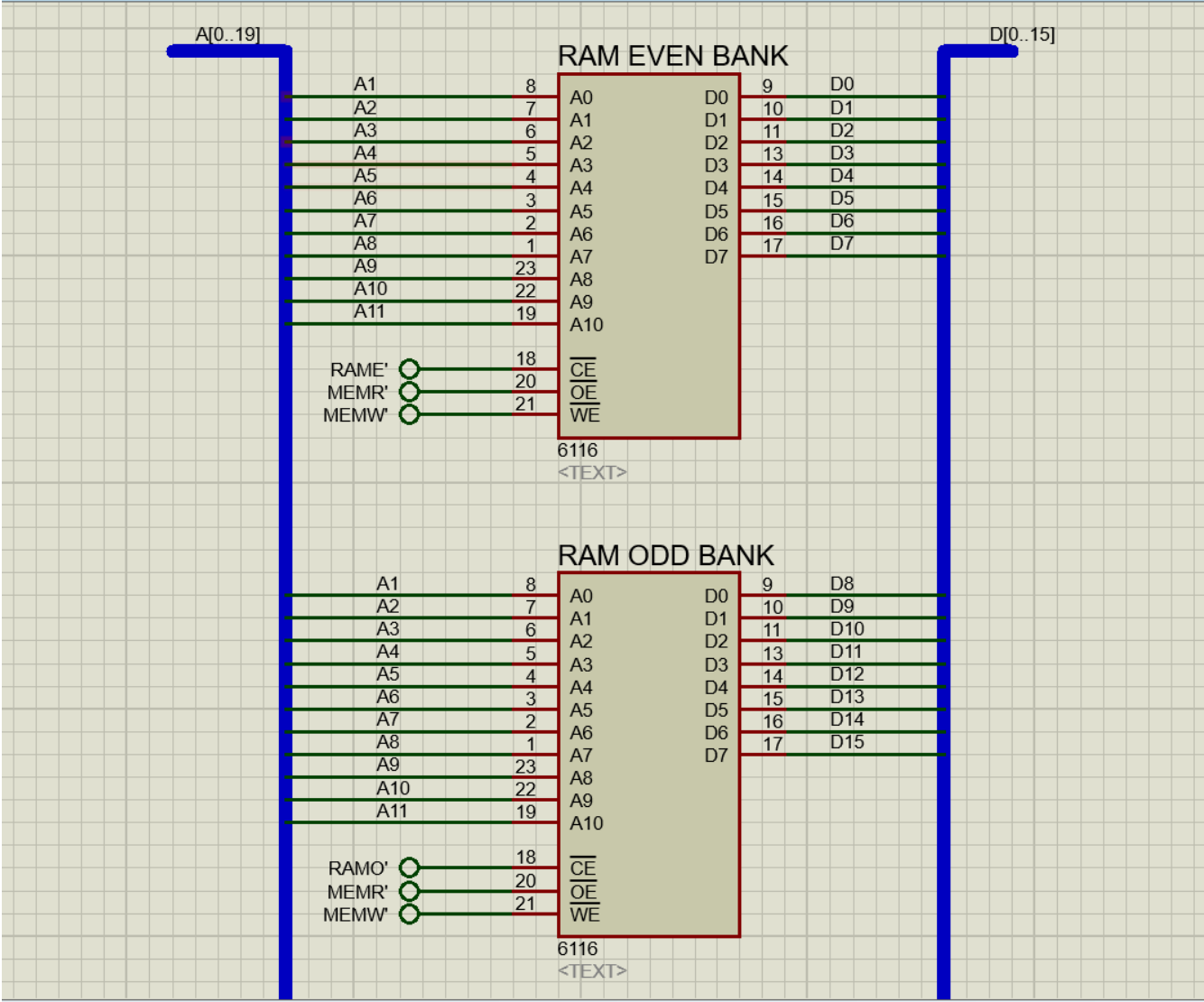
```
    CHECKR:
        IN AL,PA
        OR AL,11100111B
        CMP AL,11100111B
        JNE CHECKR
    RET
CHECK_RESUME ENDP
```

```
END
```

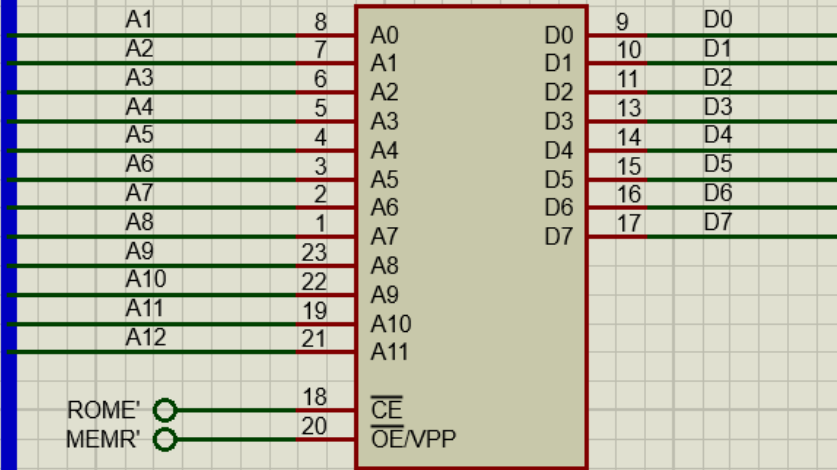






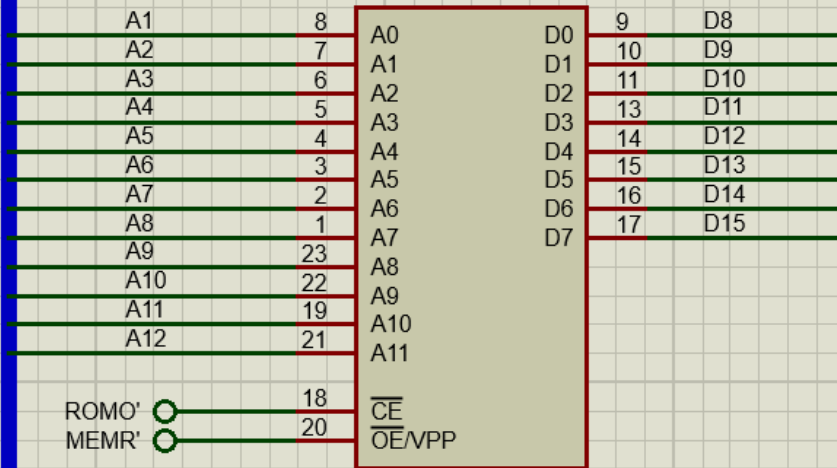


ROM EVEN BANK



2732
<TEXT>

ROM ODD BANK



2732
<TEXT>

