CS - F241
MICROPROCESSORS & INTERFACING

Design Assignment:

H_{FE} TESTER FOR NPN TRANSISTORS

Team Members:

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Problem -24

Group -29

Problem Statement:

Design a microprocessor transistor h_{FE} tester. The system has to display the h_{FE} value of NPN transistors. The transistor under test (TUT) is to be inserted in the socket, and its base is energized with a current from a device DI.

The current I produced by the device DI, can be controlled by supplying it with a DC voltage V. The relationship is as follows:

[$I = V*10^{-4}$ A]

The emitter of the transistor is grounded, and the collector is connected to a 2.2K resistor, whose other end is connected to the +5V supply. The Voltage drop across a 2.2K resistor is measured and this is related to the hFE by the following relation:

[H_{FE} *I *2200 = Voltage Drop]

The hFE value should be displayed on a LCD display. If the hFE value is less than 50, an alarm should be sounded 2 seconds.

Specification:

- User inserts the transistor into a socket and turns on a switch to indicate a transistor has been connected.
- “DI” is supplied with a voltage of 0.1V from the microprocessor using resistor-relay combination.
- The base is energized with the corresponding current gain given by the relation: **[$I = V*10^{-4}$]**
- Depending upon the input current and the hFE value of the transistor, the collector current and hence the voltage drop across the resistor varies.
- This voltage drop is fed to ADC 0804 and the hFE is calculated using the relation: **[H_{FE} *I*2200 = Voltage Drop]**

- The hFE value is displayed on the LCD.
  [If it is less than 50, the alarm is activated for 2 seconds.]

<u>“DI" device circuit:</u>

["DI" is a VCCS (Voltage Controlled Current Source) with the given transconductance of 100 Micro Ω.]

- "DI" is connected to a resistor circuit. There are two resistors of resistances 9.8KΩ and 200Ω connected to a 5V source.
- One end of each resistor is connected to a "DI" device through a relay circuit switch.
- Each of these switches are connected to the microprocessor(8086) through an 8255.When a switch is closed (i.e., logic 1 at terminals of coil) the voltage at that end of the resistor (where the switch is connected) is provided to the DI device.

<u>Assumptions:</u>

- The values of H_{FE} are integral**.**
  [The loss of resolution is insignificant for the expected values of H_{FE}]
- Voltage supplied to the device **“DI”** is 0.1 V**.**
- This value of voltage won’t drive the transistor to saturation.
- DI draws very little current (negligible) owing to its very high impedance.
- The value of H_{FE} won’t exceed 256.

Components Used:

COMPONENT	DESCRIPTION	NUMBER
Intel 8086	Microprocessor	1
82C55	Programmable Peripheral Interface	2
ADC0804	Analog to Digital Converter	1
6116	2K * 8-bit SRAM	2
2732	4K * 8-bit ROM	2
74LS244	4-bit Buffer	1
74LS373	8-bit Latch	4
74LS245	8-bit Buffer	4
2N2369	NPN Transistor	1
-	NOT gate	8
LM020L	LCD	1
ACS755XCB-130	Voltage Sensor	1

Memory Organization:

Two SRAM chips and two ROM chips are used.Both SRAM and ROM are organized into even and odd banks to facilitate both byte size and word size data transfer. The circuitry for chip selection has been shown on the drawing sheet.

STATIC RANDOM ACCESS MEMORY –SRAM

- Starting address: 08000H
- Ending address: 08FFFH

READ ONLY MEMORY –ROM

- Starting address: 00000H
- Ending address: 01FFFH

The code resides in the ROM and begins at address **00000H**.
(The address loaded as soon as the system is switched on is FFFF0H).

CHIP	A_{19}	A_{18}	A_{17}	A_{16}	A_{15}	A_{14}	A_{13}	A_{12}	A_{11}	A_{10}	A_9	A_8	A_7	A_6	A_5	A_4	A_3	A_2	A_1	A_0
EPROM 2732																				
From 00000h	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
To 01FFFh	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1
SRAM 6116																				
From 08000H	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
To 08FFFh	0	0	0	0	1	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1

I/O Organization:

8255 (1)

Port Type	Port Address	Type
A	00h	Output
B	02h	Output
C (lower)	04h	Output
C (upper)	04h	Input
Control register	06h	

8255 (2)

Port Type	Port Address	Type
A	10h	Output
B	12h	Input
C (lower)	14h	Output
C (upper)	14h	Input
Control register	16h	

Both used in i/o mode.

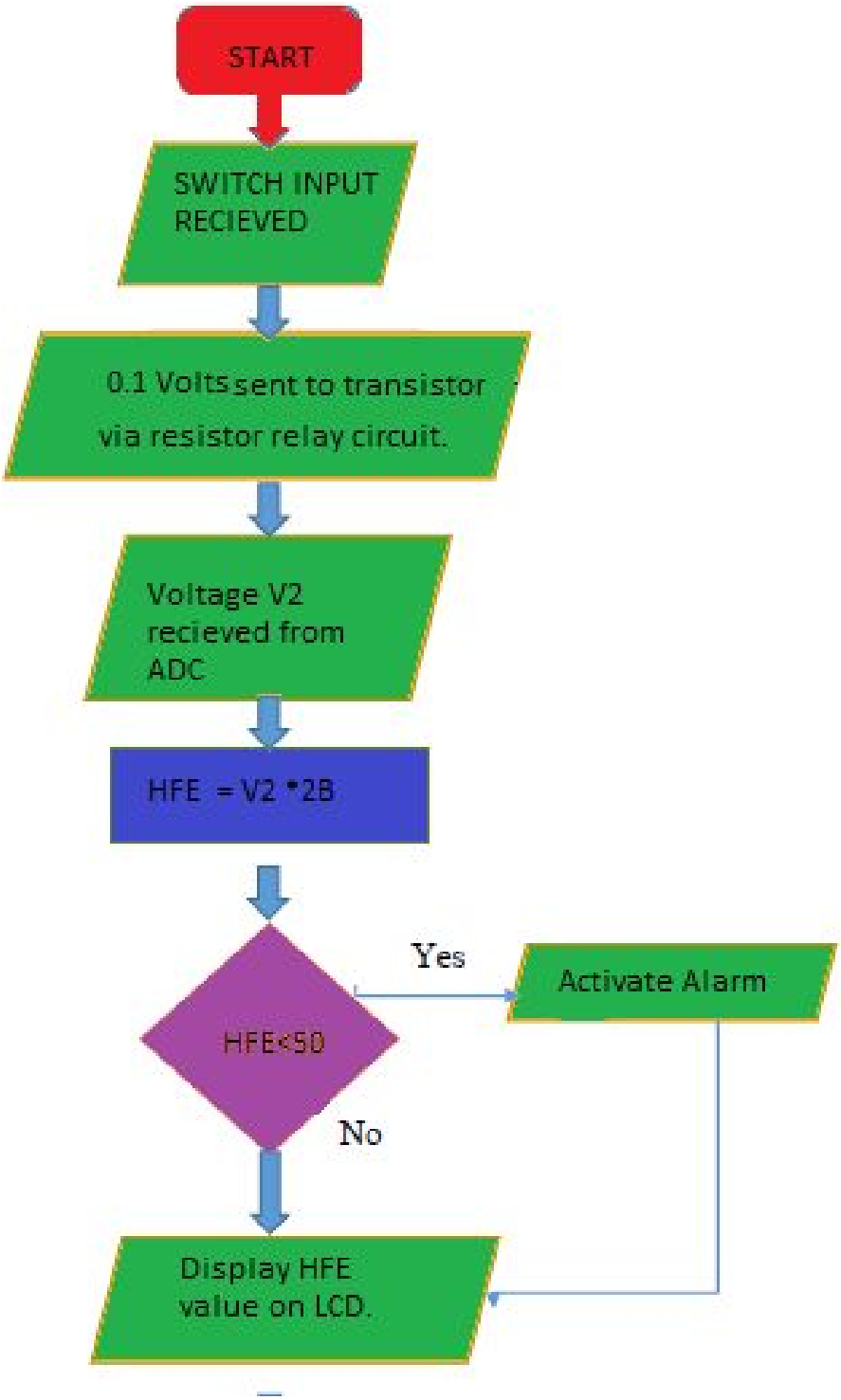
Control Word for 8255 (1): 10001000

- **Mode for port A = simple i/o (i.e. 00)**
- **Port A is used for generating control signal of LCD**
- **Port B is used for giving input to the LCD**
- **Mode for group B = simple i/o (i.e. 0)**
- **PC0 – PC3 used as output to LED.**
- **PC4 – PC7 used as input from the switch.**

Control Word for 8255 (2): 10001010

- **Mode for port A = simple i/o (i.e. 00)**
- **Port A is used for giving input to DI device**
- **Port B is used for taking input from ADC**
- **Mode for group B = simple i/o (i.e. 0)**
- **PC0 – PC3 used as output (PC2 is used for controlling the alarm)**
- **PC4 – PC7 used as input (PC5 – INTR of ADC)**

Flow Chart:


START
SWITCH INPUT RECIEVED
0.1 Volts sent to transistor via resistor relay circuit.
Voltage V2 recieved from ADC
HFE = V2 *2B
HFE<50
Yes
Activate Alarm
No
Display HFE value on LCD.

x86 Code:

```
#make_bin#
#LOAD_SEGMENT=FFFFh#
#LOAD_OFFSET=0000h#

#CS=0000h#
#IP=0000h#

#DS=0000h#
#ES=0000h#

#SS=0000h#
#SP=FFFEh#

#AX=0000h#
#BX=0000h#
#CX=0000h#
#DX=0000h#
#SI=0000h#
#DI=0000h#
#BP=0000h#

.MODEL TINY
.DATA

;8253 USED TO GENERATE CLOCK FOR ADC
CNT0 EQU 20H
CREG EQU 26H

;8255(1)  INITIALISE
PORT1A EQU 00H ;CONTROLLING THE LCD
PORT1B EQU 02H ;INPUT TO LCD
PORT1C EQU 04H ;UPPER - ROW
                ;LOWER - COLUMN
CREG1 EQU 06H

;8255(2) USED FOR ADC, ALARM AND SWITCH
```

```
PORT2A EQU 10H ;INPUT TO DI DEVICE
PORT2B EQU 12H ;ADC
PORT2C EQU 14H ;PC1 - SOC OF ADC
;PC2 - ALARM
;PC3 - ADDC OF ADC (USED FOR SELECTING THE ;FIRST INPUT CHANNEL OF ADC)
;PC5 - EOC OF ADC
CREG2 EQU 16H

TABLE_K DB 0EEH,0EDH,0EBH,0E7H,0DEH,0DDH,0DBH,0D7H,0BEH,0BDH,0BBH,0B7H,7EH,7DH,7BH,77H
DAT2 DB 3 DUP(" ");
T DB 30H,31H
.CODE
.STARTUP

MOV AL,00010110B ;INITIALIZING 8253
OUT CREG,AL
MOV AL,5
OUT CNT0,AL

MOV AL,10001000B ;INITIALIZING 8255(1)
OUT CREG1,AL
CALL DELAY_2MS

MOV AL,10001010B ;INITIALIZING 8255(2)
OUT CREG2,AL
CALL DELAY_2MS


KX1: IN AL,PORT1C
AND AL,80H
CMP AL,80H
JNZ KX1

MOV AL,20H
OUT PORT2A,AL
```

```
MOV AL,06H        ;GIVE ADC
OUT CREG2,AL

MOV AL,00H        ;GIVE ALE
OUT CREG2,AL

MOV AL,02H        ;GIVE SOC
OUT CREG2,AL

MOV AL,01H
OUT CREG2,AL

MOV AL,03H
OUT CREG2,AL

MOV AL,02H        ;GIVE SOC
OUT CREG2,AL

MOV AL,00H        ;GIVE ALE
OUT CREG2,AL

LOOP2:
IN AL,PORT2C
CALL DELAY_2MS
AND AL,20H ;CHECK FOR EOC
CMP AL,20H
JNZ LOOP2
CALL DELAY_2MS

MOV AL,10001010B ;INITIALIZING 8255(2)
OUT CREG2,AL
IN AL,PORT2B ;AL HAS THE VOLTAGE DROP ACROSS THE RESISTOR
NOT AL

CALL HFE
CALL FUNC
CALL ALARM
```

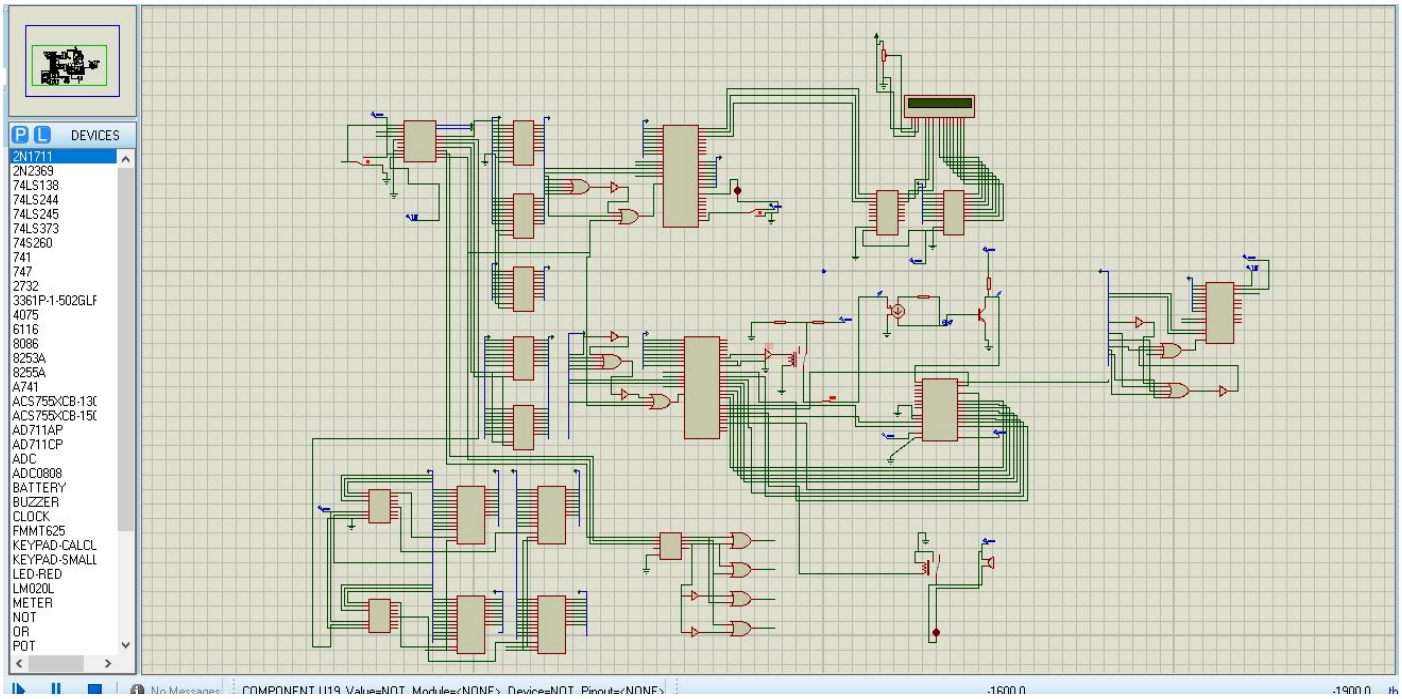
```
.EXIT

ALARM PROC NEAR
CMP AL,50
JNB Z2
MOV AL,05H
OUT CREG2,AL

CALL DELAY_2S

MOV AL,04H
OUT CREG2,AL
Z2:
MOV CX,10
Z3:
CALL DELAY_2S
LOOP Z3
CALL DELAY_2S
RET
ALARM ENDP

HFE PROC NEAR
MOV BL,2DH
MUL BL
MOV BL,033H
DIV BL
MOV AH,00H

RET
HFE ENDP


FUNC PROC NEAR
PUSH AX
MOV AL,38H
CALL COMNDWRT
CALL DELAY
CALL DELAY
CALL DELAY
```

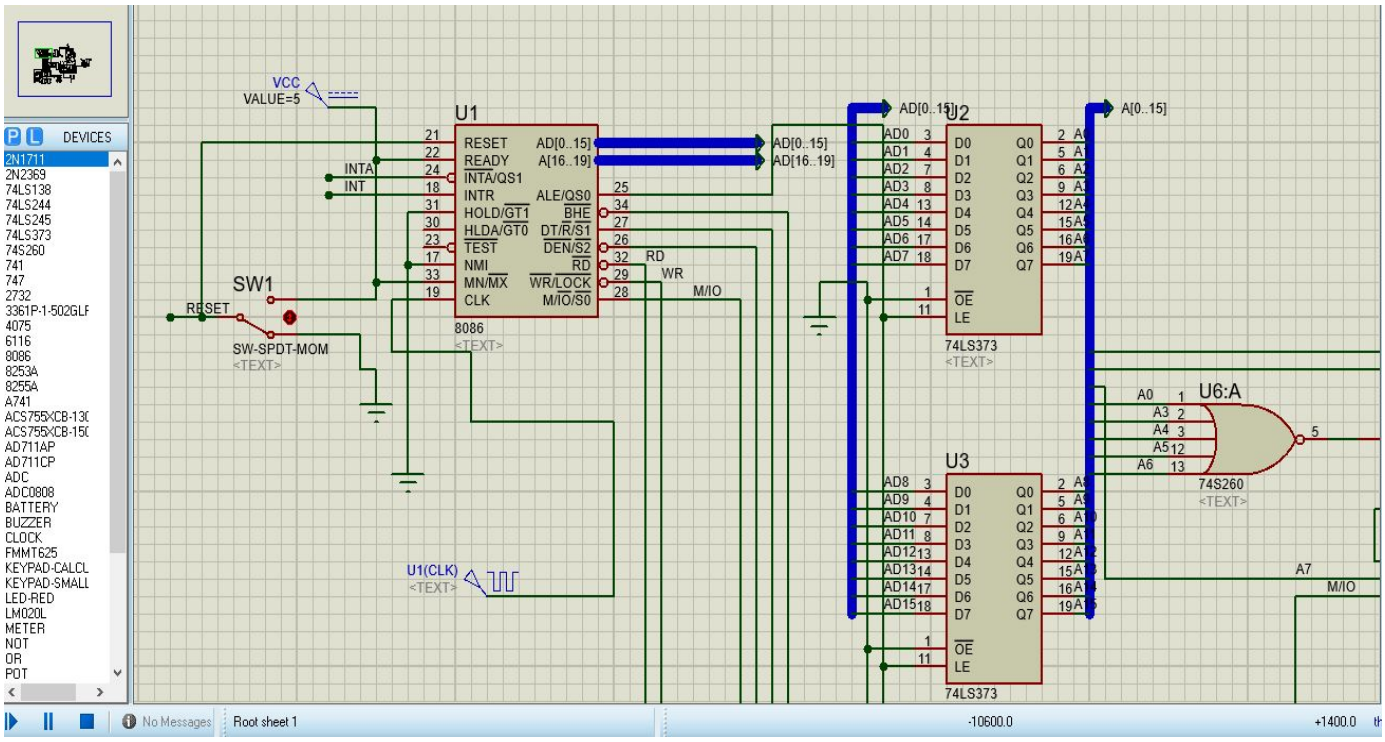
```
MOV AL,0EH
CALL COMNDWRT

MOV AL, 01  ;CLEAR LCD
CALL COMNDWRT
CALL DELAY
CALL DELAY

POP AX
PUSH AX
LEA DI,DAT2
MOV BX,100D
MOV DX,0
DIV BX
ADD AL,30H
CALL DATWRIT ;ISSUE IT TO LCD
CALL DELAY
CALL DELAY
MOV AX,DX
MOV BX,10D
MOV DX,0
DIV BX
ADD AL,30H
CALL DATWRIT
CALL DELAY
CALL DELAY
MOV AX,DX
MOV DX,0
ADD AL,30H
CALL DATWRIT
CALL DELAY
CALL DELAY
POP AX

RET
FUNC ENDP

COMNDWRT PROC ;THIS PROCEDURE WRITES COMMANDS TO LCD
OUT PORT1B, AL  ;SEND THE CODE TO PORT A
```

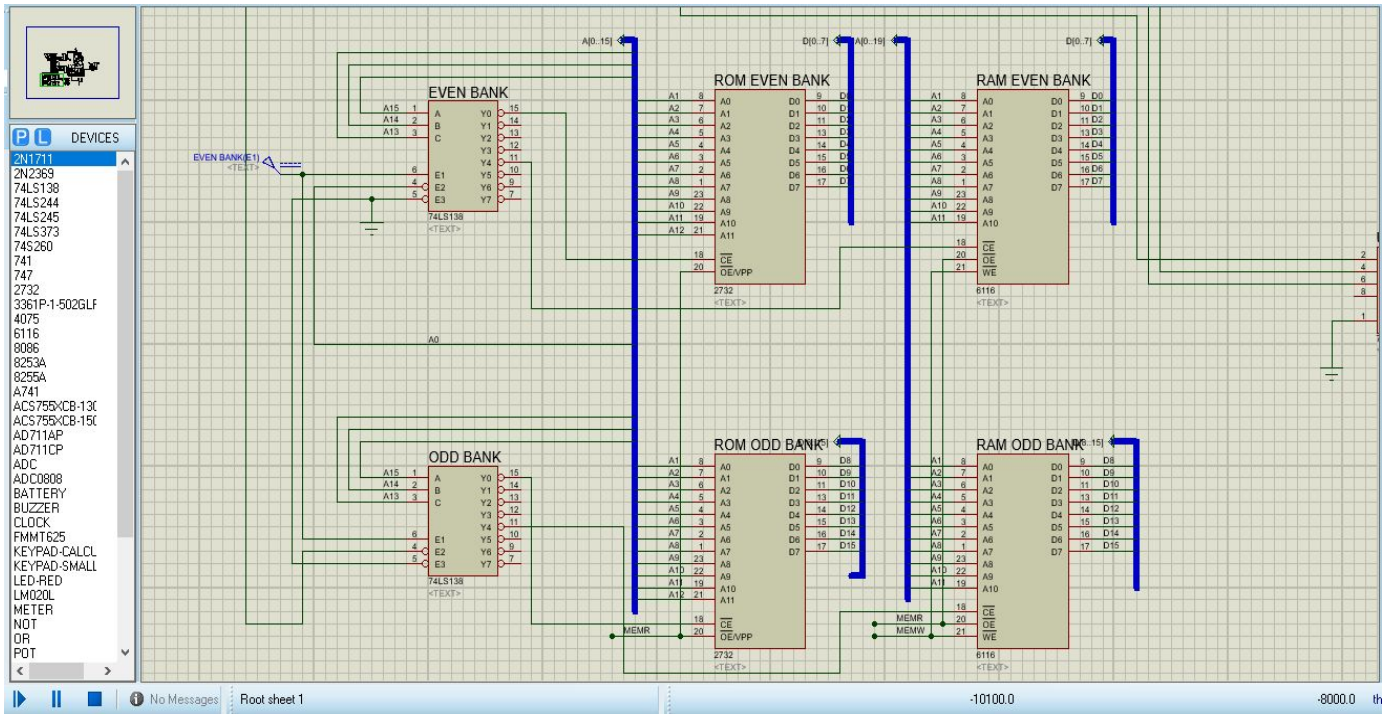
```
MOV AL, 00000100B ;RS=0,R/W=0,E=1 FOR H-TO-L PULSE
OUT PORT1A, AL
NOP
NOP
MOV AL, 00000000B ;RS=0,R/W=0,E=0 FOR H-TO-L PULSE
OUT PORT1A, AL
RET
COMNDWRT ENDP

DATWRIT PROC NEAR
        PUSH DX  ;SAVE DX
        MOV DX,PORT1B  ;DX=PORT A ADDRESS
        OUT DX, AL ;ISSUE THE CHAR TO LCD
        MOV AL, 00000101B ;RS=1, R/W=0, E=1 FOR H-TO-L PULSE
        MOV DX, PORT1A ;PORT B ADDRESS
        OUT DX, AL  ;MAKE ENABLE HIGH
        MOV AL, 00000001B ;RS=1,R/W=0 AND E=0 FOR H-TO-L PULSE
        OUT DX, AL
        POP DX
        RET
DATWRIT ENDP ;WRITING ON THE LCD ENDS

DELAY_2MS PROC NEAR
MOV CX,100
HER: NOP
 LOOP HER
RET
DELAY_2MS ENDP

;DELAY IN THE CIRCUIT HERE THE DELAY OF 20 MILLISECOND IS PRODUCED
DELAY PROC
        MOV CX, 1325 ;1325*15.085 USEC = 20 MSEC
        W1:
                NOP
                NOP
                NOP
                NOP
                NOP
        LOOP W1
```

```
        RET
DELAY ENDP

DELAY_2S PROC
        MOV CX, 33125D
        W2:
                NOP
                NOP
                NOP
                NOP
                NOP
        LOOP W2
                MOV CX, 33125D
        W3:
                NOP
                NOP
                NOP
                NOP
                NOP
        LOOP W3
                MOV CX, 33125D
        W4:
                NOP
                NOP
                NOP
                NOP
                NOP
        LOOP W4
                MOV CX, 33125D
        W5:
                NOP
                NOP
                NOP
                NOP
                NOP
        LOOP W5
        RET
DELAY_2S ENDP
END
```

Circuit Diagram:



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2N2369
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74LS244
74LS245
74LS373
74S260
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2732
3361P-1-502GLF
4075
6116
8086
8253A
8255A
A741
ACS755XCB-13(
ACS755XCB-15(
AD711AP
AD711CP
ADC
ADC0808
BATTERY
BUZZER
CLOCK
FMMT625
KEYPAD-CALCL
KEYPAD-SMALL
LED-RED
LM020L
METER
NOT
OR
POT
EVEN BANK
ODD BANK
ROM EVEN BANK
ROM ODD BANK
RAM EVEN BANK
RAM ODD BANK
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2732
6116
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A0
MEMR
MEMW
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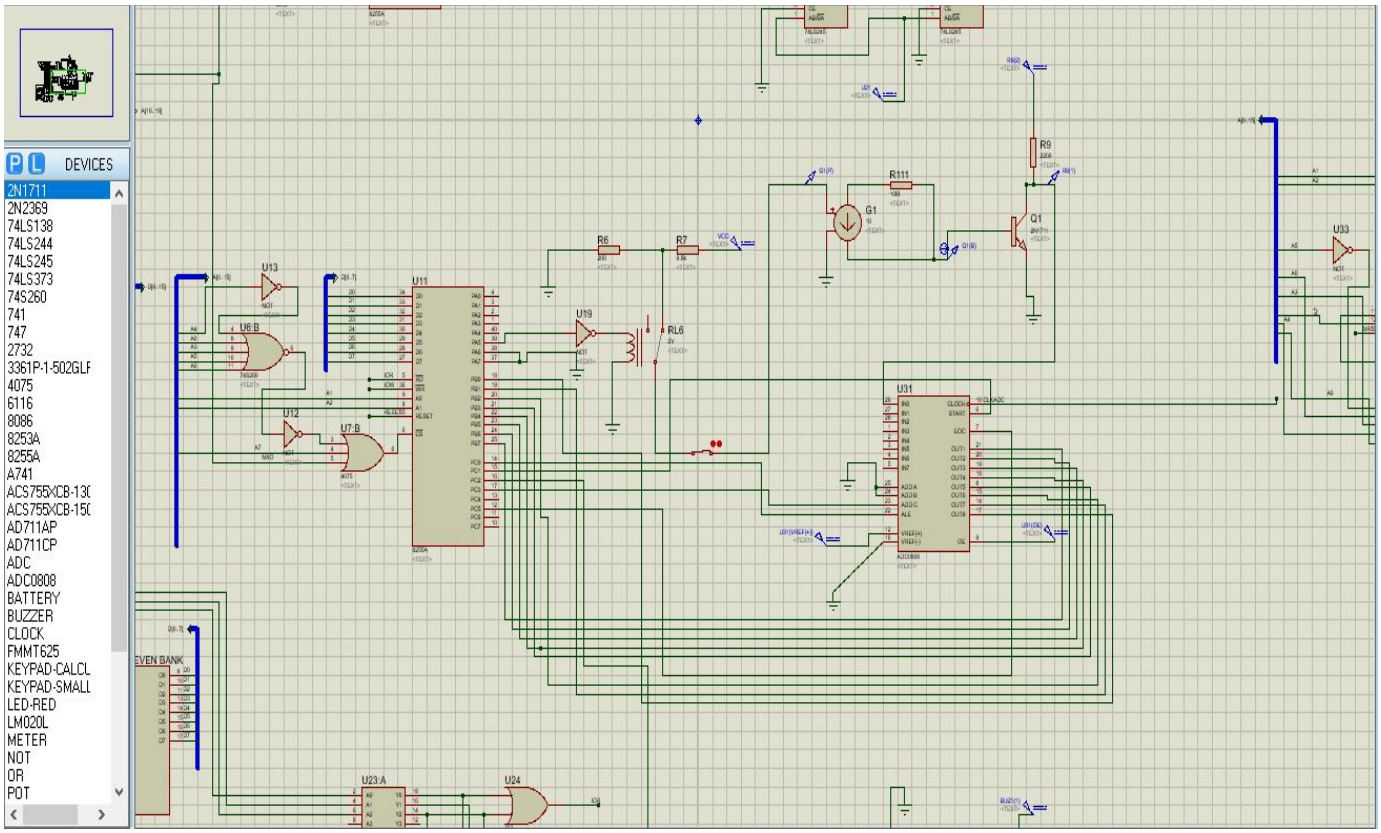
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POT
EVEN BANK
U13
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RL6
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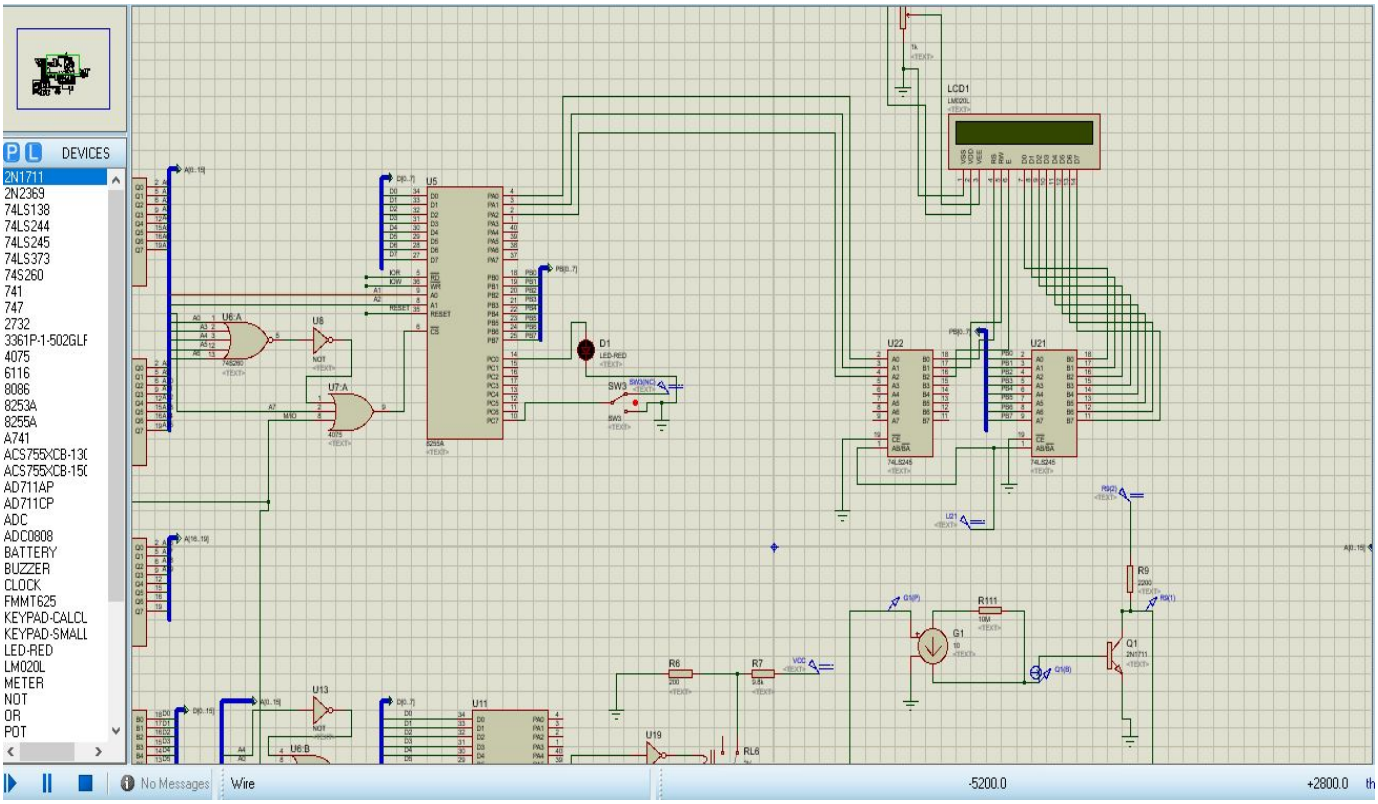
U6:B
U31
U23:A
U24
U33
R6
R7
R9
R111
G1
Q1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LCD1
U5
U6:A
U6:B
U7:A
U8
U11
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U19
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R7
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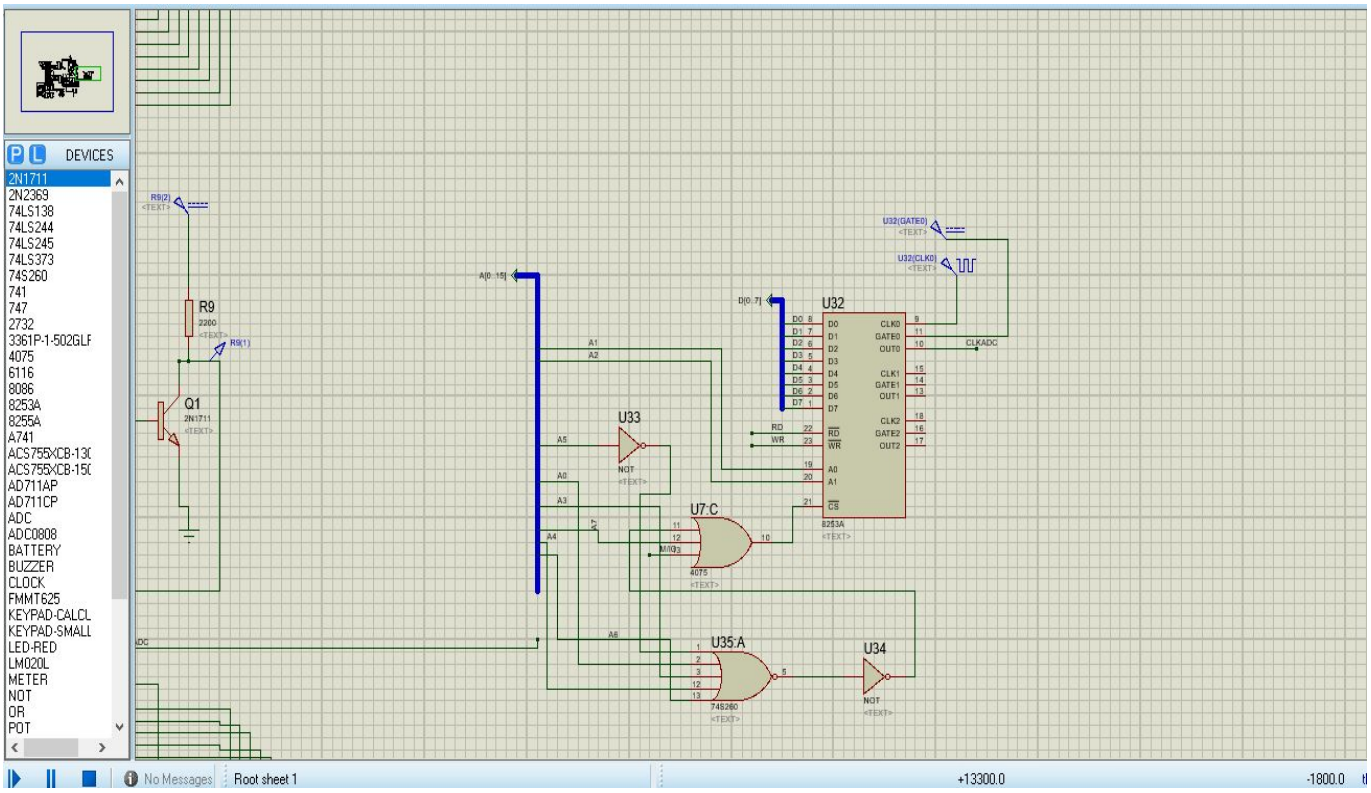
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CLOCK
FMMT625
KEYPAD-CALCL
KEYPAD-SMALL
LED-RED
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METER
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OR
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U33
U34
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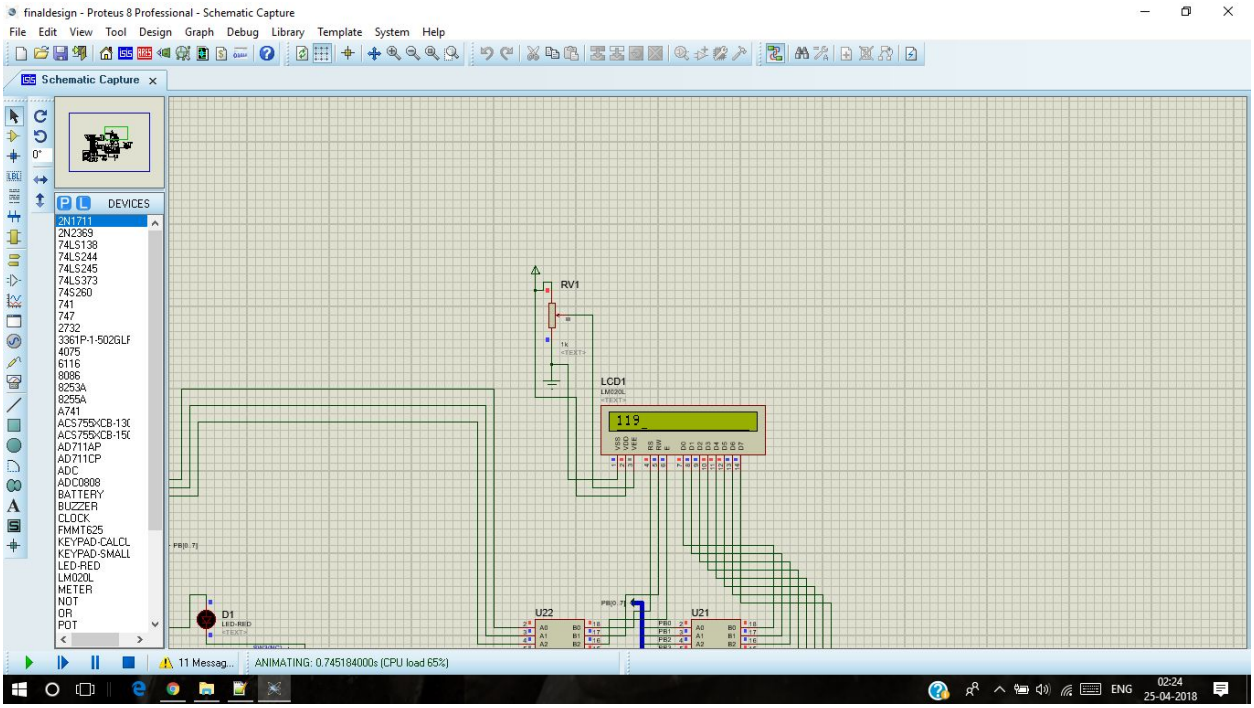
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KEYPAD-CALCL
KEYPAD-SMALL
LED-RED
LM020L
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OR
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RV1
LCD1
119
D1
U22
U21
11 Messag...
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ENG
02:24
25-04-2018