DIGITAL ELECTRONICS 2 LAB ASSIGNMENT 6

Name: Demirkan Korbey Baglamac
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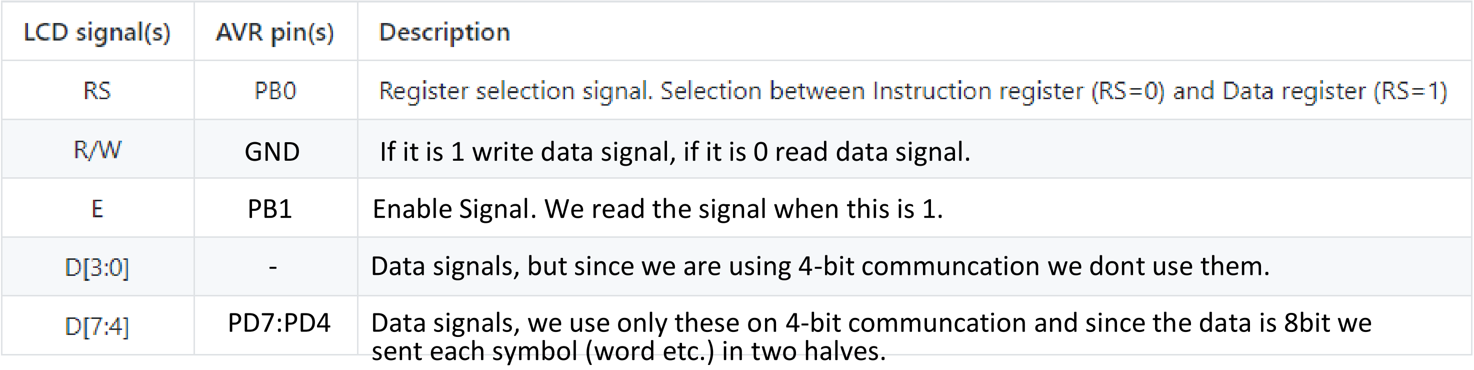
1) What data and control signals are used? What is the meaning of these signals?



LCD signal(s)	AVR pin(s)	Description
RS	PB0	Register selection signal. Selection between Instruction register (RS=0) and Data register (RS=1)
R/W	GND	If it is 1 write data signal, if it is 0 read data signal.
E	PB1	Enable Signal. We read the signal when this is 1.
D[3:0]	-	Data signals, but since we are using 4-bit communcation we dont use them.
D[7:4]	PD7:PD4	Data signals, we use only these on 4-bit communcation and since the data is 8bit we sent each symbol (word etc.) in two halves.

What is the ASCII table? What are the values for uppercase letters A to Z, lowercase letters a to z, and numbers 0 to 9 in this table?

ASCII is American Standard Code for Information Interchange.

HEXADECIMAL	BINARY	SYMBOL
30	00110000	0
31	00110001	1
32	00110010	2
33	00110011	3
34	00110100	4
35	00110101	5
36	00110110	6
37	00110111	7
38	00111000	8
39	00111001	9
41	01000001	A
42	01000010	B
43	01000011	C
44	01000100	D
45	01000101	E
46	01000110	F
47	01000111	G

48	01001000	H
49	01001001	I
4A	01001010	J
4B	01001011	K
4C	01001100	L
4D	01001101	M
4E	01001110	N
4F	01001111	O
50	01010000	P
51	01010001	Q
52	01010010	R
53	01010011	S
54	01010100	T
55	01010101	U
56	01010110	V
57	01010111	W
58	01011000	X
59	01011001	Y
5A	01011010	Z
61	01100001	a
62	01100010	b
63	01100011	c
64	01100100	d
65	01100101	e
66	01100110	f
67	01100111	g
68	01101000	h
69	01101001	i
6A	01101010	j
6B	01101011	k
6C	01101100	l
6D	01101101	m
6E	01101110	n
6F	01101111	o

70	01110000	p
71	01110001	q
72	01110010	r
73	01110011	s
74	01110100	t
75	01110101	u
76	01110110	v
77	01110111	w
78	01111000	x
79	01111001	y
7A	01111010	z

2)

Function name	Function parameters	Description	Example

`lcd_init`	`LCD_DISP_OFF`
	`LCD_DISP_ON`
	`LCD_DISP_ON_CURSOR`
	`LCD_DISP_ON_CURSOR_BLINK`
		Display off
		Display on, Cursor off
		Display on, Cursor on
		Display on, Cursor on flashing
			`lcd_init(LCD_DISP_OFF);`
			lcd_init(LCD_DISP_ON);
			lcd_init(LCD_DISP_ON_CURSOR);
			lcd_init(LCD_DISP_ON_CURSOR_BLINK);

`lcd_clrscr`	void	Clear display and set cursor to home pos.	`lcd_clrscr();`
`lcd_gotoxy`	uint8_t x, uint8_t y	Set cursor to specified position	lcd_gotoxy(0,0);
		x: horizontal position, y: vertical pos.	
`lcd_putc`	char c	Display character at current cursor.	lcd_putc(“c”);
`lcd_puts`	const char * c	Display string without auto linefeed.	lcd_puts(“hello”);
`lcd_command`	uint8_t cmd	Send LCD controller instruction command.	lcd_command(1<<LCD_CGRAM);
`lcd_data`	uint8_t data	Send data byte to LCD controller.	lcd_data(customChar[i]);

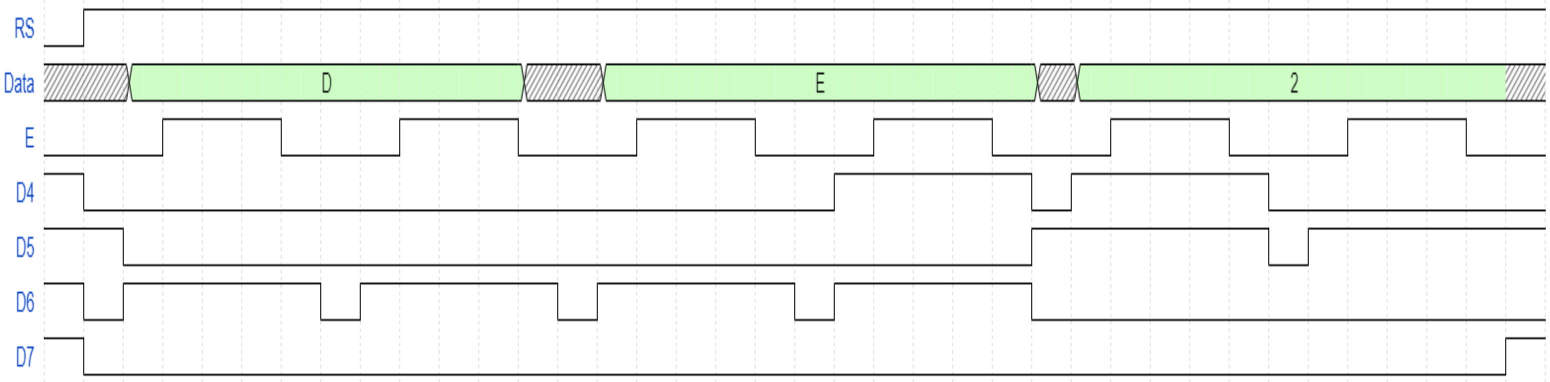
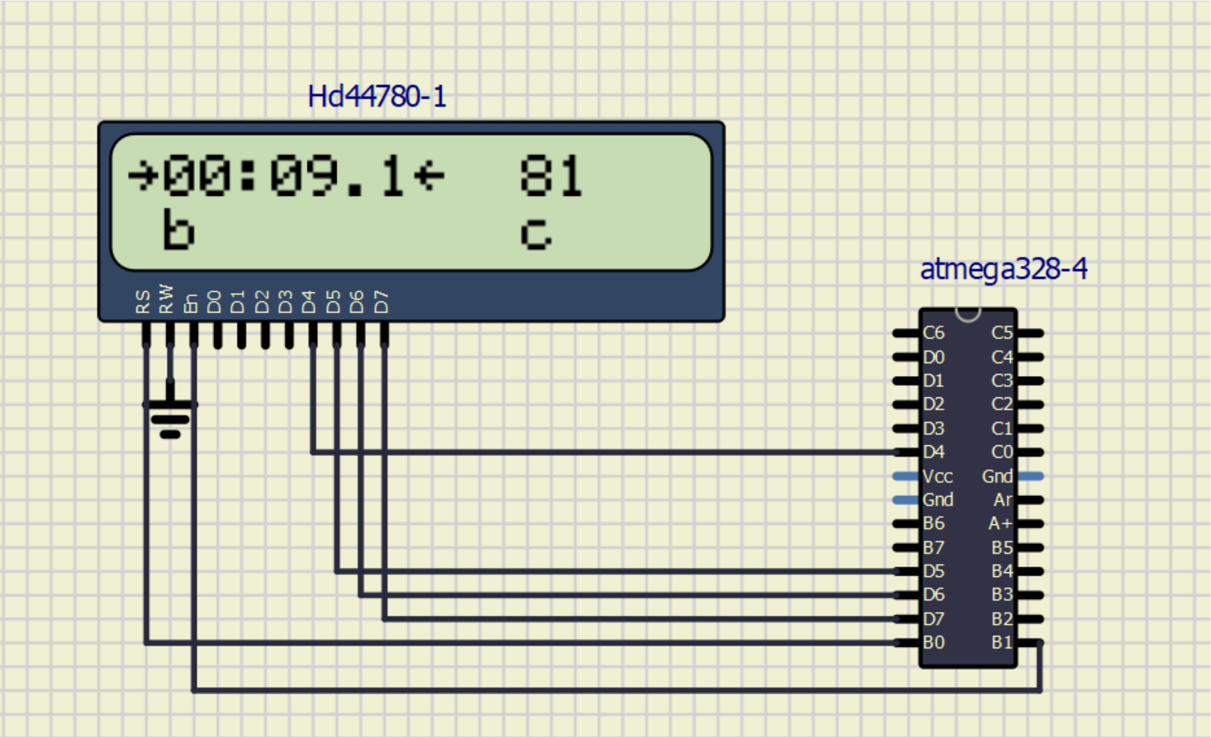


Table 1: Waveform for DE2

3) Listing of TIMER2_OVF_vect interrupt routine with complete stopwatch code (minutes:seconds.tenths) and square value computation,

```c
/**
 * ISR starts when Timer/Counter2 overflows. Update the stopwatch on
 * LCD display every sixth overflow, ie approximately every 100 ms
 * (6 x 16 ms = 100 ms).
 */
ISR(TIMER2_OVF_vect)
{
    static uint8_t number_of_overflows = 0;
    static uint8_t tens = 0;        // Tenths of a second
    static uint8_t secs = 0;        // Seconds
    static uint8_t mins = 0;        // Minutes
    char lcd_string[2] = "  ";      // String for converting numbers by itoa()
    char lcd_longstring[4];

    number_of_overflows++;
    if (number_of_overflows >= 6)
    {
        // Do this every 6 x 16 ms = 100 ms
        number_of_overflows = 0;

        // Update the tenths of a second
        tens++;
        if (tens >= 10)
        {
            tens = 0;

            //Update the seconds
            secs++;
            if(secs >= 60)
            {
                secs = 0;

                // Update the minutes
                mins++;
                if(mins >= 60)
                    mins = 0;

                // Display minutes
                lcd_gotoxy(1,0);
                if(mins < 10)
                    lcd_putc('0');
                itoa(mins, lcd_string, 10);
                lcd_puts(lcd_string);

            }

            //Display Seconds
            lcd_gotoxy(4,0);
            if(secs < 10)
                lcd_putc('0');
            itoa(secs, lcd_string, 10);
            lcd_puts(lcd_string);

            // Display the square value of the Seconds
            lcd_gotoxy(11, 0);
            itoa((secs * secs), lcd_longstring, 10);
            lcd_puts(lcd_longstring);
            if(secs == 0)
                lcd_puts("   ");
                }

                // Display hundredths of seconds
                lcd_gotoxy(7,0);
                // Converting cnt0 in decimal to string
                itoa(tens, lcd_string, 10);
                lcd_puts(lcd_string);

        }
}
```

Screenshot of the circuit:



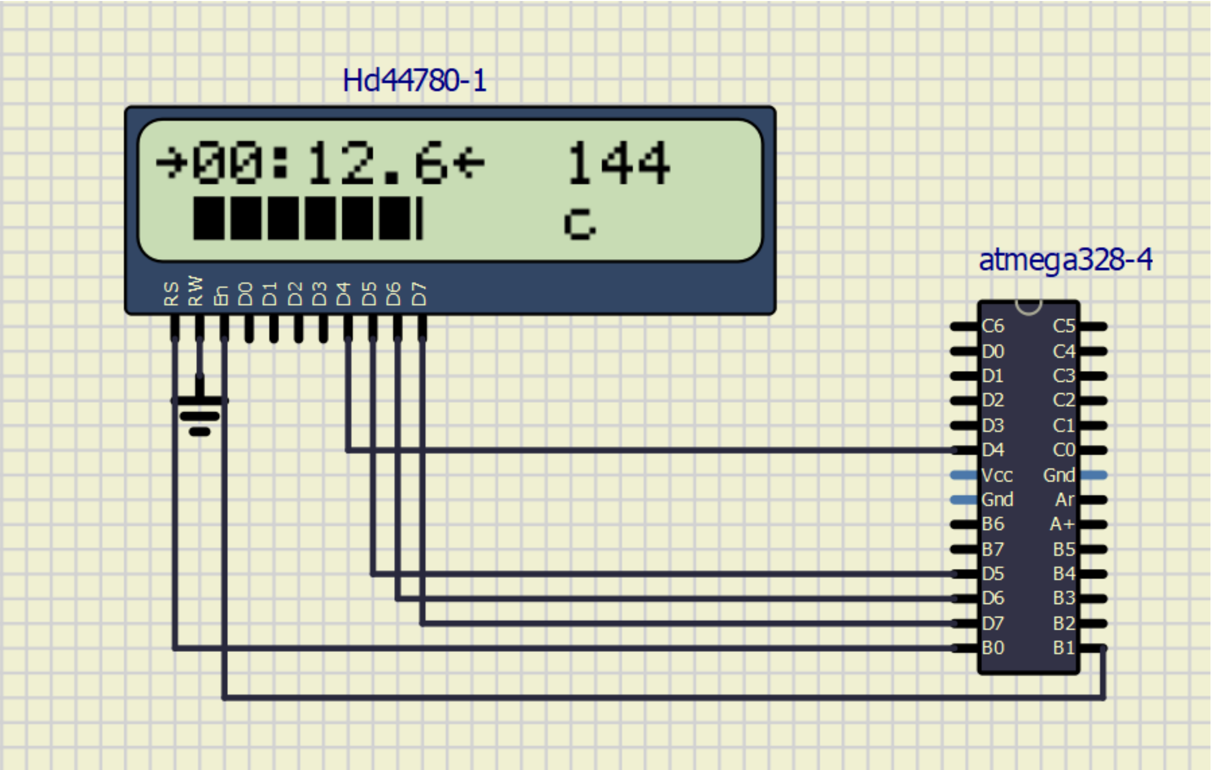
```
→00:09.1←   81
 b          c
```

4) Listing of TIMER0_OVF_vect interrupt routine with a progress bar,

```
/**
 * ISR starts when Timer/Counter0 overflows. Update the progress bar on
 * LCD display every 16 ms.
 */
ISR(TIMER0_OVF_vect)
{
        static uint8_t symbol = 0;
        static uint8_t position = 0;

        lcd_gotoxy(1 + position, 1);
        lcd_putc(symbol);
```

```
    symbol++;
    if(symbol >= 6)
    {
        symbol = 0;
        position++;
        if(position >= 10) {
            position = 0;
            lcd_gotoxy(1,1);
            for(uint8_t i; i < 10; i++) {
                lcd_putc(0);
            }
        }
    }
}
```

Screenshot of the circuit:


Hd44780-1
→00:12.6←   144
c
RS
RW
En
D0
D1
D2
D3
D4
D5
D6
D7
atmega328-4
C6
D0
D1
D2
D3
D4
Vcc
Gnd
B6
B7
D5
D6
D7
B0
C5
C4
C3
C2
C1
C0
Gnd
Ar
A+
B5
B4
B3
B2
B1