Experiment No: 11

BECS 31421

MICROCONTROLLER-BASED SIMPLE CALCULATOR

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DISCUSSION

In this experiment, a simple microcontroller-based calculator was implemented using the PIC16F628A microcontroller, a 16×2 LCD, and a 4×4 keypad. The primary goal was to perform basic arithmetic operations using two-digit numerical inputs entered via the keypad.

The system was programmed in MikroC PRO using essential libraries such as LCD, Keypad 4×4, C_String, and Conversion to facilitate communication between the microcontroller and the external devices. The keypad was scanned using polling, and ASCII codes were used to display characters on the LCD, ensuring compatibility and clarity.

User inputs were processed in a structured sequence: the user entered two digits to form the first number, selected an operator, then entered another two digits to form the second number. Once the '=' key was pressed, the microcontroller executed the operation and displayed the result.

However, in the final implementation, **only addition was successfully functional**, even though the program structure includes cases for subtraction, multiplication, and division. This limitation was due to the keypad mapping in the switch-case structure, where all three keys (8, 9, and 11) were incorrectly assigned the value **9**, preventing unique detection of '-', '*', and '/' operations. As a result, the system could not correctly identify any operation other than '+'.

In summary, the experiment demonstrated the core principles of microcontroller-based arithmetic processing and peripheral interfacing. While limited to addition due to input mapping issues, the project effectively showed how LCDs, keypads, and microcontrollers can be combined to perform interactive computing tasks.

SOURCE CODE

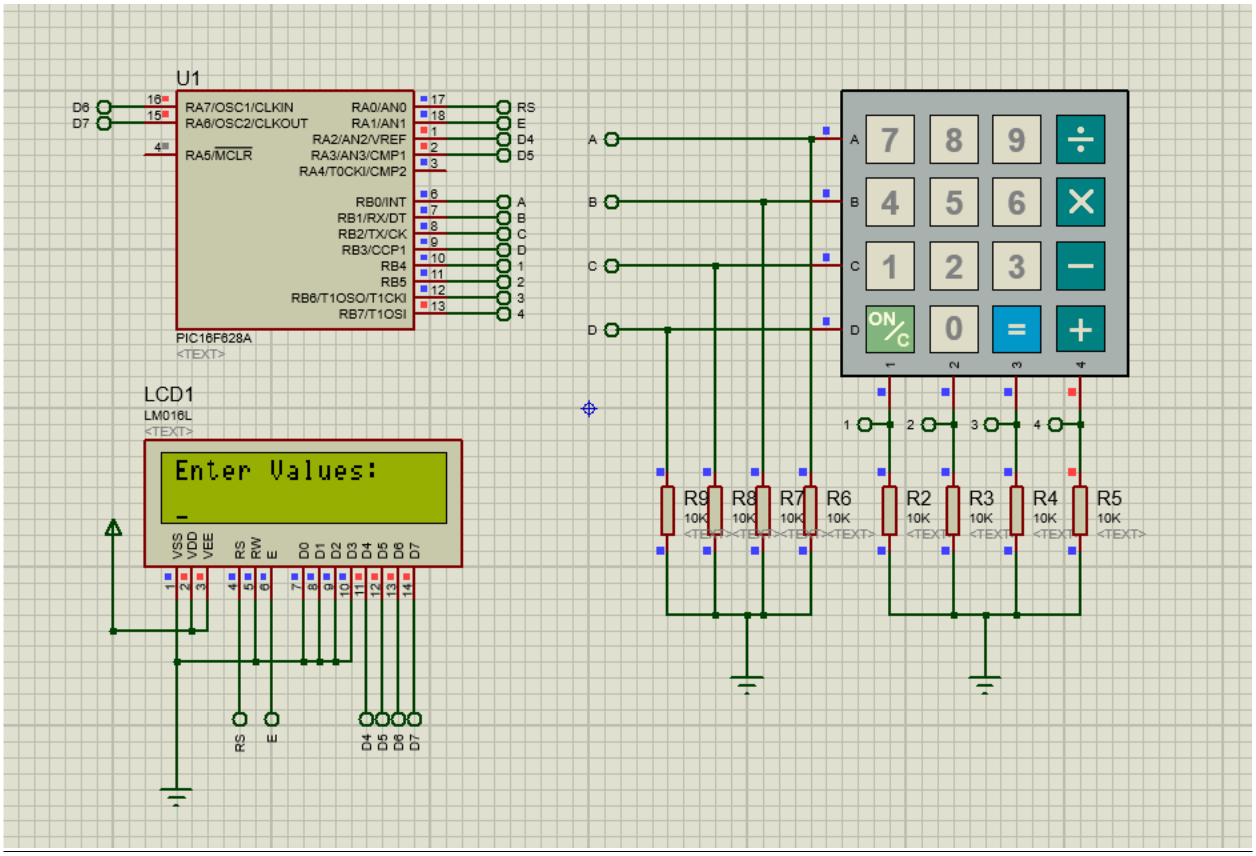
```
unsigned int kp = 0;
int val = 0;
int PW1 = 0, PW2 = 0, PW3 = 0, PW4 = 0, PW5 = 0;
int number1 = 0, number2 = 0;
long Answer = 0;
char answerx[15];
int state = 0;

#define DIVISION  '/'
#define MULTIPLY  '*'
#define SUBTRACT  '-'
#define ADD       '+'

char keypadPort at PORTB;

sbit LCD_RS at RA0_bit;
sbit LCD_EN at RA1_bit;
sbit LCD_D4 at RA2_bit;
sbit LCD_D5 at RA3_bit;
sbit LCD_D6 at RA7_bit;
sbit LCD_D7 at RA6_bit;

sbit LCD_RS_Direction at TRISA0_bit;
sbit LCD_EN_Direction at TRISA1_bit;
sbit LCD_D4_Direction at TRISA2_bit;
sbit LCD_D5_Direction at TRISA3_bit;
sbit LCD_D6_Direction at TRISA7_bit;
sbit LCD_D7_Direction at TRISA6_bit;

void ResetCalculator() {
  PW1 = PW2 = PW3 = PW4 = PW5 = number1 = number2 = Answer = 0;
```

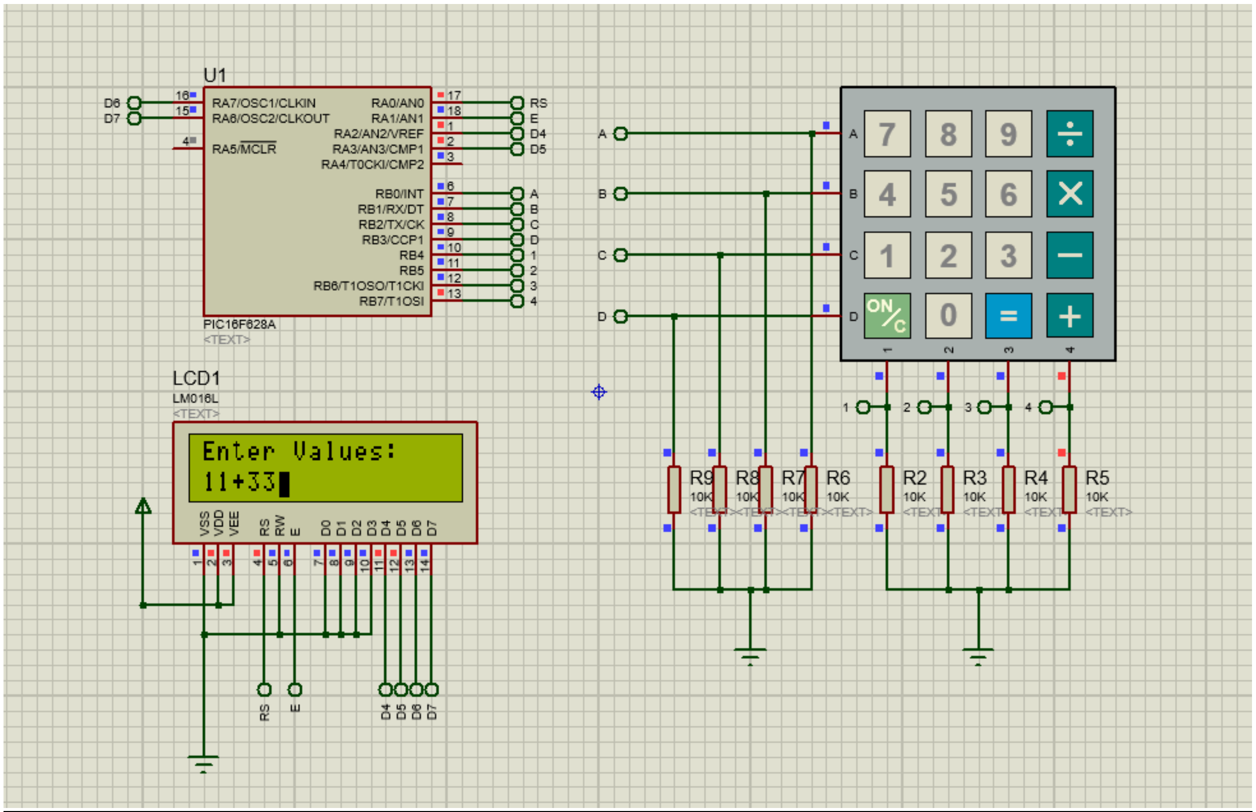
```
    state = 0;
    Lcd_Cmd(_LCD_CLEAR);
    Lcd_Out(1, 1, "Enter Values:");
    Lcd_Cmd(_LCD_SECOND_ROW);
    Lcd_Cmd(_LCD_BLINK_CURSOR_ON);
}

void main() {
    CMCON = 0x07;
    TRISA = 0x00;
    PORTA = 0x00;

    Keypad_Init();
    Lcd_Init();
    ResetCalculator();

    while (1) {
        do {
            kp = Keypad_Key_Click();
            Delay_ms(50);  // Debounce Delay
        } while (!kp);

        // Keypad Mapping
        switch (kp) {
            case  1: val = 7; break;
            case  2: val = 4; break;
            case  3: val = 1; break;
            case  4: val = 0; break;
            case  5: val = 8; break;
            case  6: val = 5; break;
            case  7: val = 2; break;
            case  8: val = 9; break;
            case  9: val = 9; break;
            case 10: val = 6; break;
            case 11: val = 3; break;
            case 12: val = '='; break;   // '=' key
            case 13: val = '/'; break;
            case 14: val = '*'; break;
            case 15: val = '-'; break;
            case 16: val = '+'; break;
            default: val = -1; break;
        }

        // Input Digits
        if (val >= 0 && val <= 9) {
            if (state == 0) {
                PW1 = val;
                Lcd_Chr_CP(PW1 + '0');
                state = 1;
            } else if (state == 1) {
                PW2 = val;
                Lcd_Chr_CP(PW2 + '0');
                number1 = PW1 * 10 + PW2;
                state = 2;
            } else if (state == 3) {
                PW4 = val;
                Lcd_Chr_CP(PW4 + '0');
                state = 4;
            } else if (state == 4) {
                PW5 = val;
                Lcd_Chr_CP(PW5 + '0');
                number2 = PW4 * 10 + PW5;
                state = 5;
            }
```

```
}

// Input Operator
if ((val == '+' || val == '-' || val == '*' || val == '/') && state == 2) {
    PW3 = val;
    Lcd_Chr_CP(PW3); // show operator
    state = 3;
}

// Equals (=) to calculate
if (val == '=' && state == 5) {
    switch (PW3) {
        case ADD:      Answer = number1 + number2; break;
        case SUBTRACT: Answer = number1 - number2; break;
        case MULTIPLY: Answer = number1 * number2; break;
        case DIVISION:
            if (number2 != 0)
                Answer = number1 / number2;
            else
                Answer = 0; // handle divide by zero
            break;
    }

    Lcd_Cmd(_LCD_CLEAR);
    Lcd_Out(1, 1, "Answer =");
    IntToStr(Answer, answerx);
    Lcd_Out(2, 1, answerx);

    // Wait for clear (C) key to reset
    while (1) {
        kp = Keypad_Key_Click();
        Delay_ms(50);
```

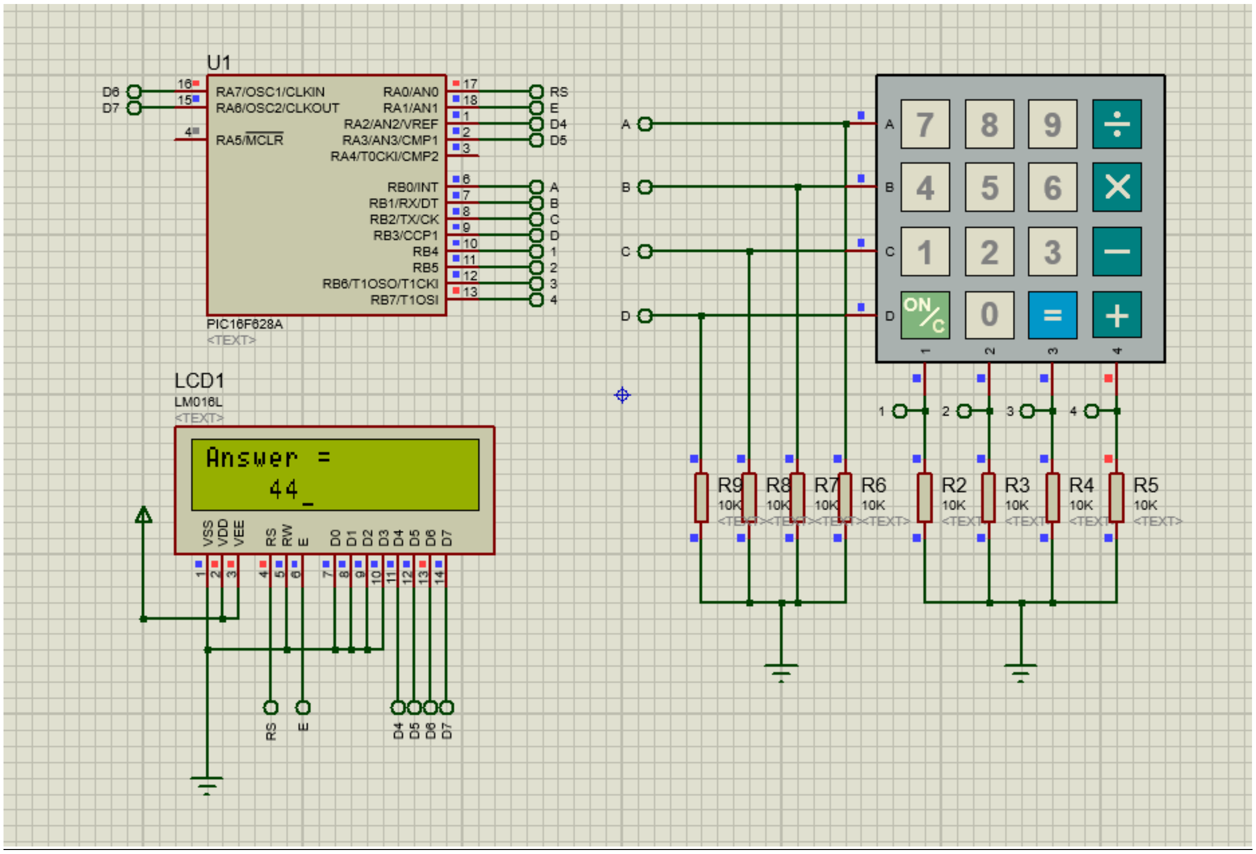
```
                if (kp == 1) break; // Press key 1 (e.g., mapped as C) to clear
            }

            ResetCalculator();
        }
    }
}
```

SIMULATION SCREENSHOTS





```
Enter Values:
11+33
```



```
Answer =
   44_
```