Basic Algebra Calculator using LCD and 4x4 keypad

1. Theoretical Part

Arduino is a small microcontroller board with a USB plug to connect to your computer and a number of connection sockets that can be wired up to external electronics, such as motors, relays, light sensors, laser diodes, loudspeakers, microphones, etc. Arduinos can be powered either through the USB connection from the computer or from a 9V battery. They can be controlled from the computer or programmed by the computer and then disconnected and allowed to work independently. [1].

A 4x4 keypad matrix working principle: Initially, all rows are set to 0(LOW) and all Columns are set to 1(HIGH). When a key press occurs the column pin will get contacted to the row pin and makes the entire column state to low. To identify the exact pin at the column, we need to scan each row by sending 1 (HIGH) and read the state at Column pins. The column which changes the state from 0(LOW) to 1(HIGH) then that is the location of the pressed key (Passes the HIGH signal from Row to Column pin).[3]
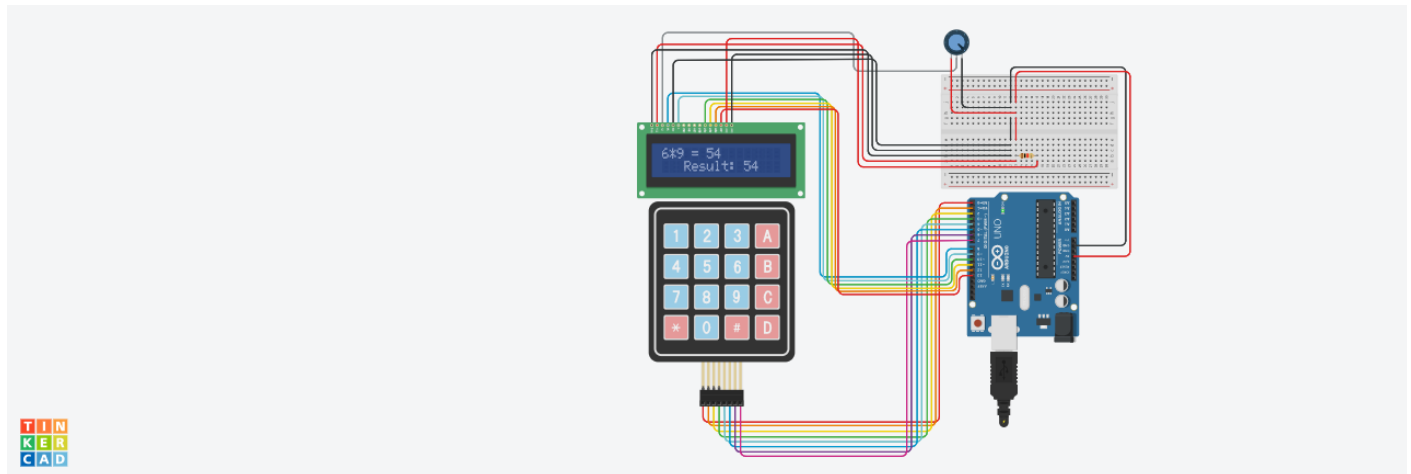

Figure 1. Calculator using Arduino, LCD display and 4x4 Keypad

A list of the components that were used for the implementation of this circuit:

Table 1. Used components

Nr. Crt	Used Components	Value
1	Arduino Uno R3	-
2	Potentiometer	5k ohm
3	Resistor	1k ohm
4	16x2 LCD display	-
5	4x4 Keypad	-
6	Small Breadboard	-

- The potentiometer adjusts the contrast of the writing on the LCD screen. When on 'low' the contrast is 0 and when on 'high' the contrast is maximum. The user needs to rotate the potentiometer until reaching the desired contrast of the colours.
- The 16x2 LCD displays the result of the computation.
- The 4x4 keypad is used by the user to select numbers and perform basic algebra computations with them.
- The Arduino Uno board is used as a microcontroller to make the connections between all the components and power them up.

2. Electrical circuit (Proteus/Tinkercad)

The circuit that I implemented is a calculator which performs basic algebra operations: addition, subtraction, multiplication and division.

For the circuit to be able to perform these tasks, there were used an Arduino Uno board, an LCD display screen and a 4x4 keypad.

The 4x4 keypad is used to store the desired numbers and perform operations between them. To do that, the user must press on the buttons of the keypad as follows:

- The buttons from '0' to '9' will store and display the numbers from 0 to 9. If one of those buttons is pressed twice or more times, then the number stored will be a*10+a.
      Ex: if '4' is pressed 2 times then the number displayed on the screen will be '44'.
- The button 'A' performs addition, '+'.
- The button 'B' performs subtraction, '-'.
- The button 'C' performs multiplication, '*'.
- The button 'D' performs division, '/'.
- The button '#' acts as 'equal', '='.
- The button '*' clears the screen.

The 16x12 LCD screen will then display the result of the computation.

On the screen, at first, will be displayed an intro message "Calculator", then the main info will be shown. On the first line will take place the operation, which will then be displayed on the second line of the screen, precedented by the message "Result:".

For a new operation to be performed, the user will need to press the '*', which clears the screen.

The link to my tinkercad project: https://www.tinkercad.com/things/7Pm2oJZ5bVI

3. Arduino IDE

```
#include <LiquidCrystal.h>
#include <Keypad.h>


const byte rows = 4;                                    // rows on the keypad
const byte cols = 4;                                    // columns on the keypad


char keys[rows][cols] =
 {{'1','2','3','A'},
  {'4','5','6','B'},
  {'7','8','9','C'},
  {'*','0','#','D'}};                                   // implements the keymap


byte rowPins[rows] = {0,1,2,3};  // the rows of the keypad are connected to these pins on the Arduino bord
byte colPins[cols] = {4,5,6,7}; // the column of the keypad are connected to these pins on the Arduino bord
Keypad kpd = Keypad( makeKeymap(keys), rowPins, colPins, rows, cols ); //for the construction of the keypad
const int rs = 8,
     en = 9,
     d4 = 10,
     d5 = 11,
     d6 = 12,
     d7 = 13;                                 // the pins to which the LCD is connected
LiquidCrystal lcd(rs, en, d4, d5, d6, d7);
long a,b,nr;
char key,action;
boolean result = false;
```

```
void setup()
{
  lcd.begin(16, 2);                          //this is what we need for a 16*2 LCD display
  lcd.print("   Calculator");                //intro message on the display

  delay(500);                                //500ms till the screen displays info
  lcd.clear();                               //clear
}



void loop() {
key = kpd.getKey();                          //storing pressed key value in a char


if (key!=NO_KEY)
DetectButtons();


if (result==true)
CalculateResult();


DisplayResult();
}



void DetectButtons(){      //detects which buttons are pressed on the keypad, and what action to perform

  lcd.clear();                               //clear
  if (key=='*')                              //cancel button '*' is pressed
  {
  Serial.println ("Cleans the screen");
  nr=a=b=0;
  result=false;}


  if (key == '1')                            //button 1 is pressed
```

```
{
Serial.println ("Button 1");
if (nr==0)
nr=1;                                    //when pressed once
else
nr = (nr*10) + 1;                        //when pressed twice
}


 if (key == '4')                         //button 4 is pressed
{
Serial.println ("Button 4");
if (nr==0)
nr=4;                                    //when pressed once
else
nr = (nr*10) + 4;                        //when pressed twice
}


 if (key == '7')                         //button 7 is pressed
{
Serial.println ("Button 7");
if (nr==0)
nr=7;                                    //when pressed once
else
nr = (nr*10) + 7;                        //when pressed twice
}



if (key == '0')
{
Serial.println ("Button 0");             //button 0 is pressed
if (nr==0)
nr=0;                                    //when pressed once
else
```

```
nr = (nr*10) + 0;                                    //when pressed twice

 }


 if (key == '2')                                      //button 2 is pressed
 {
Serial.println ("Button 2");
if (nr==0)
nr=2;                                                //when pressed once
else
nr = (nr*10) + 2;                                    //Pressed twice

 }


if (key == '5')
{Serial.println ("Button 5");                         //button 5 is pressed
if (nr==0)
nr=5;                                                //when pressed once
else
nr = (nr*10) + 5;                                    //when pressed twice

 }


 if (key == '8')
 {
 Serial.println ("Button 8");                         //button 8 is pressed
 if (nr==0)
 nr=8;                                                //when pressed once
 else
 nr = (nr*10) + 8;                                    //when pressed twice

 }


if (key == '#')                                       //button equal button '#' is pressed
{Serial.println ("=");                                //equal sign
b=nr;
result = true;
```

```
    }

  if (key == '3')
  {Serial.println ("Button 3");                                //button 3 is pressed
   if (nr==0)
  nr=3;                                                        //when pressed once
  else
  nr = (nr*10) + 3;                                            //when pressed twice
   }


   if (key == '6')                                             //button 6 is pressed
  {Serial.println ("Button 6");
  if (nr==0)
  nr=6;                                                        //when pressed once
  else
  nr = (nr*10) + 6;                                            //when pressed twice
   }


   if (key == '9')
  {Serial.println ("Button 9");                                //button 9 is pressed
  if (nr==0)
  nr=9;                                                        //when pressed once
  else
  nr = (nr*10) + 9;                                            //when pressed twice
   }



if (key == 'A' || key == 'B' || key == 'C' || key == 'D')      //the 'action' buttons
{
 a = nr;
 nr =0;
```

```
  if (key == 'A')                                    //button A is pressed
  {Serial.println ("Adds the numbers");
   action = '+';}


   if (key == 'B')                                    //button B is pressed
  {Serial.println ("Substracts the numbers");
   action = '-'; }


   if (key == 'C')                                    //button C is pressed
  {Serial.println ("Multiplies the numbers");
   action = '*';}


   if (key == 'D')                                    //button D is pressed
  {Serial.println ("Divides the numbers");
   action = '/';}
   delay(100);
  }
}


void CalculateResult(){                              //function to compute the result
 if (action=='+')
   nr = a+b;                                          //the numbers are added
 if (action=='-')
   nr = a-b;                                          //the numbers are substracted
 if (action=='*')
  nr = a*b;                                           //the numbers are multiplied
 if (action=='/')
   nr = a/b;                                          //the numbers are divided
}



void DisplayResult(){                                //function to display the result on the LCD
 lcd.setCursor(0, 0);                                // places the cursor to column 0, line 1
```

```
lcd.print(a); lcd.print(action); lcd.print(b);


if (result==true)
{lcd.print(" = ");
 lcd.print(nr);
 }                               //displays the result


 lcd.setCursor(3, 1);                   // places the cursor to column 3, line 2
 lcd.print("Result: "); lcd.print(nr);       //Result:
}
```

Reference list

[1] Laboratory 1-Introduction to Arduino and Proteus, Prof. Lorant Szolga

[2] Tinkercad, https://www.tinkercad.com/things/3LGdZ5FNwVp

[3] Factoryforward, https://www.factoryforward.com/4x4-matrix-keypad-principle-interfacing-arduino/