Keypads

ECE 376 Embedded Systems

Jake Glower - Lecture #10

Please visit Bison Academy for corresponding
lecture notes, homework sets, and solutions

Keypads

- One way to input numbers to a PIC processor

Allows you to

- Input the starting time for a clock
- Input the frequency of a signal generator
- Input the speed of a motor
- Input numbers for a calculator

Binary Device
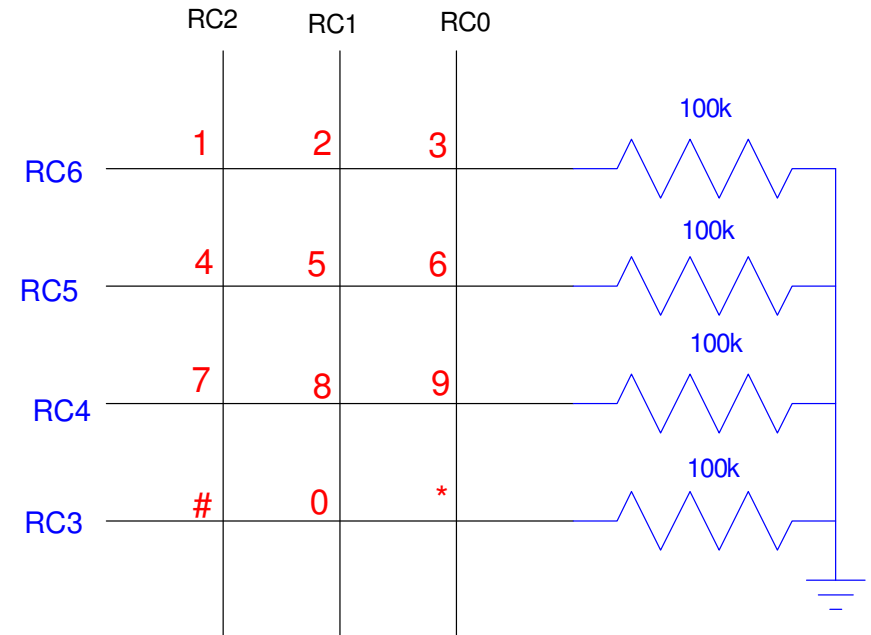
- Easy to interface with a PIC processor

Schematics:

- Membrane keypad
- $1.33 from ebay

3 x 4 keypad

- Rows shorted to colums when a button is pressed
- Hardware converts 'press' to 0V / 5V

Apply 5V to a column

- If a row is 5V, that key was pressed

Software: Scan Keypad

```
char GetKey(void)
{
    int i;
    unsigned char RESULT;
    TRISC = 0xF8;
    RESULT = 0xFF;
    PORTC = 4;
    for (i=0; i<100; i++);
    if (RC6) RESULT = 1;
    if (RC5) RESULT = 4;
    if (RC4) RESULT = 7;
    if (RC3) RESULT = 10;
    PORTC = 2;
    for (i=0; i<100; i++);
    if (RC6) RESULT = 2;
    if (RC5) RESULT = 5;
    if (RC4) RESULT = 8;
    if (RC3) RESULT = 0;
    PORTC = 1;
    for (i=0; i<100; i++);
    if (RC6) RESULT = 3;
    if (RC5) RESULT = 6;
    if (RC4) RESULT = 9;
    if (RC3) RESULT = 11;
    PORTC = 0;
    return(RESULT);
}
```
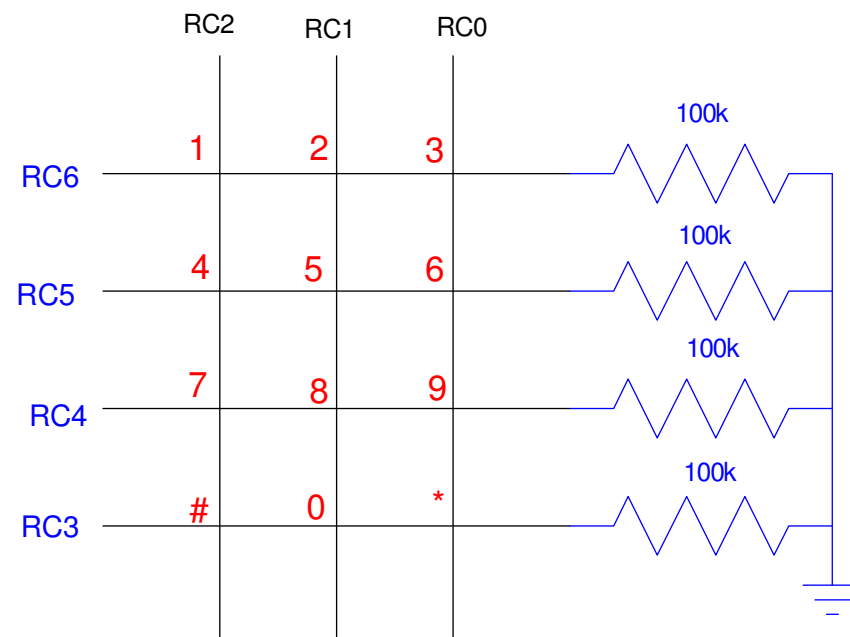
Read a single key press

Problem

- Previous code returns multiple reads when a button is pressed

Comment	C Code

Blue

- Wait until you press a button

Red

- Wait until you releast the button

Black

- Then wait another 100ms
- Prevents bouncing

- .

```c
char ReadKey(void)
{
    char X, Y;
    do {
        X = GetKey();
        }    while(X > 20);
    do {
        Y= GetKey();
        }    while(Y < 20);
    Wait_ms(100);   // debounce
    return(X);
    }
```
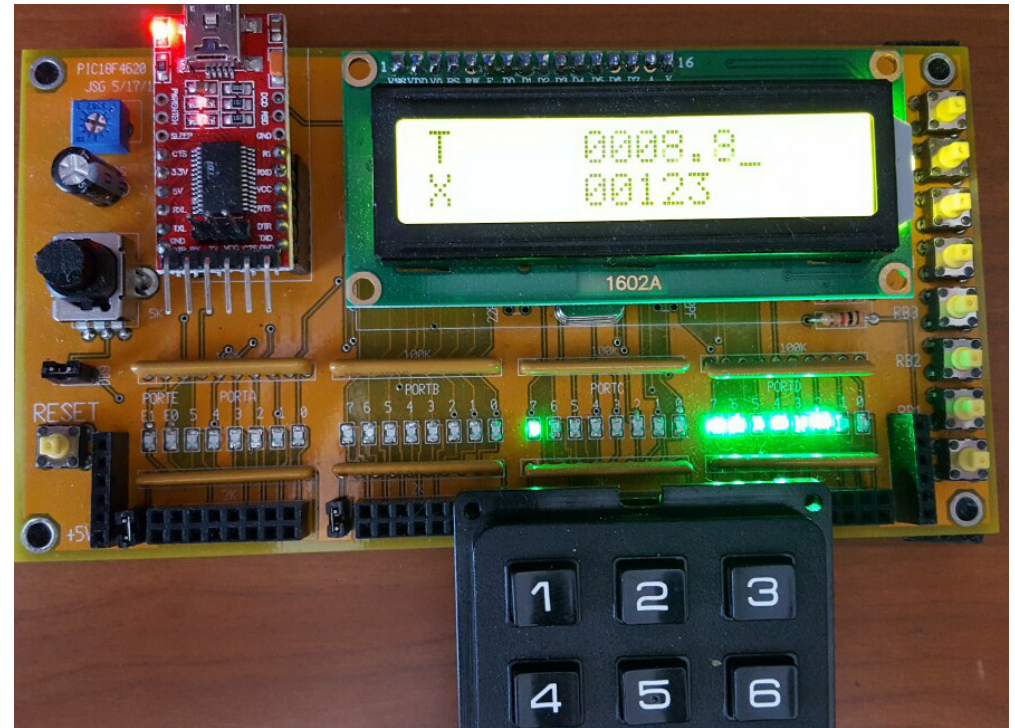
Fun with Keypads: Alarm Clock

- Input a number from 0000 to 9999.
- Press * to start. It then counts down displaying the remaining time as XXXX.X
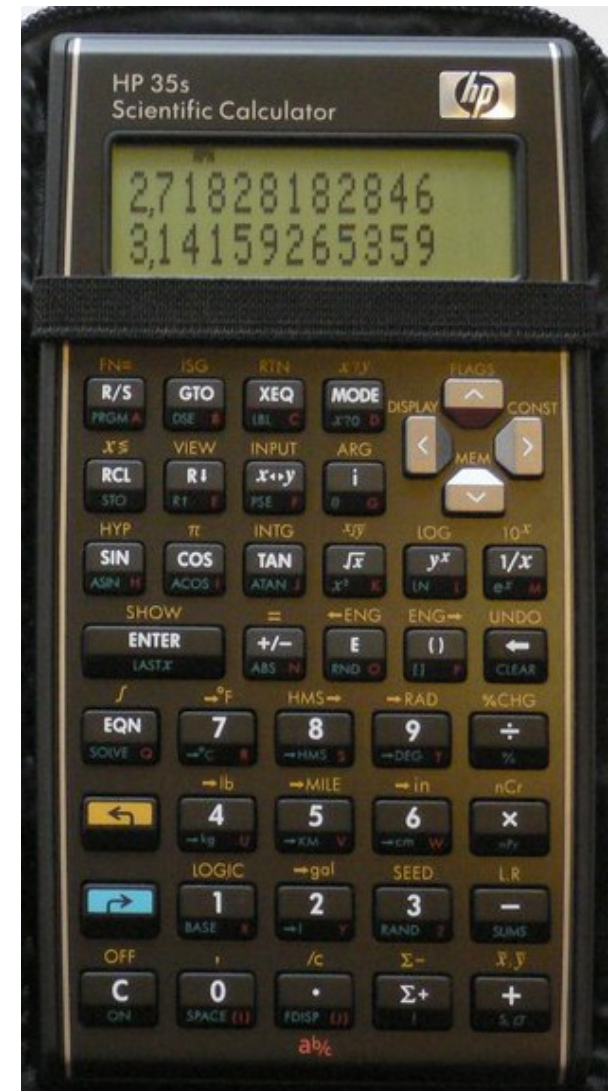
```
while(1) {
    TEMP = ReadKey();
    if (TEMP < 10) X = (X*10) + TEMP;
    if (TEMP == 10) {
        TIME = X;
        X = 0;
        RUN = 1;
        }
     if (RUN) {
        while(TIME) {
            TIME = TIME - 1;
            LCD_Move(0,5);   LCD_Out(TIME,5,1);
            Wait_ms(100);
            }
        PORTA = 0xFF;
        Wait_ms(1000);
        PORTA = 0;
        RUN = 0;
        }
    LCD_Move(1,5);   LCD_Out(X, 5, 0);
    LCD_Move(0,5);   LCD_Out(TIME, 5, 1);
    Wait_ms(100);
    }
```

Fun with Keypads: RPN Calculator

Program your PIC to operated as an RPN calculator
with the following functions:

*	#	RB5	RB4	RB3	RB2	RB1	RB0
Enter	undo	-	clear	*	/	+	-

Step 1: Modify the GetKey function so it recognizes other buttons (RB0..RB3)

```
char GetKey(void)
{
   .
   .
   .
   PORTC = 1;
   for (i=0;  i<100;  i++);
   if (RC6) RESULT = 3;
   if (RC5) RESULT = 6;
   if (RC4) RESULT = 9;
   if (RC3) RESULT = 11;
   if (RB0) RESULT = 12;
   if (RB1) RESULT = 13;
   if (RB2) RESULT = 14;
   if (RB3) RESULT = 15;
   if (RB4) RESULT = 16;
   PORTC = 0;
   return(RESULT);
}
```

Main Routine:

```
while(1) {
    TEMP = ReadKey();

    if (TEMP < 10) X = (X*10) + TEMP;

    if (TEMP == 10) {                  // * Enter (push)
        T = Z;
        Z = Y;
        Y = X;
        X = 0;
    }

    if (TEMP == 11) {                  // # undo
        X = X / 10;
    }

    if (TEMP == 12) {                  // RB0 subtract
        X = Y - X;
        Y = Z;
        Z = T;
    }

    if (TEMP == 13) {                  // RB1 add
        X = X + Y;
        Y = Z;
        Z = T;
    }
```

```c
        if (TEMP == 14) {                    // RB2 divide
           X = Y / X;
           Y = Z;
           Z = T;
           }

        if (TEMP == 15) {                    // RB3 multiply
           X = X * Y;
           Y = Z;
           Z = T;


           }
        if (TEMP == 16) {                    // RB4 clear
           X = 0;
           }

     LCD_Move(1,5);  LCD_Out(X, 5, 0);
     LCD_Move(0,5);  LCD_Out(Y, 5, 0);

     }

  }
```
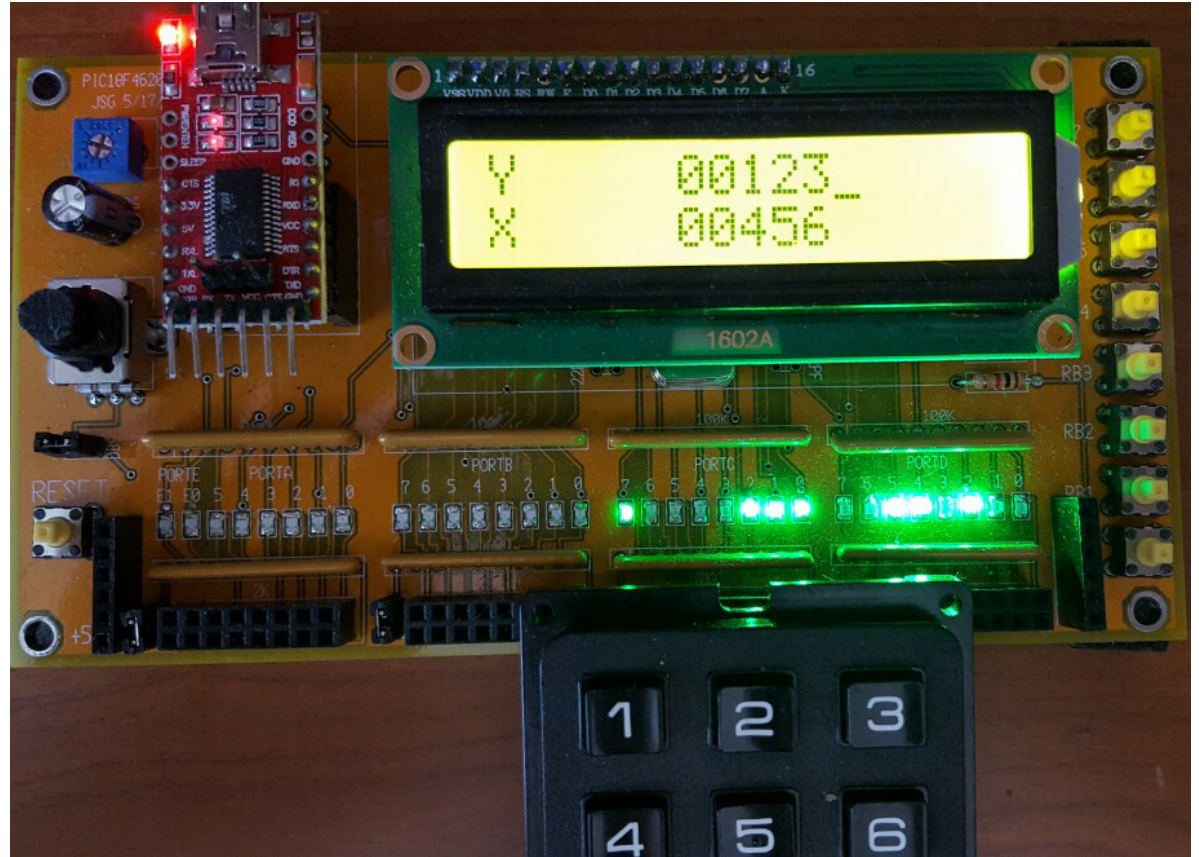
Example:

$$X = \left(\frac{(6+7)(8+9)}{(2+3)} \right) = 44.2$$

```
6
enter
7
+
8
enter
9
+
*
2
enter
3
+
/
```

RPN Complex Number Calculator

Add, subtract, multiply, divide complex numbers

Stack:
```
x, y, z, t;
ix, iy, iz, it;
```

To input a complex number, use the COMPLEX key (HP42)

To input 1 + j2

   1

   enter

   2

   complex

Addition:

(a + jb) + (c + jd) = (a + c) + j (b + d)

Subtraction:

(a + jb) - (c + jd) = (a - c) + j (b - d)

Multiplication

(a + jb)(c + jd) = (ac - bd) + j (ac + bd)

Division

$$\left(\frac{a+jb}{c+jd}\right) = \left(\frac{a+jb}{c+jd}\right)\left(\frac{c-jd}{c-jd}\right) = \left(\frac{(ac+bd)+j(bc-ad)}{c^2+d^2}\right)$$

$$\left(\frac{a+jb}{c+jd}\right) = \left(\frac{ac+bd}{c^2+d^2}\right) + j\left(\frac{bc-ad}{c^2+d^2}\right)$$

Exponent

$$\exp(a + jb) = e^a e^{jb} = e^a(\cos(b) + j\sin(b))$$

$$= e^a\cos(b) + je^a\sin(b)$$

Cosine

$$\cos(x) = \left(\frac{e^{jx} + e^{-jx}}{2}\right)$$

$$\cos(a + jb) = \left(\frac{\exp(-b + ja) + \exp(b - ja)}{2}\right)$$

$$= \left(\frac{1}{2}\right)(e^{-b}\cos(a) + je^{-b}\sin(a) + e^b\cos(a) + je^b\sin(-a))$$

$$= \left(\frac{e^{-b} + e^b}{2}\right)\cos(a) + j\left(\frac{e^{-b} - e^b}{2}\right)\sin(a)$$