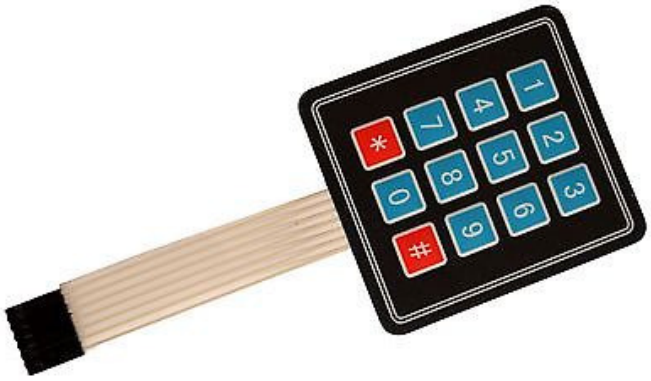
Keypads



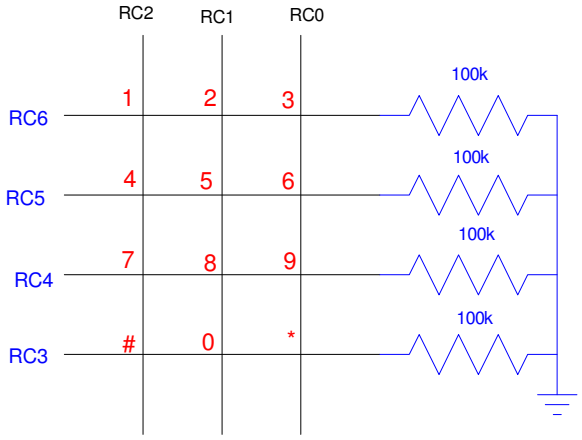
Objective:

One recurring problem with microcontrollers is how to get data to and from the controller. A keypad like the one on your calculator is one way to do this. This lecture should give you the background you need to interface a keypad to your PIC board.

Schematics:

The keypad in your lab kit come from ebay and cost $1.33 each. It plugs right into PORTC on your PIC board. There are other keypads out there, but the cost and easy interfacing to your board is why we're using this one.

A 3x4 keypad has seven pins: four for rows and 3 for columns. When you press a key, such as '1', row 1 is shorted to column 1. To detect this, the PIC needs to detect which pins are shorted.



One way to do this is as follows:

Connect each row to ground with a 100k resistor. Conveniently, this is already done on your PIC board. Set these four pins to input. If nothing happens, you'll read 0000 on these four pins.

Next, scan the three columns.

- Apply 5V to the first column. If any row reads a '1', the corresponding key in that column was pressed.
- Repeat for column 2 and 3.

Software:

Problem: Write a subroutine which scans PORTC for the keypad. Return 0xFF if no key was pressed. Return the key value for any other key.

```
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;
   if (RB0) RESULT = 12;
   if (RB1) RESULT = 13;
   if (RB2) RESULT = 14;
   if (RB3) RESULT = 15;
   if (RB4) RESULT = 16;
   PORTC = 0;
   return(RESULT);
}
```

There is probably a better way to do this, but part of the reason to use C is to produce code that is understandable and reusable.

Problem: The previous code outputs the same number over and over again when you hold the button down. Write a program which returns a single number when a button is pressed.

Solution:

```
char ReadKey(void)
{
   char X, Y;
   do {
      X = GetKey();
      }   while(X > 20);
   do {
      Y= GetKey();
      }   while(Y < 20);
   Wait_ms(100);  // debounce
   return(X);
   }
```

Note several things:

- This routine waits until you press a key (first do loop in blue)
- It then waits until you release the key (second do loop in red)
- It then waits an additional 100ms to avoid multiple reads

Alarm Clock (Alarm.C)

Input a number from 0000 to 9999.

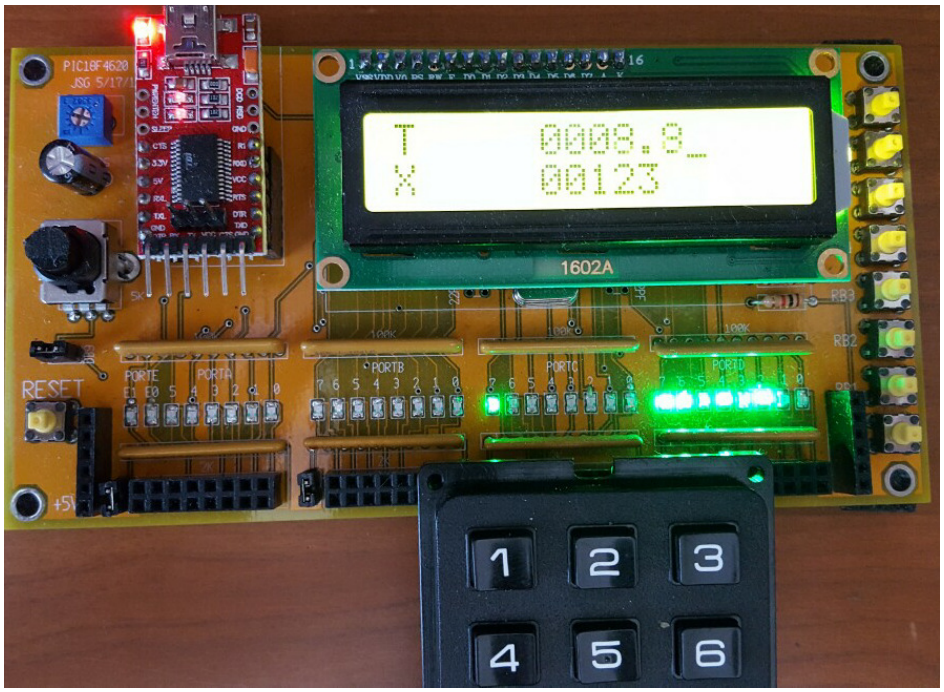
When you press the star button, have the PIC processor count down, displaying the time as XXX,X seconds. When you reach 000.0 seconds, turn on the lights on PORTA.

Solution:

```
// Main Routine

void main(void)
{
   unsigned int i, j;
   int TIME, X, RUN, TEMP;

   TRISA = 0;
   TRISB = 0xFF;
   TRISC = 0xF8;
   TRISD = 0;
   TRISE = 0;
   TRISA = 0;
   ADCON1 = 15;

   PORTA = 0;

   LCD_Init();                    // initialize the LCD

   LCD_Move(0,0);  for (i=0; i<20; i++) LCD_Write(MSG0[i]);
   Wait_ms(2000);
   LCD_Inst(1);

   TIME = 0;
   X = 0;
   RUN = 0;

   LCD_Move(0,0);  LCD_Write('T');
   LCD_Move(1,0);  LCD_Write('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);

      }

   }
```

Comments:

- The blue section of code reads the keypad - allowing you to input numbers from 0000 to 9999.
- When you press the star button '*', whatever number you input is stored in TIME. The red section of code then counts down to zero at one count every 100ms.
- When you reach 0000.0 seconds, the lights on PORTA turn on for one second.
- The code then repeats and waits for another time.



Keypad Alarm Clock: The keypad connects to PORTC pins 0..6. The number you type in is displayed as X. When you press the * key, the time is displayed as T and it counts down to 0000.0 seconds. When it reaches zero, the lights on PORTA turn on for one second.

RPN Calculator: (RPN.C) Build a calculator which has four operations: +. -, *, /

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

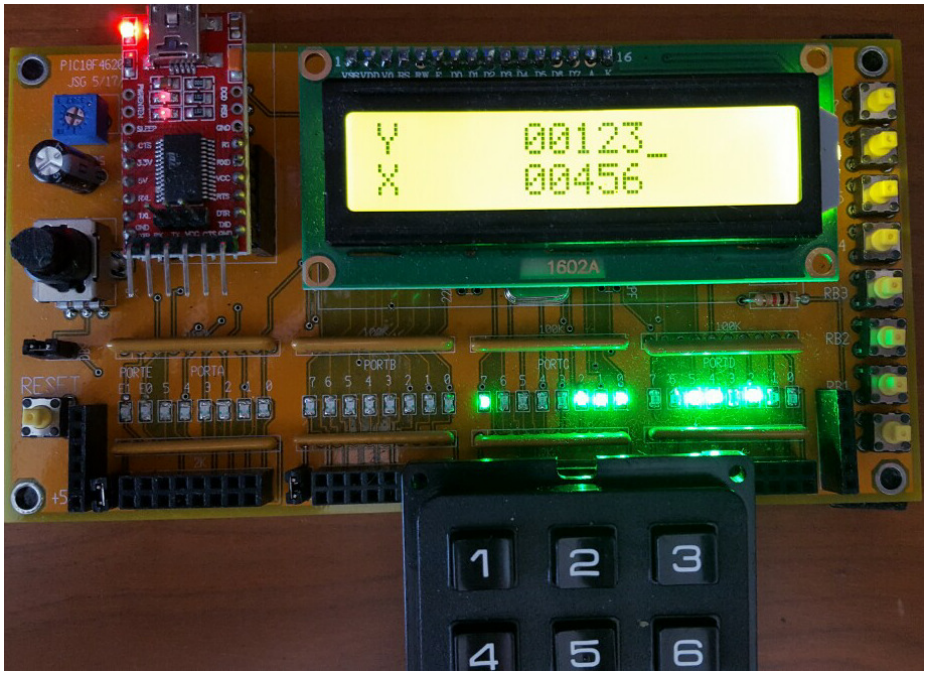
*	#	RB5	RB4	RB3	RB2	RB1	RB0
Enter	undo	-	clear	*	/	+	-

Solution: First, modify the GetKey function so it recognizes other buttons (RB0..RB3)

```
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;
   if (RB0) RESULT = 12;
   if (RB1) RESULT = 13;
   if (RB2) RESULT = 14;
   if (RB3) RESULT = 15;
   if (RB4) RESULT = 16;
   PORTC = 0;
   return(RESULT);
}
```

In the main routine, check what button you pressed to know what to do:

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

   if (TEMP < 10) X = (X*10) + TEMP;              // Input number

   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;
      }
   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);

   }

}
```



RPN Calculator. The keypad connects to PORTC pins 0..6. The number you input displays as X. You can push X onto the stack (Y). Operations are addition (RB1) subtraction (RB0), multiplication (RB4) and division (RB3)