LOW-COST LCD FREQUENCY METER

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requency meters have always been expensive tools for the average hobbyists. Now, with microcontrollers and liquid-crystal displays (LCDs) having become very economical and popular, it is possible to build a compact and low-cost LCD-based frequency meter that can measure up to 250 kHz.

A sample photo of the LCD module is shown in Fig. 1. These modules are available in 14- and 16-pin configurations. The 16-pin module has a backlight option. Popular brands are Lampex and Hantronix. Note the pin numbers before soldering to the circuit.

In this project, the LCD module used is Lampex LM16200 with 16 alphanumeric characters and two lines with backlight option. Pin details of this module are given in Table I. A functional diagram of the module is shown in Fig. 2.

However, you may use any branded or unbranded 2-line, 16-character LCD module for this project. The 10k potentiometer, which controls the contrast of the LCD module, works best when its wiper contact is nearer to ground potential.

Circuit description

Fig. 3 shows the circuit of the frequency counter including the power supply. The microcontroller used is AT89C2051, which features 2 kB of Flash, 128 bytes of RAM, 15 input/output (I/O) lines, two 16-bit timer/counters, a five-vector two-level interrupt architecture, a full-duplex serial port, a precision analogue comparator, an on-chip oscillator and clock circuitry.

Port-1 is used to drive the LCD in 4-bit mode with 10-kilo-ohm pull-up resistors. The 24MHz crystal used gives a processing speed of 2 mega-instructions per second (MIPS).

Timer 0 is used as an external counter to count the input pulses. Transistor T1 amplifies the input signal, while non-inverting gate NI (1/6 CD4050) serves as a buffer for coupling the amplified pulses to input pin 8 (P2.4) of timer-0.

A software gate of one-second duration is used to count the number of pulses corresponding to the frequency of the input signal source. The count value is read and displayed on the 2-line, 16-character LCD module. The flow-chart of the frequency counting routine is shown in Fig. 4.

A conventional power supply circuit comprising a step-down trans-
former followed by a bridge rectifier, smoothing capacitor and 5V regulator is used to power the circuit. Capacitor C2 (0.1µF) filters ripples in the output of the regulator and LED1 shows the supply status. To test the circuit, connect any pulse generator output to the probe and check the frequency displayed on the LCD screen.

The LCD module is used in the 4-bit data interface mode, wherein only data pins for DB4 through DB7 are used for data transfer. The configuration used is shown in Table II.

An actual-size, single-side PCB for the LCD frequency meter (Fig. 3) is shown in Fig. 5 and its component layout in Fig. 6.

### The software

The software is compiled using the demo version of BASCOM-8051, which can be downloaded from website 'www.mcselec.com.'

Syntax of some of the important instructions used in the program is shown in the box along with examples. The BASCOM compiler provides special instructions for use and display of data on the LCD module.

#### TABLE II

<table>
<thead>
<tr>
<th>LCD display</th>
<th>Port</th>
<th>Pin</th>
</tr>
</thead>
<tbody>
<tr>
<td>DB7</td>
<td>P1.7</td>
<td>14</td>
</tr>
<tr>
<td>DB6</td>
<td>P1.6</td>
<td>13</td>
</tr>
<tr>
<td>DB5</td>
<td>P1.5</td>
<td>12</td>
</tr>
<tr>
<td>DB4</td>
<td>P1.4</td>
<td>11</td>
</tr>
<tr>
<td>E</td>
<td>P1.3</td>
<td>6</td>
</tr>
<tr>
<td>RS</td>
<td>P1.2</td>
<td>4</td>
</tr>
<tr>
<td>RW</td>
<td>Ground</td>
<td>5</td>
</tr>
<tr>
<td>Vss</td>
<td>Ground</td>
<td>1</td>
</tr>
<tr>
<td>Vdd</td>
<td>+5 volt</td>
<td>2</td>
</tr>
<tr>
<td>Vo</td>
<td>0-5 volt</td>
<td>3</td>
</tr>
</tbody>
</table>

#### Fig. 3: Circuit diagram of frequency meter

The LCD module is used in the 4-bit data interface mode, wherein only data pins for DB4 through DB7 are used for data transfer. The configuration used is shown in Table II.

#### Syntax of Important Instructions Used in the Program with Examples

1. **CONFIG LCDPIN**
   - This instruction stores the pin usage in your program.
   - Syntax: `CONFIG LCDPIN = PIN, DB4= P1.1, DB5=P1.2, DB6=P1.3, DB7=P1.4, E=P1.5, RS=P1.6`
   - Example: `CONFIG LCDPIN = PIN, DB4= P1.1, DB5=P1.2, DB6=P1.3, DB7=P1.4, E=P1.5, RS=P1.6`
   - Note: LCD-module pin names are as used in Table II.

2. **CONFIG LCD**
   - This instruction is used for configuring the LCD display type.
   - Syntax: `CONFIG LCD = LCD type`
   - LCD type can be one of the following:
     - 40x4
     - 40x2
     - 16x1
     - 16x2
     - 16x4
     - 20x2
     - 20x4
     - 16x1a
     - 40x4a
   - Note: Default 16x2 is assumed. The 16x1a LCD display is a special one. It is intended for the display that has the memory organised as two lines of eight characters. The 40x4a LCD display is also a special one. It has two ENABLE lines.
   - Example: `CONFIG LCD = 40x4`
   - LCD type can be one of the following:
     - 40x4
     - 40x2
     - 16x1
     - 16x2
     - 16x4
     - 20x2
     - 20x4
     - 16x1a
     - 40x4a
   - Note: Default 16x2 is assumed. The 16x1a LCD display is a special one. It is intended for the display that has the memory organised as two lines of eight characters. The 40x4a LCD display is also a special one. It has two ENABLE lines.
   - Example: `CONFIG LCD = 40x4`

3. **FOURTHLINE**
   - This instruction is used for displaying '4' on the LCD screen.
   - Example: `FOURTHLINE = '4'`

4. **CONFIG TIMERx**
   - This instruction is used for configuring timer-0 or timer-1.
   - Syntax: `CONFIG TIMERx = COUNTER/TIMER`
file: efy80fm24.BAS  3-12-05
ok with word variable 45440
Frequency Meter Program using AT89c2051 microcontroller
written using bascom-51
an embedded visual basic compiler for 8051 microcontrollers
by K.S.Sankar Web: www.mostek.biz
Connect the timer0 input P3.4 to a frequency generator
define crystal speed and include file
$crystal = 24000000
'define variables used
Dim A As Byte
Dim C As Long, D As Long
Dim Count As Word
Dim Onceasec As Bit
Dim T0ic As Long
Dim Green As Byte
Dim Delayword As Word
'Initialize variables
Onceasec = 0
Count = 0
T0ic = 0
D = 0
Green = 0
'initialize ports
P1 = 0
P3 = 255
'configure lcd display
Config Lcd = 16 * 2
Config Lcdpin = Pin, Db4 = P1.4, Db5 = P1.5, Db6 = P1.6, Db7 = P1.7, E = P1.3, Rs = P1.2
'clear the LCD display
Lcd "Frequency Meter"
'define timer0
Config Timer0 = Counter, Gate = Internal, Mode = 1
Timer0 = counter : timer0 operates as a counter
Gate = Internal : no external gate control
exte/internal makes no difference
Mode = 1 : 16-bit counter
'set timer0 internal interrupt
On Timer0 Timer_0_overflow_int
'retimer0 overflow_int interrupt will be generated on every 65536 count
Priority Set Timer0
Enable Interrupts
Enable Timer0
Counter0 = 0
Clear counter
Start Counter0
enable the counter to count
Do
set up a 1 sec accurate DO NOTHING loop
Enable interrupts
wait 1 as per BASCOM-51 is not accurate
END
Fig. 5: Actual-size, single-side PCB layout for frequency meter
Fig. 6: Component layout for the PCB

For use of BASCOM, you may refer to the article ‘Real-Time Clock’ published in Jan. 2005 issue of EFY.
The source code file EFY80FM24.BAS for this LCD frequency meter in BASCOM-51 is given at the end of this article. The same may be modified to meet your specific requirements. The relevant files are included in the EFY-CD.