Frequency Counter Using PIC16C5X

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INTRODUCTION

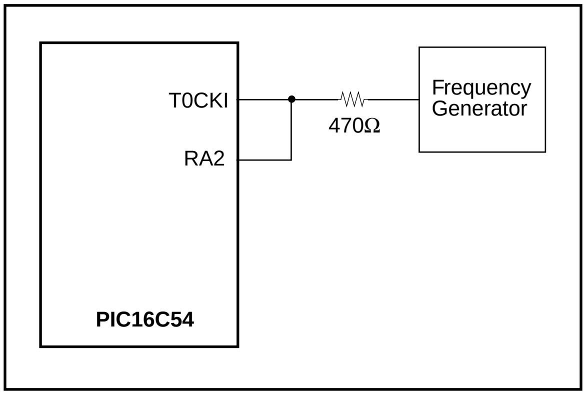
The PIC16C5X has one 8-bit timer (Timer0), which can be used with an 8-bit prescaler. The prescaler runs asynchronously, hence it can count a very high frequency. The minimum rise and fall times of the input frequency are specified to be 10 ns, so the fastest clock rate the TMR0 can count is 50 MHz. The prescaler must be used when measuring high frequency. Since the prescaler can be configured as a divide by 256 counter, the maximum resolution at which the input frequency can be measured is 16-bits. However, the prescaler cannot be directly read like a file register. This application note depicts a unique method by which the user can "extract" the 8-bit value in the prescaler, whereby the resolution of the measurement is 16-bits with the high 8-bits in TMR0 and the low 8-bits in the prescaler.

IMPLEMENTATION

A frequency counter which can read frequencies from 50 Hz to 50 MHz was implemented in this application note in order to demonstrate this method of measuring the 16-bit counter value from the prescaler and TMR0.

The basic hardware for the measurement circuit is depicted in Figure 1. It consists of the frequency input at TMR0 or T0CKI (pin 3 in a PIC16C54). T0CKI is connected to RA2. The input frequency is connected to T0CKI through a 470Ω resistor.

FIGURE 1:



TMR0 is configured to measure the input frequency, at T0CKI of the PIC16C54. The input frequency is "gated" for a precise duration of time. Before starting this precise "gate", TMR0 is cleared (which also clears the prescaler), and the RA2 pin is configured as an input. The precise "gate" is implemented in software as an accurate delay. At the end of the delay, the RA2 pin is configured as an output going low. This will cause the input to TMR0 to be "halted" or "stopped". A 16-bit value of the input frequency is now saved in TMR0 and the 8-bit prescaler. The high 8 bits are in TMR0 and can be easily read. The low 8 bits have to be "shifted out". The 8 bits in the prescaler are "shifted out" by toggling RA2 with a "BSF" and a "BCF" instruction. After every toggle, the value in TMR0 is checked to see if TMR0 has incremented. If the number of toggles required to cause TMR0 to increment by 1 is N, then the 8-bit value in the prescaler can be calculated to be = (256 - N). By concatenating the calculated value and the original value from TMR0, the 16-bit value for the frequency is determined.

To measure a wide range of frequencies, the following intermediate steps were taken:

Frequency Range	Precise "gate" delay	Resolution
50 MHz - 10 MHz	1 ms	±10 kHz
10 MHz - 1 MHz	5 ms	±2 kHz
1 MHz - 100 kHz	50 ms	±200 Hz
100 Hz - 10 kHz	200 ms	±50 Hz
50 Hz - 50 Hz	50 ms (†)	±2 Hz

Note: In this case, TMR0 uses the internal 4 MHz clock and counts the number of instances of the external clock. The maximum time required is 50 ms to make a ± 2 Hz accurate measurement for 10 kHz input frequency.

The check for the correct frequency is performed automatically starting with the high frequency and ending with the low frequency. The maximum time required for each conversion is approximately 310 ms. In other words, three frequency checks are done every second.

CONCLUSION

The PIC16C5X family can be used to make a 16-bit measurement of input frequency with a small overhead of one resistor and one I/O port.

Please check the Microchip BBS for the latest version of the source code. Microchip's Worldwide Web Address: www.microchip.com; Bulletin Board Support: MCHIPBBS using CompuServe® (CompuServe membership not required).

APPENDIX A: FREQ.ASM

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MPASM 01.40 Released             FREQ.ASM   1-16-1997  17:29:41         PAGE  1


LOC  OBJECT CODE     LINE SOURCE TEXT
  VALUE

             00001        list p=16C54
             00002 ;
             00003        include “p16c5x.inc”
             00001        LIST
             00002 ;P16C5X.INC Standard Header File, Version 3.30 Microchip Technology, Inc.
             00224        LIST
             00004
             00005 #define         _ra0            PORTA,0
             00006 #define         _ra1            PORTA,1
             00007
             00008 ;
             00009 ;This program implements the concepts for the frequency counter
             00010 ;using a PIC16C54. In this program, RA0 is connected directly
             00011 ;to the tmr0 input. Tmr0 input is connected thru a 470 ohm
             00012 ;resistor to the freq source. Please note that the
             00013 ;the input freq. is required to be a 50% duty cycle, square
             00014 ;wave. Though none of the internal calculations are based
             00015 ;on this requirement, waveforms which deviate drastically
             00016 ;for the one specified were not tested using these routines.
             00017 ;The routines written in this program, automatically measure
             00018 ;waveforms from 50MHz to 50hz in a period of approx. 300 mS.
             00019 ;After a period of approx 300 mS, the 16 bit “measured” value of
             00020 ;the freq. is read and saved in the location “flo” and “fhi”.
             00021 ;A “range” flag is set to indicate if the measurement belongs to
             00022 ;the five ranges measured namely:
             00023 ;       RANGE:                  Flag name
             00024 ;       50Mhz to 10Mhz -->  Mhz 50 to 10
             00025 ;       10Mhz to 1Mhz  -->  Mhz 10 to 1
             00026 ;       1Mhz to 100Khz -->  Khz 1K to 100
             00027 ;       100Khz to 10Khz --> Khz 100 to 10
             00028 ;       10Khz to 50hz  -->  Hz 10K to 50
             00029 ;The freq. check is repeated to give approx 3 samples/sec.
             00030 ;The “measured” value now has to go through a calculation to
             00031 ;get the actual value. Please use the math routines mentioned
             00032 ;elsewhere in the Embedded Control Handbook to determine
             00033 ;the actual value of the freq.
             00034 ;*****************************************************************
             00035 ;Calculations required to determine actual freq. values
             00036 ;*****************************************************************
             00037 ;First determine which range flag is set, then calculate as follows:
             00038 ;
             00039 ;       Mhz50to10:  freq. = (fhi|flo) X 1000
             00040 ;       Mhz10to1:   freq. = (fhi|flo) X 200
             00041 ;       Khz1Kto100: freq. = (fhi|flo) X 20
             00042 ;       Khz100to10: freq. = (fhi|flo) X 5
             00043 ;       Hz10Kto50: Please see comments above routine Freq10Kto50
             00044 ;
             00045 ;
             00046 ;       Program:          FREQ.ASM
             00047 ;       Revision Date:
             00048 ;                         1-16-97      Compatibility with MPASMWIN 1.40
             00049 ;
             00050 ;*****************************************************************
             00051 ;
  0000000B   00052 fhi     equ             .11             ;high 8 bit value for freq.
  0000000A   00053 flo     equ             .10             ;low 8 bit value for freq.
  0000000C   00054 tempa   equ             .12
  0000000D   00055 tempb   equ             .13
  0000000D   00056 limithi equ             .13
  0000000C   00057 limitlo equ             .12
  0000000D   00058 count   equ             .13
  0000000E   00059 trisabuf equ            .14
  00000010   00060 InputCounthi            equ     .16
  0000000F   00061 InputCountlo            equ     .15
             00062 #define ddra0           trisabuf,0
  00000011   00063 RangeFlag               equ     .17
             00064 #define Mhz50to10       RangeFlag,0
             00065 #define Mhz10to1        RangeFlag,1
             00066 #define Khz1Kto100      RangeFlag,2
             00067 #define Khz100to10      RangeFlag,3
             00068 #define Hz10Kto50       RangeFlag,4
             00069 #define RangeError      RangeFlag,5
             00070 ;
  00002710   00071 tenMhz  equ             .10000000/.1000
  00001388   00072 oneMhz  equ             .1000000/.200
  00001388   00073 hndredK equ             .100000/.20
  000007D0   00074 tenKhz  equ             .10000/.5
             00075 ;
  00000001   00076 Debug   equ             1
             00077 ;
             00078 enabletmr0              macro
             00079         clrf            TMR0
             00080         bsf             ddra0
             00081         movf            trisabuf,W
             00082         tris            PORTA
             00083         endm
             00084 ;
             00085 disabletmr0             macro
             00086         bcf             ddra0
             00087         bcf             _ra0
             00088         movf            trisabuf,W
             00089         tris            PORTA
             00090         endm
             00091 ;
01FF         00092         org      0x1ff
01FF 0A00    00093         goto            start
0000         00094         org      0
0000         00095 start
0000 0C0F    00096         movlw    0x0f                  ;initialize ddra
0001 002E    00097         movwf           trisabuf        ;       /
             00098         disabletmr0
0002 040E               M         bcf             ddra0
0003 0405               M         bcf             _ra0
0004 020E               M         movf            trisabuf,W
0005 0005               M         tris            PORTA
0006 0C37    00099         movlw           B’00110111’     ;set the option register
0007 0002    00100         option                          ;to measure high freq.
0008 0066    00101         clrf            PORTB
0009 0040    00102         clrw
000A 0006    00103         tris            PORTB
             00104
000B         00105 repeat
             00106         enabletmr0                      ;enable tmr0
000B 0061               M         clrf            TMR0
000C 050E               M         bsf             ddra0
000D 020E               M         movf            trisabuf,W
000E 0005               M         tris            PORTA
000F 09BA    00107                   call            delay1mS ;wait for 1mS
             00108         disabletmr0                     ;disable tmr0
0010 040E               M         bcf             ddra0
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0011 0405              M         bcf             _ra0
0012 020E              M         movf            trisabuf,W
0013 0005              M         tris            PORTA
0014 09E1    00109        call            getfreq         ;get freq in fhi and flo
0015 097C    00110        call            check10M        ;check if <= 10 Mhz
0016 0743    00111        btfss           STATUS,Z        ;yes then do lower freq.
0017 0A9F    00112        goto            Freq50Mto10M    ;found 50Mhz to 10Mhz freq.
             00113        enabletmr0                      ;enable tmr0
0018 0061              M         clrf            TMR0
0019 050E              M         bsf             ddra0
001A 020E              M         movf            trisabuf,W
001B 0005              M         tris            PORTA
001C 09C3    00114        call            delay5mS        ;wait for 5mS
             00115        disabletmr0                     ;disable tmr0
001D 040E              M         bcf             ddra0
001E 0405              M         bcf             _ra0
001F 020E              M         movf            trisabuf,W
0020 0005              M         tris            PORTA
0021 09E1    00116        call            getfreq         ;get freq in fhi and flo
0022 0990    00117        call            check1M         ;check if <= 1 Mhz
0023 0743    00118        btfss           STATUS,Z        ;yes then do lower freq.
0024 0AA2    00119        goto            Freq10Mto1M     ;else wait for 300 mS
             00120        enabletmr0                      ;enable tmr0
0025 0061              M         clrf            TMR0
0026 050E              M         bsf             ddra0
0027 020E              M         movf            trisabuf,W
0028 0005              M         tris            PORTA
0029 09CD    00121        call            delay50mS       ;wait for 50mS
             00122        disabletmr0                     ;disable tmr0
002A 040E              M         bcf             ddra0
002B 0405              M         bcf             _ra0
002C 020E              M         movf            trisabuf,W
002D 0005              M         tris            PORTA
002E 09E1    00123        call            getfreq         ;get freq in fhi and flo
002F 0995    00124        call            check100K       ;check if <= 100 Khz
0030 0743    00125        btfss           STATUS,Z        ;yes then do lower freq.
0031 0AA5    00126        goto            Freq1Mto100K    ;else wait for 250 mS
             00127        enabletmr0                      ;enable tmr0
0032 0061              M         clrf            TMR0
0033 050E              M         bsf             ddra0
0034 020E              M         movf            trisabuf,W
0035 0005              M         tris            PORTA
0036 09D7    00128        call            delay200mS      ;wait for 200 mS
             00129        disabletmr0                     ;disable tmr0
0037 040E              M         bcf             ddra0
0038 0405              M         bcf             _ra0
0039 020E              M         movf            trisabuf,W
003A 0005              M         tris            PORTA
003B 09E1    00130        call            getfreq         ;get freq in fhi and flo
003C 099A    00131        call            check10K        ;check if <= 10Khz
003D 0743    00132        btfss           STATUS,Z        ;yes then do lower freq.
003E 0AA8    00133        goto            Freq100Kto10K   ;else wait 50mS
             00134 ;
             00135 ;*********************************************************************
             00136 ;The freq. below 10khz to 50hz is got by using the input freq.
             00137 ;to gate the internal 4Mhz clock. The gate is not  “opened”
             00138 ;until a leading or falling transition is observed at the input.
             00139 ;For approx. 50 mS, the internal 1uS clock is sourced to
             00140 ;the TMR0 with a divide by 256 prescaler.  Every 20uS or so,
             00141 ;the transitions on the input line are checked. If a transition
             00142 ;is observed, then the “InputCount” is incremented. At the end of 50mS,
             00143 ;a last transition is used to close the gate and stop the measurement
             00144 ;of the internal freq.
             00145 ;Say the input freq to be measured is 1500hz. In 50mS, approx  75
             00146 ;cycles will be counted in InputCount. The 16 bit value in flo
             00147 ;and fhi is approx. 50,000. Then the freq measured:
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             00148 ;
             00149 ;                freq. = 75 X 1,000,000/60,000 = 1500 in this case
             00150 ; In general    freq. = InputCount X 1,000,000/(fhi|flo).
             00151 ;
003F         00152 Freq10Kto50
003F 0070    00153         clrf            InputCounthi    ;0 --> InputCount
0040 006F    00154         clrf            InputCountlo    ;       /
0041 0C17    00155         movlw           B’00010111’     ;start TMR0 with internal
0042 0002    00156         option                          ; clk. = 1uS
0043 0C0F    00157         movlw           B’00001111’     ;set RA0 as a input
0044 0005    00158         tris            PORTA           ;       /
0045 0705    00159         btfss           _ra0            ;see if level low
0046 0A49    00160         goto            FirstHigh       ;yes then check leading edge
0047         00161 FirstLow
0047 0605    00162         btfsc           _ra0            ;else look for falling edge
0048 0A47    00163         goto            FirstLow        ;               /
0049         00164 FirstHigh                               ;and look for first high
0049 0705    00165         btfss           _ra0            ;look for first high
004A 0A49    00166         goto            FirstHigh       ;       /
004B 0061    00167         clrf            TMR0            ;start count
004C 0CC3    00168         movlw           high .50000     ;get high byte of 50000
004D 002D    00169         movwf           limithi         ;save in RAM
004E         00170 NextLow
004E 0201    00171         movf            TMR0,W          ;50mS over?
004F 008D    00172         subwf           limithi,W       ;approx. 50
0050 0643    00173         btfsc           STATUS,Z        ;no then skip
0051 0A65    00174         goto            LastHigh        ;look for lasthigh
0052 0605    00175         btfsc           _ra0            ;look for low
0053 0A4E    00176         goto            NextLow         ;   /
0054         00177 NextHigh
0054 0201    00178         movf            TMR0,W          ;50mS over?
0055 008D    00179         subwf           limithi,W       ;approx. 50
0056 0643    00180         btfsc           STATUS,Z        ;no then skip
0057 0A5E    00181         goto            LastLow         ;look for lastlow
0058 0705    00182         btfss           _ra0
0059 0A54    00183         goto            NextHigh
005A 02AF    00184         incf            InputCountlo, F ;inc count
005B 0643    00185         btfsc           STATUS,Z        ;overflow?
005C 02B0    00186         incf            InputCounthi, F ;inc high value
005D 0A4E    00187         goto            NextLow         ;check next
005E         00188 LastLow
005E 0201    00189         movf            TMR0,W          ;tmr0 overflow?
005F 002C    00190         movwf           tempa           ;       /
0060 02AC    00191         incf            tempa, F        ;       /
0061 0643    00192         btfsc           STATUS,Z              ;no then skip
0062 0A6C    00193         goto            CloseGate       ;overflow then abort
0063 0605    00194         btfsc           _ra0            ;look for low
0064 0A5E    00195         goto            LastLow         ;       /
0065         00196 LastHigh
0065 0201    00197         movf            TMR0,W         ;tmr0 overflow?
0066 002C    00198         movwf           tempa           ;       /
0067 02AC    00199         incf            tempa, F        ;       /
0068 0643    00200         btfsc           STATUS,Z        ;no then skip
0069 0A6C    00201         goto            CloseGate       ;overflow then abort
006A 0705    00202         btfss           _ra0            ;look for high
006B 0A65    00203         goto            LastHigh
006C         00204 CloseGate
006C 0C27    00205         movlw           B’00100111’     ;stop internal clk
006D 0002    00206         option                          ;       /
             00207         disabletmr0                     ;disable tmr0
006E 040E               M         bcf             ddra0
006F 0405               M         bcf             _ra0
0070 020E               M         movf            trisabuf,W
0071 0005               M         tris            PORTA
0072 09E1    00208         call            getfreq         ;get freq
0073 028B    00209         incf            fhi,W           ;out of range?
```

```
0074 0643    00210         btfsc           STATUS,Z        ;       /
0075 0A79    00211         goto            OutofRange      ;yes then set flag
0076 0071    00212         clrf            RangeFlag       ;set Hz10Kto50 flag
0077 0591    00213         bsf             Hz10Kto50       ;       /
0078 0AAB    00214         goto            wait50mS
0079         00215 OutofRange
0079 0071    00216         clrf            RangeFlag       ;set error flag
007A 05B1    00217         bsf             RangeError
007B 0AAB    00218         goto            wait50mS
             00219 ;
             00220 ;Check10M, check if the freq < 10 Mhz if yes then the z bit
             00221 ;is set else it is cleared. This routine uses a generic routine
             00222 ;checklimit, which check the value in fhi and flo to the ones
             00223 ;in limithi and limitlo
007C         00224 check10M
007C 0C27    00225         movlw           high tenMhz     ;get hi value of 10Mhz
007D 002D    00226         movwf           limithi         ;save in limithi
007E 0C10    00227         movlw           low tenMhz      ;get lo value of 10Mhz
007F 002C    00228         movwf           limitlo         ;save in limitlo
             00229 ;checklimit, checks if the freq in flo and fhi is lower
             00230 ;than the values set in limitlo and limithi. It is a
             00231 ;common routine used to check all set limits. If the value
             00232 ;is <= the z bit = 0 else z = 1 .
0080         00233 checklimit
0080 020B    00234         movf            fhi,W           ;get high freq value
0081 00AD    00235         subwf           limithi, F      ;and check with high value
0082 0643    00236         btfsc           STATUS,Z        ;if not equal then skip
0083 0A88    00237         goto            chk10Mlo        ;else check low value
0084 0703    00238         btfss           STATUS,C        ;skip if value is < limit
0085 0800    00239         retlw    0             ;value > limit so z = 0.
0086 0040    00240         clrw                            ;z = 1
0087 0800    00241         retlw    0             ;return with z flag set
0088         00242 chk10Mlo
0088 020A    00243         movf            flo,W           ;get low value
0089 00AC    00244         subwf           limitlo, F      ;and check with low value
008A 0643    00245         btfsc           STATUS,Z        ;not equal then skip
008B 0800    00246         retlw    0             ;else return with z = 1
008C 0703    00247         btfss           STATUS,C        ;skip if value is < limit
008D 0800    00248         retlw    0             ;value > limit so z = 0
008E 0040    00249         clrw                            ; z = 1
008F 0800    00250         retlw    0             ;return with z flag set
             00251 ;
             00252 ;Check1M checks if freq is below 1 Mhz
             00253 ;
0090         00254 check1M
0090 0C13    00255         movlw           high oneMhz     ;get hi value of 1Mhz
0091 002D    00256         movwf           limithi         ;save in limithi
0092 0C88    00257         movlw           low oneMhz      ;get lo value of 1Mhz
0093 002C    00258         movwf           limitlo         ;save in limitlo
0094 0A80    00259         goto            checklimit
             00260 ;
0095         00261 check100K
0095 0C13    00262         movlw           high hndredK    ;get hi value of 100Khz
0096 002D    00263         movwf           limithi         ;save in limithi
0097 0C88    00264         movlw           low hndredK     ;get lo value of 100Khz
0098 002C    00265         movwf           limitlo         ;save in limitlo
0099 0A80    00266         goto            checklimit
             00267 ;
009A         00268 check10K
009A 0C07    00269         movlw           high tenKhz     ;get hi value of 10Khz
009B 002D    00270         movwf           limithi         ;save in limithi
009C 0CD0    00271         movlw           low tenKhz      ;get lo value of 10Khz
009D 002C    00272         movwf           limitlo         ;save in limitlo
009E 0A80    00273         goto            checklimit
             00274 ;
             00275 ;
```

```
009F         00276 Freq50Mto10M
009F 0071    00277         clrf            RangeFlag
00A0 0511    00278         bsf             Mhz50to10
00A1 0AAB    00279         goto            wait300mS
00A2         00280 Freq10Mto1M
00A2 0071    00281         clrf            RangeFlag
00A3 0531    00282         bsf             Mhz10to1
00A4 0AAB    00283         goto            wait300mS
00A5         00284 Freq1Mto100K
00A5 0071    00285         clrf            RangeFlag
00A6 0551    00286         bsf             Khz1Kto100
00A7 0AAB    00287         goto            wait250mS
00A8         00288 Freq100Kto10K
00A8 0071    00289         clrf            RangeFlag
00A9 0571    00290         bsf             Khz100to10
00AA 0AAB    00291         goto            wait50mS
             00292 ;
00AB         00293 wait300mS
             00294     If      !Debug
             00295         call            delay50mS
             00296     ENDIF
00AB         00297 wait250mS
             00298     IF      !Debug
             00299         call            delay50mS
             00300         call            delay50mS
             00301         call            delay50mS
             00302         call            delay50mS
             00303     ENDIF
00AB         00304 wait50mS
             00305     IF      !Debug
             00306         call            delay50mS
             00307     ENDIF
             00308 ;
             00309 ;
             00310     IF      Debug
             00311 ;This routine debugs freq. on a PICDEM1 board.
00AB         00312 checkRA1
00AB 0625    00313         btfsc           _ra1
00AC 0AAB    00314         goto            checkRA1
00AD 09D7    00315         call            delay200mS
00AE 020B    00316         movf            fhi,W
00AF 0026    00317         movwf           PORTB
00B0         00318 chkRA1hi
00B0 0725    00319         btfss           _ra1
00B1 0AB0    00320         goto            chkRA1hi
00B2         00321 chkRA1lo
00B2 0625    00322         btfsc           _ra1
00B3 0AB2    00323         goto            chkRA1lo
00B4 09D7    00324         call            delay200mS
00B5 020A    00325         movf            flo,W
00B6 0026    00326         movwf           PORTB
00B7 0725    00327         btfss           _ra1
00B8 0AB7    00328         goto            $-1
             00329     ENDIF
00B9 0A0B    00330         goto            repeat
             00331 ;
             00332 ;delay1ms, is a very accurate 1mS delay for a 4Mhz clock.
00BA         00333 delay1mS
00BA 0CC5    00334         movlw           .197
00BB 002D    00335         movwf           count
00BC 0000    00336         nop
00BD 0ABE    00337         goto            $+1
00BE 0ABF    00338         goto            $+1
00BF         00339 dly1mS
00BF 0AC0    00340         goto            $+1
00C0 02ED    00341         decfsz          count, F
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00C1 0ABF    00342         goto            dly1mS
00C2 0800    00343         retlw    0
             00344 ;
             00345 ;delay5mS uses delay1mS to get a very accurate 5 mS delay
00C3         00346 delay5mS
00C3 09BA    00347         call            delay1mS
00C4 09BA    00348         call            delay1mS
00C5 09BA    00349         call            delay1mS
00C6 09BA    00350         call            delay1mS
00C7 09BA    00351         call            delay1mS
00C8 0C04    00352         movlw           .4
00C9 002D    00353         movwf           count
00CA         00354 tweek5mS
00CA 02ED    00355         decfsz          count, F
00CB 0ACA    00356         goto            tweek5mS
00CC 0800    00357         return
             00358 ;
             00359 ;delay50mS uses delay1mS to get a very accurate 50mS delay
00CD         00360 delay50mS
00CD 0C32    00361         movlw           .50
00CE 002C    00362         movwf           tempa
00CF         00363 dly50mS
00CF 09BA    00364         call            delay1mS
00D0 02EC    00365         decfsz          tempa, F
00D1 0ACF    00366         goto            dly50mS
00D2 0C0E    00367         movlw           .14
00D3 002D    00368         movwf           count
00D4         00369 tweek50mS
00D4 02ED    00370         decfsz          count, F
00D5 0AD4    00371         goto            tweek50mS
00D6 0800    00372         retlw    0
             00373 ;
             00374 ;delay200mS uses delay1mS to get a very accurate 200mS delay.
00D7         00375 delay200mS
00D7 0CC8    00376         movlw           .200
00D8 002C    00377         movwf           tempa
00D9         00378 dly200mS
00D9 09BA    00379         call            delay1mS
00DA 02EC    00380         decfsz          tempa, F
00DB 0AD9    00381         goto            dly200mS
00DC 0C40    00382         movlw           .64
00DD 002D    00383         movwf           count
00DE         00384 tweek200mS
00DE 02ED    00385         decfsz          count, F
00DF 0ADE    00386         goto            tweek200mS
00E0 0800    00387         retlw    0
             00388 ;
             00389 ;getfreq, toggles the RA0 pin  to shift out the value in the
             00390 ;prescaler. The number of toggles is kept in count. If the value
             00391 ;in tmr0 increments, then the low 8 bit value = !count + 1. The low
             00392 ;value of the freq. is loaded in flo and the high in fhi.
00E1         00393 getfreq
00E1 0201    00394         movf            TMR0,W                  ;get the tmr0 value
00E2 002B    00395         movwf           fhi                     ;save in fhi
00E3 006D    00396         clrf            count                   ;keep track of the toggles
00E4         00397 toggle
00E4 02AD    00398         incf            count, F                ;inc for first
00E5 0405    00399         bcf             _ra0                    ;toggle the input
00E6 0505    00400         bsf             _ra0                    ;       /
00E7 0201    00401         movf            TMR0,W                  ;see if tmr0 incremented
00E8 008B    00402         subwf           fhi,W                   ;       /
00E9 0643    00403         btfsc           STATUS,Z                ;yes then skip
00EA 0AE4    00404         goto            toggle                  ;no then toggle again
00EB 026D    00405         comf            count, F                ;else complement count
00EC 028D    00406         incf            count,W                 ;and increment
00ED 002A    00407         movwf                   flo             ;save in flo
```

```
00EE 0800    00408         retlw           0                       ;return
             00409 ;
             00410         end

MEMORY USAGE MAP ('X' = Used,  '-' = Unused)


0000 : XXXXXXXXXXXXXXXX XXXXXXXXXXXXXXXX XXXXXXXXXXXXXXXX XXXXXXXXXXXXXXXX
0040 : XXXXXXXXXXXXXXXX XXXXXXXXXXXXXXXX XXXXXXXXXXXXXXXX XXXXXXXXXXXXXXXX
0080 : XXXXXXXXXXXXXXXX XXXXXXXXXXXXXXXX XXXXXXXXXXXXXXXX XXXXXXXXXXXXXXXX
00C0 : XXXXXXXXXXXXXXXX XXXXXXXXXXXXXXXX XXXXXXXXXXXXXXX- ----------------
01C0 : ---------------- ---------------- ---------------- ---------------X

All other memory blocks unused.

Program Memory Words Used:   240
Program Memory Words Free:   272


Errors   :     0
Warnings :     0 reported,     0 suppressed
Messages :     0 reported,     0 suppressed
```

Note the following details of the code protection feature on PICmicro® MCUs.

- The PICmicro family meets the specifications contained in the Microchip Data Sheet.
- Microchip believes that its family of PICmicro microcontrollers is one of the most secure products of its kind on the market today, when used in the intended manner and under normal conditions.
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If you have any further questions about this matter, please contact the local sales office nearest to you.

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