Ex16-LCD-Ana

1

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Chapter 1

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1.1 File List

Here is a list of all documented files with brief descriptions:

Chapter 2

File Documentation

2.1 00readme.c File Reference

Introduction.

2.1.1 Detailed Description

Introduction. This project toggles the LEDs on the timer and displays multiple messages on the first line of the LCD. The potentiometer on the Explorer 16 is read, and the value is displayed on the second line, in both a voltage and percentage.

Unlike the initial incarnations, the LCD routines are no longer included in the project but instead are in a separate library. In this way those routines may be used by other projects by simply referencing the library and header file in the new project.

The application first sets the processor speed. In main.c, there are a number of configuration fuses set. By default, these work reasonably well on the Explorer 16, but it is preferable to be explicit about what they are doing.

The first configuration line:

```
_FOSCSEL( FNOSC_PRIPLL & IESO_OFF );
```

says to use the primary oscillator (i.e. the cystal), with the PLL system, and to start up with the user selected oscillator. An alternative is to start with a default internal RC oscillator, and then switch to the primary oscillator under program control.

The next line:

```
_FOSC( POSCMD_XT & FCKSM_CSECMD );
```

tells the dsPIC that the primary oscillator is an XT crystal. This basically affects the amount of power delivered to the crystal. EC is for very low power crystals, typically watch crystals, XT is for "normal" crystals, and HS for high speed, typically >10MHz, crystals. It also says that it is permissible to switch clocks under program control, but should the selected oscillator fail, do not automatically switch to the fallback oscillator.

The third configuration line

```
_FWDT( FWDTEN_OFF );
```

disables the watchdog timer. If this were not done, the program would periodically reset, unless the program constantly resets the watchdog timer.

The next:

```
_FPOR( FPWRT_PWR64 );
```

holds off processor reset for 64 milliseconds after power has been applied. The idea is to give external circuitry an opportunity to stabilize before the program starts.

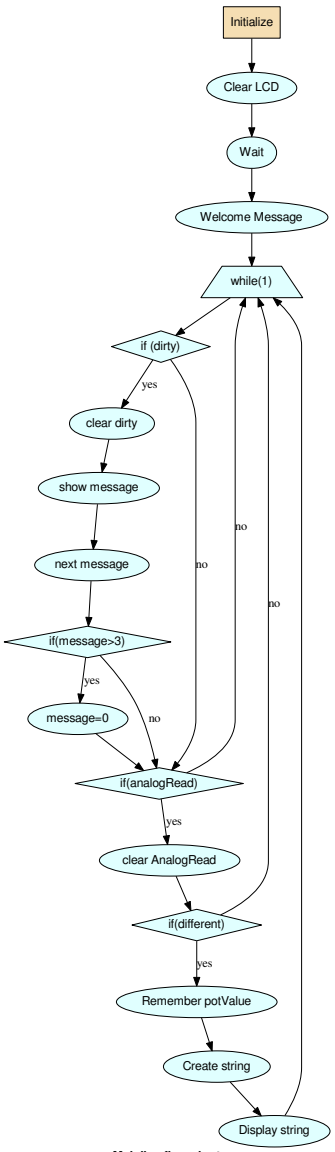
The final configuration line

```
_FICD( ICS_PGD1 & JTAGEN_OFF );
```

turns off the JTAG interface, and establishes PGD1/PGC1 as the pins for debug communication. There are three sets of programming pins on the dsPIC33FJ256GP701, so the developer may select a pair of pins that does not interfere with peripheral use for the selected circuit.

In Initialize(), two registers are set which determine how the PLL is configured. The CLKDIV register sets the pre- and post- PLL dividers which divide the clock before and after the PLL clock multiplier. PLLFBD sets the PLL feedback divisor which has the effect of multiplying the clock.

CLKDIV has a number of fields which allow the peripheral clock to be set slower than the instruction clock in some situations. These fields are not used, and are set to zero which essentially disables this feature.



Mainline flow chart

Definition in file 00readme.c.

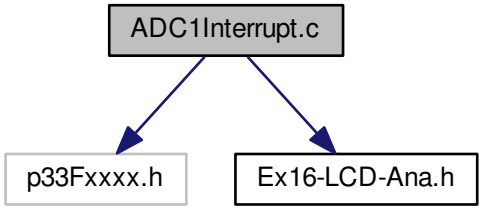
2.2 00readme.c

```
00001
```

2.3 ADC1Interrupt.c File Reference

Interrupt service routine for the Analog to Digital converter.

`#include <p33Fxxxx.h>` `#include "Ex16-LCD-Ana.h"` Include dependency graph for ADC1Interrupt.c:



Defines

- #define **EXTERN** extern

Functions

- void __attribute__ ((__interrupt__, auto_psv))
  ADC1 Interrupt Service Routine.

2.3.1 Detailed Description

Interrupt service routine for the Analog to Digital converter. This file provides the (very simple) ISR that is executed whenever an analog conversion has completed.

Definition in file ADC1Interrupt.c.

2.3.2 Function Documentation

2.3.2.1 void __attribute__ ((__interrupt__, auto_psv))

ADC1 Interrupt Service Routine.

Pseudocode:

```
    Clear the interrupt flag
    Grab the analog value and store it in potValue
    increment analogRead
```

Definition at line 22 of file ADC1Interrupt.c.

```
{
  IFS0bits.AD1IF = 0;       // Clear A/D interrupt flag
  potValue = ADC1BUF0;      // Save the potentiometer value
  analogRead++;             // Remember it has been read
}
```

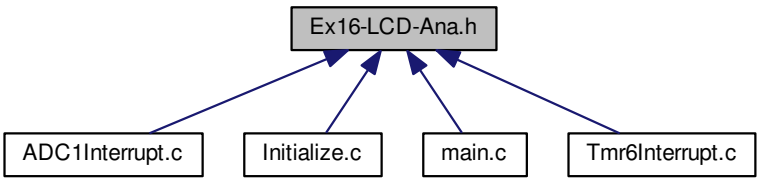
2.4 ADC1Interrupt.c

```
00001
00008 #include <p33Fxxxx.h>
00009
00010 #define EXTERN extern
00011 #include "Ex16-LCD-Ana.h"
00012
00014
00022 void __attribute__((__interrupt__, auto_psv)) _ADC1Interrupt( void )
00023 {
00024   IFS0bits.AD1IF = 0;       // Clear A/D interrupt flag
00025   potValue = ADC1BUF0;      // Save the potentiometer value
00026   analogRead++;             // Remember it has been read
00027 }
```

2.5 Ex16-LCD-Ana.h File Reference

Global declarations for Ex16-LCD-Ana.

This graph shows which files directly or indirectly include this file:



Functions

- void Initialize (void)

  Initialization for Ex16-LCD-Ana.

Variables

- EXTERN unsigned int analogRead

  Remember whether analog value has been read.
- EXTERN int dirty

  Dirty flag - if non-zero display is updated.
- EXTERN int message

  Current message number to display.
- EXTERN unsigned int potValue

  Value from the A/D converter.

2.5.1 Detailed Description

Global declarations for Ex16-LCD-Ana. File: Ex16-LCD-Ana.h Author: jjmcd

Created on June 19, 2012, 9:28 AM

Definition in file Ex16-LCD-Ana.h.

2.5.2 Function Documentation

2.5.2.1 void Initialize (void)

Initialization for Ex16-LCD-Ana.

- Sets the processor clock to 40 MHz
- Initializes the ports
- Initializes timer 6
- Initialize the A/D converter
- Initializes the dirty flag and message number

Definition at line 40 of file Initialize.c.

```
{
    // Set the instruction clock speed
    //
    // Fcy 40 MIPS
    // DOZE = Fcy/8 = 011
    // DOZEN = 1
    // PLLPRE 2 = 00000
    // PLLDIV 40 = .38 = 0x26 = 0 0010 0110
    // PLLPOST 2 00
    //ROI    DOZE  DOZEN FRCDIV PLLPOST X    PLLPRE
    // 15 14 13 12  11   10 9 8    7 6    5  4 3 2 1 0
    //  0  0  0  0   0    0 0 0    0 0    0  0 0 0 0 0

    CLKDIV = 0x0000;
    PLLFBD = 0x0026;

    // Fcy 20 MIPS
    // PLLPRE 2 = 00000
    // PLLDIV 40 = .38 = 0x26 = 0 0010 0110
    // PLLPOST 4 01
    //ROI    DOZE  DOZEN FRCDIV PLLPOST X    PLLPRE
    // 15 14 13 12  11   10 9 8    7 6    5  4 3 2 1 0
    //  0  0  0  0   0    0 0 0    0 1    0  0 0 0 0 0
/*
    CLKDIV = 0x0008;
    PLLFBD = 0x0026;
*/

    TRISA = 0;              // All PORTA pins outputs
    LATA = 0x0001;          // Right LED on

    // Set timer 6 for right LED
    // Explanation ...
    //   Timer 6 will increment every 128 instruction cycles
    //   Once the count reaches 50,000, the timer 6 interrupt will fire
    //   and the count will be reset
    PR6 = 50000;            // Timer 6 counter to 50,000
    TMR6 = 0;               // Clear timer 6
    T6CON = 0x8030;         // 1:256 prescale, timer on, Clock Fcy
    IEC2bits.T6IE = 1;      // Enable Timer 6 interrupt

    // Initialize the LCD
    LCDinit();

    // Initialize ADC
    /* set port configuration here */
```

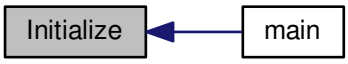
```
    AD1PCFGLbits.PCFG4 = 0;         // ensure AN4/RB4 is analog (Temp Sensor)
    AD1PCFGLbits.PCFG5 = 0;         // ensure AN5/RB5 is analog (Analog Pot)
    /* set channel scanning here, auto sampling and convert,
       with default read-format mode */
    AD1CON1 = 0x00E4;
    /* select 12-bit, 1 channel ADC operation */
    AD1CON1bits.AD12B = 1;
    /* No channel scan for CH0+, Use MUX A,
       SMPI = 1 per interrupt, Vref = AVdd/AVss */
    AD1CON2 = 0x0000;
    /* Set Samples and bit conversion time */
    AD1CON3 = 0x032F;
    /* set channel scanning here for AN4 and AN5 */
    AD1CSSL = 0x0000;
    /* channel select AN5/RB5 */
    AD1CHS0 = 0x0005;
    /* reset ADC interrupt flag */
    IFS0bits.AD1IF = 0;
    /* enable ADC interrupts */
    IEC0bits.AD1IE = 1;
     /* turn on ADC module */
    AD1CON1bits.ADON = 1;



    // Initialize global variables
    dirty = 0;              // Message dirty flag
    message = 0;            // Current message number
    analogRead = 0;         // Set to A/D not read

}
```

Here is the caller graph for this function:



2.5.3 Variable Documentation

2.5.3.1 EXTERN unsigned int analogRead

Remember whether analog value has been read.

Definition at line 25 of file Ex16-LCD-Ana.h.

2.5.3.2 EXTERN int dirty

Dirty flag - if non-zero display is updated.

Definition at line 19 of file Ex16-LCD-Ana.h.

2.5.3.3 EXTERN int message

Current message number to display.

Definition at line 21 of file Ex16-LCD-Ana.h.

2.5.3.4 EXTERN unsigned int potValue

Value from the A/D converter.

Definition at line 23 of file Ex16-LCD-Ana.h.

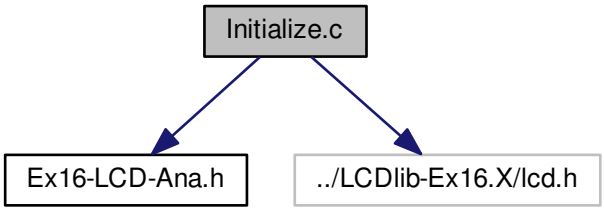
2.6 Ex16-LCD-Ana.h

```
00001
00011 #ifndef EX16_LCD_ANA_H
00012 #define EX16_LCD_ANA_H
00013
00014 #ifdef  __cplusplus
00015 extern "C" {
00016 #endif
00017
00019 EXTERN int dirty;
00021 EXTERN int message;
00023 EXTERN unsigned int potValue;
00025 EXTERN unsigned int analogRead;
00026
00028 void Initialize( void );
00029
00030
00031 #ifdef  __cplusplus
00032 }
00033 #endif
00034
00035 #endif  /* EX16_LCD_ANA_H */
00036
```

2.7 Initialize.c File Reference

Initialization for Ex16-LCD-Ana.

`#include "Ex16-LCD-Ana.h" #include "../LCDlib-Ex16.X/lcd.-h"` Include dependency graph for Initialize.c:



Defines

- #define **EXTERN** extern

Functions

- void Initialize (void)

  Initialization for Ex16-LCD-Ana.

2.7.1 Detailed Description

Initialization for Ex16-LCD-Ana.

Definition in file Initialize.c.

2.7.2 Function Documentation

2.7.2.1 void Initialize (void)

Initialization for Ex16-LCD-Ana.

- Sets the processor clock to 40 MHz
- Initializes the ports

- Initializes timer 6
- Initialize the A/D converter
- Initializes the dirty flag and message number

Definition at line 40 of file Initialize.c.

```
{
    // Set the instruction clock speed
    //
    // Fcy 40 MIPS
    // DOZE = Fcy/8 = 011
    // DOZEN = 1
    // PLLPRE 2 = 00000
    // PLLDIV 40 = .38 = 0x26 = 0 0010 0110
    // PLLPOST 2 00
    //ROI    DOZE  DOZEN FRCDIV PLLPOST X   PLLPRE
    // 15 14 13 12  11  10 9 8   7 6   5  4 3 2 1 0
    //  0  0  0  0   0   0 0 0   0 0   0  0 0 0 0 0

    CLKDIV = 0x0000;
    PLLFBD = 0x0026;

    // Fcy 20 MIPS
    // PLLPRE 2 = 00000
    // PLLDIV 40 = .38 = 0x26 = 0 0010 0110
    // PLLPOST 4 01
    //ROI    DOZE  DOZEN FRCDIV PLLPOST X   PLLPRE
    // 15 14 13 12  11  10 9 8   7 6   5  4 3 2 1 0
    //  0  0  0  0   0   0 0 0   0 1   0  0 0 0 0 0
/*
    CLKDIV = 0x0008;
    PLLFBD = 0x0026;
*/

    TRISA = 0;              // All PORTA pins outputs
    LATA = 0x0001;          // Right LED on

    // Set timer 6 for right LED
    // Explanation ...
    //   Timer 6 will increment every 128 instruction cycles
    //   Once the count reaches 50,000, the timer 6 interrupt will fire
    //   and the count will be reset
    PR6 = 50000;            // Timer 6 counter to 50,000
    TMR6 = 0;               // Clear timer 6
    T6CON = 0x8030;         // 1:256 prescale, timer on, Clock Fcy
    IEC2bits.T6IE = 1;      // Enable Timer 6 interrupt

    // Initialize the LCD
    LCDinit();

    // Initialize ADC
    /* set port configuration here */
    AD1PCFGLbits.PCFG4 = 0;         // ensure AN4/RB4 is analog (Temp Sensor)
    AD1PCFGLbits.PCFG5 = 0;         // ensure AN5/RB5 is analog (Analog Pot)
    /* set channel scanning here, auto sampling and convert,
       with default read-format mode */
    AD1CON1 = 0x00E4;
    /* select 12-bit, 1 channel ADC operation */
    AD1CON1bits.AD12B = 1;
    /* No channel scan for CH0+, Use MUX A,
       SMPI = 1 per interrupt, Vref = AVdd/AVss */
    AD1CON2 = 0x0000;
    /* Set Samples and bit conversion time */
```

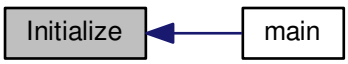
```
    AD1CON3 = 0x032F;
    /* set channel scanning here for AN4 and AN5 */
    AD1CSSL = 0x0000;
    /* channel select AN5/RB5 */
    AD1CHS0 = 0x0005;
    /* reset ADC interrupt flag */
    IFS0bits.AD1IF = 0;
    /* enable ADC interrupts */
    IEC0bits.AD1IE = 1;
     /* turn on ADC module */
    AD1CON1bits.ADON = 1;



    // Initialize global variables
    dirty = 0;              // Message dirty flag
    message = 0;            // Current message number
    analogRead = 0;         // Set to A/D not read

}
```

Here is the caller graph for this function:



2.8 Initialize.c

```
00001
00007 #if defined(__PIC24E__)
00008 #include <p24Exxxx.h>
00009
00010 #elif defined (__PIC24F__)
00011 #include <p24Fxxxx.h>
00012
00013 #elif defined(__PIC24H__)
00014 #include <p24Hxxxx.h>
00015
00016 #elif defined(__dsPIC30F__)
00017 #include <p30Fxxxx.h>
00018
00019 #elif defined (__dsPIC33E__)
00020 #include <p33Exxxx.h>
00021
00022 #elif defined(__dsPIC33F__)
00023 #include <p33Fxxxx.h>
00024
00025 #endif
00026
00027 #define EXTERN extern
```

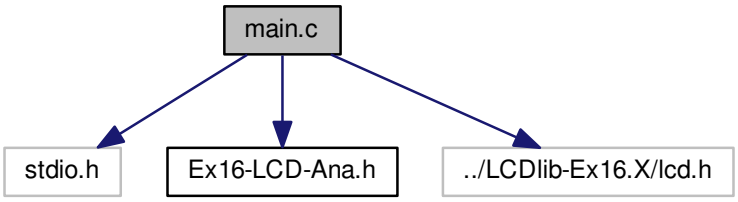
```
00028 #include "Ex16-LCD-Ana.h"
00029
00030 #include "../LCDlib-Ex16.X/lcd.h"
00031
00033
00040 void Initialize( void )
00041 {
00042     // Set the instruction clock speed
00043     //
00044     // Fcy 40 MIPS
00045     // DOZE = Fcy/8 = 011
00046     // DOZEN = 1
00047     // PLLPRE 2 = 00000
00048     // PLLDIV 40 = .38 = 0x26 = 0 0010 0110
00049     // PLLPOST 2 00
00050     //ROI    DOZE  DOZEN FRCDIV PLLPOST X    PLLPRE
00051     // 15 14 13 12  11  10 9 8    7 6    5  4 3 2 1 0
00052     //  0  0  0  0   0   0 0 0    0 0    0  0 0 0 0 0
00053
00054     CLKDIV = 0x0000;
00055     PLLFBD = 0x0026;
00056
00057     // Fcy 20 MIPS
00058     // PLLPRE 2 = 00000
00059     // PLLDIV 40 = .38 = 0x26 = 0 0010 0110
00060     // PLLPOST 4 01
00061     //ROI    DOZE  DOZEN FRCDIV PLLPOST X    PLLPRE
00062     // 15 14 13 12  11  10 9 8    7 6    5  4 3 2 1 0
00063     //  0  0  0  0   0   0 0 0    0 1    0  0 0 0 0 0
00064 /*
00065     CLKDIV = 0x0008;
00066     PLLFBD = 0x0026;
00067 */
00068
00069     TRISA = 0;              // All PORTA pins outputs
00070     LATA = 0x0001;          // Right LED on
00071
00072     // Set timer 6 for right LED
00073     // Explanation ...
00074     //   Timer 6 will increment every 128 instruction cycles
00075     //   Once the count reaches 50,000, the timer 6 interrupt will fire
00076     //   and the count will be reset
00077     PR6 = 50000;            // Timer 6 counter to 50,000
00078     TMR6 = 0;               // Clear timer 6
00079     T6CON = 0x8030;         // 1:256 prescale, timer on, Clock Fcy
00080     IEC2bits.T6IE = 1;      // Enable Timer 6 interrupt
00081
00082     // Initialize the LCD
00083     LCDinit();
00084
00085     // Initialize ADC
00086     /* set port configuration here */
00087     AD1PCFGLbits.PCFG4 = 0;         // ensure AN4/RB4 is analog (Temp Sensor)
00088     AD1PCFGLbits.PCFG5 = 0;         // ensure AN5/RB5 is analog (Analog Pot)
00089     /* set channel scanning here, auto sampling and convert,
00090        with default read-format mode */
00091     AD1CON1 = 0x00E4;
00092     /* select 12-bit, 1 channel ADC operation */
00093     AD1CON1bits.AD12B = 1;
00094     /* No channel scan for CH0+, Use MUX A,
00095        SMPI = 1 per interrupt, Vref = AVdd/AVss */
00096     AD1CON2 = 0x0000;
00097     /* Set Samples and bit conversion time */
00098     AD1CON3 = 0x032F;
00099     /* set channel scanning here for AN4 and AN5 */
00100     AD1CSSL = 0x0000;
00101     /* channel select AN5/RB5 */
00102     AD1CHS0 = 0x0005;
```

```
00103     /* reset ADC interrupt flag */
00104     IFS0bits.AD1IF = 0;
00105     /* enable ADC interrupts */
00106     IEC0bits.AD1IE = 1;
00107      /* turn on ADC module */
00108     AD1CON1bits.ADON = 1;
00109
00110
00111
00112     // Initialize global variables
00113     dirty = 0;              // Message dirty flag
00114     message = 0;            // Current message number
00115     analogRead = 0;         // Set to A/D not read
00116
00117 }
```

2.9 main.c File Reference

Mainline for Ex16-LCD-Ana.

`#include <stdio.h>  #include "Ex16-LCD-Ana.h"  #include "../LCDlib-Ex16.X/lcd.h"` Include dependency graph for main.c:



Functions

- _FICD (ICS_PGD1 &JTAGEN_OFF)

  Communicate on PGC1/EMUC1 and PGD1/EMUD1, JTAG is Disabled.
- _FOSC (POSCMD_XT &FCKSM_CSECMD)

  XT Oscillator Mode, Clock switching is enabled, Fail-Safe Clock Monitor is disabled.
- _FOSCSEL (FNOSC_PRIPLL &IESO_OFF)

  Primary Oscillator (XT, HS, EC) w/ PLL, Start up with user-selected oscillator.
- _FPOR (FPWRT_PWR64)

  Power-on reset timer 64 ms.

- _FWDT (FWDTEN_OFF)

  Watchdog timer enabled/disabled by user software.
- int main (void)

  Mainline for Ex16-LCD-Ana.

Variables

- char szMessage [4][17]

  Table of messages to be displayed.

2.9.1 Detailed Description

Mainline for Ex16-LCD-Ana. This application is intended to show use of the timer and the LCD. A flag is passed from the ISR to the mainline to indicate time to update the display.

A second line of the display contains the message number, to demonstrate LCD cursor positioning.

File: main.c Author: jjmcd

Created on June 19, 2012, 9:27 AM

Definition in file main.c.

2.9.2 Function Documentation

2.9.2.1 _FICD (ICS_PGD1 & *JTAGEN_OFF*)

Communicate on PGC1/EMUC1 and PGD1/EMUD1, JTAG is Disabled.

2.9.2.2 _FOSC (POSCMD_XT & *FCKSM_CSECMD*)

XT Oscillator Mode, Clock switching is enabled, Fail-Safe Clock Monitor is disabled.

2.9.2.3 _FOSCSEL (FNOSC_PRIPLL & *IESO_OFF*)

Primary Oscillator (XT, HS, EC) w/ PLL, Start up with user-selected oscillator.

2.9.2.4 _FPOR (FPWRT_PWR64)

Power-on reset timer 64 ms.

2.9.2.5 _FWDT (FWDTEN_OFF)

Watchdog timer enabled/disabled by user software.

2.9.2.6 int main (void)

Mainline for Ex16-LCD-Ana.

Display a selected message and analog value on the LCD

Pseudocode:

```
Initialize()
Clear the LCD display
Delay one dirty flag cycle
Display a welcome message
Wait until ready to clear display
do forever
  if the dirty flag is set
    clear the dirty flag
    clear the display
    display the current message
    increment the message number
    if we are at the end of messages
      point to the first message
    Set oldValue to impossible value
  if a new analog value is available
    remember we read the value
    if the value has changed enough to matter
      Set oldValue to potValue
      Create a string containing voltage and percentage
      display the string on the second line
```

Remember previous analog value

Definition at line 113 of file main.c.

```
{
    int oldValue;

    // Initialize ports and variables
    Initialize();

    // Clear the screen
    LCDclear();

    // Wait a while to pretend like we are thinking hard
    dirty = 0;
    while ( !dirty )
        ;
    dirty = 0;

    // Display a friendly welcome mesage
    LCDputs("In Principio    erat Verbum ");

    //Hold off initial analog display until ready to clear welcome message
    while ( !dirty )
        ;

    while (1)
```

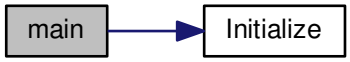
```
    {
        // If the message needs to be updated
        if ( dirty )
        {
            // Remember we did it
            dirty = 0;
            // Clear the display
            LCDclear();
            // Display the current message
            LCDputs(szMessage[message]);
            // Point to the next message
            message++;
            // If we are at the end of the messages
            if ( message > 3 )
                // point back to the firest message
                message = 0;
            // Force display of analog
            oldValue = 10000;
        }
        if ( analogRead )
        {
            // Work string for display
            char szValue[16];

            // Remember we read the analog
            analogRead = 0;

            // Check enough difference to display
            // (to prevent jitter in the last digit)
            if ( abs( oldValue-potValue ) > 10 )
            {
                // Remember current value
                oldValue = potValue;
                // Place the voltage and percentage into the string
                sprintf(szValue,"%5.3fV  %5.2f%%",
                        3.3*(float)potValue/4096.0,
                        100.0*(float)potValue/4096.0 );
                // Position to the second line and write string to LCD
                LCDposition( 0x40+1 );
                LCDputs(szValue);
            }
        }

    }
}
```

Here is the call graph for this function:



2.9.3 Variable Documentation

2.9.3.1 char szMessage[4][17]

Initial value:

```
{
    "Message One     ",
    "msg num 2       ",
    "Number three    ",
    "I am number four"
}
```

Table of messages to be displayed.

Definition at line 78 of file main.c.

2.10 main.c

```
00001
00018 /*********************************************************************************
00019  * Software License Agreement
00020  *
00021  * GPLV2+
00022  *
00023  *********************************************************************************/
00024
00025
00026 #if defined(__PIC24E__)
00027 #include <p24Exxxx.h>
00028
00029 #elif defined (__PIC24F__)
00030 #include <p24Fxxxx.h>
00031
00032 #elif defined(__PIC24H__)
00033 #include <p24Hxxxx.h>
00034
00035 #elif defined(__dsPIC30F__)
00036 #include <p30Fxxxx.h>
00037
00038 #elif defined (__dsPIC33E__)
00039 #include <p33Exxxx.h>
00040
00041 #elif defined(__dsPIC33F__)
00042 #include <p33Fxxxx.h>
00043
00044 #endif
00045
00046 #include <stdio.h>
00047
00048
00049 /*  This is cheating
00050  *
00051  * This is sort of a trick.  Global variables must be defined once,
00052  * but anyplace they are used, they must be referenced as extern.  To
00053  * simplify keeping track, globals are declared in the header file
00054  * as EXTERN.  In the mainline, EXTERN is defined as nothing before
00055  * the header is included.  In all other files, EXTERN is declared
00056  * as extern.  This way all globals are created in the mainline but
00057  * are visible to all the other routines.
00058  */
00059 #define EXTERN
```

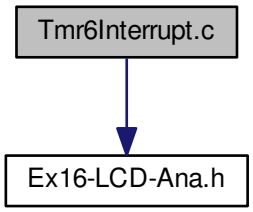
```
00060 #include "Ex16-LCD-Ana.h"
00061 // Notice that the LCD header file is provided by the LCD library project
00062 #include "../LCDlib-Ex16.X/lcd.h"
00063
00064 // Configuration fuses
00065 //
00067 _FOSCSEL( FNOSC_PRIPLL & IESO_OFF );
00069 _FOSC( POSCMD_XT & FCKSM_CSECMD );
00071 _FWDT( FWDTEN_OFF );
00073 _FPOR( FPWRT_PWR64 );
00075 _FICD( ICS_PGD1 & JTAGEN_OFF );
00076
00078 char szMessage[4][17] =
00079 {
00080     "Message One     ",
00081     "msg num 2       ",
00082     "Number three    ",
00083     "I am number four"
00084 };
00085
00087
00113 int main(void)
00114 {
00116     int oldValue;
00117
00118     // Initialize ports and variables
00119     Initialize();
00120
00121     // Clear the screen
00122     LCDclear();
00123
00124     // Wait a while to pretend like we are thinking hard
00125     dirty = 0;
00126     while ( !dirty )
00127         ;
00128     dirty = 0;
00129
00130     // Display a friendly welcome mesage
00131     LCDputs("In Principio    erat Verbum ");
00132
00133     //Hold off initial analog display until ready to clear welcome message
00134     while ( !dirty )
00135         ;
00136
00137     while (1)
00138     {
00139         // If the message needs to be updated
00140         if ( dirty )
00141         {
00142             // Remember we did it
00143             dirty = 0;
00144             // Clear the display
00145             LCDclear();
00146             // Display the current message
00147             LCDputs(szMessage[message]);
00148             // Point to the next message
00149             message++;
00150             // If we are at the end of the messages
00151             if ( message > 3 )
00152                 // point back to the firest message
00153                 message = 0;
00154             // Force display of analog
00155             oldValue = 10000;
00156         }
00157         if ( analogRead )
00158         {
00159             // Work string for display
00160             char szValue[16];
```

```
00161
00162             // Remember we read the analog
00163             analogRead = 0;
00164
00165             // Check enough difference to display
00166             // (to prevent jitter in the last digit)
00167             if ( abs( oldValue-potValue ) > 10 )
00168             {
00169                 // Remember current value
00170                 oldValue = potValue;
00171                 // Place the voltage and percentage into the string
00172                 sprintf(szValue,"%5.3fV  %5.2f%%",
00173                         3.3*(float)potValue/4096.0,
00174                         100.0*(float)potValue/4096.0 );
00175                 // Position to the second line and write string to LCD
00176                 LCDposition( 0x40+1 );
00177                 LCDputs(szValue);
00178             }
00179         }
00180
00181     }
00182 }
```

2.11 Tmr6Interrupt.c File Reference

Timer 6 interrupt service routine.

`#include "Ex16-LCD-Ana.h"` Include dependency graph for Tmr6Interrupt.c:



Defines

- #define **EXTERN** extern

Functions

- void __attribute__ ((__interrupt__, auto_psv))

  Timer 6 Interrupt Service Routine.

Variables

- int delayCount

  Counter used to delay toggling dirty flag.

2.11.1 Detailed Description

Timer 6 interrupt service routine. Whenever Timer 6 expires, this routine toggles the rightmost 2 LEDs. After 5 interrupts, it sets the dirty flag causing the mainline to display a new message on the LCD.

Definition in file Tmr6Interrupt.c.

2.11.2 Function Documentation

2.11.2.1 void __attribute__ ((__interrupt__, auto_psv))

Timer 6 Interrupt Service Routine.

Gets executed whenever Timer 6 expires

Pseudocode:

```
Clear timer interrupt flag
Toggle right 2 LEDs (XOR LATA with 3)
increment delayCount
if  delayCount > 5
    Set dirty flag
    Reset delay count
```

Definition at line 50 of file Tmr6Interrupt.c.

```
{
    IFS2bits.T6IF = 0;      // Clear timer interrupt flag
                            // This is always the first order of
                            // business in an interrupt routine

    LATA ^= 0x0003;         // Toggle right 2 LEDs
    delayCount++;           // Increment delayCount
    if ( delayCount > 5 )   // Only update display every 5
    {                       // toggles of LEDs
        dirty = 1;          // Set the dirty flag
        delayCount = 0;     // Reset the delayCount
    }
}
```

2.11.3 Variable Documentation

2.11.3.1 int delayCount

Counter used to delay toggling dirty flag.

Definition at line 35 of file Tmr6Interrupt.c.

2.12 Tmr6Interrupt.c

```
00001
00011 #if defined(__PIC24E__)
00012 #include <p24Exxxx.h>
00013
00014 #elif defined (__PIC24F__)
00015 #include <p24Fxxxx.h>
00016
00017 #elif defined(__PIC24H__)
00018 #include <p24Hxxxx.h>
00019
00020 #elif defined(__dsPIC30F__)
00021 #include <p30Fxxxx.h>
00022
00023 #elif defined (__dsPIC33E__)
00024 #include <p33Exxxx.h>
00025
00026 #elif defined(__dsPIC33F__)
00027 #include <p33Fxxxx.h>
00028
00029 #endif
00030
00031 #define EXTERN extern
00032 #include "Ex16-LCD-Ana.h"
00033
00035 int delayCount;
00036
00038
00050 void __attribute__((__interrupt__, auto_psv)) _T6Interrupt( void )
00051 {
00052     IFS2bits.T6IF = 0;      // Clear timer interrupt flag
00053                             // This is always the first order of
00054                             // business in an interrupt routine
00055
00056     LATA ^= 0x0003;         // Toggle right 2 LEDs
00057     delayCount++;           // Increment delayCount
00058     if ( delayCount > 5 )   // Only update display every 5
00059     {                       // toggles of LEDs
00060         dirty = 1;          // Set the dirty flag
00061         delayCount = 0;     // Reset the delayCount
00062     }
00063 }
```