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Fail-Safe Monitoring and Clock Frequency Switching Using the PIC16F684

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INTRODUCTION

This application note discusses the Fail-Safe Monitoring and Clock Switching features on the new 8/14/20-pin Flash microcontroller family. This new family of microcontrollers takes Microchip's Mid-Range Family of products to the next level with its new 8 MHz internal oscillator that can be switched in real time from 8 MHz down to 31 kHz (8 steps). In addition, the device contains a fail-safe feature that monitors the external (primary) oscillator and will automatically switch over to the internal (secondary) oscillator if the primary oscillator fails. These new features make applications more robust in the event of a primary oscillator failure and allow greater flexibility by using the clock frequency switching capabilities of the internal oscillator.

This application note will discuss the following:

• Enabling and monitoring the fail-safe option on the PIC16F684
• Switching clock frequencies using the 8 MHz internal oscillator on the PIC16F684
• Example Application

ENABLING THE FAIL-SAFE FEATURE

The fail-safe feature is enabled by setting bit 11 (FCMEN) in the configuration word of the device. Figure 1 shows an example configuration word setup in MPLAB® IDE. Please refer to the PIC16F684 Data Sheet (DS41202) or the PIC16F684 Programming Specification (DS40060) for more information on the configuration word.

MONITORING FOR AN EXTERNAL OSCILLATOR FAILURE

OSCCON<3> (OSTS) indicates whether the device is running from the primary or secondary oscillator. When a failure on the primary oscillator is detected, the device will switch over to its secondary oscillator and clear OSCCON<3> (OSTS). Also, when a failure occurs, an interrupt can be generated by setting PIE1<2> (OSFIE). To attempt to restart the primary oscillator, set OSCCON<0> (SCS) and then clear OSCCON<0> (SCS). Please refer to the PIC16F684 Data Sheet (DS41202) for more information on fail-safe monitoring.
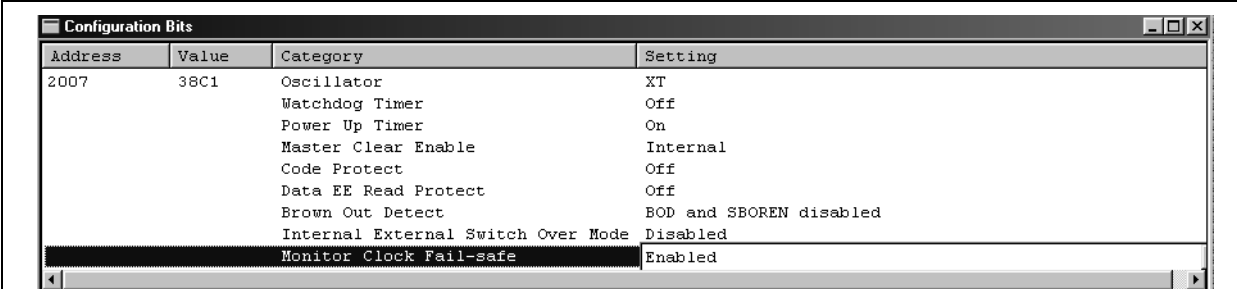
SWITCHING INTERNAL OSCILLATOR FREQUENCIES

The PIC16F684 internal oscillator can be switched from 8 MHz down to 31 kHz (8 steps) in real time. OSCCON<6:4> (IRCF<2:0>) bits are used to set the frequency for running the internal oscillator. Please refer to the PIC16F684 Data Sheet for more information on the OSCCON register.

EXAMPLE APPLICATION

This example application demonstrates the fail-safe monitoring and clock switching features on the PIC16F684. This application was written using the HI-TECH C Compiler and the MPLAB® IDE development platform.

FIGURE 1:   CONFIGURATION WORD SET-UP IN MPLAB® IDE

Address	Value	Category	Setting
2007	38C1	Oscillator	XT
		Watchdog Timer	Off
		Power Up Timer	On
		Master Clear Enable	Internal
		Code Protect	Off
		Data EE Read Protect	Off
		Brown Out Detect	BOD and SBOREN disabled
		Internal External Switch Over Mode	Disabled
		Monitor Clock Fail-safe	Enabled

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HARDWARE

The application uses a LCD display to show whether the device is running from the primary or secondary oscillator and the frequency that the secondary oscillator is running at. An external crystal oscillator is used as the primary oscillator. The primary crystal oscillator is installed in a socket where it could be easily inserted and removed while the application is running. A potentiometer is used to select the secondary oscillator frequency (See Figure A-1).

FIRMWARE

Reading The Potentiometer

The A/D converter is used to read the voltage coming from the potentiometer. A Timer0 interrupt is used to periodically sample the voltage coming from the potentiometer. When an A/D converter interrupt occurs, a binary search algorithm is used to select 1 of the 8 possible internal oscillator frequencies, based on the result of the A/D conversion. The code snippet in Example 1 demonstrates the Timer0 and A/D Interrupt handler routines. A flowchart for the Interrupt Service Routine (ISR) is shown in Figure 3.

Restarting The Primary Oscillator

In the event of a primary oscillator failure and bit 11 (FCMEN) in the configuration word is set, the device will switch over from the primary to the secondary oscillator. Timer1 is used to periodically create an interrupt for attempting to restart the primary oscillator when the device is running from the secondary oscillator. The code snippet in Example 2 demonstrates the Timer1 interrupt handler routine. A flowchart for the Interrupt Service Routine (ISR) is shown in Figure 3.

Switching Secondary Oscillator Frequencies

The secondary internal oscillator frequency can be easily switched by masking out the OSCCON<6:4> bits and loading the step corresponding to the desired frequency. The code snippet in Example 3 demonstrates loading OSCCON<6:4>.

EXAMPLE 1: TIMER0 AND A/D INTERRUPT

```
if ((T0IE & T0IF) == SET)        //If A Timer0 Interrupt, Then
    {
        GODONE = SET;            //Start an A/D Conversion
        T0IF = CLEAR;            //Clear Timer0 Interrupt Flag
    }

else if ((ADIE & ADIF) == SET)   //If an A/D Complete Interrupt, Then
    {
        current = ADRESH;
        if (current != prev)     //If Potentiometer Changed Position, Then
            ClockSwitch();       //Update Secondary Oscillator Frequency
        prev = current;
        ADIF = CLEAR;            //Clear A/D Interrupt Flag
    }
```

EXAMPLE 2: TIMER1 INTERRUPT

```
if ((TMR1IE & TMR1IF) == SET)    //If a Timer 1 Interrupt, Then
    {
        if (OSTS == SECONDARY)   //Try and restart primary oscillator
        {
            SCS = SET;
            SCS = CLEAR;
        }
        TMR1IF = CLEAR;          //Clear Timer1 Interrupt Flag
    }
```

EXAMPLE 3: OSCCON<6:4>

```
OSCCON &= 0B10001111;            //Mask out OSCCON<6:4>
OSCCON |= OSC_8_MHZ << 4;        //Switch internal oscillator to 8MHz
```

Updating the LCD Display

The LCD is updated in the main program. A flowchart for the main routine program is shown in Figure 2.

CONCLUSION

This application note demonstrates through example how easily the fail-safe monitoring and clock frequency switching features on the new 8/14/20-pin Flash microcontrollers can be used to improve the flexibility and robustness in an application.

REFERENCES

[1]   PIC16F684 Data Sheet DS41202A - *14-Pin Low Power Flash Microcontroller*, Microchip Technology Inc., www.microchip.com.

[2]   Programming Specifications DS41204A - *PIC12F6XX/16F6XX Memory*, Microchip Technology Inc., www.microchip.com.

[3]   HI-TECH C, www.htsoft.com.

[4]   MPLAB® IDE, www.microchip.com.
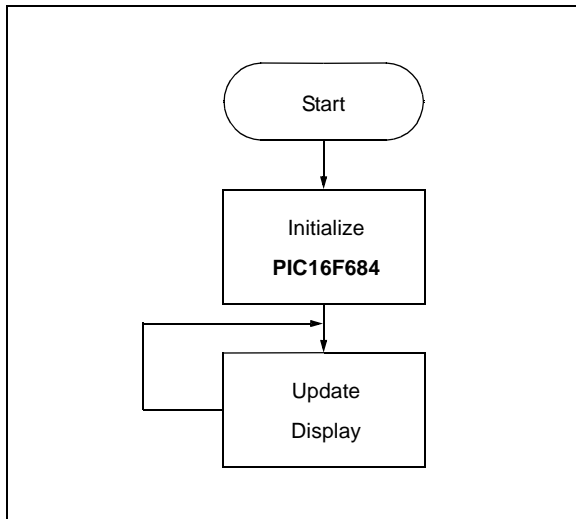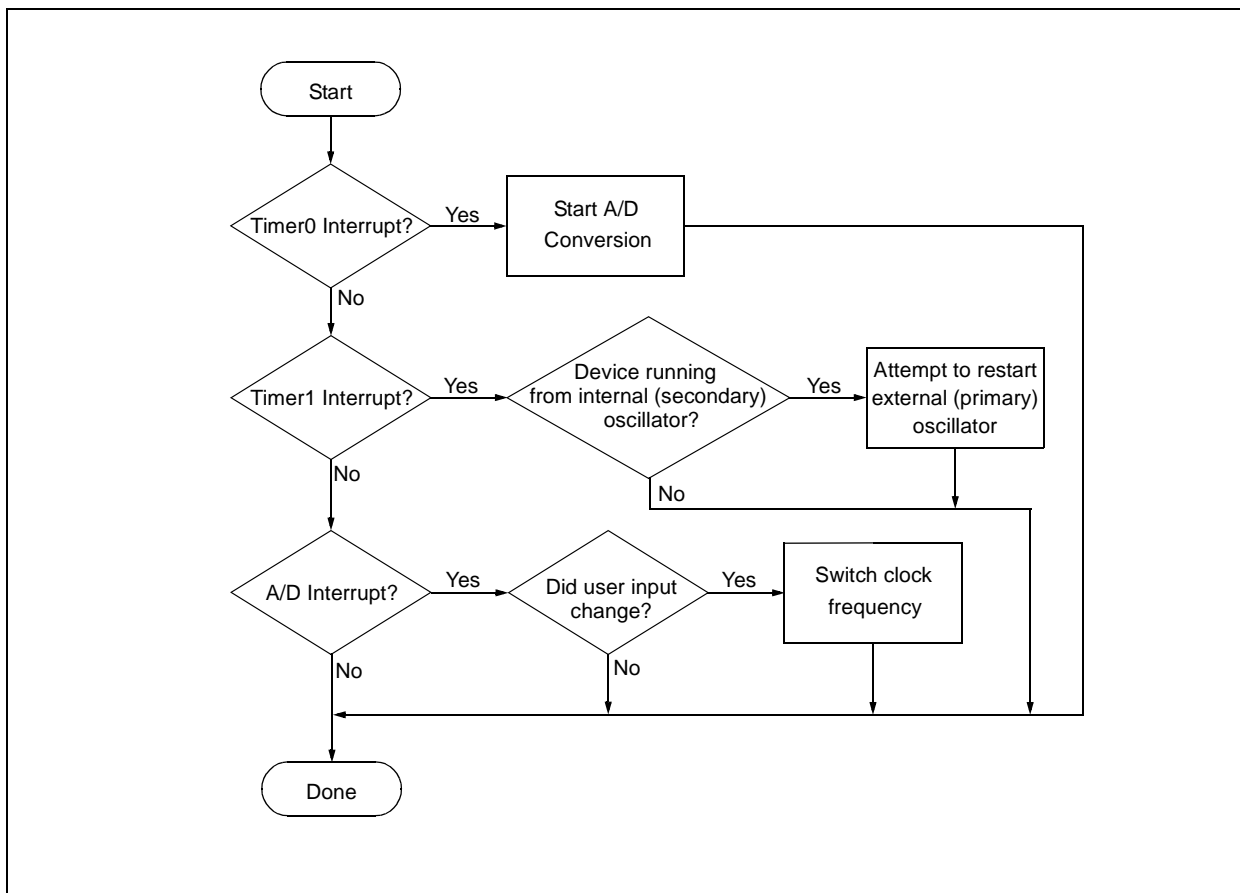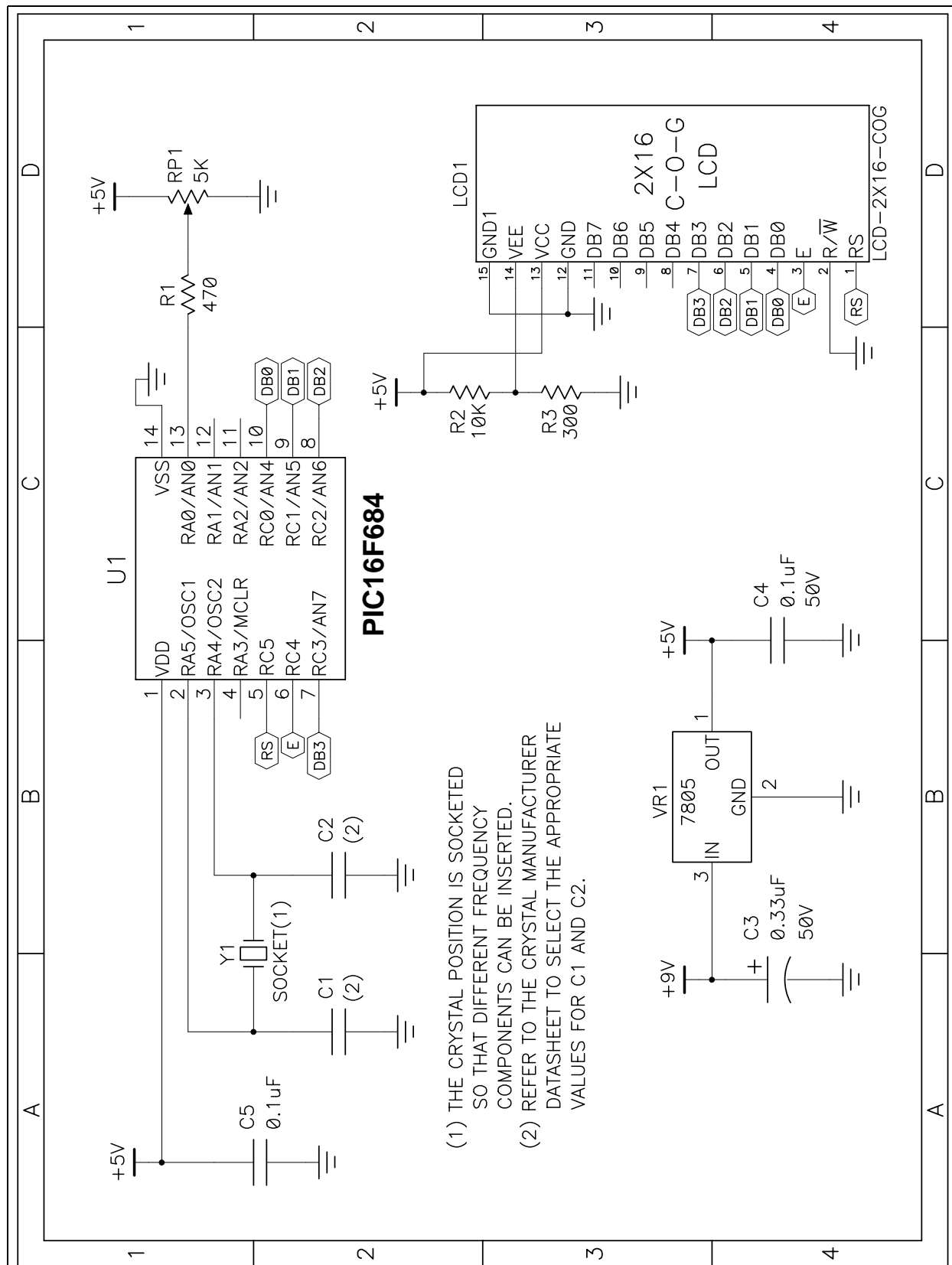
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FIGURE 2: **MAIN ROUTINE FLOW CHART**

```
        ┌──────────┐
        │  Start   │
        └────┬─────┘
             │
             ▼
      ┌──────────────┐
      │  Initialize  │
      │  PIC16F684   │
      └──────┬───────┘
             │
   ┌────────▶▼
   │  ┌──────────────┐
   │  │    Update    │
   │  │   Display    │
   │  └──────┬───────┘
   └─────────┘
```

FIGURE 3: **INTERRUPT ROUTINE FLOW CHART**

```
                    ┌──────────┐
                    │  Start   │
                    └────┬─────┘
                         │
                         ▼
              ◇ Timer0 Interrupt? ◇──Yes──▶┌─────────────┐
                         │                 │  Start A/D  │──────┐
                         No                │ Conversion  │      │
                         │                 └─────────────┘      │
                         ▼                                      │
              ◇ Timer1 Interrupt? ◇──Yes──▶◇ Device running ◇──Yes──▶┌──────────────────┐
                         │                 │ from internal   │       │Attempt to restart│
                         No                │   (secondary)   │       │external (primary)│
                         │                 │   oscillator?   │       │    oscillator    │
                         │                 └────────┬────────┘       └────────┬─────────┘
                         │                          No                        │
                         ▼                          │                         │
              ◇ A/D Interrupt? ◇──Yes──▶◇ Did user input ◇──Yes──▶┌─────────────┐     │
                         │              │    change?      │        │Switch clock │     │
                         No             └────────┬────────┘        │  frequency  │     │
                         │                       No                └──────┬──────┘     │
                         ▼                       │                        │            │
                    ┌──────────┐◀────────────────┴────────────────────────┴────────────┘
                    │   Done   │
                    └──────────┘
```

APPENDIX A: SCHEMATICS

FIGURE A-1: FAIL-SAFE AND CLOCK SWITCHING SCHEMATIC

NOTES:

Note the following details of the code protection feature on Microchip devices:

- Microchip products meet the specification contained in their particular Microchip Data Sheet.

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