Application Report
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Using the VLO Library

Lane Westlund *MSP430 Applications*

ABSTRACT

The very low oscillator (VLO) is a clock source included in the 2xx family of devices. This library provides a method of measuring the speed of the VLO without using any external components such as a 32-kHz crystal. Once measured, the VLO can be used to trigger periodic interrupts with greater accuracy. Measuring the VLO also allows for setting the DCO to a specific frequency using a software frequency locked loop (FLL).

Source files for the VLO library can be downloaded from http://www.ti.com/lit/zip/slaa340.

Introduction

A feature of most 2xx devices is the very low oscillator (VLO). This oscillator is designed to give a MSP430 the ability to periodically wake up from LPM3 without using external hardware such as a crystal. For many applications in which accuracy is not as critical as power consumption, simply using the VLO as a source for a timer is a perfect solution. A thermostat is a good example of this, where waking up in approximate time intervals is sufficient for temperature measurement.

However, sometimes greater accuracy is desired when measuring a time period using the VLO. Using this library, it is possible for an MSP430 to measure the speed of its VLO and, therefore, set timers accordingly for more accurate interval measurement.

Usage from C

```
void main(void)
{
   volatile unsigned int i;
   WDTCTL = WDTPW +WDTHOLD;          // Stop Watchdog Timer
   P1DIR |= 0x11;                    // P1.0,1,4 outputs
   P1SEL |= 0x10;                    // P1.4 = SMCLK output

   BCSCTL3 |= LFXT1S_2;              // ACLK = VLO
   BCSCTL1 = CALBC1_8MHZ;            // 8MHz cal value
   DCOCTL = CALDCO_8MHZ;             // 8MHz cal value
   dco_delta = TI_measureVLO();      // dco delta = number of
                                     // 1MHz cycles in 8 ACLK cycles

   CCTL0 = CCIE;                     // CCR0 interrupt enabled
   CCR0 = (8000000 / dco_delta);     //
   TACTL = TASSEL_1 + MC_1;          // ACLK, upmode
   P1OUT = 0x01;
   _BIS_SR(LPM3_bits + GIE);         // Enter LPM3 w/ interrupt

}

// Timer A0 interrupt service routine
#pragma vector=TIMERA0_VECTOR
__interrupt void Timer_A (void)
{
   P1OUT ^= 0x01;                    // Toggle P1.0
}
```

NOTE: Due to VLO tracking the DCO, a more accurate measurement can be made if the VLO measurement function is edited to run the DCO at the desired end application speed during measurement.

The file VLO_Library.h must be included to gain access to the variables and functions provided by the library from a C program.

The appropriate device header file must also be included in the library. This requires editing the VLO_Library.s43 file. The correct device header file must be included to accommodate for differences between ACLK connections in Timer_A2 and Timer_A3 devices.

The VLO library contains only one function and one variable. The function: TI_measureVLO(), when called, performs the following actions:

1. Save the current clock settings in registers and on the stack.
2. Set the DCO to the 1MHz calibrated value stored in flash.
3. Set ACLK to the VLO/8.
4. Measure the number of 1-MHz clock pulses in 1 ACLK (VLO/8) pulse.
5. Store the measured result in the variable TI_8MHz_Counts_Per_VLO_Clock.
6. Reload the previous clock settings.
7. Return variable TI_8MHz_Counts_Per_VLO_Clock from the function.

Although the device measures the number of 1-MHz clock periods in eight VLO clock periods, this is mathematically equivalent to knowing the number of 8-MHz clock periods in one VLO clock period. For clarity, this description was chosen.

In the preceding example, the DCO is first set to 8 MHz, to demonstrate that the clock system is correctly set back to the state it was in prior to measuring the VLO. (This example code is included in the associated zip file.)

Code Size

VLO Library: 138 bytes

Included Library Files

NOTE: In the zip file accompanying this application report, there are two directories: source_CCE and source_IAR. The files in these directories are functionally equivalent and contain only minor changes to allow for compiling using CCE or IAR, respectively.

VLO_Library.s43

This file includes the function and variable used for measuring the speed of the VLO relative to the built-in constant values.

VLO_Library.h

This file includes the definitions for the function and variable used in VLO_Library.s43.

Variable Description

NOTE: All VLO library variables begin with the 'TI_' prefix to avoid collision with any other variable names used in an end application.

TI_8MHz_Counts_Per_VLO_Clock

This variable is identical to the last returned value of TI_measureVLO. It contains the number of 8-MHz clock periods per VLO clock period.

Function Description

TI_measureVLO(…..)

This function measures the speed of the VLO. It returns the number of 8-MHz clock periods that fit into one VLO clock.

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