

## ***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 FLL.

---

### **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
}
```

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.

## IMPORTANT NOTICE

Texas Instruments Incorporated and its subsidiaries (TI) reserve the right to make corrections, modifications, enhancements, improvements, and other changes to its products and services at any time and to discontinue any product or service without notice. Customers should obtain the latest relevant information before placing orders and should verify that such information is current and complete. All products are sold subject to TI's terms and conditions of sale supplied at the time of order acknowledgment.

TI warrants performance of its hardware products to the specifications applicable at the time of sale in accordance with TI's standard warranty. Testing and other quality control techniques are used to the extent TI deems necessary to support this warranty. Except where mandated by government requirements, testing of all parameters of each product is not necessarily performed.

TI assumes no liability for applications assistance or customer product design. Customers are responsible for their products and applications using TI components. To minimize the risks associated with customer products and applications, customers should provide adequate design and operating safeguards.

TI does not warrant or represent that any license, either express or implied, is granted under any TI patent right, copyright, mask work right, or other TI intellectual property right relating to any combination, machine, or process in which TI products or services are used. Information published by TI regarding third-party products or services does not constitute a license from TI to use such products or services or a warranty or endorsement thereof. Use of such information may require a license from a third party under the patents or other intellectual property of the third party, or a license from TI under the patents or other intellectual property of TI.

Reproduction of information in TI data books or data sheets is permissible only if reproduction is without alteration and is accompanied by all associated warranties, conditions, limitations, and notices. Reproduction of this information with alteration is an unfair and deceptive business practice. TI is not responsible or liable for such altered documentation.

Resale of TI products or services with statements different from or beyond the parameters stated by TI for that product or service voids all express and any implied warranties for the associated TI product or service and is an unfair and deceptive business practice. TI is not responsible or liable for any such statements.

Following are URLs where you can obtain information on other Texas Instruments products and application solutions:

<b>Products</b>		<b>Applications</b>	
Amplifiers	<a href="http://amplifier.ti.com">amplifier.ti.com</a>	Audio	<a href="http://www.ti.com/audio">www.ti.com/audio</a>
Data Converters	<a href="http://dataconverter.ti.com">dataconverter.ti.com</a>	Automotive	<a href="http://www.ti.com/automotive">www.ti.com/automotive</a>
DSP	<a href="http://dsp.ti.com">dsp.ti.com</a>	Broadband	<a href="http://www.ti.com/broadband">www.ti.com/broadband</a>
Interface	<a href="http://interface.ti.com">interface.ti.com</a>	Digital Control	<a href="http://www.ti.com/digitalcontrol">www.ti.com/digitalcontrol</a>
Logic	<a href="http://logic.ti.com">logic.ti.com</a>	Military	<a href="http://www.ti.com/military">www.ti.com/military</a>
Power Mgmt	<a href="http://power.ti.com">power.ti.com</a>	Optical Networking	<a href="http://www.ti.com/opticalnetwork">www.ti.com/opticalnetwork</a>
Microcontrollers	<a href="http://microcontroller.ti.com">microcontroller.ti.com</a>	Security	<a href="http://www.ti.com/security">www.ti.com/security</a>
Low Power Wireless	<a href="http://www.ti.com/lpw">www.ti.com/lpw</a>	Telephony	<a href="http://www.ti.com/telephony">www.ti.com/telephony</a>
		Video & Imaging	<a href="http://www.ti.com/video">www.ti.com/video</a>
		Wireless	<a href="http://www.ti.com/wireless">www.ti.com/wireless</a>

Mailing Address: Texas Instruments  
Post Office Box 655303 Dallas, Texas 75265

Copyright © 2006, Texas Instruments Incorporated