

# NI 6608 TIMING I/O DEVICE

## Introduction

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This document contains information and step-by-step instructions for calibrating the oven-controlled crystal oscillator (OCXO) on the NI 6608 timing I/O device.

### What Is Calibration?

*Calibration* consists of two steps: verifying the measurement accuracy of a device and correcting for any measurement error. *Verification* is measuring the performance of a device and comparing the results to the factory specifications of the device. If the device is not operating within its specifications, use the second step of the calibration procedure to correct the measurement error of the NI 6608.

### Why Should You Calibrate?

The accuracy of timing components can drift with time and temperature, which could cause them to be less accurate than specified. Calibration ensures that the NI 6608 still meets National Instruments specifications.

### How Often Should You Calibrate?

The measurement requirements of the application determine how often you should calibrate the device to ensure its accuracy. NI recommends that you calibrate the NI 6608 at least once every year. You can shorten this interval to six months or 90 days based on the demands of the application.

# Equipment and Other Test Requirements

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This section describes the equipment, software, documentation, and test conditions required for calibrating the NI 6608.

## Test Equipment

Calibrating the NI 6608 requires the following equipment:

- A highly stable 10 MHz clock source that is accurate to within 0.75 parts-per-billion (ppb). NI recommends a rubidium frequency standard clock source.
- An SH68-68-D1 cable or a standard 68-pin cable connector
- A 68-pin breakout box

## Software and Documentation

You need the following software and documentation to calibrate the NI 6608. You can download these from the NI Web site at [ni.com/manuals](http://ni.com/manuals):

- The latest version of the NI-DAQ driver
- *NI-DAQ Function Reference Help* file
- *NI-DAQ User Manual for PC Compatibles*

### Software

The NI 6608 calibration procedure requires using the latest version of the NI-DAQ driver software. NI-DAQ supports a number of application development environments (ADEs) and programming languages, including LabVIEW, LabWindows/CVI, Microsoft Visual C++, Microsoft Visual Basic, and Borland C++. When you install the driver, you only need to install support for the ADE or programming language that you are using.



**Note** You can find the calibration software for adjusting the frequency of the 10 MHz OCXO on the NI 6608 on the NI calibration web page at [ni.com/support/calibrat](http://ni.com/support/calibrat). Click the *Manual Calibration Procedures* link.

### Documentation

The *NI-DAQ Function Reference Help* file and *NI-DAQ User Manual for PC Compatibles* contain detailed information on using the NI-DAQ driver. The help file, which you can access by clicking **Start»Programs»National Instruments»NI-DAQ»NI-DAQ Help**, includes detailed information on the driver functions. The *NI-DAQ User Manual for PC Compatibles* provides instructions on installing NI-DAQ. This manual also includes detailed information on creating applications that use the NI-DAQ driver.

These sources are your primary references for writing your calibration utility. You can also refer to the documentation for the programming language you are using. For further information on the device you are calibrating, refer to the *660X User Manual*.

## Test Conditions

Follow these guidelines to optimize connections and test conditions during the calibration procedure:

- Keep connections to the device as short as possible. Long cables and wires act as antennae by picking up extra noise that can affect measurements.
- Maintain a temperature of approximately 25 °C.
- Keep relative humidity below 80%.
- Use shielded copper wire for all cable connections to the device. Use twisted-pair wire to eliminate noise and thermal offsets.
- Allow a warm-up time of at least 15 minutes to ensure the measurement circuitry is at a stable operating temperature.

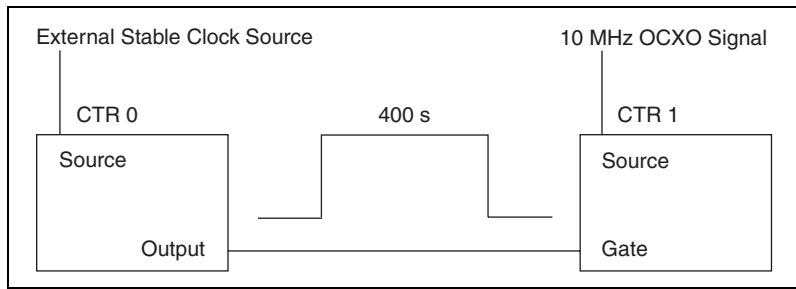
## Verifying the Frequency of the NI 6608

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**Note** If you prefer, you can go directly to the [Adjusting the Frequency of the 10 MHz OCXO on the NI 6608](#) section.

This section contains instructions for verifying the performance of the OCXO on the NI 6608 using a stable clock source. Verifying the performance of the oscillator on an NI 6608 requires two counters on the NI 6608—counters 0 and 1. Counter 0 uses the stable clock as the source to generate a 400 s single pulse, which is applied to the GATE of counter 1. The 10 MHz OCXO signal on the NI 6608 is the SOURCE of counter 1. Counter 1 counts the number of clock edges of the 10 MHz signal that occur during the 400 s pulse and calculates the frequency of the oscillator to determine if the device is within its specifications. Figure 1 shows a simple diagram of the verification process.



**Figure 1.** NI 6608 Verification Process

The frequency measurement has an uncertainty that is equal to the sum of the stable clock error and the quantization error caused by the counter. The clock error should be 0.75 ppb or less, as specified in the [Test Equipment](#) section of this document. The quantization error, which is the inherent uncertainty in digitizing an analog value, is always up to 100 ns. Using a measurement duration of 400 s gives a quantization error as follows:

$$\frac{100 \text{ ns}}{400 \text{ s}} = 0.25 \text{ ppb}$$

The sum of the stable clock error, 0.75 ppb, and the quantization error, 0.25 ppb, gives a total measurement uncertainty of 1 ppb. You can reduce measurement uncertainty by using a more stable clock, by increasing the measurement duration, or both. The value returned from the [Measuring the Frequency of the 10 MHz OCXO](#) section allows for a 1 ppb measurement uncertainty.

Both NI-DAQ programming and LabVIEW programming instructions are presented in the following sections. Choose the appropriate instructions for your programming environment.

## Connecting the Clock Source to the NI 6608



**Note** The stable clock must meet the specifications described in the [Test Equipment](#) section of this document. Also, allow adequate time for the stable clock to warm up.

To connect a clock source to the NI 6608, complete the following steps:

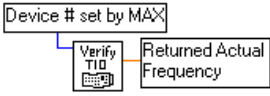
1. Connect the NI 6608 to a 68-pin breakout box using the SH68-68-D1 cable.
2. Connect the stable clock to pin 2 (PFI\_39), which is the SOURCE of counter 0 on the NI 6608.
3. Connect the ground of the stable clock to pin 36, which is the digital ground.

# Measuring the Frequency of the 10 MHz OCXO



**Note** Make sure you plug the NI 6608 in the star trigger slot (slot 2) of the PXI chassis and configure it in Measurement & Automation Explorer.

To measure the frequency of the 10 MHz OCXO the NI 6608 for verification, do the following:

NI-DAQ Function Call	LabVIEW Block Diagram
<p>Call <code>Verify_TIO</code> with the following parameters:</p> <p><b>deviceNumber:</b> The value set by MAX</p> <p><b>actualFrequency:</b> A user-declared variable.</p> <p>Example:</p> <pre>double frequency; Verify_TIO (deviceNumber, &amp;frequency);</pre>	 <p><b>Note:</b> You can set or view the parameters above on the front panel of the Verify TIO VI.</p>



**Note** The verification process for the NI 6608 takes at least 6 minutes.

After the software has finished, you have completed verifying the frequency of the 10 MHz OCXO on the NI 6608. Refer to the next section to ensure the NI 6608 is within specifications.

## Comparing Measured Frequency to NI 6608 Device Specifications

Compare the values returned from the *Measuring the Frequency of the 10 MHz OCXO* section with the following values:

- If the frequency you measure falls between the upper limit of 10,000,000.1 Hz and the lower limit of 9,999,999.9 Hz, the NI 6608 is operating within its specifications.
- If the frequency you measure does not fall between the upper limit of 10,000,000.1 Hz and the lower limit of 9,999,999.9 Hz, the NI 6608 needs to be adjusted.

You have completed verifying the performance of the NI 6608. If the NI 6608 needs to be adjusted, the next section guides you through the process.

# Adjusting the Frequency of the 10 MHz OCXO on the NI 6608

This section contains instructions for adjusting the frequency of the OCXO on the NI 6608. The adjustment process iteratively measures the OCXO frequency and adjusts the hardware until the measured frequency is within specification. The final settings are stored in the device EEPROM and are automatically loaded upon device initialization.

Both NI-DAQ programming and LabVIEW programming instructions are presented in the following table. Choose the appropriate instructions for your programming environment.



**Note** Prior to adjusting the frequency on the 10 MHz OCXO, refer to the [Connecting the Clock Source to the NI 6608](#) section earlier in this document.

After you have downloaded the NI 6608 calibration software and have set up the hardware connections, you are ready to adjust the frequency of the 10 MHz OCXO. Configure the NI 6608 to do an external calibration with a 10 MHz reference frequency as follows:

NI-DAQ Function Call	LabVIEW Block Diagram
<p>Call <code>C_Calibrate_TIO</code> with the following parameters:</p> <p><b>deviceNumber:</b> The value set by MAX</p> <p><b>operation:</b> <code>ND_EXTERNAL_CALIBRATION</code></p> <p><b>setOfCalConst:</b> <code>ND_USER_EEPROM_AREA</code></p> <p><b>referenceFreq:</b> <code>10000000.00</code></p>	<p><b>Note:</b> You can set the parameters above on the front panel of the Calibrate TIO VI.</p>



**Note** The adjustment process for the NI 6608 takes at least 95 minutes.

After the software has finished executing, you have completed adjusting the frequency on the 10 MHz OCXO on the NI 6608. If the measured frequency is outside the device specification, an error is returned. If you get an error, verify that the external stable clock source is operating properly and is connected to the NI 6608. If you still get an error, contact NI for repair.