

# 1

## **Getting Started with the LabVIEW Sound and Vibration Toolkit**

This tutorial is designed to introduce you to some of the sound and vibration analysis capabilities in the industry-leading software tool for designing test, measurement, and control systems – NI LabVIEW. These exercises will give you an overview of how you can use the LabVIEW Sound and Vibration Toolkit to create flexible applications for acoustic, NVH, and machine monitoring applications. Upon completion of the tutorial, you will be able to do sound level measurements, analyze vibration level and others.

This tutorial covers only the beginning. Once you've finished, please feel free to explore the environment, the LabVIEW Sound and Vibration Toolkit has numerous analysis capabilities to offer.

This manual assumes that you are familiar with the basic LabVIEW programming concepts that are covered in the Getting Started with LabVIEW manual.

# Sound Level Measurements

In this exercise, you will use LabVIEW and the Sound & Vibration Toolkit to measure the sound level of a microphone and then perform one-third octave analysis. The goal of this exercise is to introduce the user to some basic analysis capabilities in the toolkit.

The completed front panel and block diagram will look similar to those in Figure 1-1.

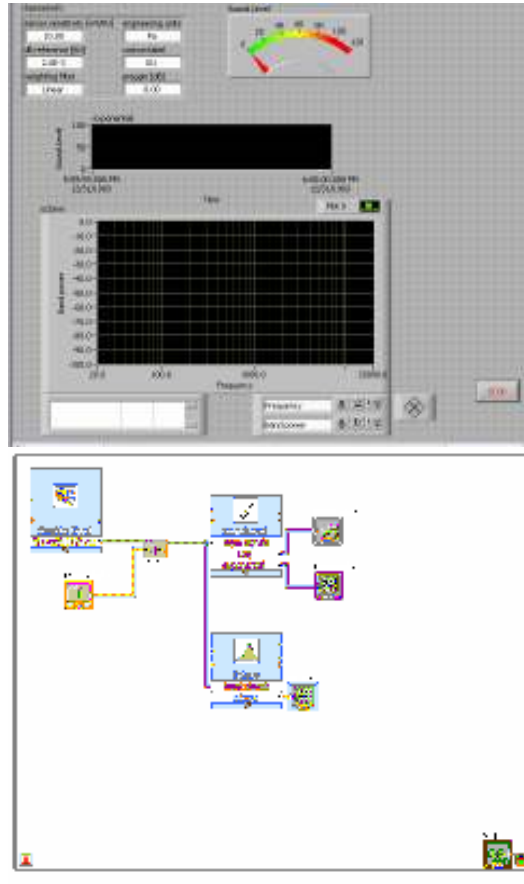


Figure 1-1. Front Panel and block diagram for the Sound Level Measurements VI

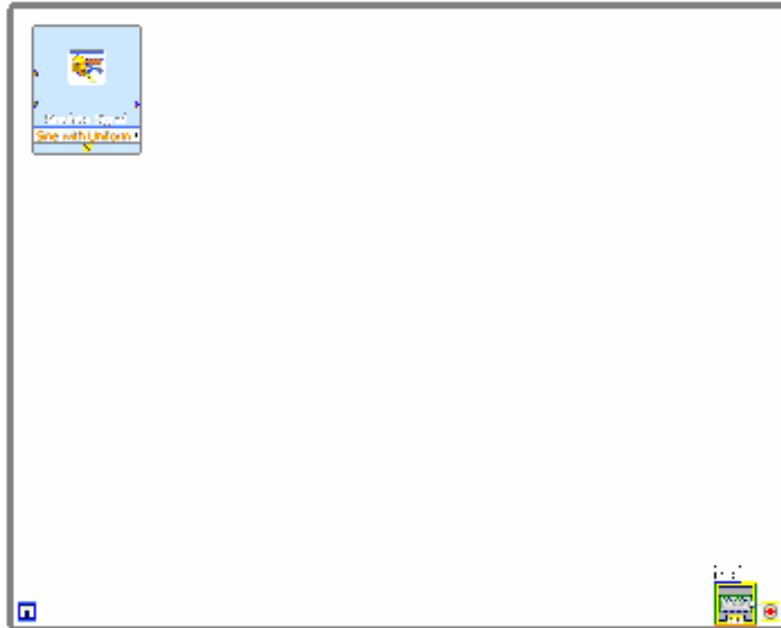
## Signal Setup and Scaling

1. Launch LabVIEW and open the Sound Level Meter VI.
2. The front panel will look like this:



**Figure 1-2.** Sound Level Meter Front Panel

3. Go to the block diagram by pressing Ctrl+E. The block diagram will look like Figure 1-3.

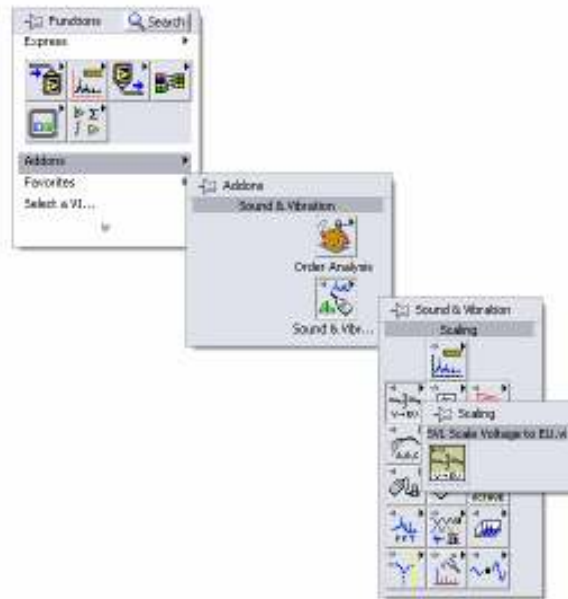


**Figure 1-3.** Sound Level Meter Block Diagram

The Simulate Signal Express VI is used to generate a simulated signal from a microphone. The generated signal is a 1 kHz, 2Vpp sine wave with 0 offset and uniform white noise. It is sampled at 50 kS/s with a block size of 5000 samples.

The VI has already been setup with a While loop for continuous analysis and a **stop** button to control the VI.

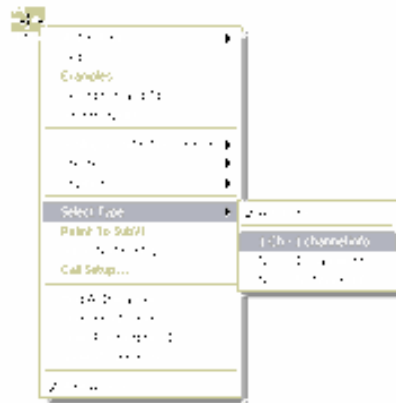
4. Right-click on the block diagram to bring up the Functions palette. Go to Functions >> Addons >> Sound & Vibration >> Scaling palette and place the SVL Scale Voltage to EU VI on the block diagram. This VI is used to scale the signal from a voltage to an engineering unit (EU). For this application, the EU is sound pressure which is measured in units of Pascals (Pa).



**Figure 1-4.** Functions palettes to select the SVL Scale Voltage to EU VI

The Sound & Vibration Toolkit has 16 sub-palettes grouped by analysis type such as vibration level, distortion measurements, weighting, etc.

5. Right-click on the SVL Scale Voltage to EU VI and Select Type >> 1 Ch – 1 channel info. This will apply scaling to only one channel of simulated microphone data.



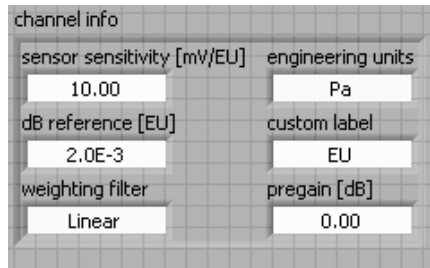
**Figure 1-5.** Shortcut menu to the the Type of the SVL Scale Voltage to EU VI

6. Right-click again on the **channel info** input of the SVL Scale Voltage to EU VI and select Create >> Control. This creates a cluster control on the front panel where scaling data is entered. This shortcut allows the user to quickly create the necessary controls on the front panel of the VI.



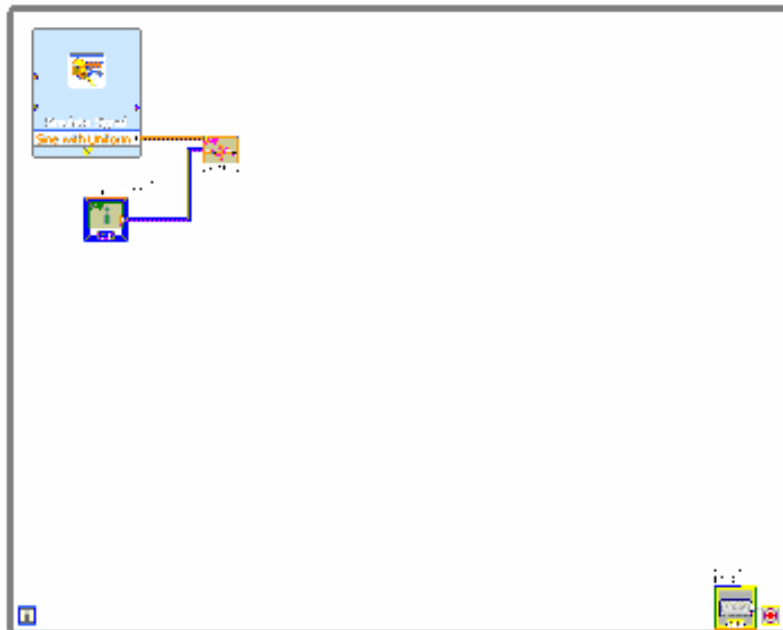
**Figure 1-6.** Shortcut to create scaling Control of SVL Scale Voltage to EU VI

7. On the front panel, set the **channel info** control with this data:
- **sensor sensitivity [mV/EU]:** 10.0
  - **engineering units:** Pa
  - **dB reference [EU]:**  $2 \times 10^{-6}$



**Figure 1-7.** Front panel settings for channel scaling

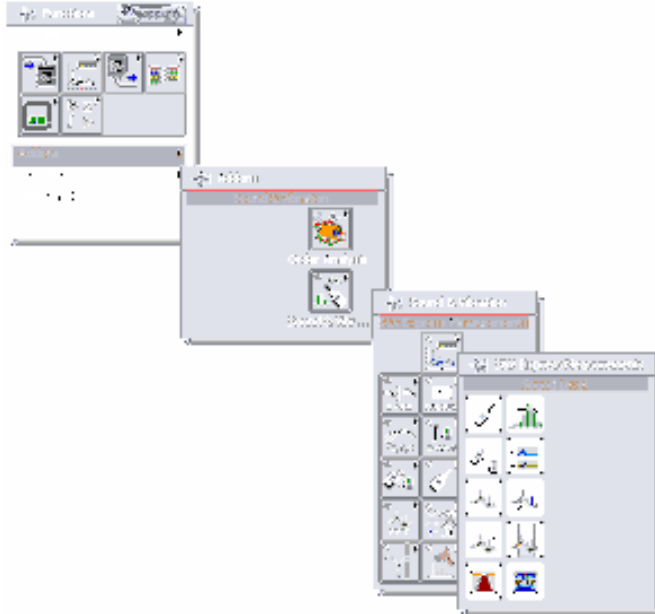
8. Connect the **Sine with Uniform** output of the Simulate Signal Express VI to the **signal [V]** input of the SVL Scale Voltage to EU VI. The block diagram of your code should now look like figure 1-8.



**Figure 1-8.** Block diagram of scaling and setup

## Sound Level Analysis

1. Go to Functions >> Addons >> Sound & Vibration >> S&V Express Measurements palette and place the Sound Level Express VI on the block diagram. This Express VI performs sound level calculations on the scaled data from a microphone. The LabVIEW Sound & Vibration toolkit contains 10 Express VIs to make it easier to perform analysis for noise, acoustic, and vibration applications.



**Figure 1-9.** Functions palettes to select the Sound Level Express VI

2. The Sound Level Express VI opens the configuration window..

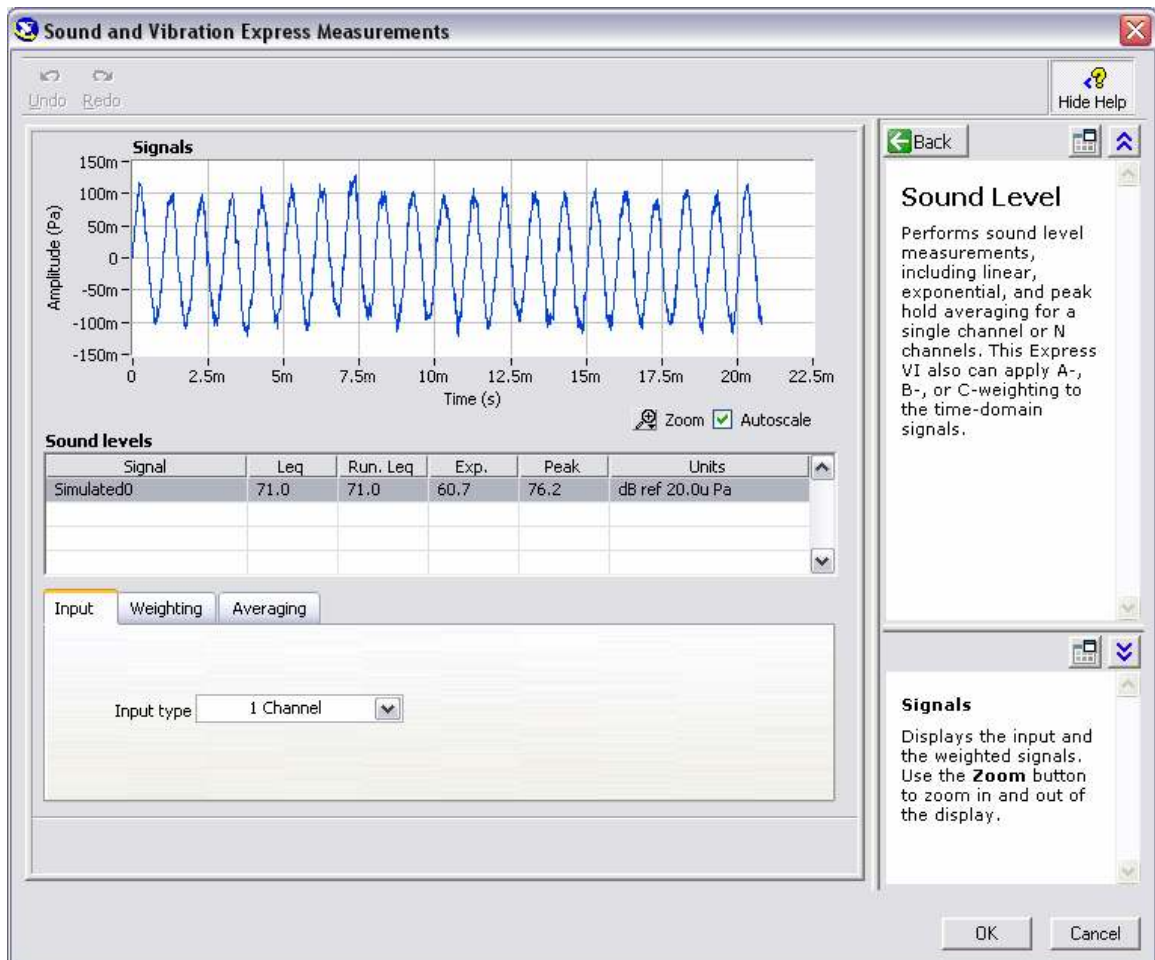
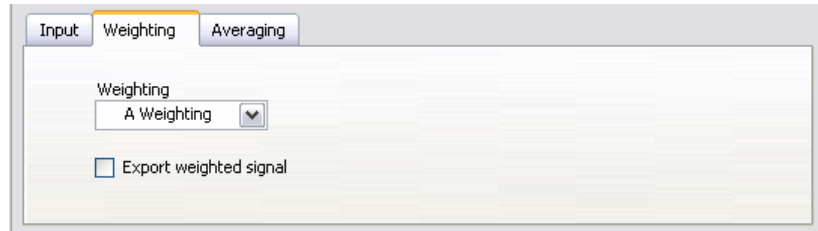


Figure 1-10. Configuration window of Sound Level Express VI

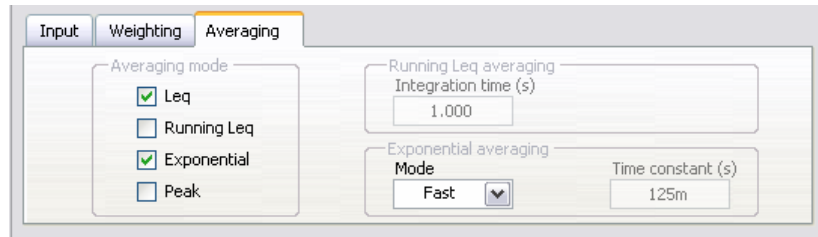
The Sound Level Express VI can analyze data from one or multiple channels (N Channels) simultaneously.

3. Go the **Weighting** tab and select **A Weighting** from the pull down menu. The Sound & Vibration Toolkit contains several common weighting filters for acoustic analysis.



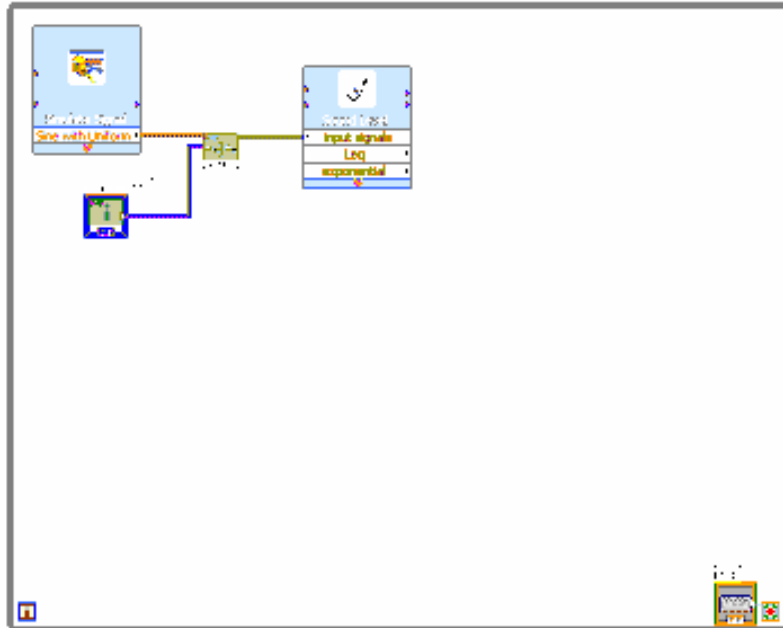
**Figure 1-11.** Weighting tab of the Sound Level Express VI

4. Go to the **Averaging** tab and select **Leq** and **Exponential** averaging modes for the sound level. The user can select one or more sound level averaging modes for the Express VI to calculate. Then click OK to close the configuration window.



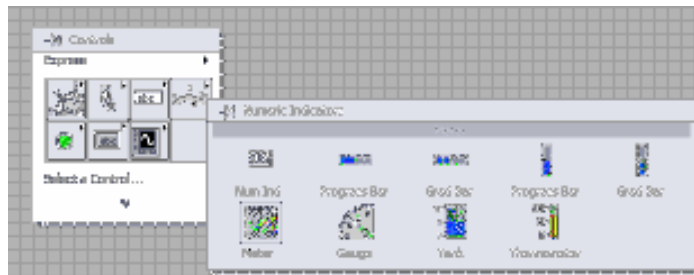
**Figure 1-12.** Averaging tab of the Sound Level Express VI

5. Connect the scaled signal [EU] output of the SVL Scale Voltage to EU VI to the input signals input of the Sound Level Express VI. The block diagram of your code should now look like figure 1-13.



**Figure 1-13.** Block diagram with Sound Level Express VI

6. On the front panel, add a meter to display the sound level (Leq). Right-click to show the Controls palette and go to Controls >> Numeric Indicators >> Meter. This meter is only one of many types of indicators that can be used to display a sound level measurement. You could also use a digital display, chart, or progress bar.



**Figure 1-13.** Control palette to add a meter

7. Change the upper limit of the meter to 120. The sound level (Leq) is in units of dB(A) ref 2.00µ Pa, so it is important to set the upper limit

properly. Because the data was scaled using the SVL Scale Voltage to EU VI, the Sound Level Express VI will automatically report the units at the unit labels output.

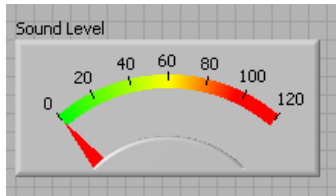


Figure 1-14. Meter range set to 120

8. Now add a chart to display the exponentially averaged sound level. There is a shortcut to do this in the block diagram. Right-click on the **exponential** output of the Sound Level Express VI and select Create >> Indicator. Connect the indicators as in figure 1-15.

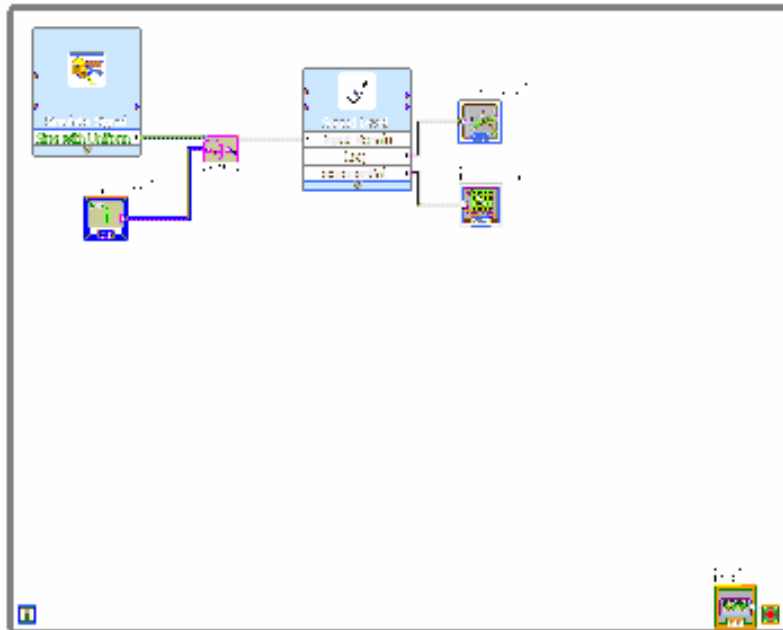


Figure 1-15. Block diagram connections

9. The front panel will look like figure 1-16.



Figure 1-16. Front panel setup

## Third Octave Analysis

The octave analysis in the LabVIEW Sound & Vibration toolkit meets the standards for IEC and ANSI fractional octave analysis.

1. Go to Functions >> Addons >> Sound & Vibration >> S&V Express Measurements palette and place the Octave Analysis Express VI on the block diagram. This Express VI performs fractional octave analysis on the scaled data from a microphone. The Octave Analysis Express VI opens the configuration window in figure 1-17.

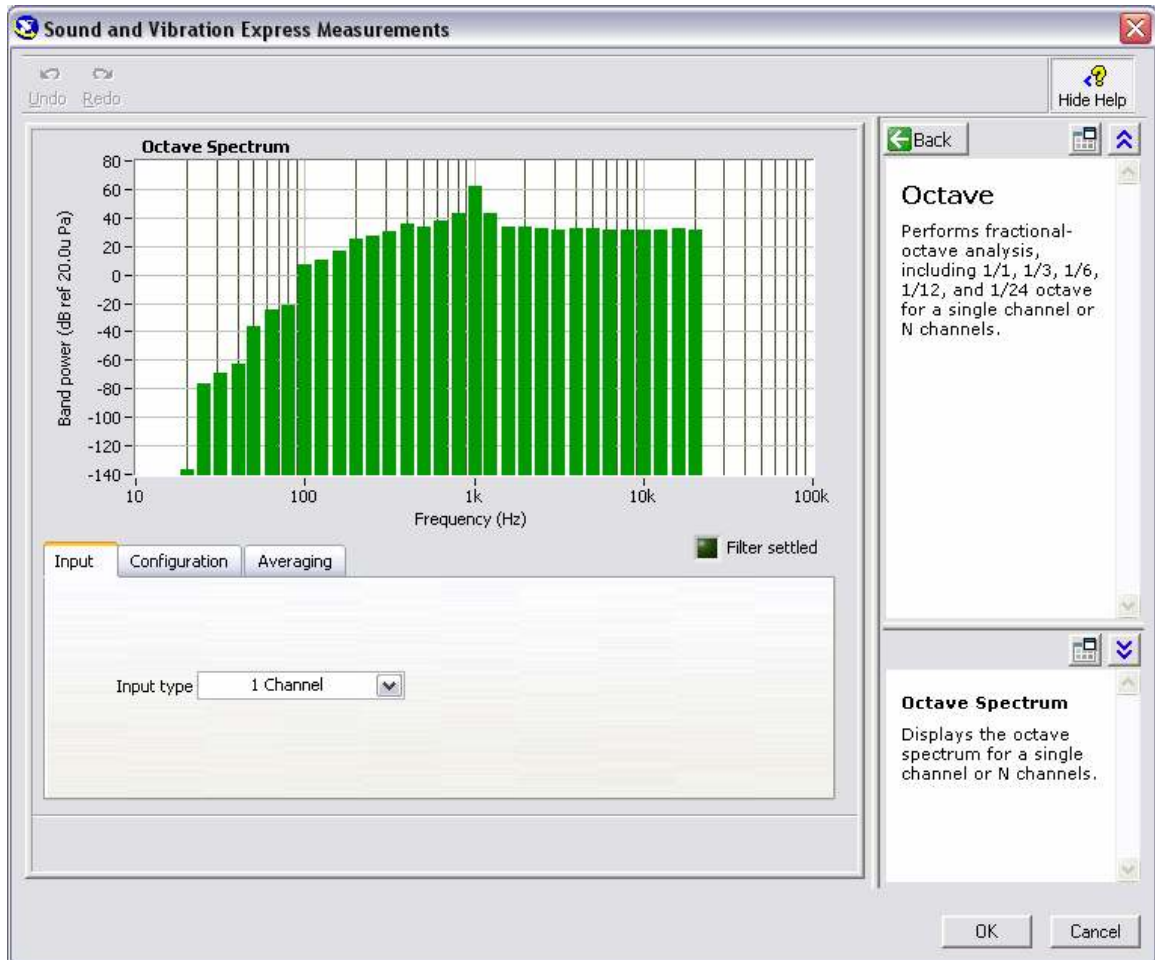


Figure 1-17. Configuration window of Octave Analysis Express VI

Like the Sound Level Express VI, the Octave Analysis Express VI can also analyze data from one or multiple channels (N Channels) simultaneously

2. Go to the **Configuration** tab and make sure the **Weighting** is set to **A Weighting**. Users can select additional options such as full, 1/3, 1/6, 1/12, or 1/24 octave analysis and set frequency ranges in this tab. Octave analysis in the Sound & Vibration Toolkit can be used to analyze standard frequency ranges (such as 20 Hz to 20 kHz for

acoustic measurements) and arbitrary frequency ranges (such as 0.5 Hz to 80 Hz for human vibration measurements).

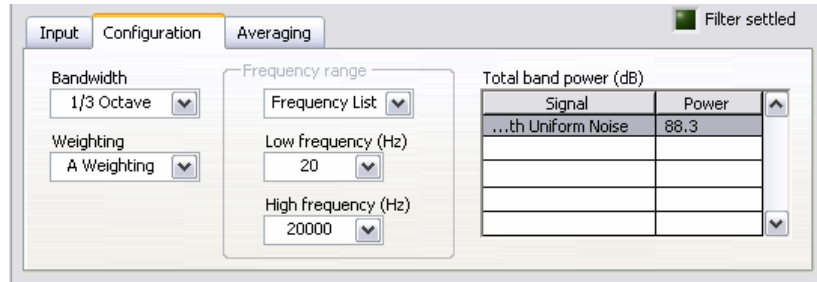


Figure 1-18. Configuration tab of the Octave Analysis Express VI

3. Go to the **Averaging** tab and select **Exponential** averaging mode. Then click OK to close the configuration window. The Octave Analysis Express VI can perform linear, exponential, equal confidence, or peak averaging.

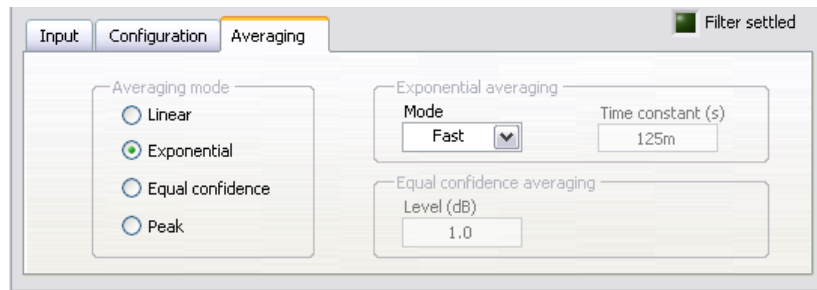
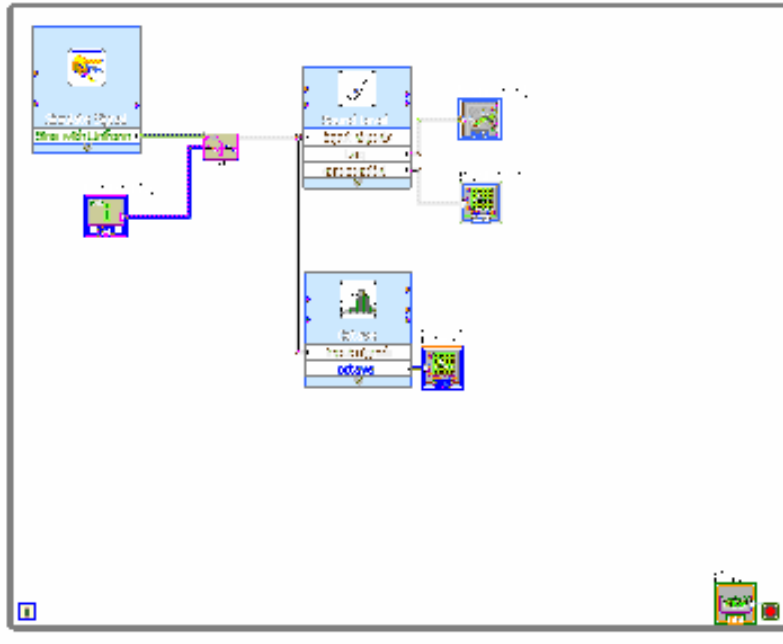


Figure 1-19. Averaging tab of the Octave Analysis Express VI

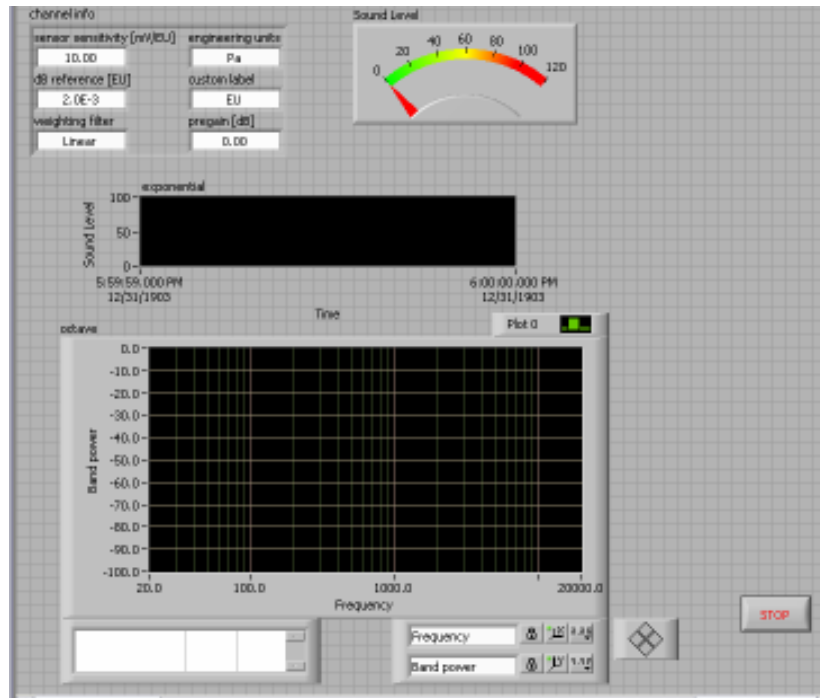
4. Right-click on the **octave** output of the Octave Analysis Express VI and select Create >> Indicator. Connect the octave graph indicator and Octave Analysis Express VI like figure 1-20.



**Figure 1-20.** Block diagram of the sound level analysis VI

The octave graph that is created displays the data in standard bar graph form.

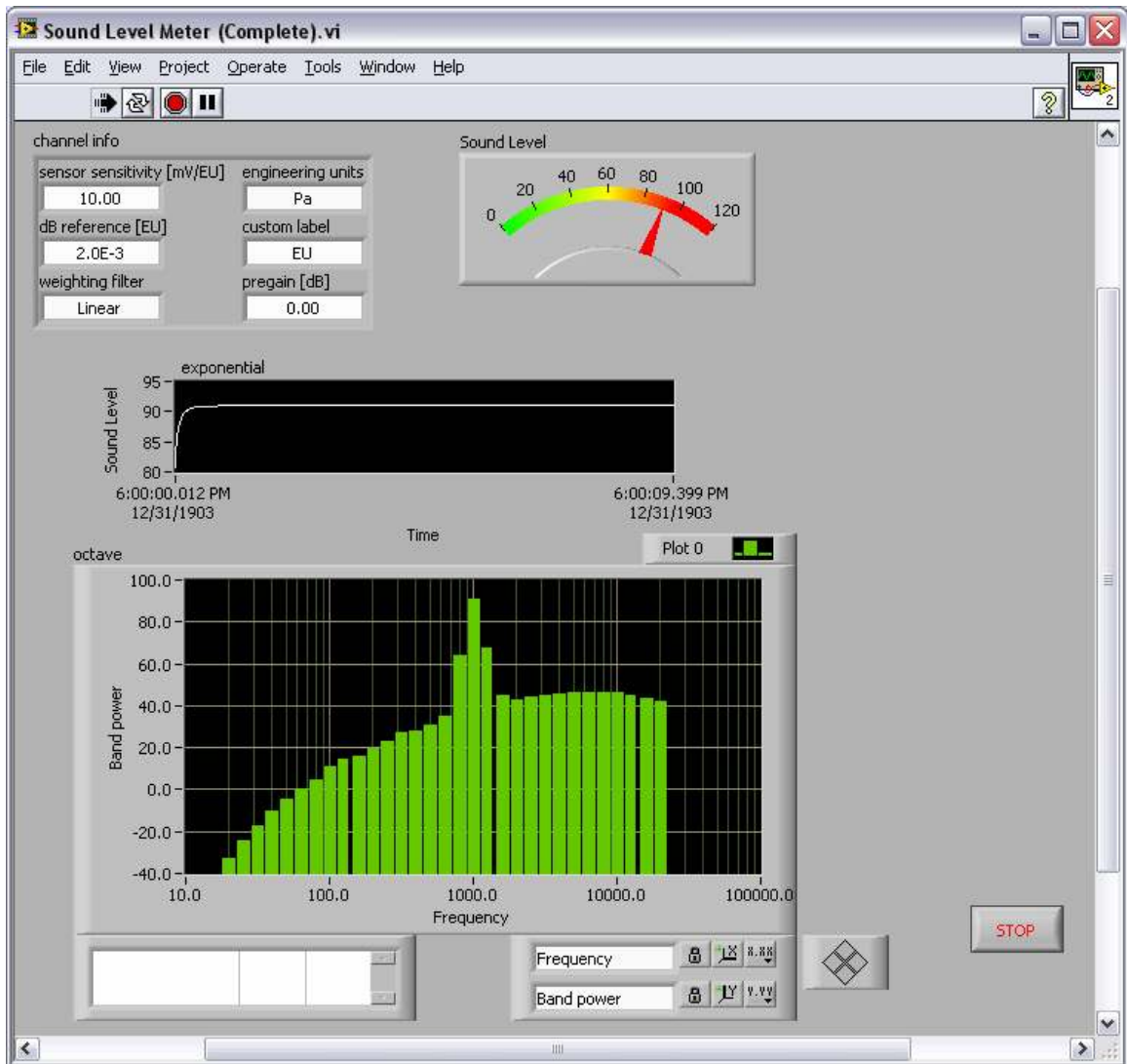
5. The front panel should look like figure 1-21.



**Figure 1-21.** Front panel of the Sound Level Meter VI

6. Run the VI.

Notice how the octave graph displays third octave analysis and the exponential graph keeps a time history of the sound level. The running VI should look like figure 1-22.



**Figure 1-22.** Running Sound Level Meter VI

Congratulations!! You have just built a sound level meter and third octave analyzer from scratch in LabVIEW. Open the Sound Level Meter (Complete) to view a finished application.

To learn about some of the additional capabilities in the Sound & Vibration Toolkit, check out the challenge exercises below. They can be added into the Sound Level Meter that you just built.

**Challenges:**

- Add a limit test to the sound level measurement. Hint: Go to Functions >> Addons >> Sound & Vibration >> S&V Express Measurements palette and place the Limit Test Express VI on the block diagram. This Express VI checks to see if a value meets certain test limits.
- Use a chart to compare each of the different types of sound level measurements (i.e. exponential, RMS, running RMS, etc). Hint: Double click on the Sound Level Express VI to open the configuration window and check all of the averaging options.
- Compare a full octave analysis to 1/3 octave analysis. Hint: Double click on the Octave Analysis Express VI to open the configuration window and change the bandwidth to 1 octave.

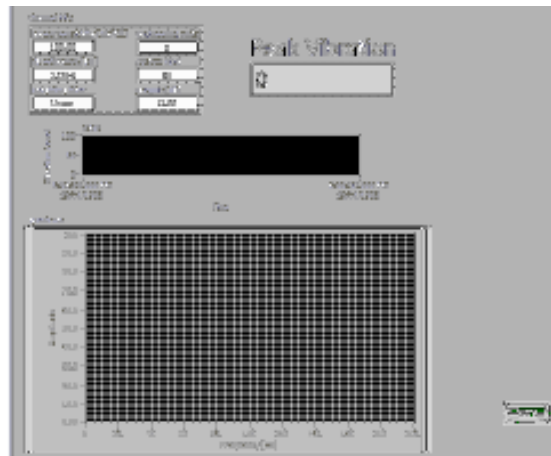
To see one way of implementing these challenges, you can open the Sound Level Meter (Challenge) VI.

# 2

## Vibration Level Measurements

In this exercise, you will use LabVIEW and the Sound & Vibration Toolkit to measure vibration level and perform a power spectrum on simulated data.

The completed front panel and block diagram will look like figure 2-1.



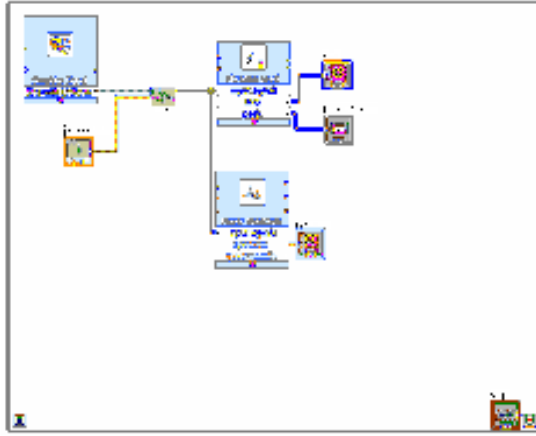


Figure 2-1: Front panel and block diagram for Vibration Analysis VI

## Signal Setup and Scaling

1. Launch LabVIEW and open the Vibration Analysis VI.
2. The front panel will look like figure 2-2:



Figure 2-2. Vibration Analysis VI Front Panel

3. Go to the block diagram by pressing Ctrl+E. The block diagram will look like Figure 2-3.



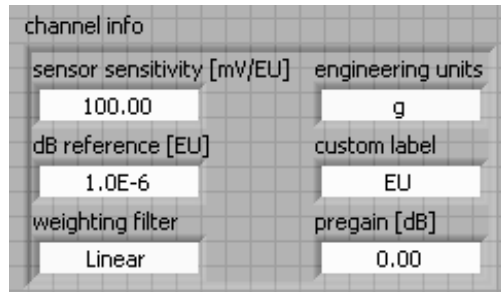
**Figure 2-3.** Vibration Analysis VI Block Diagram

The Simulate Signal Express VI is used to generate a simulated signal from an accelerometer. The generated signal is a 1 kHz, 2Vpp sine wave with 0 offset and uniform white noise. It is sampled at 25.6 kS/s and a block size of 2048 samples.

4. Place the SVL Scale Voltage to EU VI on the block diagram from the Functions >> Addons >> Sound & Vibration >> Scaling palette. This VI is used to scale the signal from a voltage to an engineering unit (EU). For this application, the EU is acceleration which is measured in units of g.
5. Right-click on the SVL Scale Voltage to EU VI and Select Type >> 1 Ch – 1 channel info. This will apply scaling to only one channel of simulated microphone data.
6. Right-click again on the channel info input of the SVL Scale Voltage to EU VI and select Create >> Control. This creates a cluster control

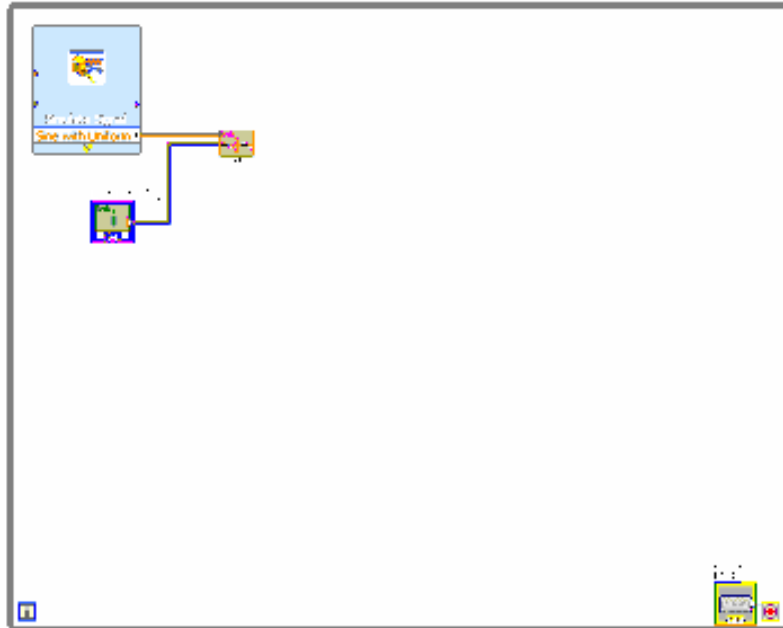
on the front panel where scaling data is entered. This shortcut makes it easier to enter all of the required data for data scaling.

7. On the front panel, set the channel info control with this data:
  - **sensor sensitivity [mV/EU]:** 100.0
  - **engineering units:** G
  - **dB reference [EU]:** 1.0e-6



**Figure 2-4.** Front panel settings for channel scaling

8. Connect the Sine with Uniform output of the Simulate Signal Express VI to the signal [V] input of the SVL Scale Voltage to EU VI. The block diagram of your code should now look like figure 2-5.



**Figure 2-5.** Block diagram of scaling and setup

## Vibration Level Analysis

1. Go to Functions >> Addons >> Sound & Vibration >> S&V Express Measurements palette and place the Vibration Level Express VI on the block diagram. This Express VI performs vibration level calculations on the scaled data from an accelerometer.
2. The Vibration Level Express VI opens the configuration window shown in Figure 2-6.

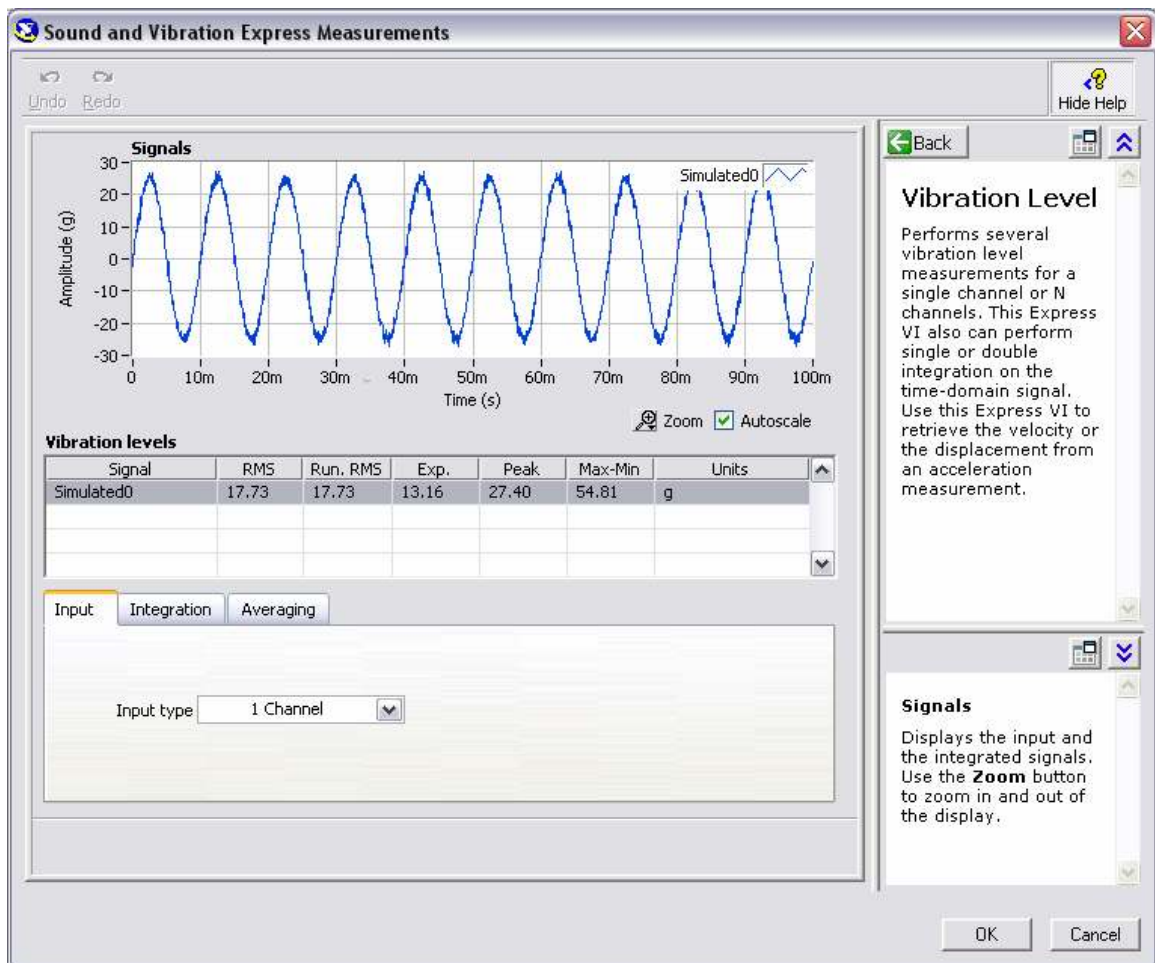
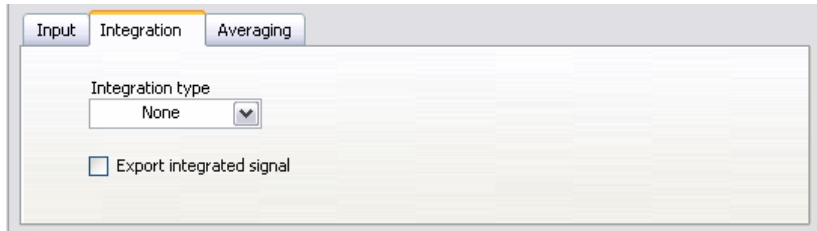


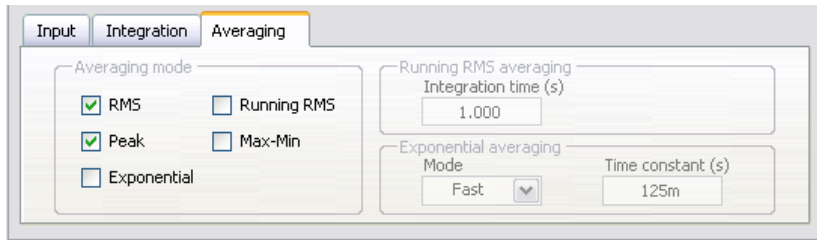
Figure 2-6. Configuration window of the Vibration Level Express VI

3. Go to the **Integration** tab and make sure that **Integration Type** is **None**. The Sound & Vibration Toolkit supports both single and double integration so that you can obtain velocity or displacement data from accelerometers or velocity probes.



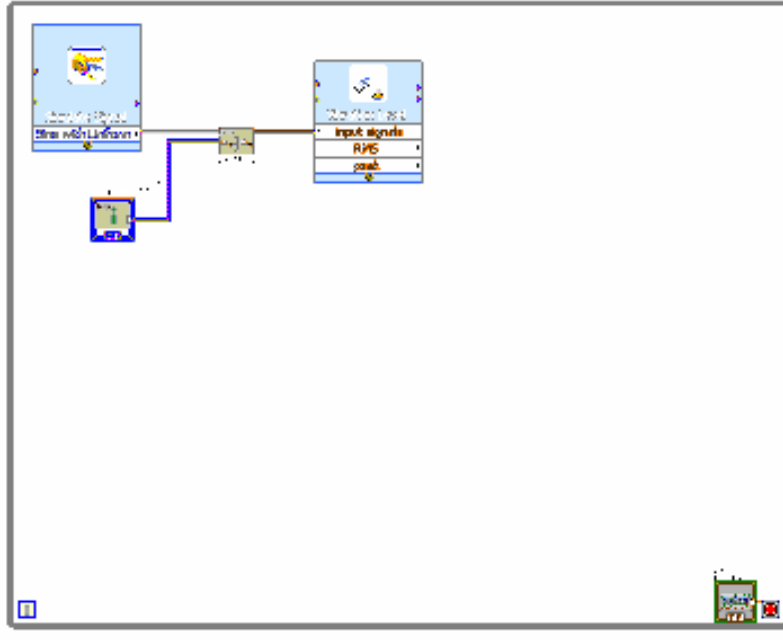
**Figure 2-7.** Integration tab of the Vibration Level Express VI

4. Go to the **Averaging** tab and select **RMS** and **Peak** averaging modes. Then click OK to close the configuration window. The Vibration Level Express VI can simultaneously calculate RMS, peak, exponential, running RMS, and max-min averaging.



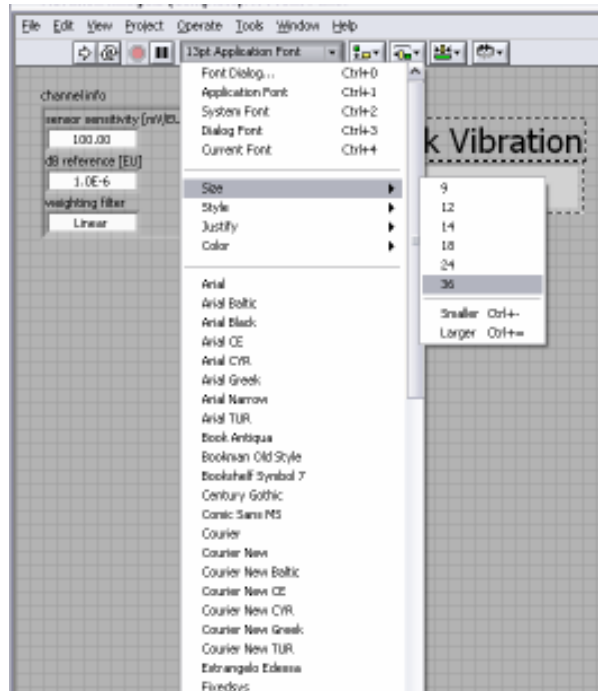
**Figure 2-8.** Averaging tab of the Vibration Level Express VI

5. Connect the **scaled signal [EU]** output of the SVL Scale Voltage to EU VI to the **input signals** input of the Sound Level Express VI. The block diagram of your code should now look like figure 2-9.



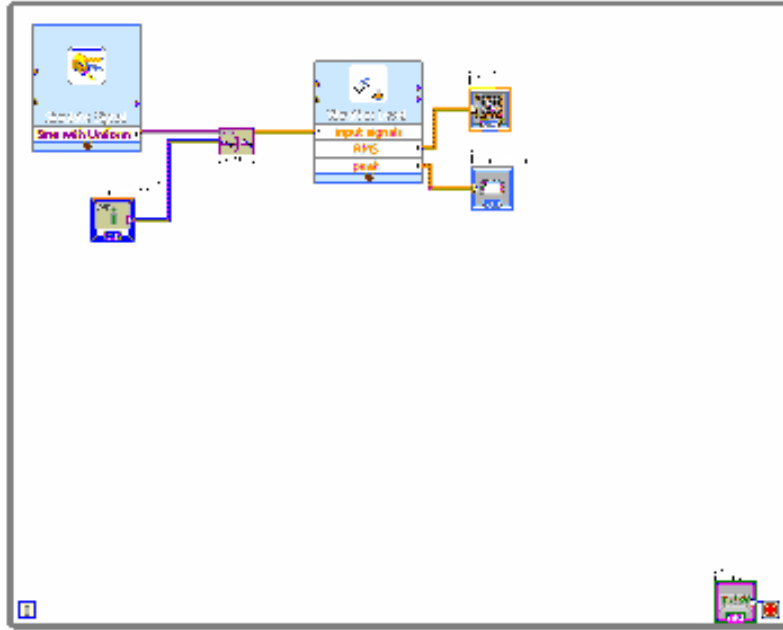
**Figure 2-9.** Block diagram of the Vibration Analysis VI

6. On the front panel, add a numeric indicator to display the peak vibration level. Right-click to show the Controls palette and go to Controls >> Numeric Indicators >> Numeric Indicator. This digital display is only one of many types of indicators that can be used to show a vibration level measurement. You could also use a meter, chart, or progress bar.
7. Customize the display with larger font so that the peak vibration is easier to read. To do this, select the display and increase the size from the pull down menu selecting Size >> 36.



**Figure 2-10.** Increasing the font size of the **Peak Vibration** indicator

8. Now add a chart to display the RMS vibration level. Right-click on the **RMS** output of the Vibration Level Express VI and select Create >> Indicator. Connect the indicators like figure 2-11.



**Figure 2-11.** Block diagram of Vibration Analysis VI

9. The front panel will look like figure 2-12.

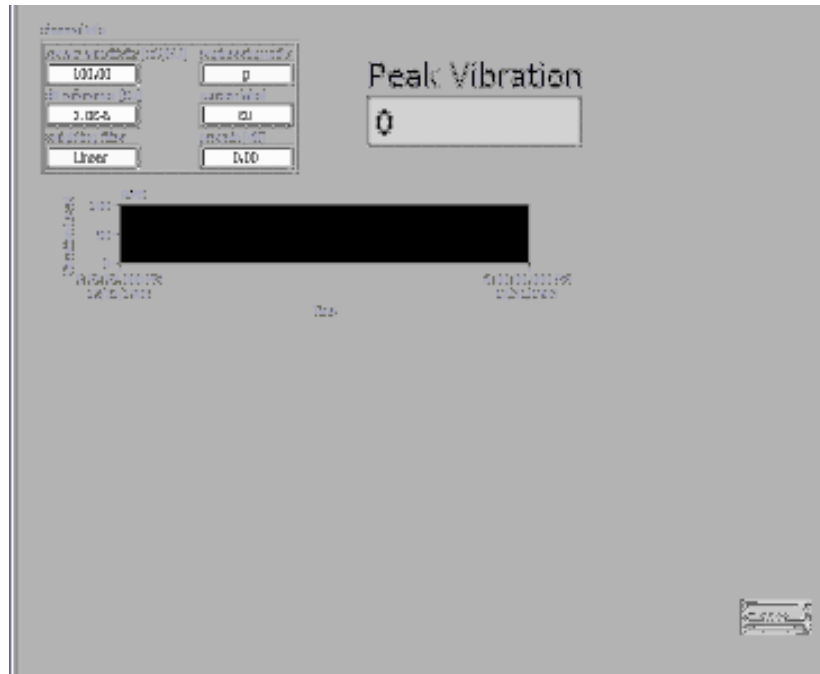
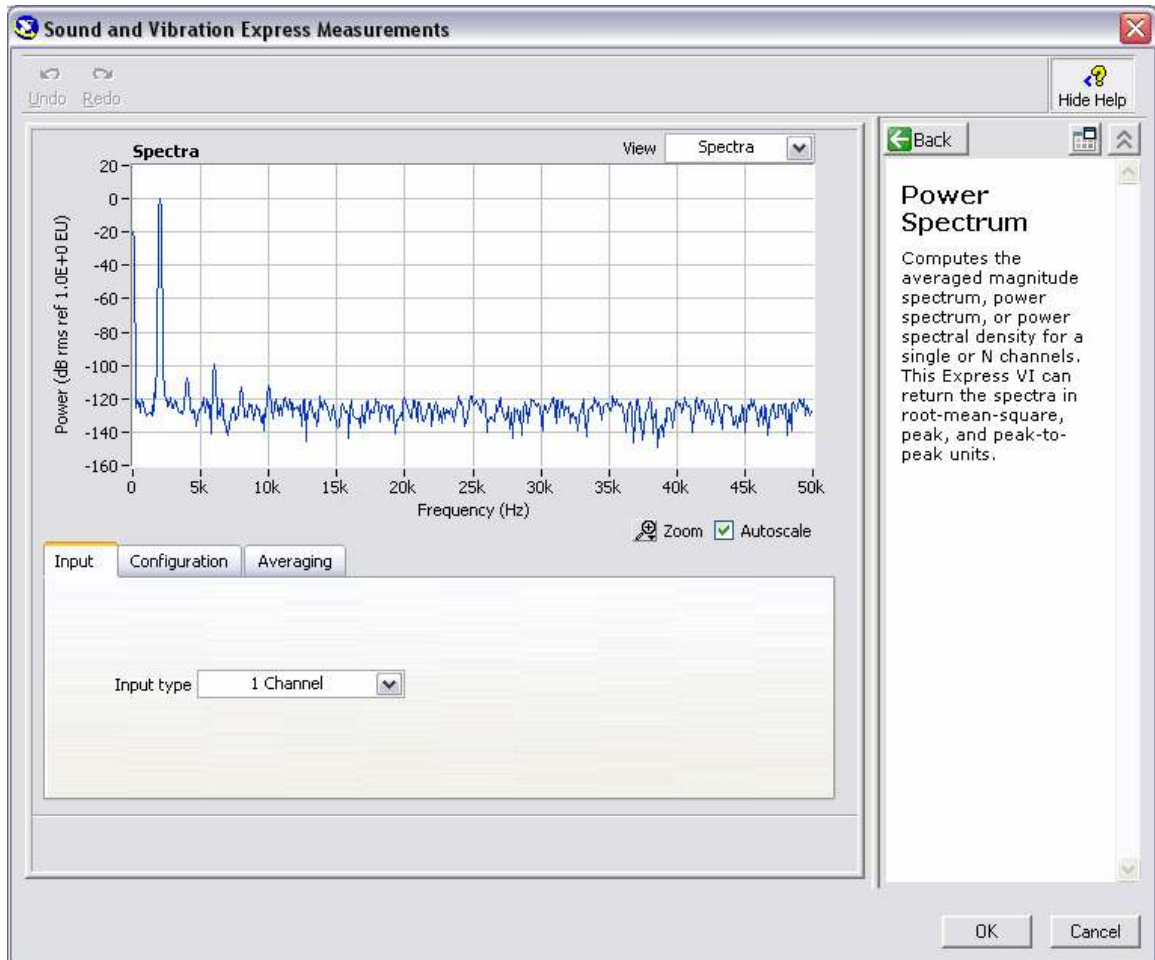


Figure 2-12. Front panel of Vibration Analysis VI

## Frequency (FFT) Analysis

The Simulate Signal Express VI simulates a sine wave by default. You can customize the simulated signal by changing the options in the **Configure Simulate Signal** dialog box. Complete the following steps to change the simulated signal from a sine wave to a DC signal with uniform white noise.

1. Go to Functions >> Addons >> Sound & Vibration >> S&V Express Measurements palette and place the Power Spectrum Express VI on the block diagram. The Power Spectrum Express VI opens the configuration window in figure 2-13.



**Figure 2-13.** Configuration window of the Power Spectrum Express VI

Like the Vibration Level Express VI, the Power Spectrum Express VI can also analyze data from one or multiple channels (N Channels) simultaneously

2. Go to the **Configuration** tab and make sure that the scaling is selected as **Magnitude** and **Linear**. You can also select additional options for RMS or peak to peak or power spectral density (PSD). The Power Spectrum Express VI also supports a number of windowing options including Hanning, Hamming, Blackman-Harris,

Exact Blackman, Blackman, Flat Top, 4- and 7-term Blackman Harris, and Low Sidelobe.

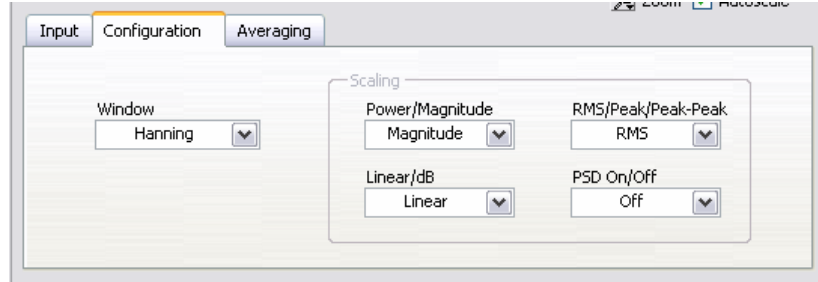


Figure 2-14. Configuration tab of the Power Spectrum Express VI

3. Go to the **Averaging** tab and select **RMS Averaging** for the averaging mode. Then click OK to close the configuration window. The Power Spectrum Express VI can perform other averaging and weighting modes.

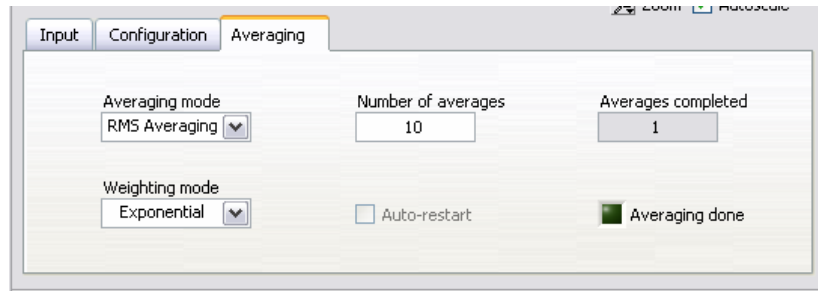
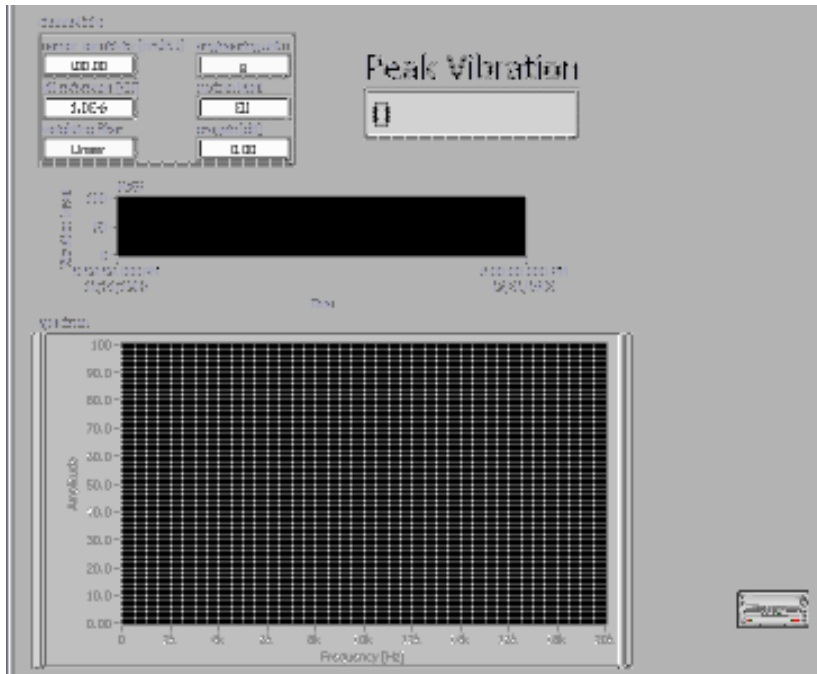


Figure 2-15. Averaging tab of the Power Spectrum Express VI

4. Right-click on the **spectrum** output of the Power Spectrum Express VI and select Create >> Indicator. Connect the spectrum graph indicator and Power Spectrum Express VI like figure 2-16.

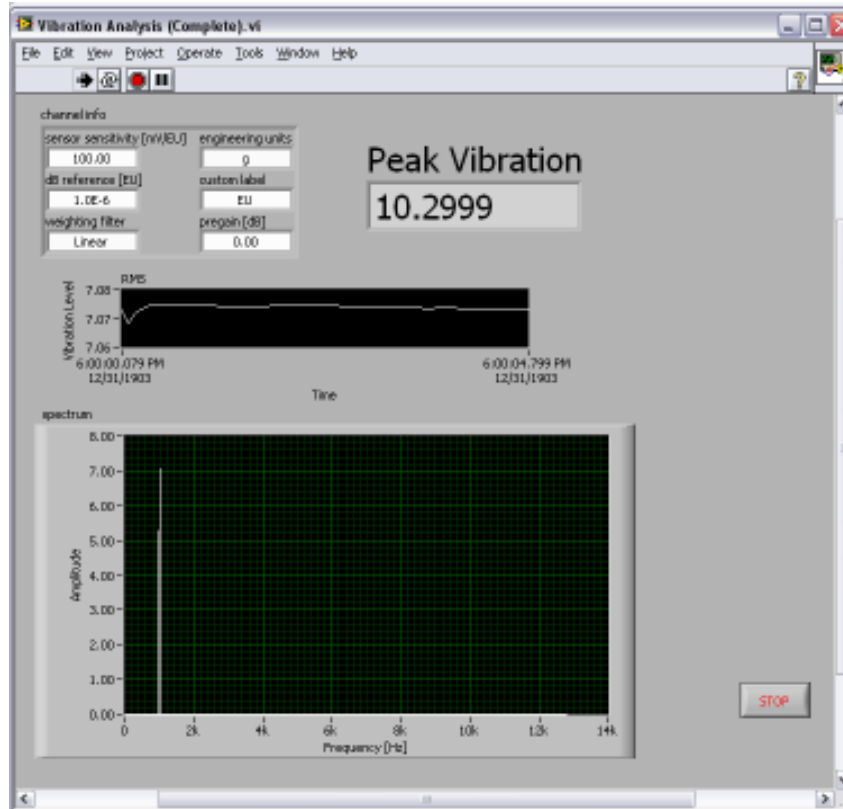




**Figure 2-17.** Front panel of Vibration Analysis VI

6. Run the VI.

Notice that the peak vibration has held its value while the chart displaying the RMS vibration shows minor vibration fluctuation. The spectrum confirms that the simulated signal is a 1 kHz.



**Figure 2-18.** Running Vibration Analysis VI

Congratulations!! You have just built a vibration analyzer from scratch in LabVIEW. Open the Vibration Analysis (Complete) VI to view a finished application.

To learn about some of the additional capabilities in the Sound & Vibration Toolkit, check out the challenge exercises below. They can be added into the Vibration Analyzer that you just built.

**Challenges:**

- Find the peak amplitude and corresponding frequency in the spectrum. Hint: Go to Functions >> Addons >> Sound & Vibration >> S&V Express Measurements palette and place the Peak Search Express VI on the block diagram. This Express VI will find peaks in a spectrum and return their frequency and value.

- Calculate the power between 800 Hz and 1200 Hz. Hint: Go to Functions >> Addons >> Sound & Vibration >> S&V Express Measurements palette and place the Power in Band Express VI on the block diagram. This Express VI will calculate the power between set frequencies.

To see one way of implementing these challenges, you can open the Vibration Analysis (Challenge) VI.

# 3

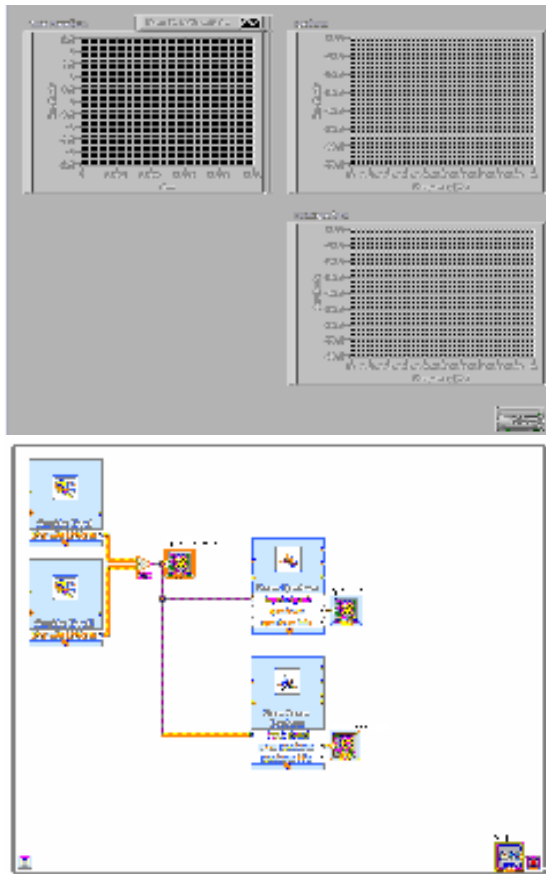
## Baseband vs. Zoom FFT

In this exercise, you will use LabVIEW and the Sound & Vibration Toolkit to examine the differences between baseband and zoom FFTs. The Zoom FFT is included with the Sound & Vibration Toolkit for applications when you need to obtain the spectral information with very fine frequency resolution over a limited portion of the baseband span. In other words, you must zoom in on a spectral region to observe the details of that spectral region.

With baseband FFT analysis, the acquisition time determines the frequency resolution of the computed spectrum. The number of samples used in the baseband FFT determines the number of lines computed in the spectrum. Zoom FFT analysis achieves a finer frequency resolution than the baseband FFT by decoupling the frequency resolution from the block size.

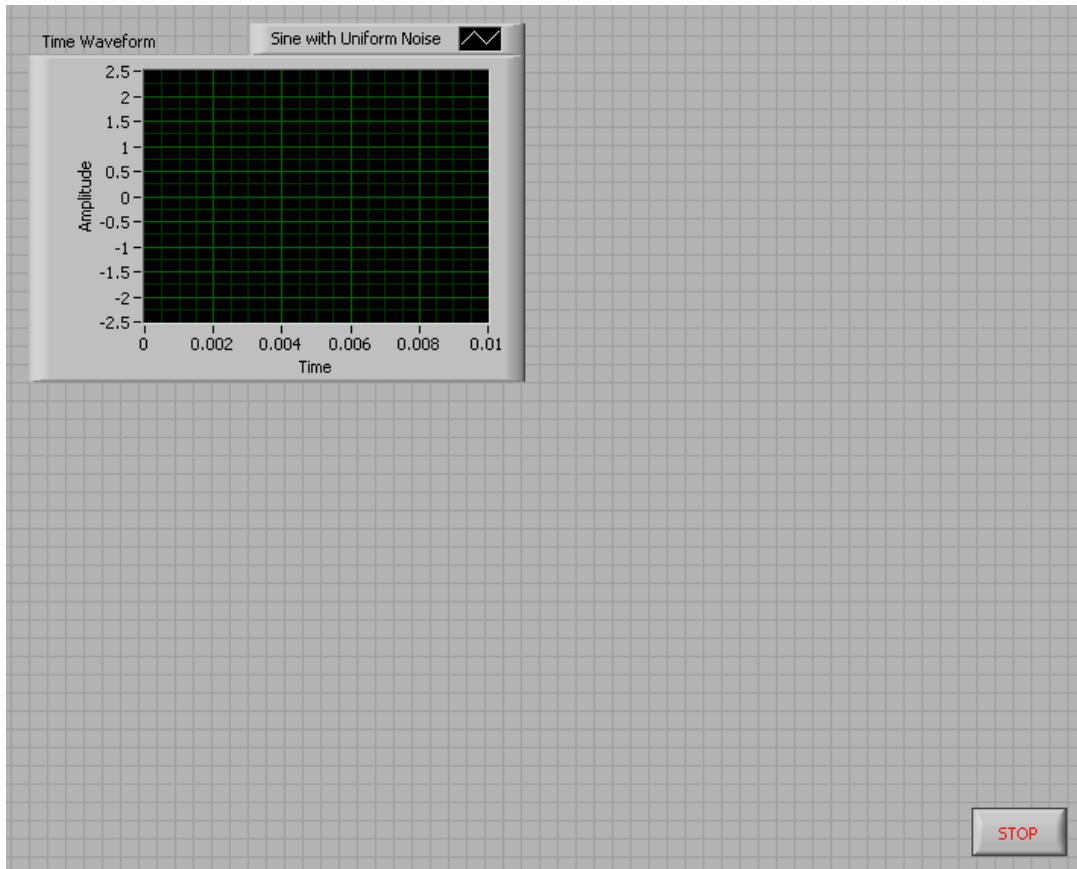
The Zoom FFT VI acquires multiple blocks of data, modulates, and downsamples to obtain a lower sampling frequency. The block size is decoupled from the achievable frequency resolution because the Zoom FFT VI accumulates the decimated data until you acquire the required number of points. Because the transform operates on a decimated set of data, you only need to compute a relatively small spectrum. Since, the data is accumulated, the acquisition time is no longer the same as the time required to acquire one block of samples. Instead, the acquisition time is the time required to accumulate the required set of decimated samples.

The completed front panel and block diagram will look like figure 3-1.



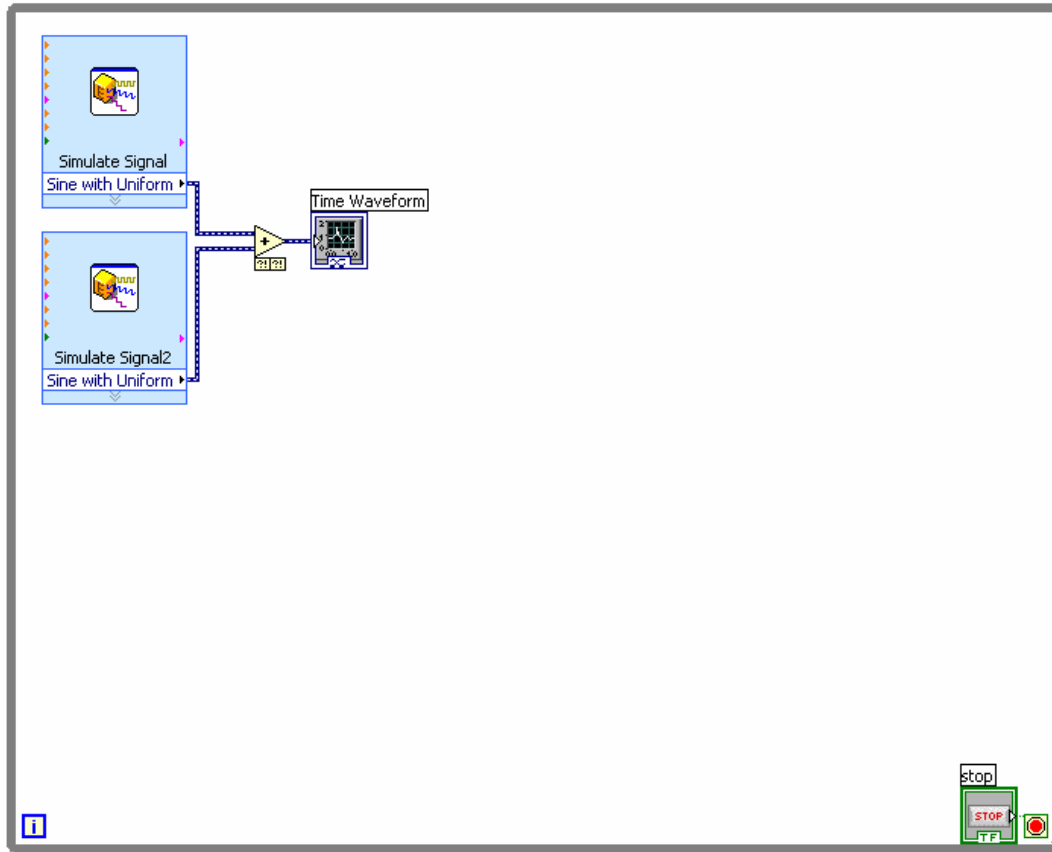
**Figure 1-1.** Front Panel and block diagram for the Zoom FFT VI

1. Launch LabVIEW and open the Vibration Analysis VI.
2. The front panel looks like this.



**Figure 3-2.** Front panel of Zoom FFT VI

3. Go to the block diagram by pressing Ctrl+E. The block diagram looks like figure 3-3.



**Figure 3-3.** Block diagram of Zoom FFT VI

This VI uses two Simulate Signal Express VIs to generate a simulated signal that is made up of two tones. The outputs from each Simulated Signal Express VI are summed and displayed on the **Time Waveform** graph. The final signal is the sum of two 2Vpp sine waves with 0 offsets and uniform white noise, one sine wave at 3.50 kHz and the other at 3.55 kHz. The generated signal is sampled at 50 kS/s with a block size of 2500 samples

4. Go to Functions >> Addons >> Sound & Vibration >> S&V Express Measurements palette and place the Power Spectrum Express VI on the block diagram. The Power Spectrum Express VI opens the configuration window in figure 3-4.

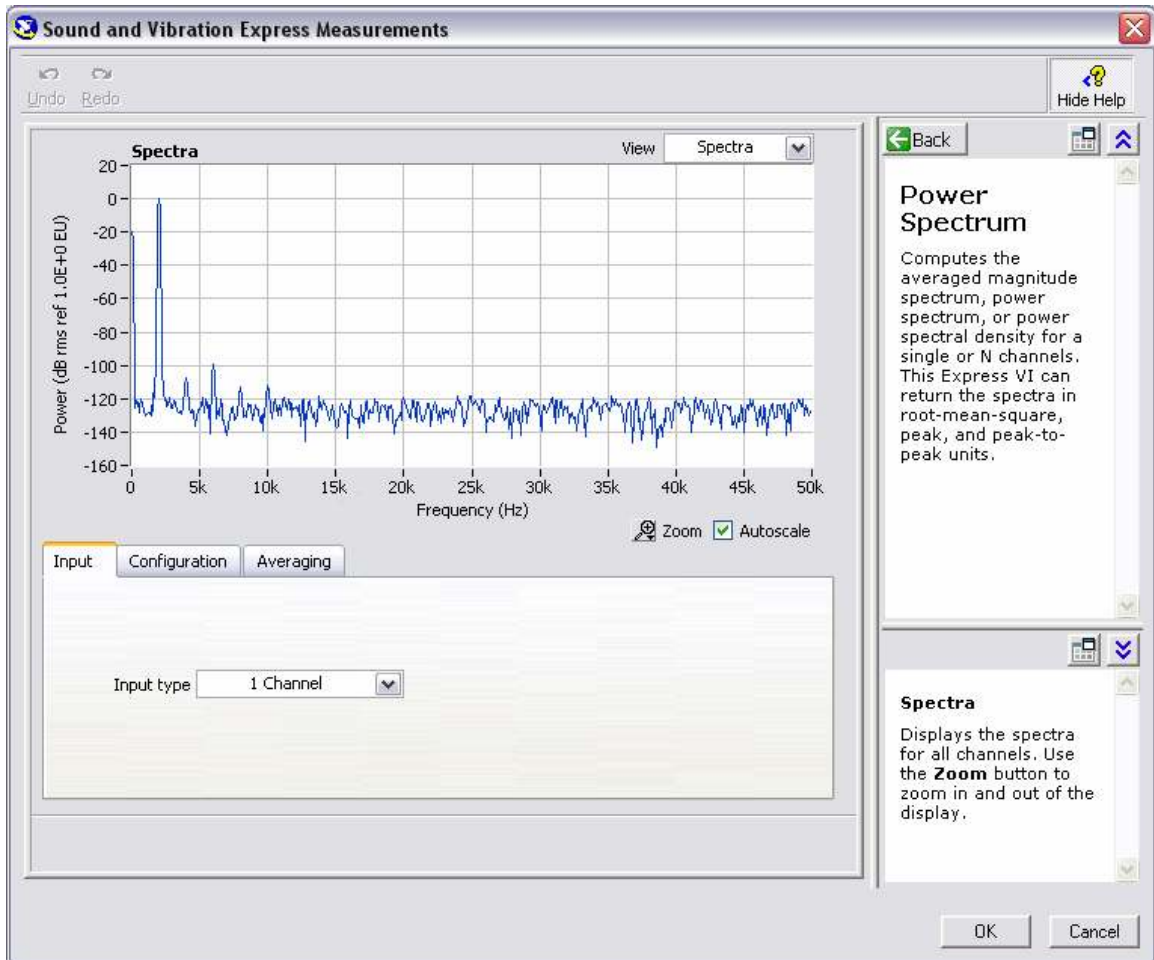
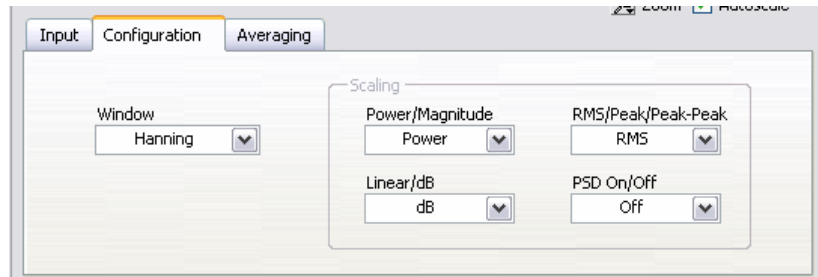


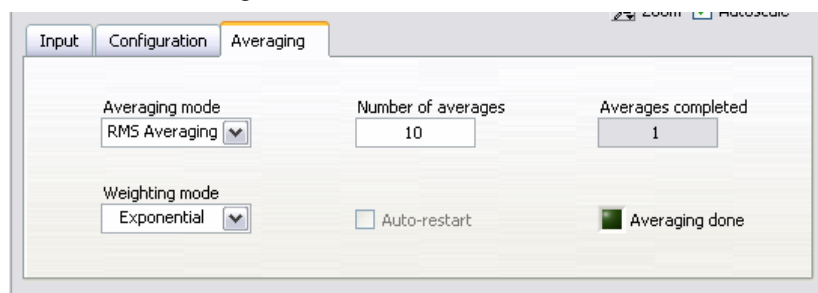
Figure 3-4. Configuration window of Power Spectrum Express VI

5. Go to the **Configuration** tab and make sure that the scaling is selected as **Power** and **dB**. You can also select additional options for RMS or peak to peak or power spectral density (PSD).



**Figure 3-5.** Configuration tab of the Power Spectrum Express VI

6. Go to the **Averaging** tab and select **RMS Averaging** for the averaging mode and 10 for the **Number of averages**. Then click OK to close the configuration window.



**Figure 3-6.** Averaging tab of the Power Spectrum Express VI

7. Right-click on the **spectrum** output of the Power Spectrum Express VI and select Create >> Indicator. Connect the spectrum graph indicator and Power Spectrum Express VI like figure 3-7.

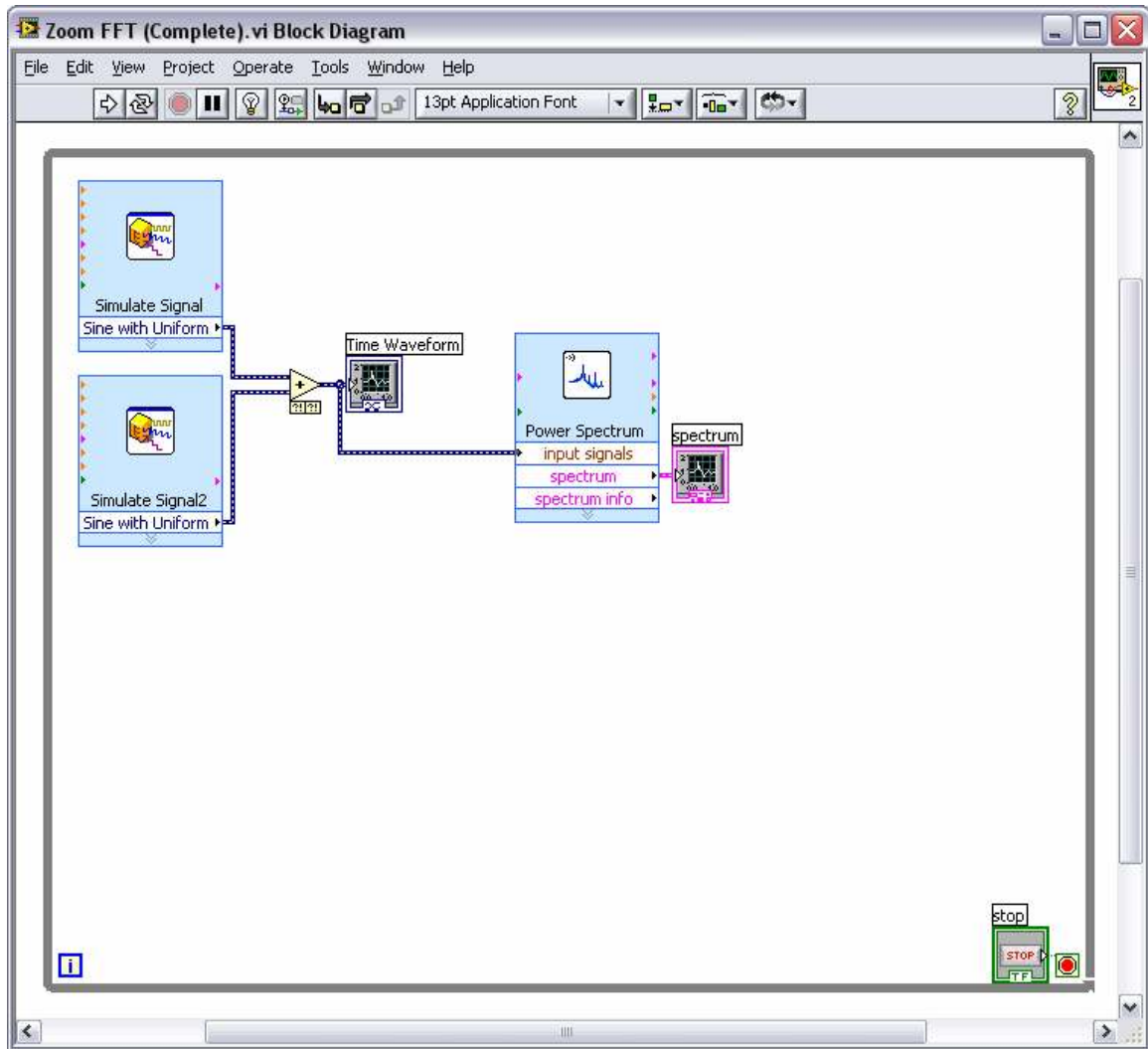


Figure 3-7. Block diagram of Zoom FFT VI

8. Now add the Zoom FFT Express VI. Go to Functions >> Addons >> Sound & Vibration >> S&V Express Measurements palette and place the Zoom Power Spectrum Express VI on the block diagram. The Zoom Power Spectrum Express VI opens the configuration window in figure 3-8.

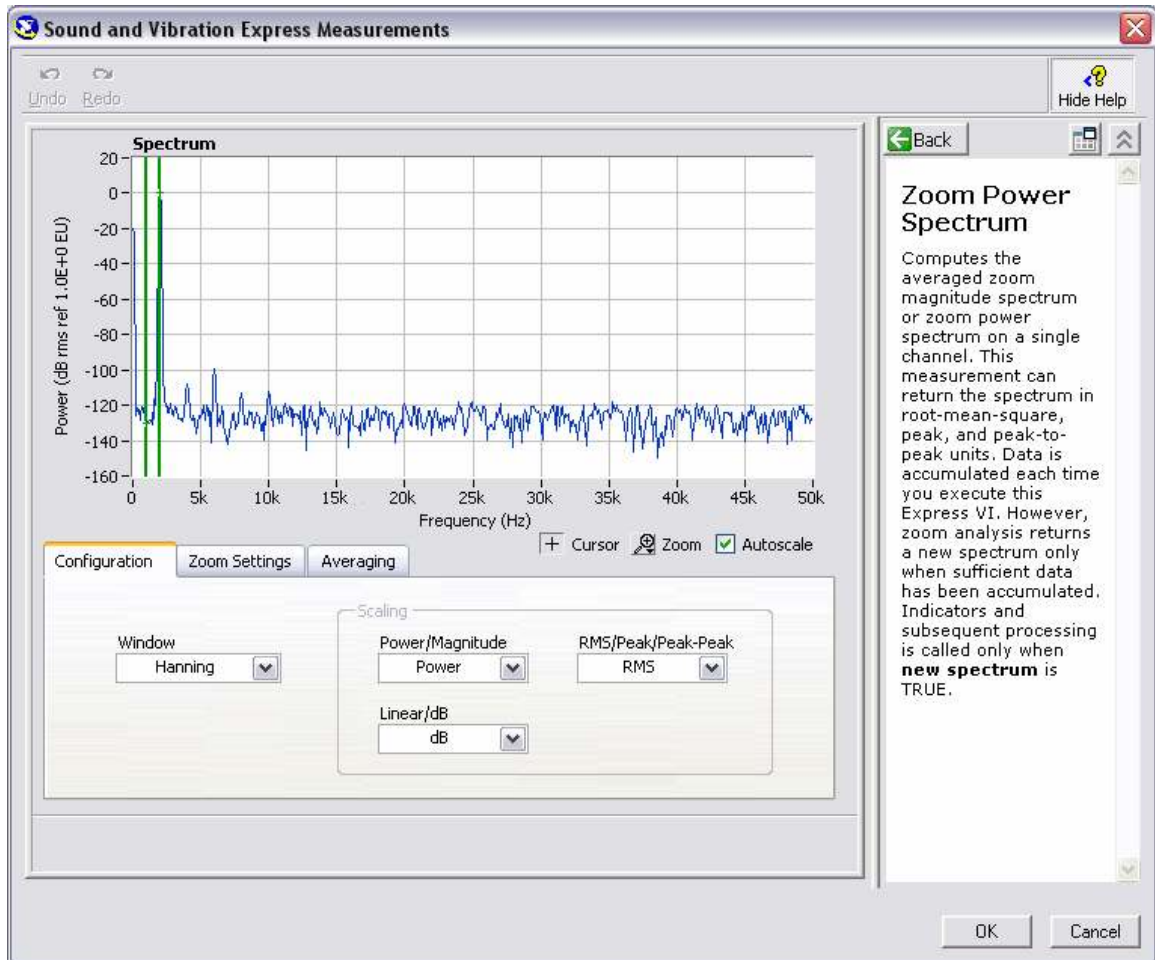
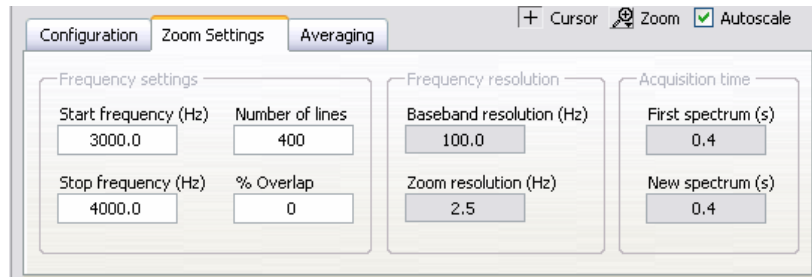


Figure 3-8. Configuration window of Zoom FFT Express VI

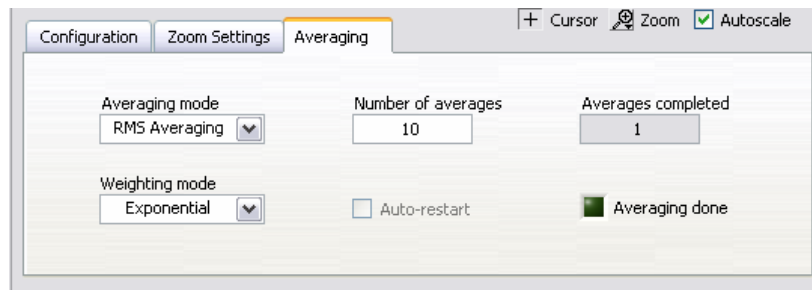
Make sure that the scaling is selected as **Power** and **dB**. You can also select additional options for RMS or peak to peak.

9. On the **Zoom Settings** tab, set the **Start Frequency** to 3000 Hz and the **Stop Frequency** to 4000 Hz.



**Figure 3-9.** Zoom Settings tab of the Zoom FFT Express VI

10. Go to the **Averaging** tab and select **RMS Averaging** for the averaging mode and 10 for the **Number of averages**. Then click OK to close the configuration window. Note that the settings are the same for both the baseband FFT and the zoom FFT so that an equal comparison can be made.



**Figure 3-10.** Averaging tab of the Zoom FFT Express VI

11. Right-click on the **zoom spectrum** output of the Zoom Power Spectrum Express VI and select Create >> Indicator. Connect the spectrum graph indicator and Zoom Power Spectrum Express VI like figure 3-11.

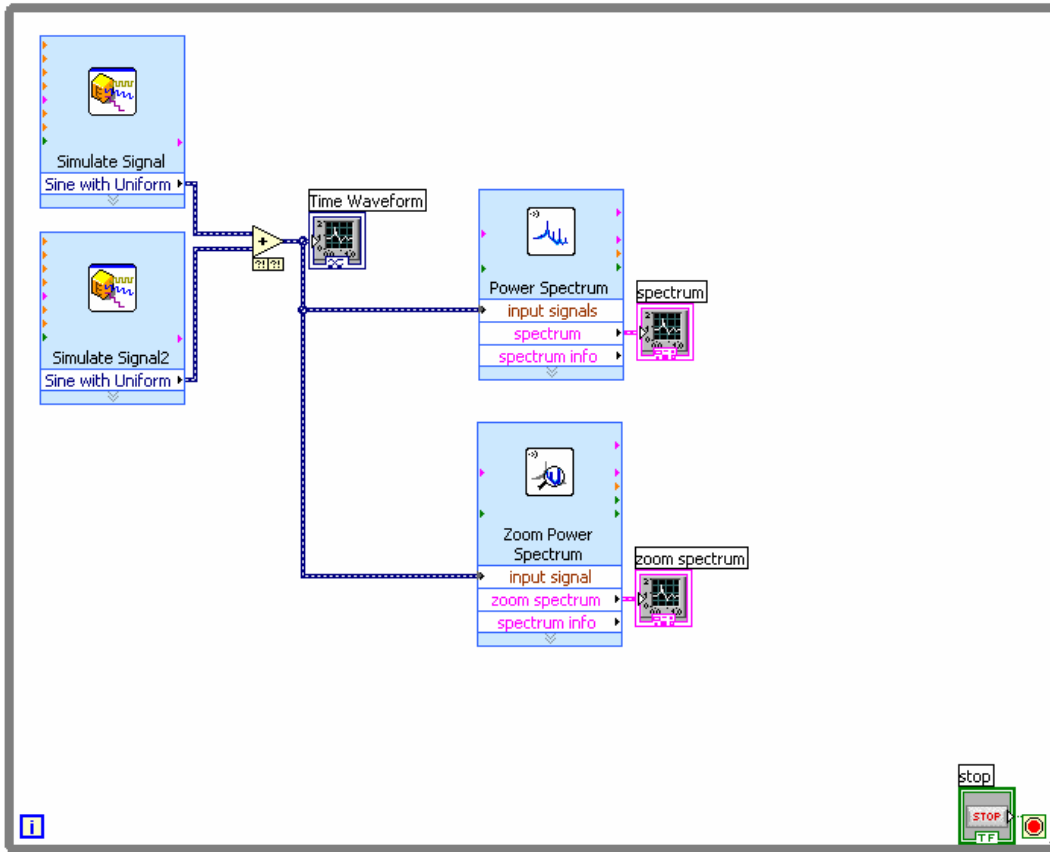
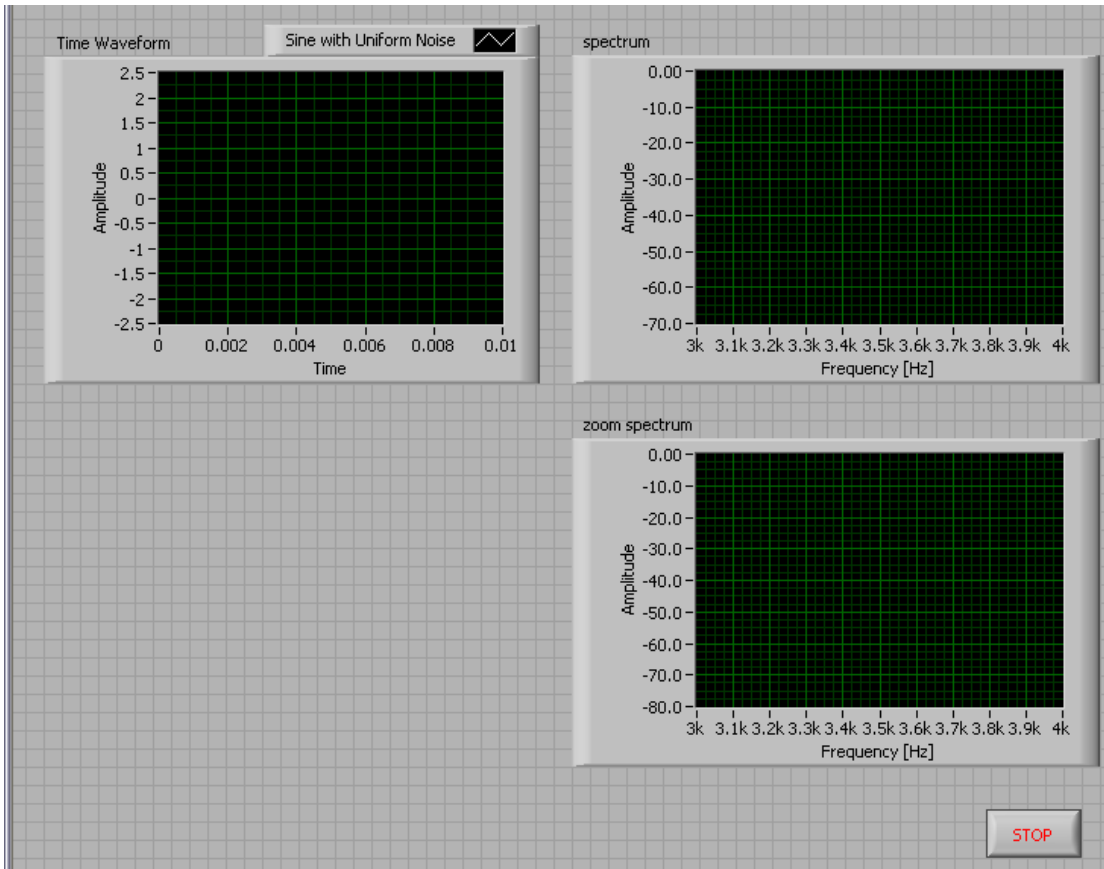


Figure 3-11. Block diagram of Zoom FFT VI

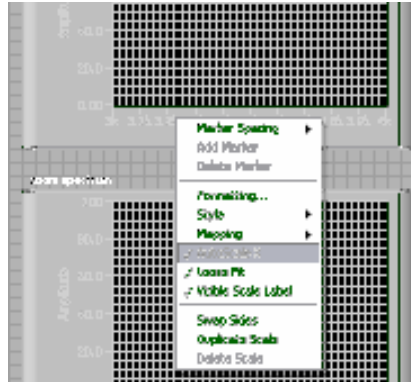
12. Arrange the front panel to look like figure 3-12.



**Figure 3-12.** Front panel of Zoom FFT VI

Set the Frequency range (X-axis) of the **spectrum** graph to 3000 Hz – 4000 Hz. Also set the Frequency range (X-axis) of the **zoom spectrum** graph to the same values.

13. Right-click on the X-axis of the **spectrum** graph and de-select the AutoScale X option. Repeat this for the **zoom spectrum** graph.



**Figure 3-13.** Autoscale selection on X-axis

14. Run the VI.

Notice that the two frequencies are “blurred” together in the baseband FFT spectrum graph. In the **zoom spectrum** graph, the zoom FFT is able to clearly show the two frequencies at 3.50 kHz and 3.55 kHz.

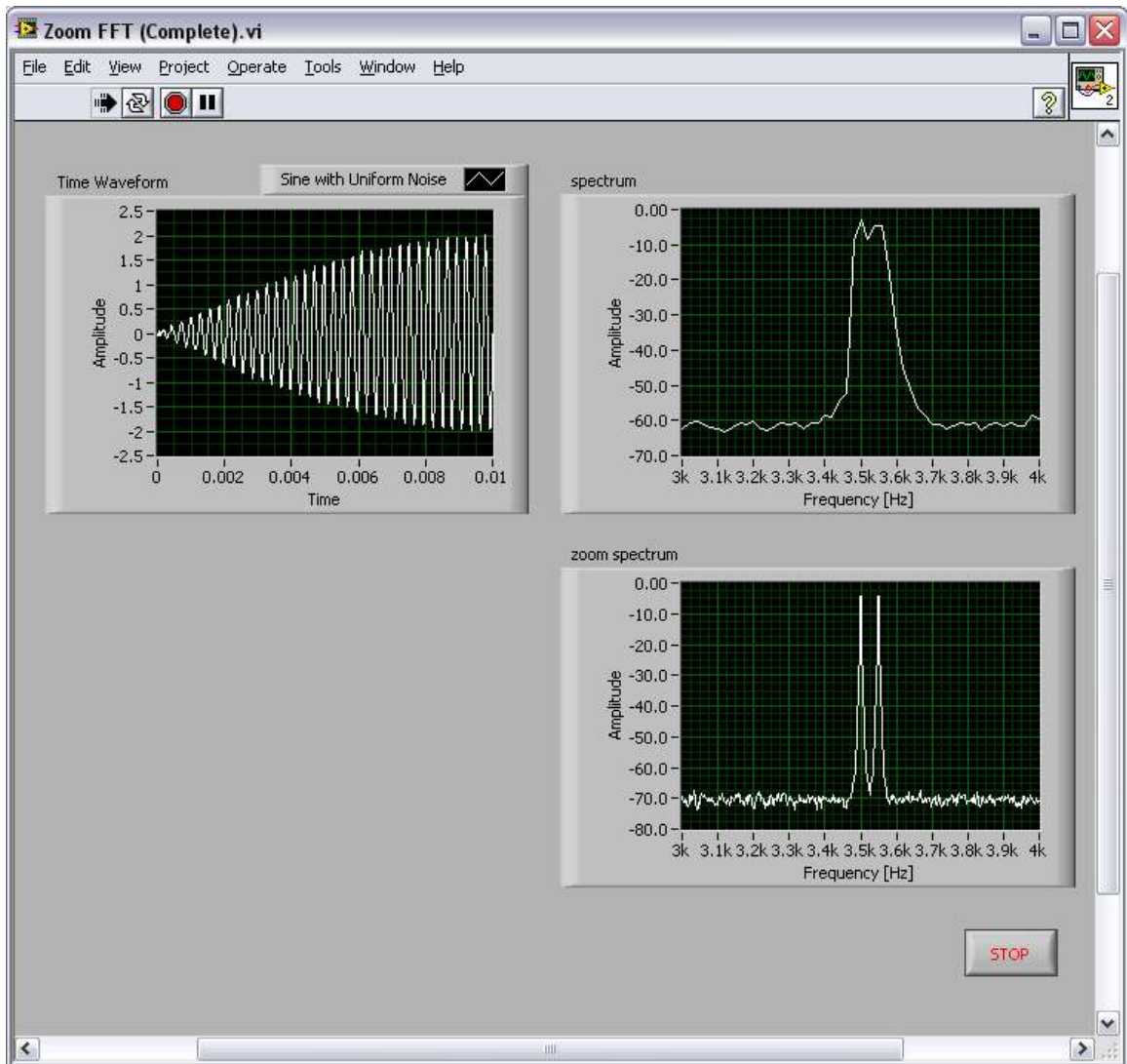
The frequency resolution of the baseband FFT is 20 Hz. Frequency resolution ( $df$ ) for a baseband FFT is calculated by dividing the sampling frequency ( $f_s$ ) by the number of samples ( $N$ ).

$$df = f_s / N = 50000 / 2500 = 20$$

The frequency resolution of the zoom FFT is 2.5 Hz. For a zoom FFT, frequency resolution is calculated with the following formula:

$$df = (\text{stop frequency} - \text{start frequency}) / \text{number of lines}$$

$$df = (4000 - 3000) / 400 = 2.5$$



**Figure 3-14.** Running Zoom FFT VI

Congratulations!! You have just built an FFT analyzer that utilizes both the baseband FFT and Zoom FFT in the Sound and Vibration Toolkit. Open the Zoom FFT (Complete) VI to view a finished application.

# 4

## **Additional Analysis Capabilities**

This exercise is meant to introduce you to some of the additional analysis in the LabVIEW Sound and Vibration Toolkit. No programming is required to complete this exercise.

### **Getting Started with the Sound and Vibration Toolkit**

The LabVIEW Sound and Vibration Toolkit includes a Getting Started VI that you can access from either the NI Example Finder or from the Windows Start menu at Start >> Programs >> National Instruments >> Sound and Vibration Toolkit 4.0 >> Getting Started example. More information on the examples included with the Sound and Vibration Toolkit can be found later in this exercise.

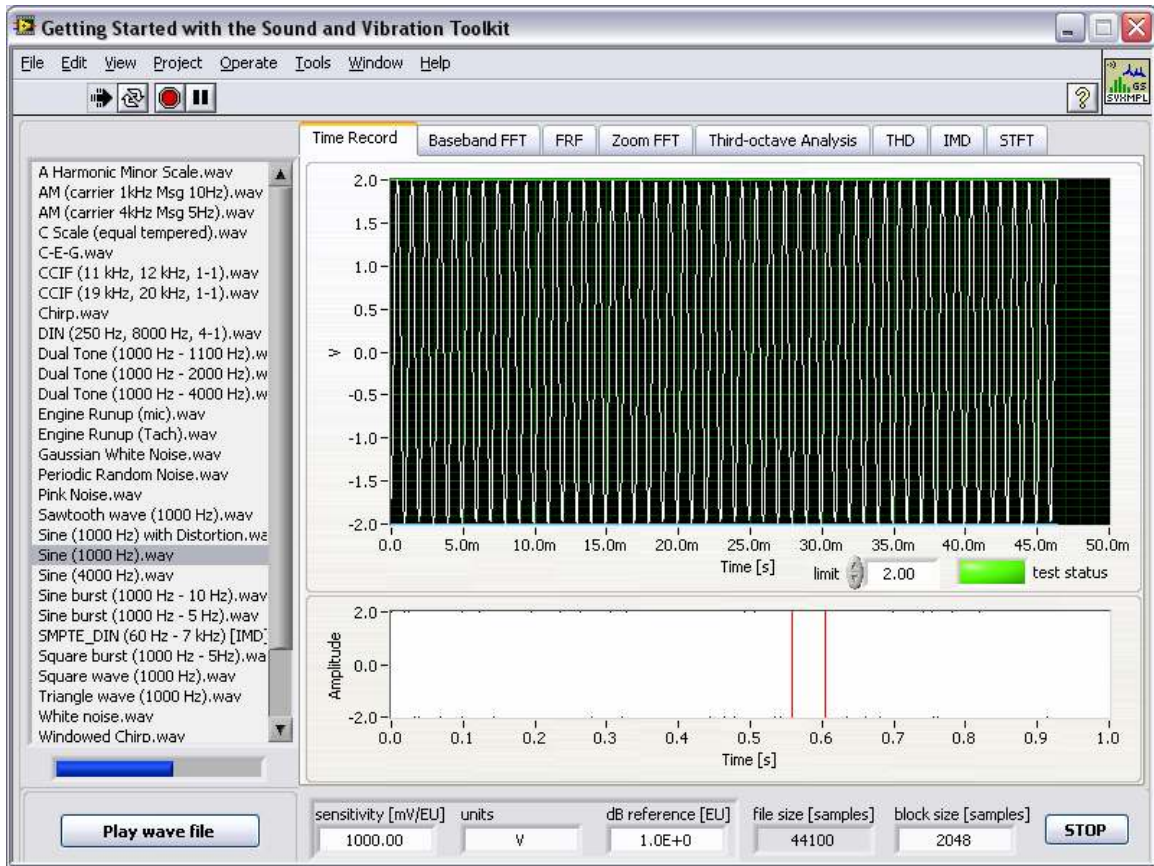
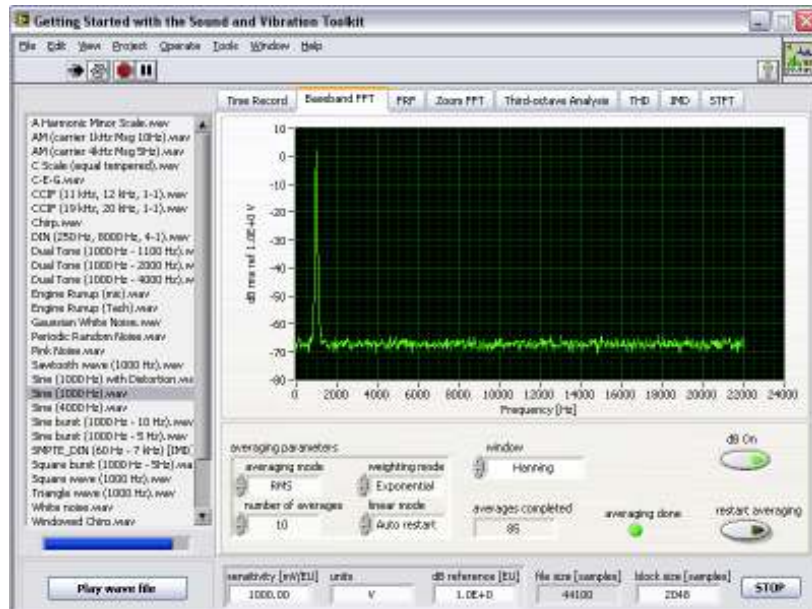


Figure 4-1. Getting Started with the Sound and Vibration Toolkit VI

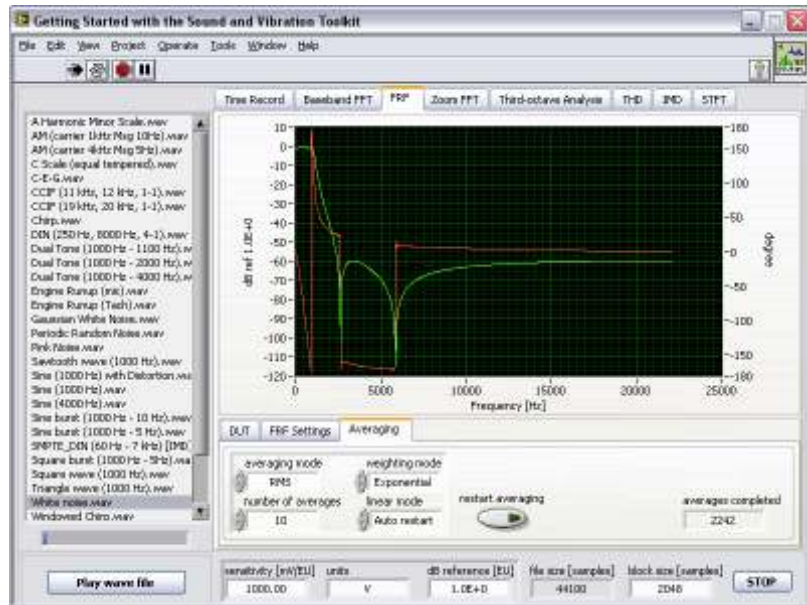
The Getting Started VI has 8 tabs with different types of analysis and a list of sample data to analyze on the left.

Some activities to try with the Getting Started VI include:

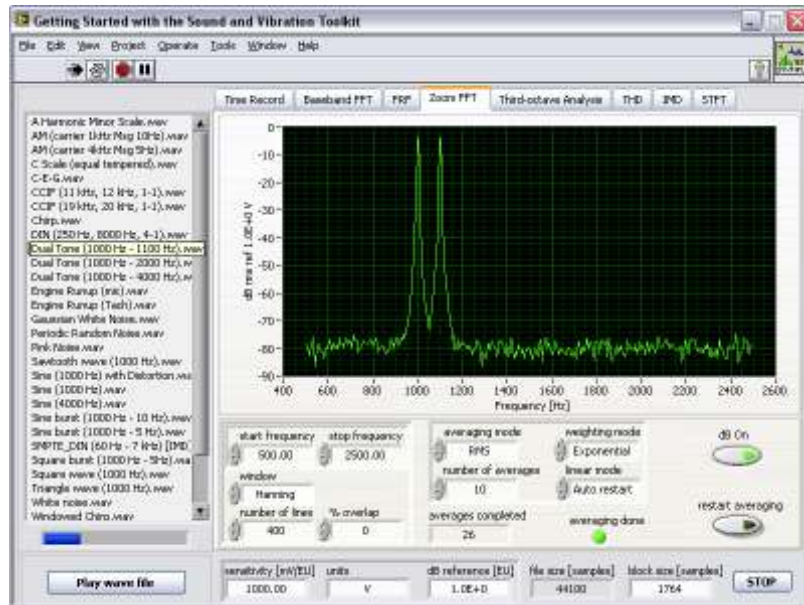
- Baseband FFT – click on the **Baseband FFT** tab and view an FFT of some sample data



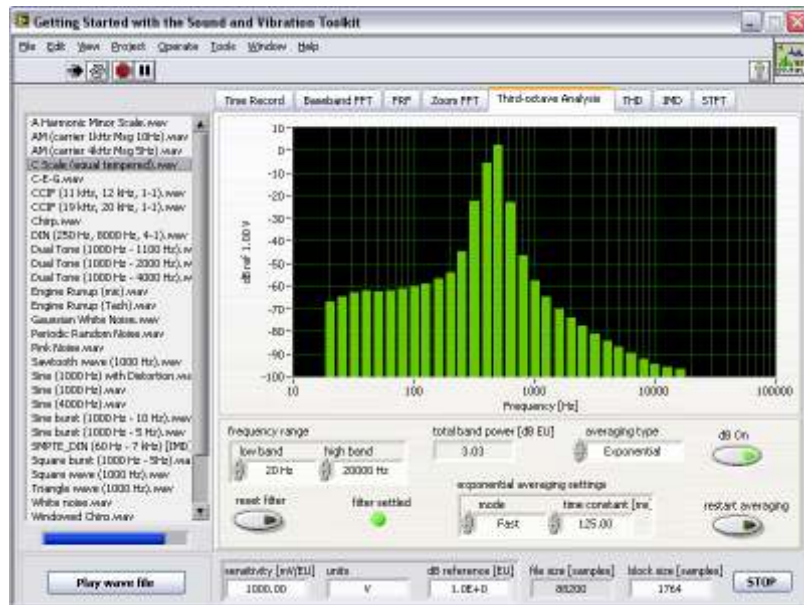
- Frequency Response Function (FRF) - click on the **FRF** tab and the Getting Start VI will perform a broadband frequency response measurement on simulated low pass filter (cutoff: 1 kHz) with white noise as the stimulus. The green plot is the magnitude response (corresponding to the left axis) and the red plot of the phase response (corresponding to the right axis).



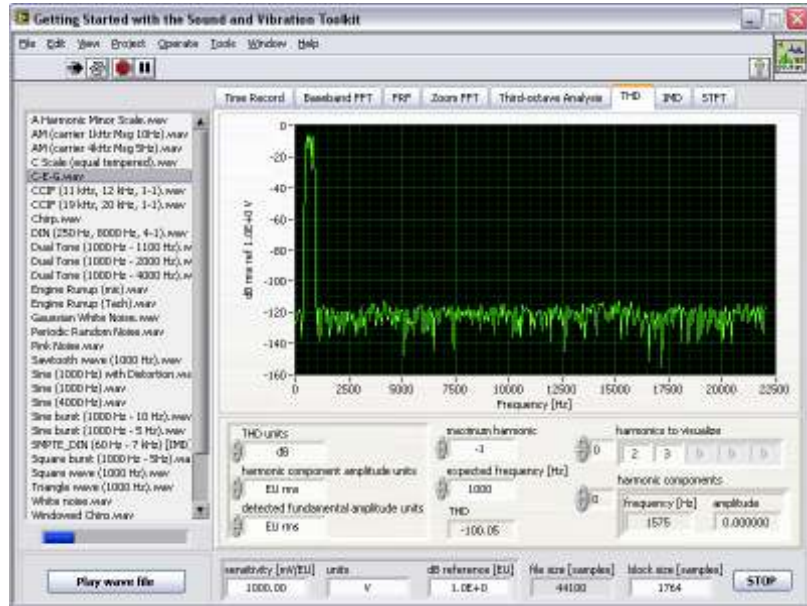
- Zoom FFT – click on the **Zoom FFT** tab to see a zoom FFT performed on sample data. Select the **Dual Tone (1000 Hz – 1100 Hz).wav** data and switch between the **Zoom FFT** and **Baseband FFT** tabs to see the increase in frequency resolution with the Zoom FFT.



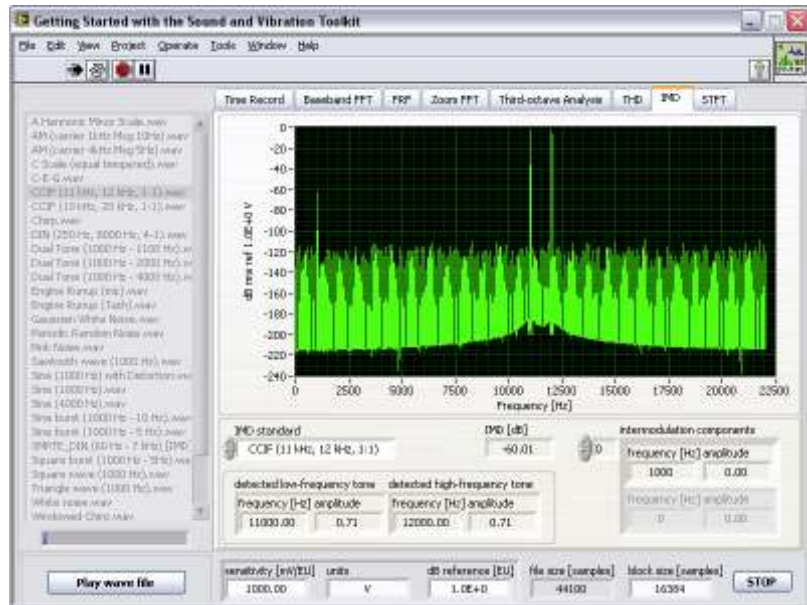
- Third Octave Analysis – click on the **Third-octave Analysis** tab to view ANSI and IEC certified fractional octave analysis.



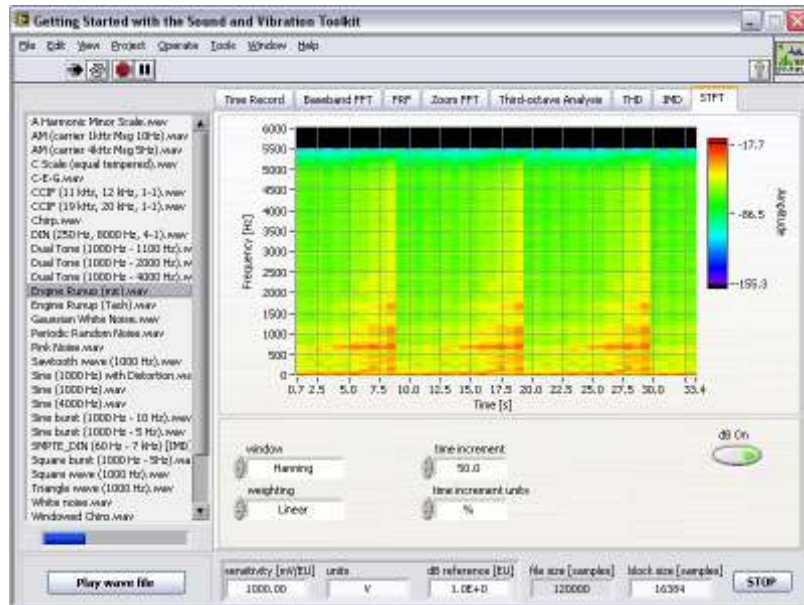
- Total Harmonic Distortion (THD) – click on the **THD** tab to perform THD measurements on selected data.



- Intermodulation Distortion (IMD) – click on the **IMD** tab to view the results of an IMD calculation. The Getting Started VI will automatically select the dual-tone CCIF signal needed to perform IMD analysis.



- Short Time Fourier Transfer (STFT) – click on the **STFT** tab to see how short time Fourier analysis can be used to analyze signal with changing frequency content. Select the **Engine Runup (mic)** file to see data that has changing frequency content.



## Sound and Vibration Toolkit Example VIs

Launch the NI Example Finder from LabVIEW with the Help >> Find Examples... menu. You can browse to the sound and vibration examples by double-clicking on the Toolkits and Modules >> Sound and Vibration folders in the Example Finder.

The LabVIEW Sound and Vibration Toolkit includes over 60 example VIs to help you get started. Most example VIs in the toolkit have three variations:

- Simulated
- Traditional DAQ
- DAQmx

These different VIs are to show how different types of National Instruments data acquisition hardware can work with the Sound and Vibration Toolkit. However, the LabVIEW Sound and Vibration Toolkit is completely hardware independent so you can use recorded data or any other type of hardware.

Any of the example VIs that include the term “Simulated” in their name can be opened and run as part of this exercise. Other example VIs that include “Traditional DAQ” and “DAQmx” include functions to control NI hardware so they will not run here, but the analysis capabilities can be utilized in other VIs. Browse through the selection to find one that meets your objectives. They include:

- Baseband FFT (Fast Fourier Transform)
- Baseband FRF (Frequency Response Function)
- Engine Run-up
- Getting Started with SVT
- Integration
- Limit Testing
- Multichannel FFT
- Shock Response Spectrum
- Sound Level Meter
- Subset FFT
- Third-Octave Analysis
- Vibration Analysis
- Waterfall Display
- Weighting and Peak Search
- Zoom FFT
- Zoom FRF

# 5

## Hardware for Sound and Vibration Data Acquisition

National Instruments offers a complete platform of data acquisition hardware for sound and vibration applications that include:

- 24-bit input and output resolution for maximum linearity
- Up to 120 dB dynamic range
- Anti-aliasing filters
- Simultaneous sampling and synchronization up to 5000 channels
- IEPE signal conditioning power (constant current) for microphones and accelerometers

### Configuring and Testing a Device in the Measurement & Automation Explorer (MAX)

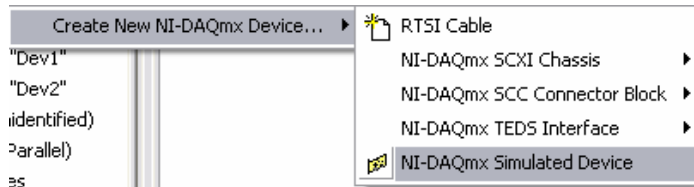
The Measurement & Automation Explorer (MAX) is used to configure and test National Instruments hardware for data acquisition. This exercise is designed to show you how a sound or vibration application can be setup in MAX.

1. Launch Measurement & Automation Explorer (MAX) from the link on the desktop.



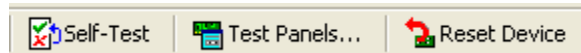
2. The Expand the **Devices and Interfaces** and then expand the **NI-DAQmx Devices** tree in MAX.

3. To simulate a National Instrument data acquisition device, right-click **NI-DAQmx Devices** >> **Create New DAQmx Device...** >> **NI-DAQmx Simulated Device**.

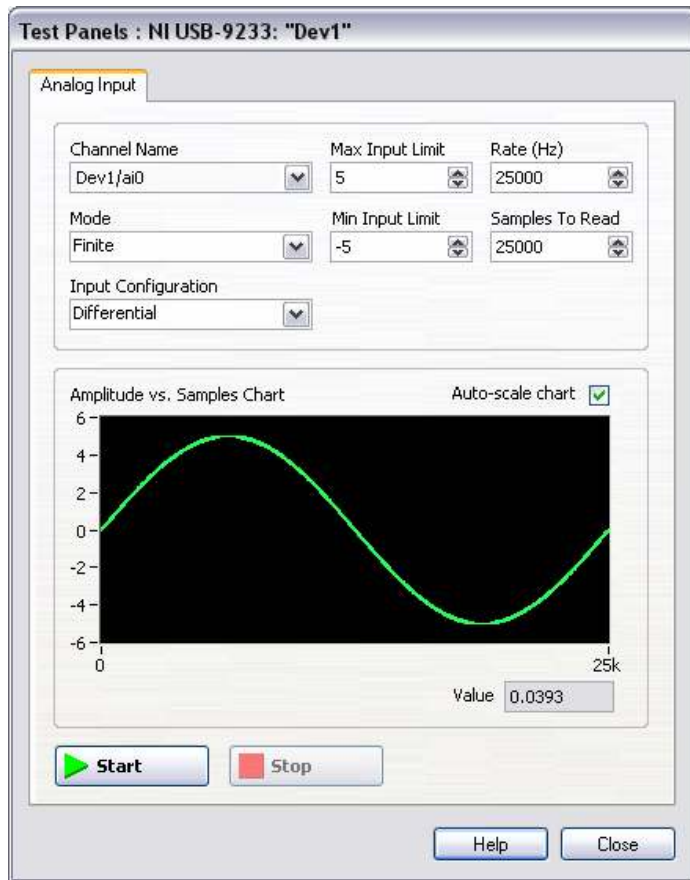


Expand the **USB DAQ** menu and choose the **USB-9233** and click OK. The USB-9233 is a four-channel dynamic signal acquisition module that delivers 102 dB of dynamic range and IEPE signal conditioning for accelerometers and microphones. The four input channels simultaneously digitize input signals at rates from 2 to 50 kS/s.

4. Highlight the USB-9233 and then run a self-test on the device by clicking on the **Self-Test** button.

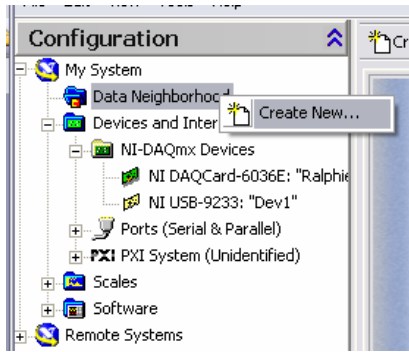


5. Launch the test panel by clicking on the **Test Panels...** button. The test panel provides a quick way to verify that the device is functioning properly. Click the start button in the test panel to acquire one second of data from channel 0. Then close the test panel and return to MAX. The data that is shown is simulated.

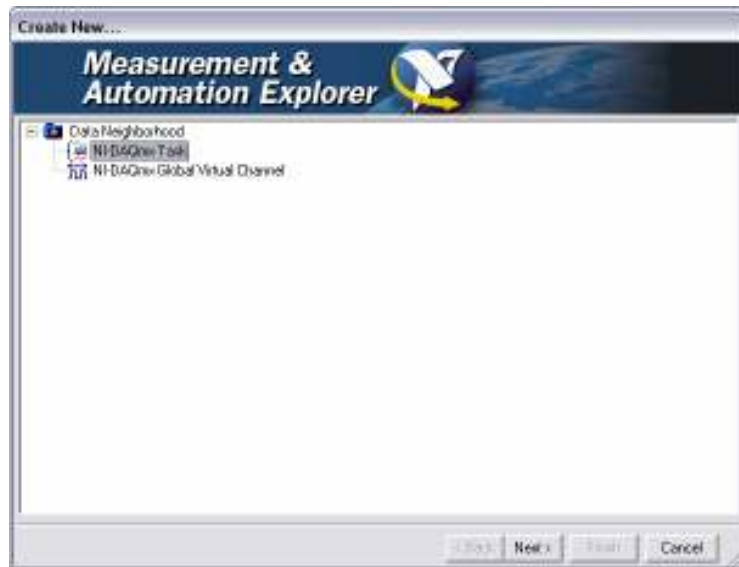


## Setup a Measurement Task in MAX

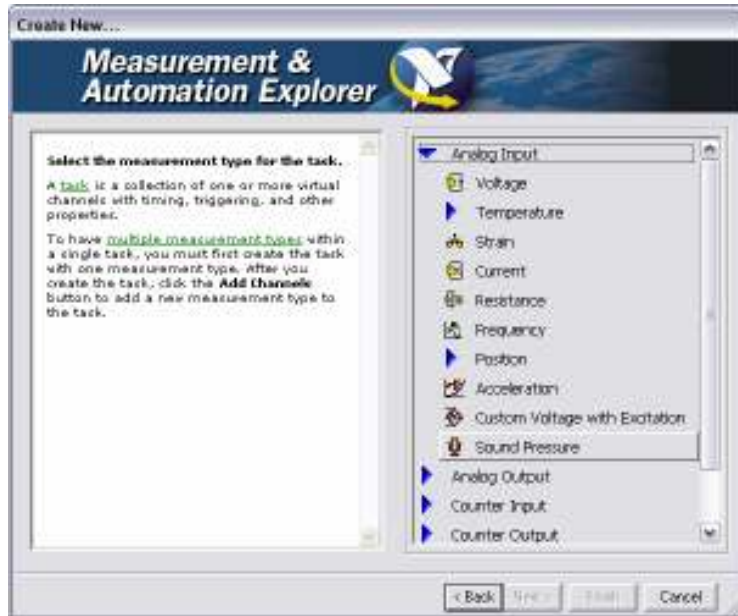
1. Setting up a task is the first step in acquiring sound and vibration data from a National Instruments data acquisition device. The task contains information such as the physical channel, scaling information, timing information, and other data. Right-click on **Data Neighborhood** and select **Create New**.



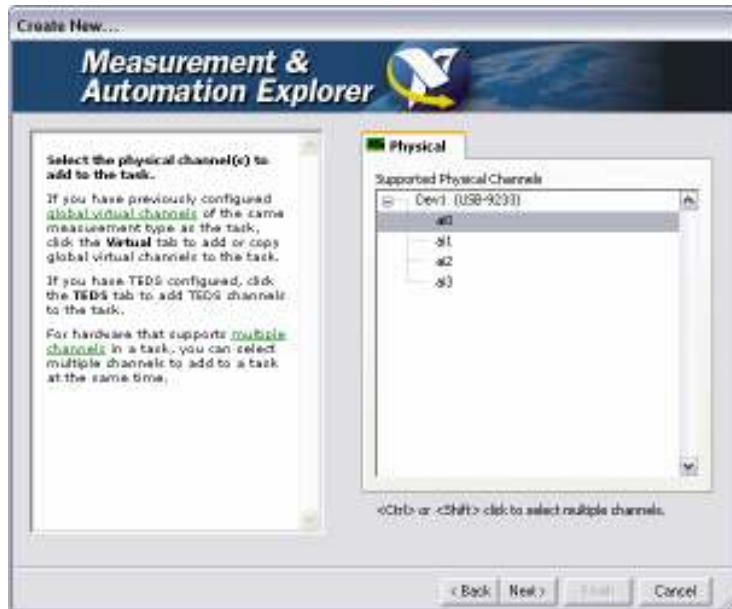
2. Choose **NI-DAQmx Task** and click **Next**.



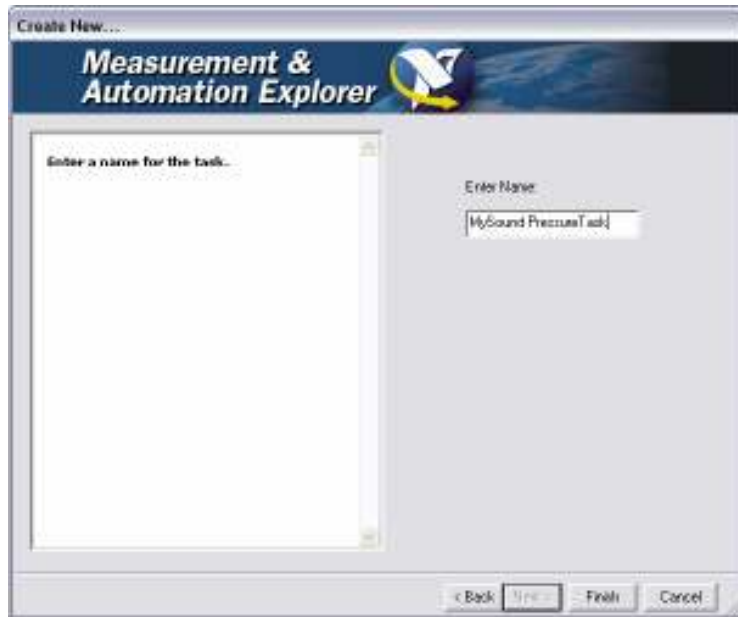
3. Choose **Analog Input >> Sound Pressure**



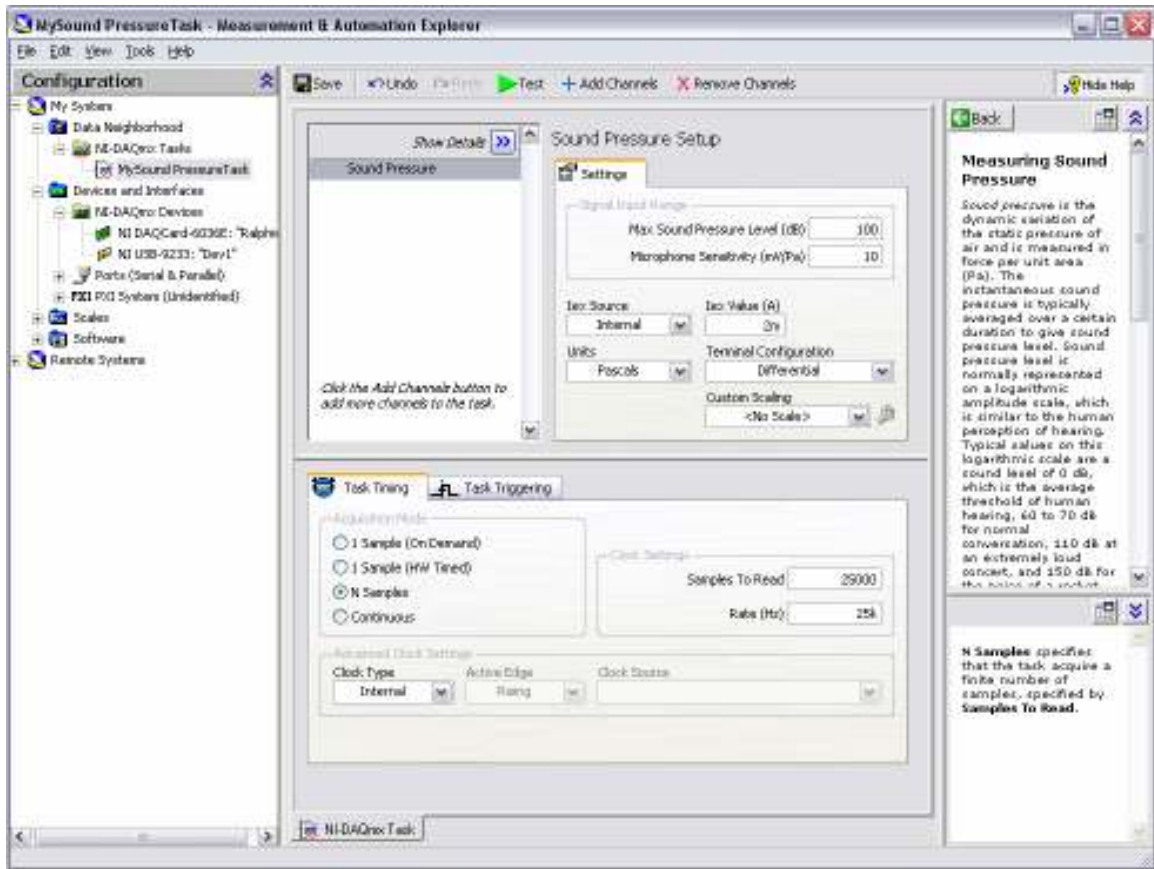
4. Choose **ai0** under the simulated USB-9233 and click **Next**.



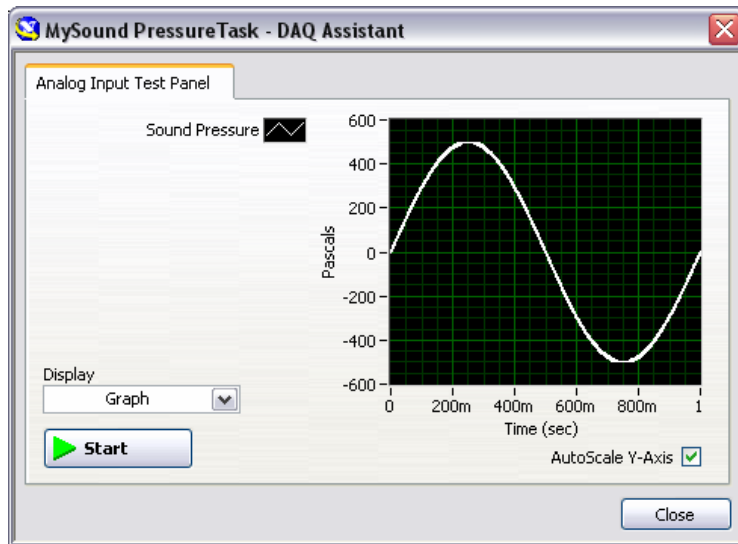
5. Enter a name for your task and click **Finish**



6. This is where you can enter information and setting for scaling, timing, triggering, etc. for this sound pressure acquisition task. This task is set to acquire at 25 kS/s for 25000 samples, which is one second of data. The microphone is set to 10 mV/Pa sensitivity and the data will be scaled to that setting.



7. Click **Test** and you will acquired scaled (simulated) data according to the settings in the previous screen.



8. Close MAX and exit.

Congratulations! You have completed the final exercise and in the process, configured a data acquisition task that could be used to read data from a microphone or with a few changes from an accelerometer.

# 6

## Summary

Congratulations! During this short tutorial you have successfully learned how to perform basic analysis for acoustic, noise, and vibration applications using the LabVIEW Sound and Vibration Toolkit.

Exercise 1 introduced you to sound level and fractional octave analysis using the Express VIs in the Sound and Vibration Toolkit. Exercise 2 further used Express VIs to calculate overall RMS vibration level and perform spectral analysis. In Exercise 3 you built a VI to compare the results between baseband and zoom FFTs. Exercise 4 helped you explore some additional analysis capabilities in the Sound and Vibration Toolkit with the Getting Started VI. Finally, in Exercise 5 you configured and tested a data acquisition device for a sound pressure measurement.