Get Control
Accelerometer Test Tool
User's Guide

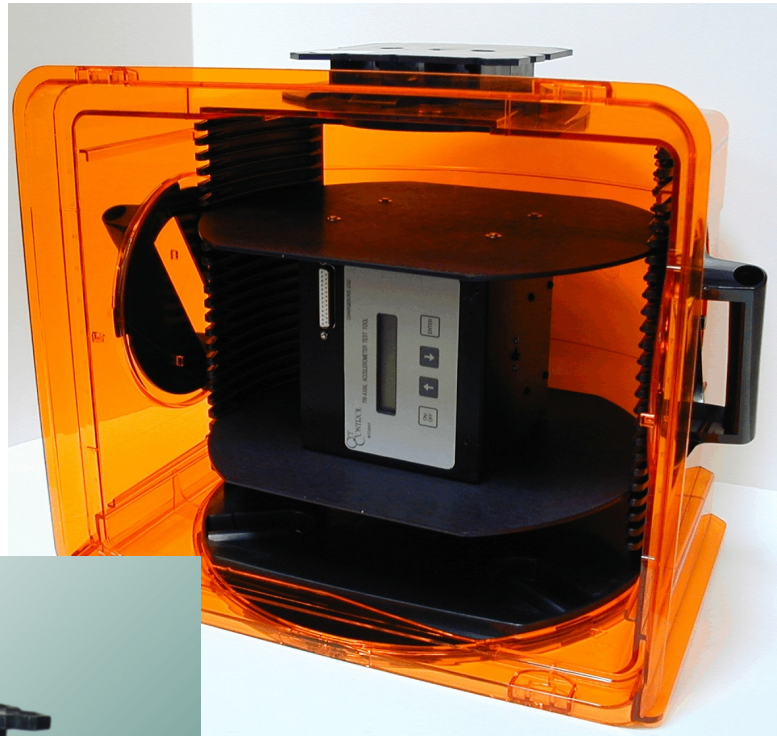**Version 5.6**

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1   Introduction

The GCI Accelerometer Test Tool (also known as the Vib Tool) provides precise measurements of the acceleration that semiconductor wafers and reticles experience during automatic and manual transportation. Using three accelerometers mounted in a tri-axial configuration, the Vib Tool simultaneously acquires and records data on the X, Y, and Z axis. Time-domain data is recorded at a rate of 512 Hz (512 samples per second, for each axes) to internal flash memory. Recorded data files can be uploaded to the PC for analysis using the GCI VibPlot Application.

The Vib Tool provides two packaging options, one for use in wafer carriers and FOUPS, the other for reticle pods (RSP 150). The FOUP packaging option ships with mounting plates to securely mount the tool inside an industry-standard 300mm FOUP. The reticle packaging option ships with mounting bars to securely mount the tool inside an industry-standard 150mm reticle pod.

The Control Panel provides the Vib Tool's user interface. It consists of a 16 character by two line Liquid Crystal Display (LCD) and a 4-key membrane keypad. The LCD displays the Tool's menus and the keypad provides user' control of menu navigation and selection of various options. It also provides a switch to turn the Tool on and off.

The Vib Tool records data to internal flash memory. Recording time is limited by the remaining available space on the internal flash memory (up to 24 hours per recording session).

Figure 1 - Vib Tool mounted in 300 mm FOUP

The Tool is self-contained with a rechargeable nickel-metal hydride battery pack. The batteries provide continuous Tool operation for approximately 28 hours between recharges. A +15VDC Universal (110/220 VAC) Power Source plugs into the Tool's Control Panel to recharge the battery pack. A lithium battery provides battery backup for calibration values and the built-in real-time clock.
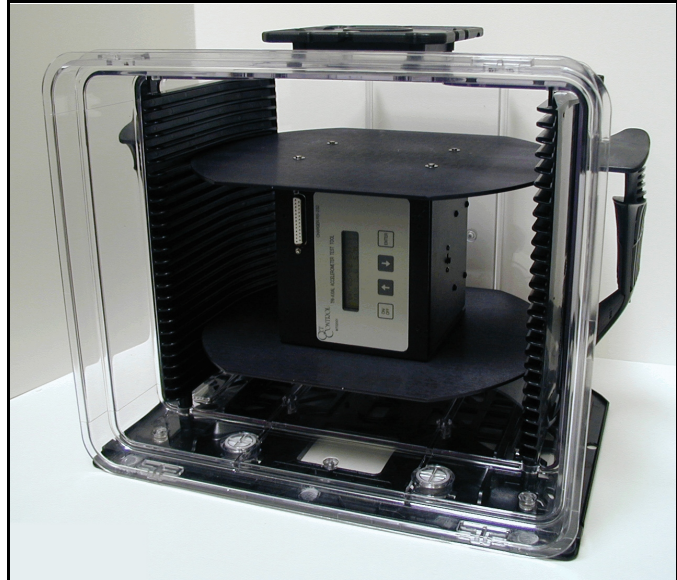

Figure 2 - Vib Tool packaged for Reticle Pod

2   Operation

The Control Panel provides the Vib Tool's user interface. The operator selects various options from the Tool's menus to setup and perform acquisition.

2.1   Control Panel

The Test Tool's Control Panel is visible on the top of the unit. It consists of an anodized aluminum panel that contains a 16 character by two line LCD, a 4-key membrane keypad, a power entry plug and a 9-pin (DB-9) RS-232 connector.

The LCD provides display of the Tool's menus. The Up, Down, and Enter keys allow the operator to page through the menus and select from the various options within the menus. The On/Off switch toggles power to the Tool.

The RS-232 connector provides the communications interface for uploading recorded data files to the PC via the GCI VibPlot Application. The power entry plug is used to charge the internal nickel-metal hydride battery pack using a 15 VDC wall transformer.

2.2   Menu Structure

Figure 3 shows a flowchart of the Vib Tool's message sequence. Typically, the top line of the LCD displays the current menu title or mode. The bottom line displays the current option or Tool status. Press the Up and Down arrow keys to scroll through the menu options. Press the Enter key to select the displayed option.
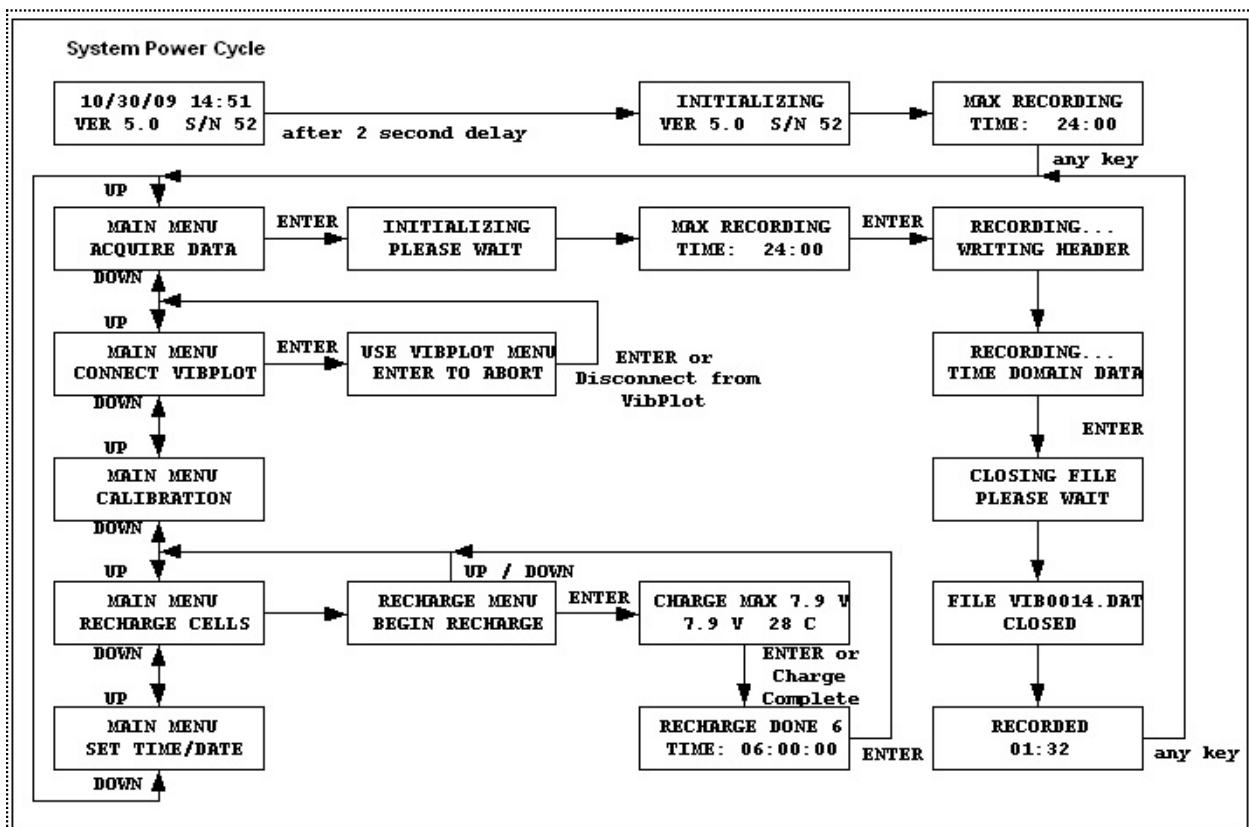

Figure 3 - Vib Tool Menu Flowchart

2.2.1   Numeric Data Entry

The test Tool accepts numeric entry using the up and down arrow keys. Use numeric entry to set the Accelerometer coefficients and the test Tool's internal date and time. When the Tool enters a numeric entry menu, the current setting of the menu's parameter appears with the cursor located under the left most digit. Use the Up and Down arrow keys to increment or decrement the digit at the cursor. Press the Enter key to advance the cursor right one digit. When the cursor is on the right-most digit of the parameter, press Enter to accept the parameter.

2.2.2   Main Menu - Startup Screens

When first powered up, a sign-on message is displayed, showing the tools internal time and date, firmware version number and serial number.

After a two second delay, the tool runs through an initialization process. During this process, the time and date is replaced with the word "Initializing". This indicates that the tool has successfully booted. If the "Initializing" message is not displayed after several seconds, the Vib Tool may not have booted properly. Cycle power to retry.

Part of the inititialization process is a check of available space on the internal flash memory for recorded data. The Maximum Recording Time is displayed at the end of the initialization step. This message can be used to determine when data files should be removed from internal storage.

Pressing the ENTER key will clear this message and display the main system menu, starting with the Acquire Data option.

The Main Menu contains six options: Acquire Data, Connect VibPlot, Calibration, Recharge Cells, and Set Time and Date. Use the arrow keys to scroll through the options and press the Enter key to select an option. Sections 2.2.3 through 2.2.7 describe the five main menu options and their functions.

2.2.3   Main Menu - Acquire Data

Press the ENTER key at the **MAIN MENU / ACQUIRE DATA** screen to initiate a recording session. The Vib Tool displays a **INITIALIZING / PLEASE WAIT** message while it prepares internal storage to accept the recorded data. It then displays a maximum recording time message. The system will automatically terminate acquisition when the displayed time expires. Alternately, the user can terminate recording manually.

Press the ENTER key to start recording data. The Vib Tool writes some header information into the data file, including the tool's S/N, firmware version number and time and date. While the header information is being written (which takes a few seconds), the tool displays the **RECORDING... / WRITING HEADER** message. When the header has been written, the system initiates it's time-domain data acquisition module and begins streaming recorded data to the data file. The display changes to **RECORDING... / TIME DOMAIN DATA.** While this message is displayed, the system is continuously recording time-domain data to internal flash memory.

To terminate the recording session, press the ENTER key. The Vib Tool displays several messages while it halts it's acquisition module and closes the recorded data file. Do not turn the Vib Tool's power off until the file closing process has completed.

The tool displays the **CLOSING FILE / PLEASE WAIT** message, followed by a file closed message which includes the filename (**FILE VIB0004.DAT / CLOSED**). Pressing the ENTER key will clear this message and display a message indicating the amount of time-domain data recorded (**RECORDED / 00:10:32**). Press the ENTER key to clear this message and return to the Main Menu.

2.2.4   Connect VibPlot Menu

Press ENTER at the **MAIN MENU / CONNECT VIBPLOT** message to prepare the Vib Tool for uploading the data file to the PC using the VibPlot Application. The Vib Tool displays the **USE VIBPLOT MENU / ENTER TO ABORT** message.

Connect the Vib Tool's communications port connector (female DB-9) to an available PC COM port using a straight through, 9-pin, male to female communications cable (provided). Launch the VibPlot Application and use the **Connect to Vib Tool** dialog box, to upload recorded data files. See the separate document **VibPlot Users Guide** for details on the VibPlot Application.

Before the connection is initiated, press the ENTER key to abort, and return to the Main Menu. Once a connection with the PC is made, it must be terminated from the PC - it cannot be aborted using the Vib Tool's menu keys.

After connecting with the VibPlot Application, the Vib Tool displays **CONNECTED / TO VIBPLOT** message. The Vib Tool will automatically return to the Main Menu when it is disconnected from the PC using the **Connect To Vib Tool** dialog box **Disconnect** button.

2.2.5   Calibration Menu

Press the Enter key at the Main Menu Calibration option to advance to the Display Calibration Menu. The Calibration menu provides verification of the Tool's operation and a method to change each accelerometer's coefficients.

The factory sets the accelerometer coefficients and it is not necessary to modify them under normal operating conditions. They do, however, need to be modified when replacing an accelerometer.

2.2.5.1 Display Static Vibration Menu

Press the Enter key at the Display Calibration Menu to display the X-Axis vibration level. The Tool updates the current X-axis vibration approximately two times per second. The vibration is displayed as specified by the Analysis Type option; acquired data is not recorded in this mode. Use the arrow keys to scroll through the three axes. From the X-axis display, press the Down arrow to display the Y-axis vibration and the Up arrow to display Z-axis vibration.

Press the Enter key to return to the Main Menu.

Tool verification is possible by taking advantage of the accelerometer's static acceleration response. The accelerometers will report approximately 1.0 g of acceleration when they are parallel to earth gravity. Rotating each accelerometer through earth gravity while monitoring the static response will verify correct Tool operation. If the reading for any axis varies by more than 10% (±0.10 g), please contact GCI technical support.

2.2.5.2 Set Accelerometer Coefficients

The Set Accelerometer Coefficients option provides a method to change the accelerometer's factory coefficients. This is only necessary when replacing one of the Tool's accelerometers. Coefficients must match those reported by the accelerometer manufacturer. A set of coefficients are shipped with each Test Tool documenting the three accelerometers installed.

Press the Enter key to advance to the X-axis Offset and Sensitivity menu. Press the Down arrow from the Set Coefficients Calibration Menu to return to the Main Menu. The Tool displays one numeric entry menu for each accelerometer for a total of three menus. Each menu prompts for the Accelerometer Offset and Sensitivity. After setting the three axes coefficients, a final menu allows for entry of the voltage and temperature offsets. Refer to Section 2.2.1 for instructions on numeric data entry.

2.2.5.3 Flash Vib

The Vib Tool firmware is field ungradable. The Flash Vib menu option allows the user to upgrade the Test Tool firmware with a new version supplied by GCI. This menu option should not be used unless a firmware image file has been received from GCI, along with instructions on upgrading the firmware.

2.2.5.4 Flash SD Module

The Vib Tool hardware includes a second processor dedicated to storage management of the internal flash memory. The firmware for this second processor is also field ungradable. The Flash Logger menu option allows the user to upgrade the Time Domain Module firmware with a new version supplied by GCI. This menu option should not be used unless a firmware image file has been received from GCI, along with instructions on upgrading the firmware.

2.2.6   Recharge Cells Menu

Press the Enter key at the Main Menu Recharge Cells option to recharge the internal nickel-metal hydride battery pack. The battery pack can be recharged at any time by connecting the supplied 15 VDC Universal (110/220 VAC) Power Supply to the Tool.

During the fast recharge operation, the Tool displays a 'Recharging' message along with the battery Voltage and the Temperature measurements. The software automatically terminates the fast charging operation if it detects voltage or temperature extremes.

The+15 VDC Universal Power Supply provides a trickle charge to the battery pack when it is plugged in and connected to the Vib Tool. Complete fast charging of the battery pack takes approximately five hours. When the charge cycle has completed, a 'Charge Complete' message will be displayed. Press the Enter key to return to the main menu. The charge operation may be aborted at any time by pressing the Enter key.

The Tool will display a low-battery warning indicator when it requires charging. An Omega (Ω) appears in the menus when the Tool is not recording data to indicate the low battery condition. When the battery level reaches a point that further discharge will damage the battery, the Tool automatically shuts itself off. During data recording, the Tool does not display the low battery warning indicator before it shuts off due to a low battery condition. When the Tool shuts itself off during recording, all data up to the point of the shutdown will be available after the battery is recharged.

2.2.7   Set Time and Date Menu

The Set Time and Date option provides the method to set the time and date of the Vib Tool's built-in real-time clock. The Set Time and Date option contains two menus: One to enter the date and the other to enter the time. Refer to Section 2.2.1 for instructions on numeric entry. After entering the Date and Time, the Tool returns to the Main Menu.

The test Tool contains a built-in real-time clock. It provides a two-digit year counter which is Year 2000 compatible. The test Tool will maintain the correct time, date of the month, day of the week, month and two-digit year with correct leap year compensation up to year 2099. The test Tool provides the year with a two-digit counter. It does not provide century information.

3   Mechanical

3.1   Mounting Brackets for 300mm FOUP Installation

When packaged for 300 mm FOUP installation, the Vib Tool requires 300mm plates that allow it to be mounted inside the FOUP. Standard 300 mm mounting plates can be attached to the Test Tool using the supplied hardware.

Figure 4 shows the location of the mounting holes for 200/300 mm plates. These mounting holes are on each side of the Vib Tool. To attached the bottom 300mm mounting plate, use the included 8/32 x 1/2" socket head screws. Tighten the plate firmly against one side of the tool. This will be at the bottom when inserted into a FOUP.

To attach the top 300mm mounting plate, use the included 8/32 x 1" socket head screws, washers and springs (as shown on the next page).   When using the Tool with 300mm mounting plates, please note that the axes have been rotated. The data recorded will still be reported as X, Y, and Z Axis data, but the Y Axis will be the vertical axis.
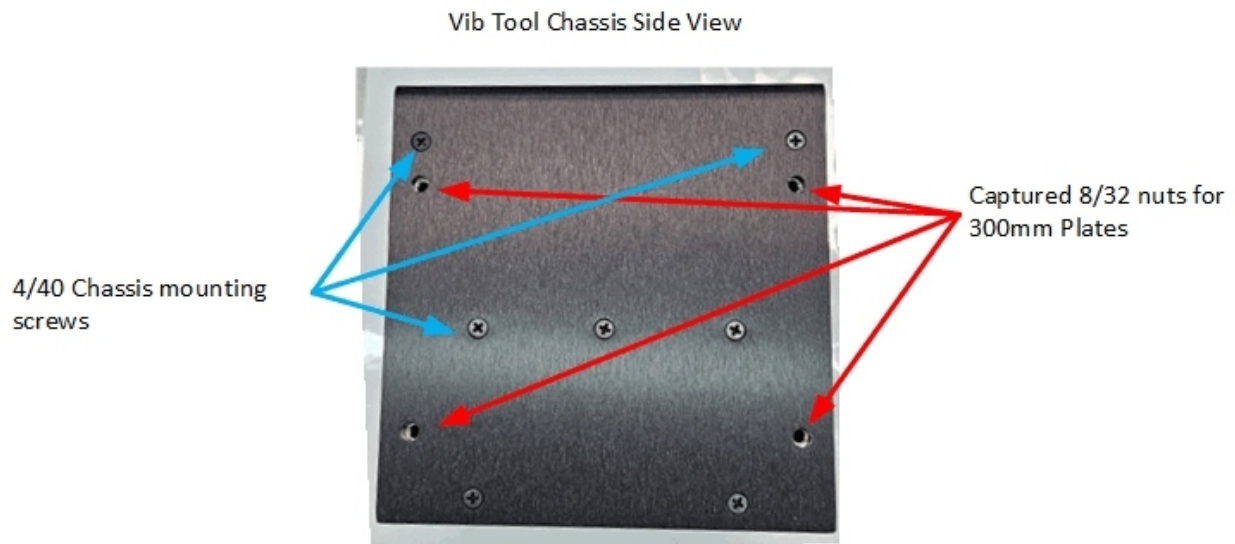

Figure 4 - 200/300 mm Plate Mounting Holes

3.1.1   Mounting Hardware for 300mm FOUP Installation

The Vib Tool ships with all required mounting hardware to attach 300mm plates to the Vib Tool. Kit contents are listed to the right.

300mm FOUP Mounting Kit Hardware

4 – 8/32 x ½" Socket Cap Screws
4 – 8/32 x 1" Socket Cap Screws
4 – Springs
8 – Flat Washers
1 – 9/64" Hex End L-Wrench

Figure 5 - 300 mm Plate Hardware Kit

Figure 6 shows details on attaching the 300 mm Mounting Plates to the Vib Tool. The bottom plate is fastened directly to the enclosure. The top plate is mounted with springs between the enclosure and plate. The top screws are left loose to allow the unit to align with wafer slots in the FOUP. Once the unit is placed into the FOUP, the socket head screws are tightened down (using the included 9/64" L-Wrench) to firmly grip the slot fingers. Tighten the screws such that the Vib Tool is secure to the FOUP. Over tightening may damage the FOUP and/or the Vib Tool.

Figure 6 - Test Tool with 300 mm Mounting Plate

3.2 Mounting Brackets for 150 mm Reticle Pod Installation

When packaged for 150 mm reticle pod installation, the Vib Tool is shipped with all required mounting brackets attached.

3.3   Mounting Brackets for 200 mm Carrier Installation

When packaged for 200 mm FOUP installation, the Vib Tool requires 200mm plates that allow it to be mounted inside a standard wafer carrier. Standard 200 mm mounting plates can be attached to the Test Tool using the supplied hardware.

Figure 4 shows the location of the mounting holes for 200/300 mm plates. These mounting holes are on each side of the Vib Tool. To attached the two 200mm mounting plates, use the included 8/32 x 1/2" socket cap screws. Tighten the plates firmly against each side of the tool.

Figure 7 - 200 mm Plates Mounted on Vib Tool

Once the 200 mm plates have been attached, the Vib Tool can be inserted into a standard 200 mm carrier.

Figure 8 - Vib Tool Installed in 200 mm Carrier

3.4   Control Panel

The Control Panel is located on the top of the main structure. The Control Panel consists of a membrane keypad, a power entry port, and a 9-pin female connector. The membrane keypad and connector fasten to the enclosure such that it remains completely enclosed to minimize particulate generation from the Vib Tool's PC board.

3.5   Charge Unit

A Universal (110/220 VAC) +15 VDC Power Supply is used to recharge the internal nickel-metal hydride battery pack.

3.5.1   Low-Battery Sense

The Vib Tool continuously monitors the nickle-metal hydride battery voltage and reports a low-battery warning by displaying an Omega (Ω)symbol on the LCD (when not recording data). If the battery level falls below an operational level, the Vib Tool shuts itself off. During recording, a warning is not displayed, but the Tool will automatically shut off. In all cases, data is retained regardless of the level of the internal batteries.

3.6   RS-232 Cable

A standard 9-Pin adapter cable (P/N 9101-22-030) is used to transfer recorded data to a PC.

3.7   Flash Memory

The Vib Tool includes 1 GB of flash memory used for recorded data storage. The Vib Tool manages the flash memory similar to a standard PC hard drive. Each recording session is given it's own data file that is used to store recorded time-domain data. This allows the user to run multiple, separate recording sessions before uploading the recorded data to the PC for analysis. Each file is uniquely named, and contains header information detailing the time and date recording was initiated, along with the Test Tool's S/N and firmware version information.

4   Software

4.1   Data Acquisition

The Vib Tool simultaneously samples each of the vibration data channels at a uniform rate of 512 samples per second.

4.2   Data Recording

The Vib Tool continuously streams time-domain data to internal flash memory. The Vib Tool stores the initial start time and date and begins recording data points at a uniform rate of 512 points per second on each channel. Data recording continues until the onboard flash memory fills (up to 24 hours per recording session) or the user presses the Enter key. Note that the time and date of recording is based on the Vib Tool's internal real-time clock. Ensure that the time and data are properly set before initiating a recording session.

4.3   Data Reduction

Data reduction of the recorded time-domain data is handled by the VibPlot Application running on a PC. Use the VibPlot Application to upload the recorded data files to the PC for analysis. Please see the separate document **VibPlot Users Guide** for additional details on available data reduction options.

4.4   Data Retrieval

The Vib Tool supports data uploading to a Host PC via a standard RS-232 communications port. Using the VibPlot Application, the user connects to the Vib Tool and requests a list of available data files. The user selects the desired file and uploads the data to the PC's hard drive. The file can then be opened by the VibPlot Application for data reduction and graphical analysis. Please see the separate document **VibPlot Users Guide** for additional details on the data retrieval process.

5   Technical Support

If you encounter problems using the Vib Tool, Get Control technical support can be reached the following ways:

By email at support@getcontrol.com.

By phone at 1-480-539-0478 (9am - 5pm Mountain Standard Time).

Also see our web site at www.getcontrol.com for additional information about Get Control, Inc.

6   Operation Verification Application Note

This application note shows how to verify operation of the Vib Tool system. Using the *Calibration Display* feature and earth gravity, each of the three axis can be verified. Turn on the Tool and advance to the *Calibration Display* menu. Press enter and the real-time DC component of the X-axis vibration is displayed. The orientation of each axis is drawn on the keypad (newer models) or etched into the top of the enclosure (older models). From the face of the tool, positive X points to the front of the tool, positive Y points to the right side of the tool, and positive Z is down into the tool. The orientation of the Z-axis is assumed, not shown, for clarity.

Verify that the tool's Calibration Coefficients are set to the accelerometer data sheet specifications provided with your tool (default nominal is 2.500 V offset and 1000 mV/g sensitivity). These coefficients are stored in battery-backed RAM. For this verification, it is not critical that they exactly match the data sheets, but they must be reasonable numbers (close to default nominal) for the Calibration Display feature to operate properly. If the battery-backed RAM corrupts where the Calibration Coefficients are stored, the tool firmware detects this and resets them to default nominal. Refer to the User's Guide for instructions to perform this verification.

Using the *Calibration Display* menu, we orient each axis of the test tool perpendicular to earth gravity and verify its ability to sense this 1g constant. This function is only used for the purpose of verifying test tool operation. It is not used for calibration and the test tool does not record earth gravity during normal operation. Several factors affect this measurement including:

- The test tool circuits contain DC offsets that make this reading accurate to 10%.
- Earth gravity is slightly dependant on geographic location.
- It is difficult to hold the tool exactly perpendicular to the earth without a leveling mechanism.

Orient the tool so that its front is facing up, the positive X axis is parallel to earth gravity as shown in **Figure 9**. Verify that the tool reads **+1.00g +/-0.10.**
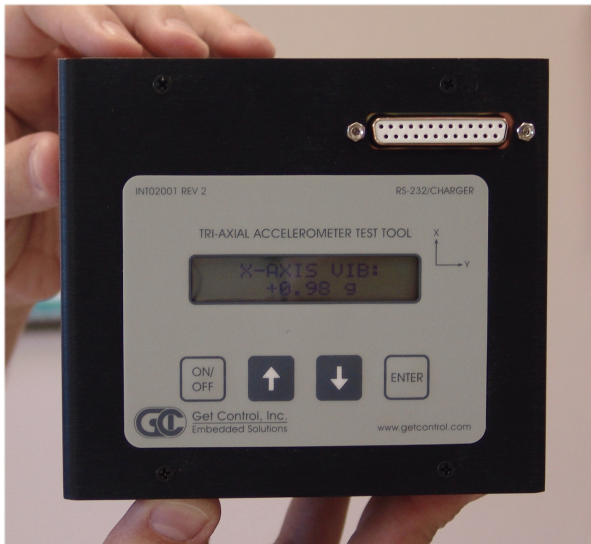

Figure 9 - X Axis Positive

Figure 10 - X Axis Negative

Orient the tool so that its front is facing down, the negative X axis is parallel to earth gravity as shown in **Figure 10**. Verify that the tool reads **-1.00g +/-0.10.**

Press the *Down Key* to advance to display the Y Axis. Orient the tool so that its right side is facing up, the positive Y axis is parallel to earth gravity as shown in **Figure 11**. Verify that the tool reads **+1.00g +/-0.10**.

Figure 11 - Y Axis Positive

Figure 12 - Y Axis Negative

Orient the tool so that its right side is facing down, the negative Y axis is parallel to earth gravity as shown in **Figure 12**. Verify that the tool reads **-1.00g +/-0.10.**

Press the *Down Key* to advance to display the Z Axis. Orient the tool so its top is facing up, the positive Z axis is parallel to earth gravity as shown in **Figure 13**. Verify that the tool reads **+1.00g +/-0.10**.

Figure 13 - Z Axis Positive

Figure 14 - Z Axis Negative

Orient the tool so that its top is facing down (lift the tool over your head), the negative Z axis is parallel to earth gravity as shown in **Figure 14**. Verify that the tool reads **-1.00g +/- 0.10.**

If the tool measures earth gravity to +/-0.1g (+/-10%) using the Calibration Display feature, it is working properly.

To remove the system DC offsets to get a more accurate verification, use a level to improve the accuracy of each axis measurement. Record each positive and negative axis reading. Then subtract the negative axis measurement from the positive axis measurement and divide this result by 2. This number should be close to 1.00g. This method removes the tool's DC offsets from the measurements. However, it does not account for geographical earth gravity variances or inaccuracies in orienting the tool perpendicular to earth gravity.

Get Control
VibPlot
User's Guide

Version 1.7.6

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1   Introduction

The Get Control Tri-Axial Accelerometer Test Tool (Vib Tool) has become the industry standard device used to analyze the vibration characteristics of AMHS delivery vehicles and tracks within 200 mm and 300 mm fabs. Get Control, Inc. developed the Vib Tool's hardware and firmware in cooperation with wafer fabrication leaders to take time-domain vibration data at a 512 Hz sampling rate, and reduce it two data records per second over three axes.

The initial release of the Vib Tool, now termed <u>legacy</u>, utilized a data reduction algorithm consisting of FFT's to convert the time-domain data into the frequency domain (on 2 Hz bins), and averaging calculations to produce several data points for each ½ second data record. Data points for each axes include a summed RMS value, the Peak Amplitude value, the Frequency at Peak and the number of frequency bins with data over 0.3 g's. The true RMS calculation over all three axes is also included.

Each ½ second, the legacy Vib Tool acquires 256 samples of time-domain data on each axes, while performing data reduction on the previously acquired ½ second worth of data. In this way, the legacy Vib Tool reduces recorded time-domain data internally into reduced data packets, discarding the time-domain data as reduction is completed. The reduced data packets are stored internally in battery backed RAM, and available to upload to a PC for analysis as a formatted ASCII text. The time-domain samples are not retained, and are unavailable for post reduction analysis.

Beginning with firmware version 5.0, the Vib Tool replaces the legacy tool's on-board data reduction by recording all time-domain data directly to internal flash memory. Data reduction is relocated to the PC using the GCI VibPlot Application. This allows the time-domain data to be available for more detailed analysis than was possible using the legacy Vib Tool's on-board data reduction.

The VibPlot Application provides users with powerful graphical analysis features. Time-domain data can be graphically displayed, along with graphs of several data reduction calculations, including legacy reduction modes that duplicate the Vib Tool's on-board data reduction. Legacy reduced data can be exported to a text file in the same format produced by legacy Vib Tools. This allows customers to continue to use their own customized legacy analysis methods with the new Vib Tool, and take advantage of the new graphical analysis options provided by the VibPlot Application.

The **VibPlot User's Guide** provides details on using the VibPlot Application.

1.1   Overview

VibPlot provides data reduction and graphical display of time-domain data recorded by the GCI Vib Tool. Graphing options include:

- recorded time-domain vibration data
- summary of averages
    - RMS vs. Time
    - Legacy RMS vs. Time (legacy Vib Tool reduction)
    - True RMS vs. Time
    - Peak Amplitude vs. Time
    - Resultant Amplitude vs. Time
- frequency analysis
    - Amplitude vs. Frequency Spectrograms
    - Three-Dimensional Spectrograms
- indicated violations of defined tolerances
    - True RMS
    - Peak Amplitude
    - Resultant Amplitude

Time-domain and Reduced data can be exported to a comma-delimited (CSV) text file. The current graphics window can be printed or exported to one of several image formats.

VibPlot also provides the link between the GCI Vib Tool and the PC for uploading recorded data files, and managing the Vib Tool's internal flash memory. The Vib Tool's recording of time-domain data results in large data files. A typical 10 minute recording session will generate a 1.3 MB data file. This results in an upload time of approximately 1.5 minutes. When recording for longer periods of time, the file size grows accordingly, resulting in longer upload times.

1.2   GCI VibPlot Licensing

The GCI VibPlot application requires a license key. The first time the application is started, an **Authorization Required** dialog box is displayed indicating that VibPlot has not been authorized.
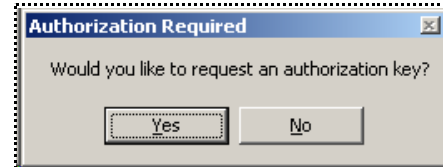
Press the **No** button to indicate that you have not received a key file yet. A second dialog box is displayed asking if you want to request an authorization key.

Figure 1 - Key Request

Press the **Yes** button to generate an authorization file. The file "**Request for VibPlot Key.bin**" will be created on your desktop. This file contains a unique identifier based on your specific installation of VibPlot.

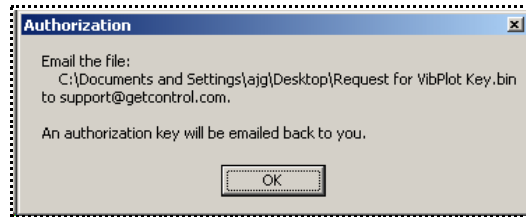You will be instructed to email this file to GCI. GCI will respond with an Authorization Key file.

When you receive the Key file, copy it to your system, and launch VibPlot. When the initial dialog box is displayed asking if you have a key file, press the **Yes** button. You will be prompted to locate the VibPlot Key File using a standard Windows file open dialog box.

Figure 2 - Authorization Email Dialog

Locate the desired file and press   **Open**. If the Key File contains a valid license from GCI, the VibPlot application will open.

After a valid license key has been added to VibPlot, the application will open normally without prompting for a key file. Keys are required for each individual installation of VibPlot.

1.3   Vib Tool Operation

Vib Tool operation is covered in detail in the **GCI Tri-Axial Accelerometer Test Tool Users Guide**. This section provides a short introduction to the Vib Tool, including:

Figure 3 - Select Key Dialog

● initiating a recording session
● connecting to VibPlot to upload a data file
● setting the internal clock
● recharging the batteries

Figure 4 shows a flowchart of the Vib Tool's message sequence. When first powered up, a sign-on message is displayed, showing the tools internal time and date, firmware version number and serial number.

After a two second delay, the tool runs through an initialization process. During this process, the time and date is replaced with the word "Initializing". This indicates that the tool has successfully booted. If the "Initializing" message is not displayed after several seconds, the Vib Tool may not have booted properly. Cycle power to retry.

Part of the inititialization process is a check of available space on the internal flash memory for recorded data. The Maximum Recording Time is displayed at the end of the initialization step. This message can be used to determine when data files should be removed from internal storage.

Pressing the ENTER key will clear this message and display the main system menu, starting with the Acquire Data option.
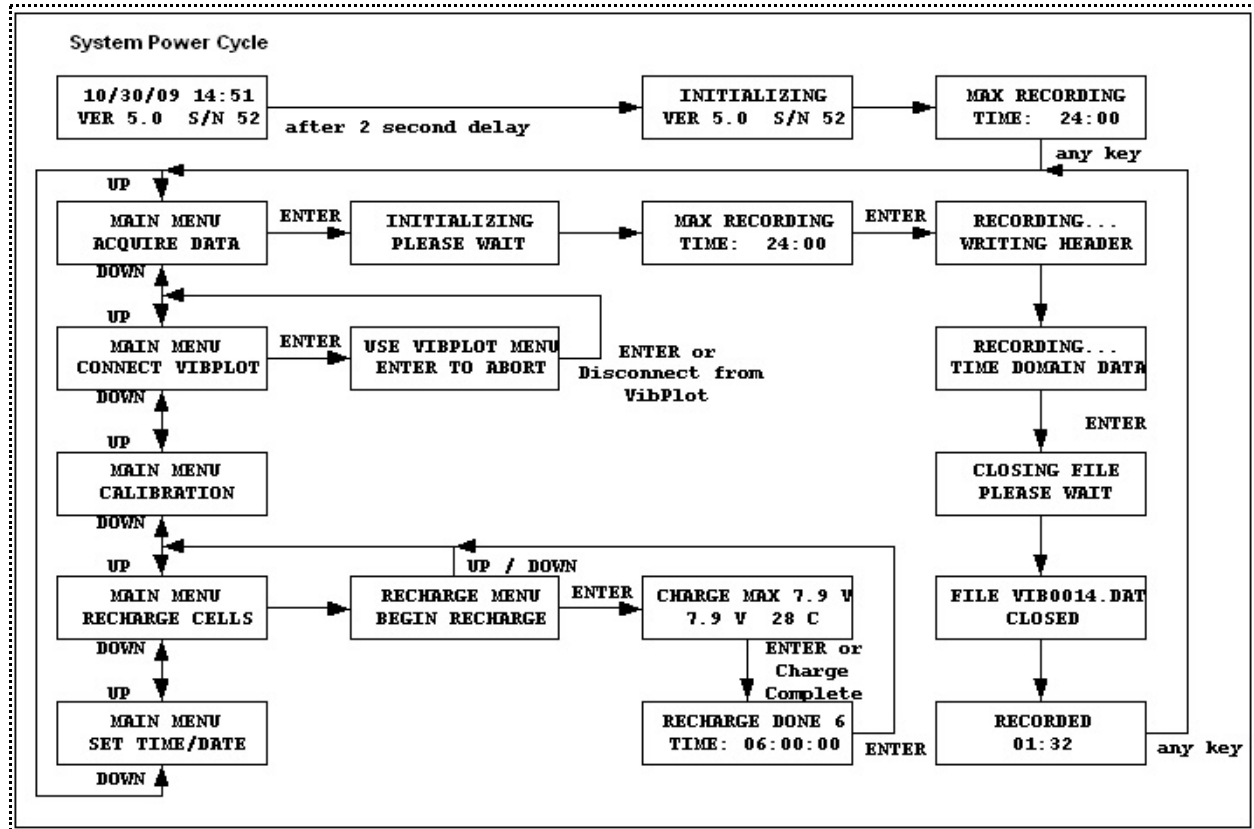

Figure 4 - Vib Tool Menu Flowchart

1.3.1   Recording Time Domain Data

Press the ENTER key at the **MAIN MENU / ACQUIRE DATA** screen to initiate a recording session. The Vib Tool displays a **INITIALIZING / PLEASE WAIT** message while it prepares internal storage to accept the recorded data. It then displays a maximum recording time message. The system will automatically terminate acquisition when the displayed time expires. Alternately, the user can terminate recording manually.

Press the ENTER key to start recording data. The Vib Tool writes some header information into the data file, including the tool's S/N, firmware version number and time and date. While the header information is being written (which takes a few seconds), the tool displays the **RECORDING... / WRITING HEADER** message. When the header has been written, the system initiates it's time-domain data acquisition module and begins streaming recorded data to the data file. The display changes to **RECORDING... / TIME DOMAIN DATA.** While this message is displayed, the system is continuously recording time-domain data to internal flash memory.

To terminate the recording session, press the ENTER key. The Vib Tool displays several messages while it halts it's acquisition module and closes the recorded data file. Do not turn the Vib Tool's power off until the file closing process has completed.

The tool displays the **CLOSING FILE / PLEASE WAIT** message, followed by a file closed message which includes the filename (**FILE VIB0004.DAT / CLOSED**). Pressing the ENTER key will clear this message and display a message indicating the amount of time-domain data recorded (**RECORDED / 00:10:32**). Press the ENTER key to clear this message and return to the Main Menu.

Press ENTER at the **MAIN MENU / CONNECT VIBPLOT** message to prepare the Vib Tool for uploading the data file to the PC using the VibPlot Application (see the **Connecting VibPlot to the Vib Tool** section).

1.3.2   Setting the Clock

Recorded data files are marked with the time and date when recording was initiated. The time and date used is from the Vib Tool's internal real-time clock. If the Vib Tool clock is not set properly, the file will reflect the incorrect recording time.

The Vib Tool's clock is set at the factory to Arizona, USA time. The end user should re-set the Vib Tool clock prior to starting a recording session. Use the **MAIN MENU / SET TIME/DATE** option to set the tools clock.

The tool displays **ENTER DATE: / MM/DD/YY**, with a cursor under the first month digit. Use the UP / DOWN arrow keys to adjust the current digit. Press the ENTER key to advance to the next digit. Each press of the ENTER key advances the cursor to the next digit in the month / day / year. When the second digit of the year is set, the enter key causes the display to change to the current time.

The tool displays **ENTER TIME: / HH:MM**, with a cursor under the first hour digit. Use the UP / DOWN arrow keys to adjust the current digit. Press the ENTER key to advance to the next digit. Each press of the ENTER key advances the cursor to the next digit in the hour / minute. When the second digit of the minute is set, the enter key causes the display to change back to the Main Menu.

1.3.3   Recharging the Batteries

The Vib Tool contains a set of rechargeable batteries that must be periodically recharged. The batteries are changed at the factory, but may require recharging after shipping. Initiate the charge cycle by navigating to the **MAIN MENU / RECHARGE CELLS** option. Press the ENTER key to display **RECHARGE MENU / BEGIN RECHARGE**. Press ENTER again to start the charge cycle.

While charging, the Vib Tool displays a message in the form **CHARGE MAX 7.9 V / 7.9 V 29 C**. The voltage level displayed on the top line is the maximum voltage reading at the current stage of the recharge cycle. The voltage level on the second line is the current voltage reading. The current battery temperature is also displayed. Every five seconds, the display shows the current charge time.

The Vib Tool charge algorithm continuously monitors the charge voltage and battery temperature. The charge cycle will automatically terminate based on several factors. Maximum charge time is five hours. When the charge cycle terminates, a status code is displayed, along with the charge time. Press ENTER to return to the Main Menu.

2   Starting VibPlot

Start VibPlot by clicking on the VibPlot icon. The VibPlot application requires a license key. If this is the first time the application is started, a license key must be requested from GCI.

By default, VibPlot opens with a blank graphics window. Optionally, a file name can be passed as a command line argument, which causes VibPlot to attempt to open the data file as it starts. For example, dragging a recorded time-domain data file onto the VibPlot desktop icon will launch VibPlot and open the selected file.

3   Default Analysis Display

The VibPlot graphics display is split into three sections. Each section can display recorded data in a particular graph format, depending on the current View Option settings (see **View Menu Options** below). The three sections are the Average Window, the Time-Domain Window, and the Frequency Analysis Window.

For the currently opened data file, the Serial Number and Firmware Version of the recording Vib Tool is displayed in the upper left corner of the Average Window.
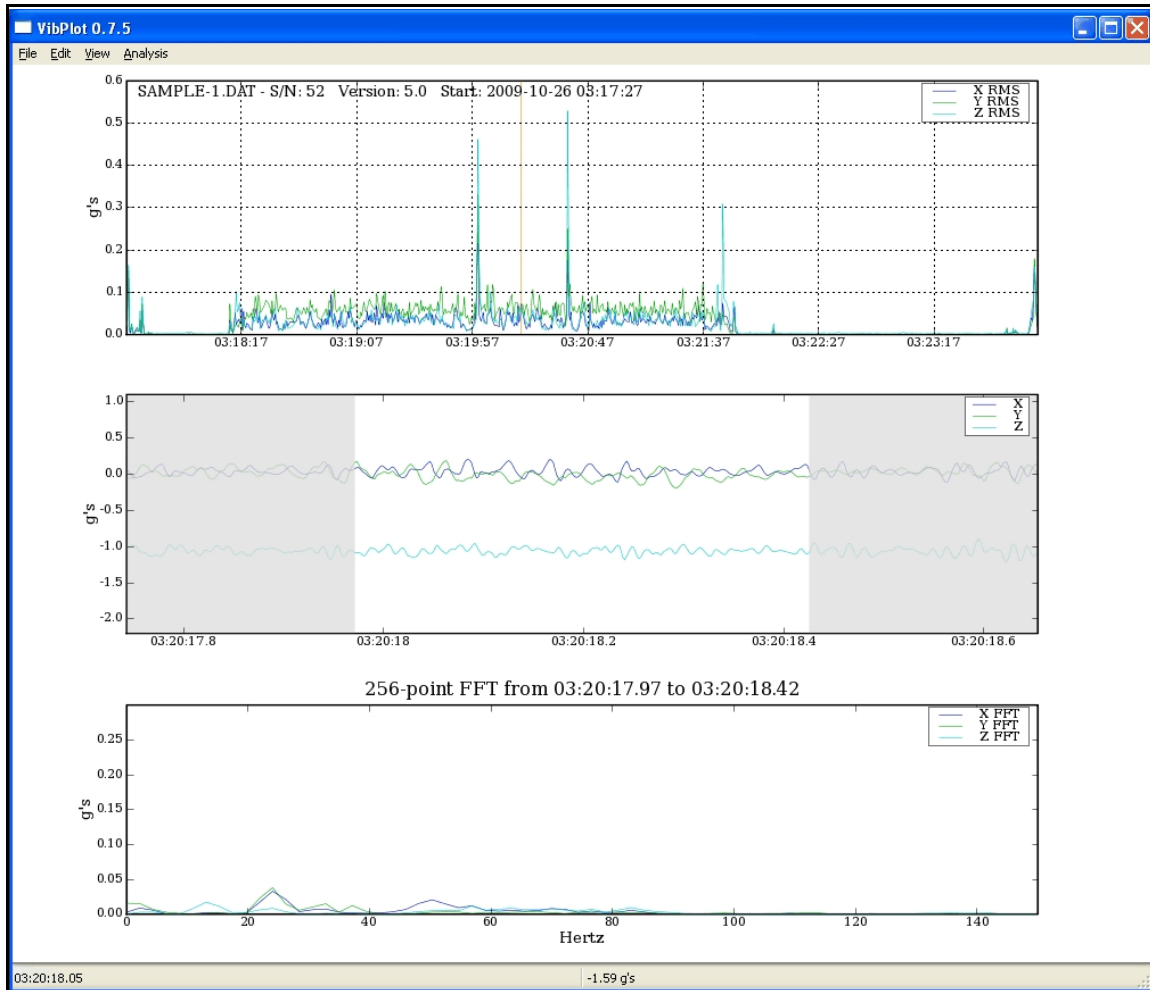

Figure 5 - Default Analysis Display

3.1   Average Window

The Average Window is displayed at the top of the graphics window. By default, VibPlot displays RMS vs. Time in the Average Window.

The Average Window displays reduced recorded data in RMS, legacy RMS (summing mode), legacy True RMS, or legacy Peak formats. Each data point represents ½ seconds of time-domain data reduced using the selected calculation mode. When displaying one of the Legacy modes, the data displayed is equivalent to data recorded by legacy Vib Tools (prior to firmware version 5.0).

3.1.1   Time-Slice Cursor

While the initial Average Window displays data covering the entire recorded data set, the Time-Domain and Frequency Analysis Windows display data from a single ½ seconds of recorded data. To select the desired ½ second of data to display in the lower two windows, the Average Window provides the Time-Slice Cursor.

The Time-Slice Cursor (**Figure 6**) consists of a vertical orange line displayed in the Average Window. It selects the time slice that the Time-Domain and Frequency Analysis Windows display.

Position the mouse cursor in the Average Window and click the left mouse button to move the Time-Slice Cursor to a specific time slice. Use the left and right arrow keys on the keyboard to move the Time-Slice Cursor incrementally by one time slice.

As the Time-Slice Cursor is moved, the graphs displayed in the Time-Domain and Frequency Analysis Windows are updated.
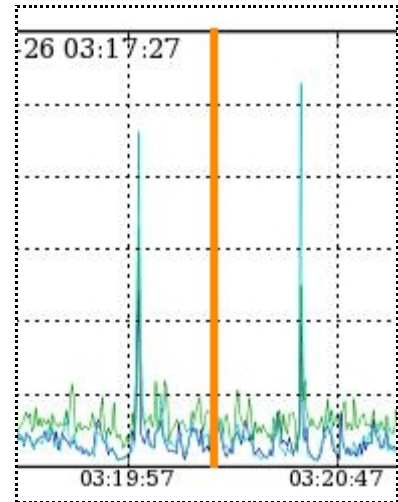

Figure 6 - Time Slice Cursor

3.1.2   Zooming In

VibPlot displays the entire data set in the Average Window when a data file is first opened. To zoom to a particular area of the data, click the left mouse button on the left side of the area of interest in the Average Window. While holding down the left mouse button, drag the mouse to the right side of the area of interest and release the left mouse button.

The zoom area is highlighted in red as shown in **Figure 7**. When you release the left mouse button, the Average Window will zoom to the selected area. Click the right mouse button anywhere in the Average Window to restore the view of the entire data set.

The Zoom option is only available in the Average Window.   The Time-Domain and Frequency Analysis Windows cannot be zoomed.
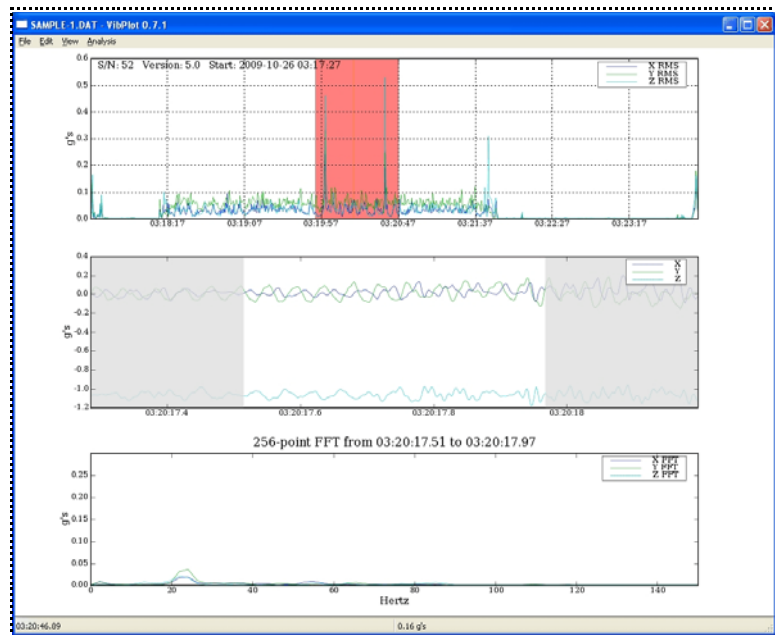

Figure 7 - Zooming In

3.2   Time-Domain Window

The Time-Domain Window is displayed in the middle of the graphics window. By default, VibPlot displays Amplitude vs. Time of the Time-Domain data in this window.

The Amplitude vs. Time plot in the Time-Domain Window displays the expanded data at the time-slice selected by the Time-Slice Cursor. The Time-Domain Window initially shows a full second of time-domain data, showing events prior to and after the selected time-slice. The quarter seconds before and after the current time-slice are shaded gray in the Time-Domain Window.

Alternately, using options in the **Analysis Menu**, the Time-Domain Window can display up to 60 seconds of time-domain data. This expanded display of time-domain data can be used to get a broader picture of the time-domain events before and after the currently selected time-slice. Time-domain data for the selected time slice is always displayed on a white background, with data before and after shaded gray. The gray bands expand significantly when displaying longer periods of time-domain data.

3.3   Frequency Analysis Window

The Frequency Analysis Window is displayed at the bottom of the graphics window. By default, VibPlot displays Amplitude vs. Frequency in the Frequency Analysis Window.

The Amplitude vs Frequency plot in the Frequency Analysis Window displays the expanded data at the time-slice selected by the Time-Slice Cursor. The Frequency Analysis Window shows the results of a 256 point FFT on the ½ second worth of data selected by the Time-Slice Cursor.

4 VibPlot Menu Options

A horizontal menu is displayed at the top of the screen which includes *File*, *Edit*, *View*, and *Analysis* menu options.

4.1 *File Menu*

The *File Menu* provides options related to recorded data files. These options allow the user to open previously uploaded time-domain data files, connect to the GCI Vib Tool to upload recorded data files, Save and Export the current data file in various graphical and text formats, print the currently displayed graphs and exit the VibPlot Application.

4.1.1 *Open*

Opens a previously uploaded data set. This option displays a standard Windows File Open dialog box. Browse to the folder that contains previously uploaded vibration data files. Select a file and then select the **Open** button. VibPlot opens the selected data file and displays its data as shown in **Figure 5**.
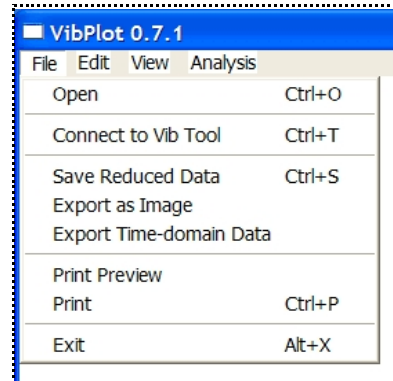

Figure 8 - File Menu

VibPlot displays the name of the open file in the upper left corner (in this example, sample-1.dat). A Status Bar is provided at the bottom of the VibPlot Window. It displays the coordinates of the current Mouse Cursor position in units that are context sensitive to the Window that the Mouse Cursor is positioned in.

Due to the potentially large size of recorded time-domain data sets, VibPlot will automatically divide large recorded files into multiple smaller files. This is done to minimize the latency experienced when displaying large amounts of time domain data.

When first opened, recorded data sets greater than 1 hours long will be divided into multiple 1 hour (maximum) data files.

The new files will be automatically named using the base file name, plus the time and date of the first data point in the file. For example, a large data file named VIB0048.DAT might be divided into two files named:

Figure 9 - File Open Menu

VIB0048-20091019083313.DAT
(data recorded at 10/19/2009 - 08:33:13)

VIB0048-20091019092813.DAT
(for continuing data at 09:28:13)

The data in the smaller files overlap by several minutes to aid in analysis. VibPlot opens the first smaller data file and displays its data. The original long file is not altered. A warning message is displayed indicating that the original file has been divided.
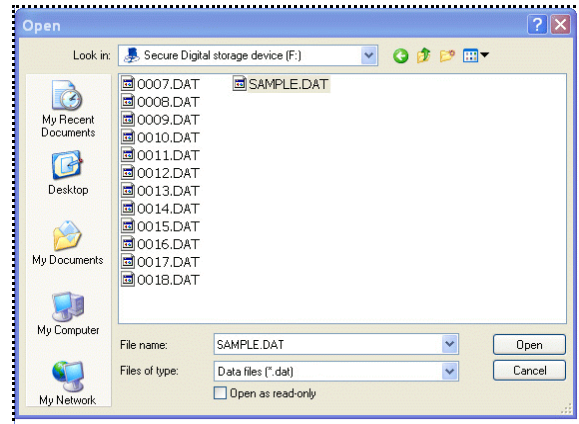
4.1.2 *Connect to Vib Tool*

This option provides the connection between the VibPlot Application and the GCI Vib Tool. Use this option to manage the Vib Tool's internal flash memory.

Connect the Vib Tool's communications port connector (female DB-9) to an available PC COM port using a straight through, 9-pin, male to female communications cable (provided). Power up the Vib Tool and advance to the **MAIN MENU / CONNECT VIBPLOT** option.

Press the 'Enter' key to display the **USE VIBPLOT MENU / ENTER TO ABORT** message. With the Vib Tool in this condition, open the Connect to Vib Tool dialog box using the *Connect to Vib Tool* menu option.

Figure 10 - Connect To Vib Tool

On VibPlot's **Connect to Vib Tool** dialog box, use the Ports: drop-down list, select the COM port connected to the Vib Tool, then press the **Connect** button. This instructs the VibPlot Application to attempt to connect to the Vib Tool.

If the connection is successful, the Files: drop-down list is populated with a listing of all data files stored on the Vib Tool's internal flash memory. Three additional buttons are displayed below the Files: drop-down list (**Figure 11**).

If the connection attempt fails, verify the connection between the PC and the Vib Tool. Confirm that the Vib Tool is displaying the **USE VIBPLOT MENU / ENTER TO ABORT** message.

4.1.2.1 Files List - Viewing the List of Data Files

When the VibPlot Application successfully connects to the Vib Tool, it requests a listing of all recorded data files currently on the tool. Data files are listed in reverse order by recording date and time, with the most recently recorded files listed first.
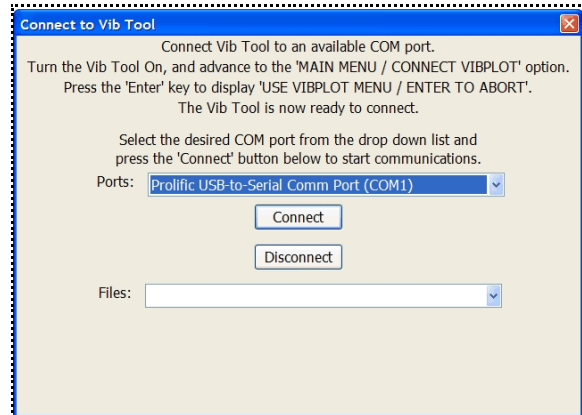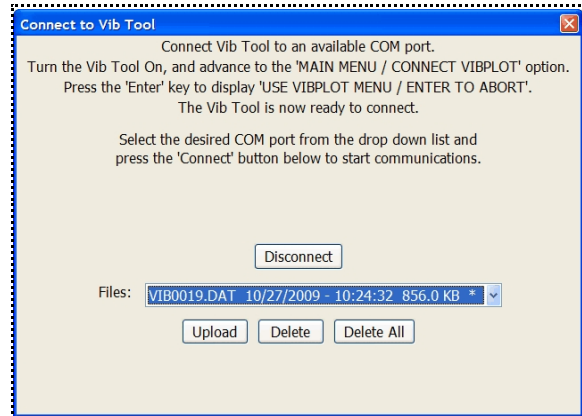

Figure 11 - Connected to Vib Tool

Figure 12 shows the Files: drop-down list populated with the contents of a connected Vib Tool. Each line in the drop-down list contains information from one data file. The filename, the time and date the file was recorded, and the file size are all displayed.

An asterisk is added to the far right of the file information if the filename is found in the current working directory on the PC. This allows the user to quickly see which files have already been uploaded to the PC (assuming the current directory contains files from only one Vib Tool).

4.1.2.2 Upload Button - Uploading a Recorded Data File

Figure 12 - Files List

To upload a recorded data file to the PC, first select the desired file from the Files: drop-down list, then press the **Upload** button. A standard Windows Save As dialog box is displayed, allowing the user to select the location and name of the uploaded data file. If the selected filename is not found in the current directory, the file upload process will begin immediately.

A progress dialog box is displayed showing the estimated upload time. As the file is uploaded, the progress bar advances from left to right, and the remaining time counts down.

Figure 13 - Progress Dialog

When the file upload completes, the upload progress dialog is removed and a Completed message is displayed. Uploaded data files remain on the Vib Tool's internal storage until deleted by the user.

If the selected filename exists in the current directory, a warning message is displayed asking if the user wishes to overwrite the existing file. If the user confirms the overwrite, the upload will begin and the existing file will be overwritten.

Uploaded data files retain the internal Vib Tool filename (VIB####.DAT), with a file creation time and date set to the time the recording session was initiated (based on the Vib Tool's internal real time clock settings). It is a good practice to rename the uploaded data file using a more descriptive file name. This enables the user to provide a description of the recording session in the file name, and ensure that future uploads from the Vib Tool do not inadvertently overwrite an important file.

4.1.2.3 Removing Files from Internal Vib Tool Storage

The Vib Tool includes an internal 1 GB flash memory used for data storage. Data files can remain on the Vib Tool indefinitely, but do reduce the available space for new recordings. Vib Tool recording sessions are limited to the available space on its internal storage, up to a maximum of 24 hours. When the Vib Tool is powered up, a message is displayed listing the maximum recording time available based on current storage usage.

If the internal storage fills, the maximum available recording time may fall below the users desired recording session. At this point, old data files can be removed from the Vib Tool to increase available storage, allowing for longer recording sessions.

VibPlot provides two option buttons on the **Connect to Vib Tool** dialog box that can be used to remove old data files from the Vib Tool. The **Delete** option button deletes the currently selected data file (using the File: drop-down list). The **Delete All** button deletes all data files from the Vib Tool.
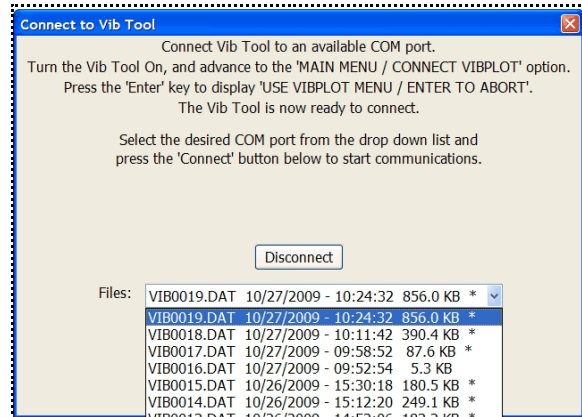
4.1.2.3.1 Delete Button
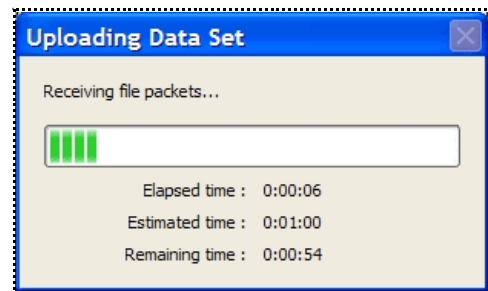
When selected, the **Delete** button will first display a dialog box asking the user to confirmation his choice to delete a file. If the user confirms his deletion request, the selected file is removed from the Vib Tool.
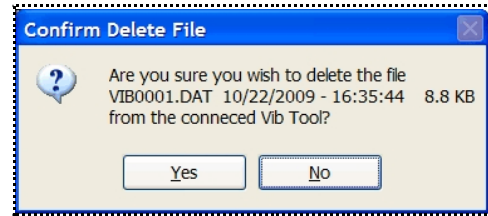
4.1.2.3.2 Delete All Button

When the Vib Tool powers up, it checks it's internal storage to determine the largest filename number currently on the system. The Vib Tool uses this number to initialize it's File Number value.

Figure 14 - Delete Confirmation

It uses this value when creating new data files. New data files are automatically named based on the current Vib Tool File Number. When internal storage is empty, the File Number is reset to 1. With each new recorded file, the File Number is incremented. The first file created by the Vib Tool is named VIB0001.DAT. The second is named VIB0002.DAT, etc. This numbering sequence continues as new files are created.

The **Delete All** button removes all data files from the Vib Tool. It additionally resets the Vib Tool's File Number value. If the user elects to delete all files from the Vib Tool, file naming resets to VIB0001.DAT. Care must be taken to ensure that files previously uploaded to the PC are not overwritten due to a reset in the Vib Tool's File Number value.

Pressing the Delete All button will first display a dialog box asking the user to confirmation his choice to delete all data files from the Vib Tool. If the user confirms his deletion request, VibPlot instructs the Vib Tool to remove all data files.
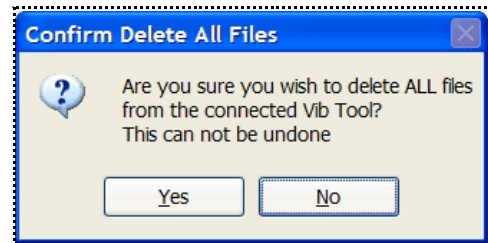
If the Vib Tool contains a large number of data files, the removal process can take several seconds. A dialog box is displayed showing the deletion progress.

Figure 15 - Confirm Delete All

4.1.3 *Save Reduced Data*

This option saves the reduced data in legacy Vib Tool format. This creates a formatted text file containing one data record for each ½ second of recorded data. Each ½ second of Time-Domain data is reduced using several legacy reduction techniques. Each record contains the X, Y, and Z axes data point in Legacy RMS, Peak Amplitude, and Frequency at Peak, along with the True RMS calculation, the number of frequencies containing vibration greater than 0.3 g's, and the Resultant Amplitude calculation.

The file format is identical to that uploaded by legacy Vib Tool's with the exception of the Resultant Amplitude.

```
ACCELEROMETER TEST TOOL DATA    VERSION 5.0   S/N 52
TEST INITIATED: 10/28/09 10:00:23   CONTINUOUS R, P, F, RMS & N > 0.03 g's
1222 RECORDS ACQUIRED
Time RMS X Y Z  Peak X Y Z  Freq X Y Z  True RMS  N > 0.03 g's X Y Z

0.0 0.00 0.00 0.03 0.00 0.00 0.02 152 152 040 0.02 000 000 000
0.5 0.00 0.00 0.08 0.00 0.00 0.02 152 152 036 0.04 000 000 000
1.0 0.00 0.00 0.04 0.00 0.00 0.01 152 152 038 0.02 000 000 000
1.5 0.00 0.00 0.00 0.00 0.00 0.00 152 152 152 0.00 000 000 000
...
610.0 0.00 0.00 0.00 0.00 0.00 0.00 152 152 152 0.00 000 000 000
610.5 0.00 0.00 0.00 0.00 0.00 0.00 152 152 152 0.00 000 000 000
```

Figure 16 - Sample Legacy Reduced Data File

The reduced data can also be saved in comma delimited (CSV) text format.

Selecting this option displays a standard Windows **File Save** dialog box. Use the <u>Save as type:</u> drop-down list to select the desired file format.

Use file type 'Text files (*.txt)' to save the data in legacy Vib Tool format.

Use file type 'CSV files (*.csv)' to save the data in CSV file format.
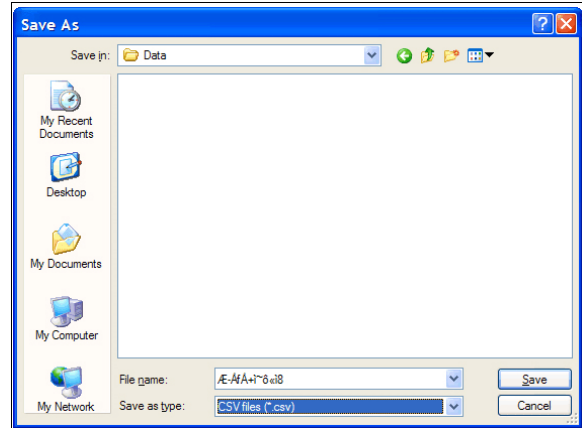

Figure 17 - Save As CSV

4.1.4   *Export as Image*

This option creates a graphics file of the current screen display (in one of several formats). Supported graphics formats include Windows Bitmap (BMP), Graphics Interchange Format (GIF) and JPEG (JPG).

Selecting this option displays a standard Windows **File Save** dialog box. Use the <u>Save as type:</u> drop-down list to select the desired graphics file format.

4.1.5   *Export Time-domain Data*

This option saves the Time-Domain data to a comma delimited (CSV) text file for import into a spreadsheet or other program. The column format of the file is Time, X, Y, and Z. One line exists for each sample time (512 Hz).

4.1.6   *Print Preview*

Displays a print preview of the current graphics view.

4.1.7   *Print*

Prints the current graphics view to any available printer.

4.1.8   *Exit*

Exits the VibPlot Application.

4.2   *Edit Menu*

4.2.1   *Copy*

The *Copy* option copies the current view to the Windows clipboard. From the clipboard, the image can be pasted into another running program.

4.3   *View Menu*

VibPlot can display the recorded vibration data in several formats. The format of the display is controlled from the *View Menu*.

4.3.1   *Average Window View Options*

The contents displayed in the Average Window are controlled by the selection in the upper section of the *View Menu*. Available options are *RMS*, *Legacy RMS*, *True RMS* and *Peak*. Changing display options for the Average Window do not affect the display options for the Time-Domain and Frequency Analysis Windows.

The *RMS*, *Legacy RMS* and *Peak* options display one data point per axes for each ½ seconds of time-domain data. A legend is displayed in the upper right corner of the graph, showing the three axes (X in dark blue, Y in green, and Z in light blue).
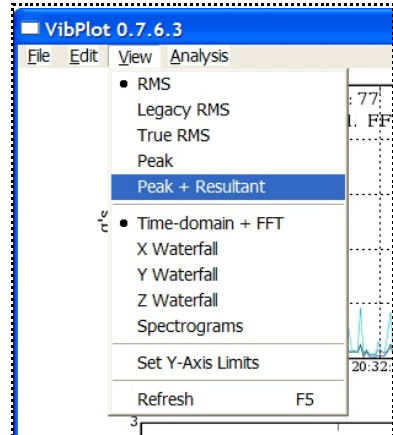
Figure 18 - View Menu

The *Peak + Resultant* option is identical to the *Peak* option, with the inclusion of the Resultant value, calculated over all three axes.

The *True RMS* option displays a single data point for each ½ seconds of time-domain data. A legend is displayed in the upper right corner of the graph, with True RMS in red.

The ½ seconds of time-domain data is first converted into a 75 point frequency domain spectrum (in 2 Hz bins) using a Fast Fourier Transform (FFT) algorithm.

4.3.1.1 *RMS Mode*

RMS Mode is the default graphic displayed in the Average Window when a new data file is opened.

RMS Mode displays a single RMS (root-mean-square) value (in g's) for each axes, for each 75 point frequency spectrum.

$$RMS_x = \sqrt{\frac{\sum (A_x[f])^2}{75}} \qquad RMS_y = \sqrt{\frac{\sum (A_y[f])^2}{75}} \qquad RMS_z = \sqrt{\frac{\sum (A_z[f])^2}{75}}$$
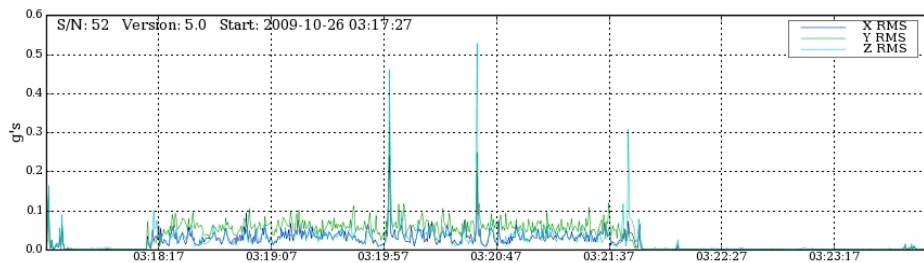
Figure 19 - RMS Mode Graph

4.3.1.2 *Legacy RMS Mode*

Legacy RMS Mode duplicates the RMS reduction provided by the legacy Vib Tool. *Legacy RMS Mode* displays a single legacy RMS (summing) value (in g's) for each axes, for each 75 point frequency spectrum.

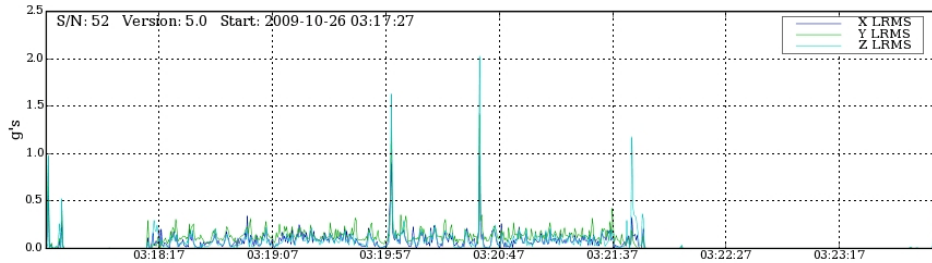$$LRMS_x = \sum A_x[f] \qquad LRMS_y = \sum A_y[f] \qquad LRMS_z = \sum A_z[f]$$

Figure 20 - Legacy RMS Mode Graph

4.3.1.3 *True RMS Mode*

True RMS Mode displays a single 'True' RMS (root-mean-square) value (in g's) for all three axes, for each 75 point frequency spectrum.

$$TrueRMS = \sqrt{\frac{\sum (A_x[f])^2 + \sum (A_y[f])^2 + \sum (A_z[f])^2}{75}}$$
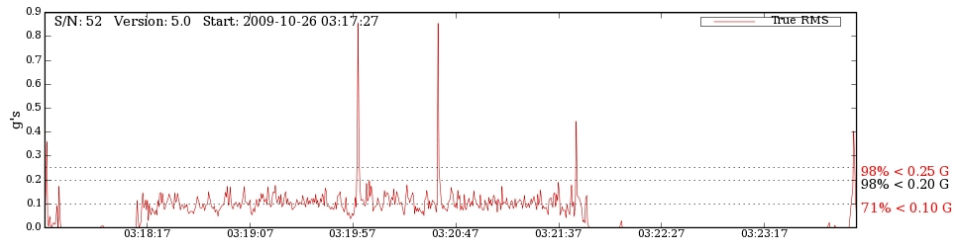

Figure 21 - True RMS Mode Graph

4.3.1.4 *Peak Mode*

Peak Mode displays the peak amplitude value for each axes, for each 75 point frequency spectrum.

$$Peak_x = MAX(A_x[f]) \qquad Peak_y = MAX(A_y[f]) \qquad Peak_z = MAX(A_z[f])$$

Figure 22 - Peak Mode Graph

4.3.1.5 *Peak + Resultant Mode*

Peak + Resultant Mode displays the peak amplitude value for each axes, for each 75 point frequency spectrum, plus the Resultant amplitude for all three axes.

$$Peak_x = MAX(A_x[f]) \qquad Peak_y = MAX(A_y[f]) \qquad Peak_z = MAX(A_z[f])$$

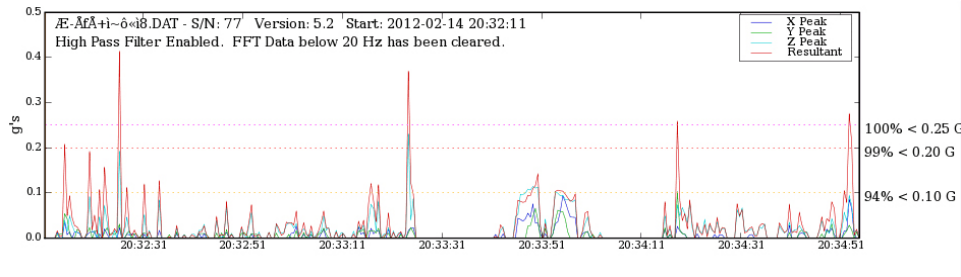$$Resultant = \sqrt{Peak_x{}^2 + Peak_y{}^2 + peak_z{}^2}$$

Figure 24 - Peak + Resultant Mode Graph

4.3.2 *Time-Domain and Frequency Analysis Window View Options*

The contents displayed in the Time-Domain and Frequency Analysis Windows are controlled by the selection in the lower section of the *View Menu*. Available options are *Time-domain + FFT*, *X Waterfall*, *Y Waterfall*, *Z Waterfall*, and *Spectrograms*.

The *Time-domain + FFT* option displays two graphs. The Time-Domain Window shows up to 60 seconds of time-domain data showing events prior to and after the selected time-slice (using the Time-Slice Cursor, discussed in section 3.1.1). The time-domain data from before and after the current time-slice are shaded gray in the Time-Domain Window. The Frequency Analysis Window displays the FFT associated with the currently selected time-slice.

The *Waterfall* and *Spectrograms* options display a single graph that fills both the Time-Domain and Frequency Analysis Windows.

Changing display options for the Time-Domain and Frequency Analysis Windows do not affect the display options for the Average Window.

4.3.2.1 *Time-Domain + FFT Mode*

The *Time-domain + FFT* option displays the time-domain data in the Time-Domain Window and a single spectrogram in the Frequency Analysis Window.

The Time-Domain Window displays the 256 time-domain data points for each axis associated with the time-slice defined by the Time-Slice Cursor. It also displays between 128 and 15,232 (depending on **Analysis Menu** options) time-domain data points prior to, and following the current time slice, shaded gray. The time-domain data is in g's vs. time (displayed as clock time, based on the start-recording time stamp). A legend is displayed in the upper right corner of the graph. The three axes use the same colors used in the Average Window display (X in dark blue, Y in green, and Z in light blue).

The Frequency Analysis Window displays the results of the 256 point FFT computed for the selected time-domain data. The frequency domain spectrum contains 75 data points (in 2 Hz bins) and is displayed in g's vs. Hertz
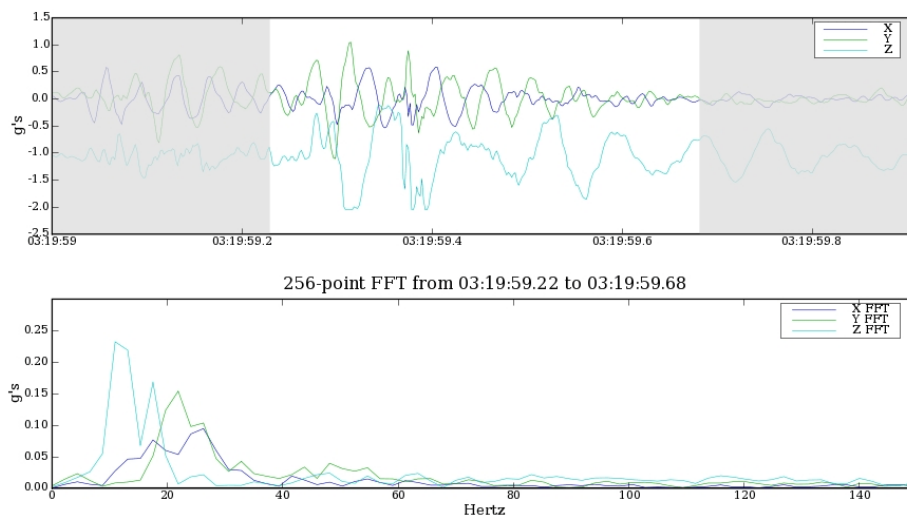
Figure 25 - Time-domain + FFT Mode Graph

4.3.2.2 *Waterfall Plots*

Waterfall plots display a three-dimensional spectrogram of the X, Y, or Z-Axis frequency domain data, as Amplitude vs Frequency vs Time.

Waterfalls display a series of spectrograms, one for each time-slice (half-second) of time-domain data. It plots Frequency on the X axis, amplitude on the Y axis, and Time on the Z axis. The number of time slices plotted on the Waterfall time axis depends on the height of the Analysis Window. The Time-Slice Cursor in the Average Window controls the range of time that is plotted. The spectrogram corresponding to the Time-Slice Cursor plots as an Orange line of amplitude and frequency on the Waterfall plot.
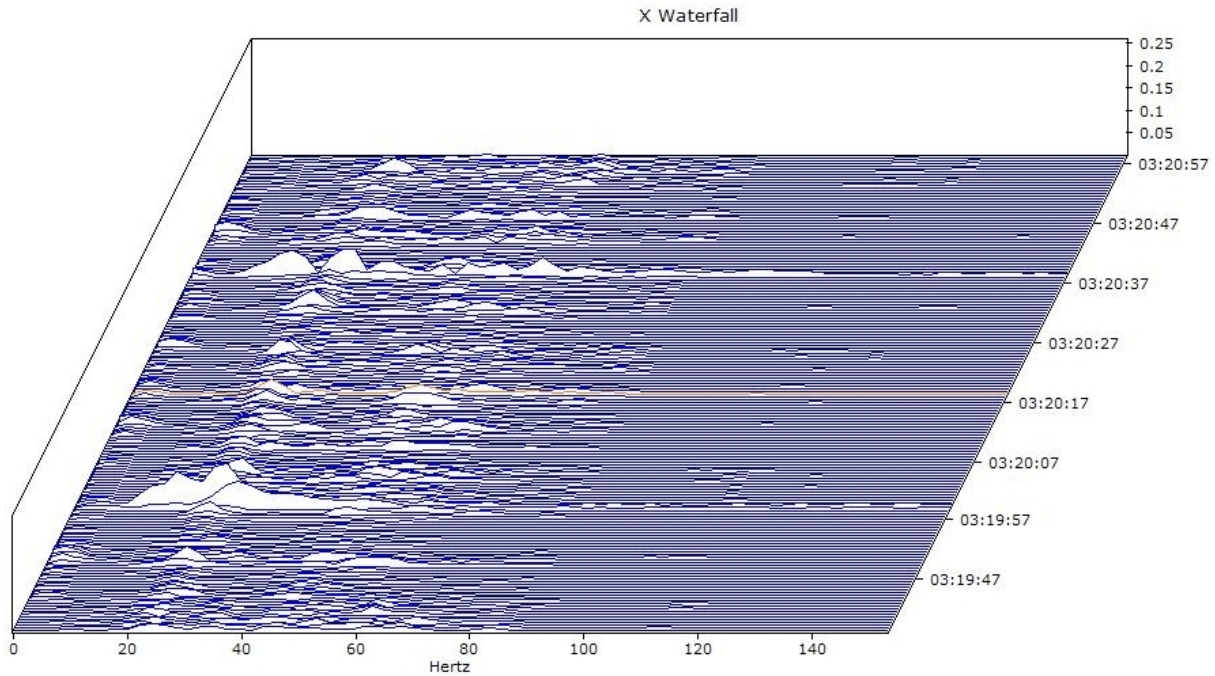

Figure 26 - X-Axis Waterfall Plot

4.3.2.3 Spectrograms

Spectrograms displays the X, Y, and Z data in three dimensional spectrograms. Frequency and Time are two axis, Amplitude is displayed as color.

VibPlot displays three-dimensional spectrogram plots for each axis. Spectrograms display a series of spectrograms, one for each half-second of time-domain data. Time is plotted on the X axis and frequency is plotted on the Y axis. The time scale is correlated to the Average Window so these plots can be zoomed. Color represents the vibration amplitude. A color bar along the right side of the spectrograms correlates the colors to amplitude level.
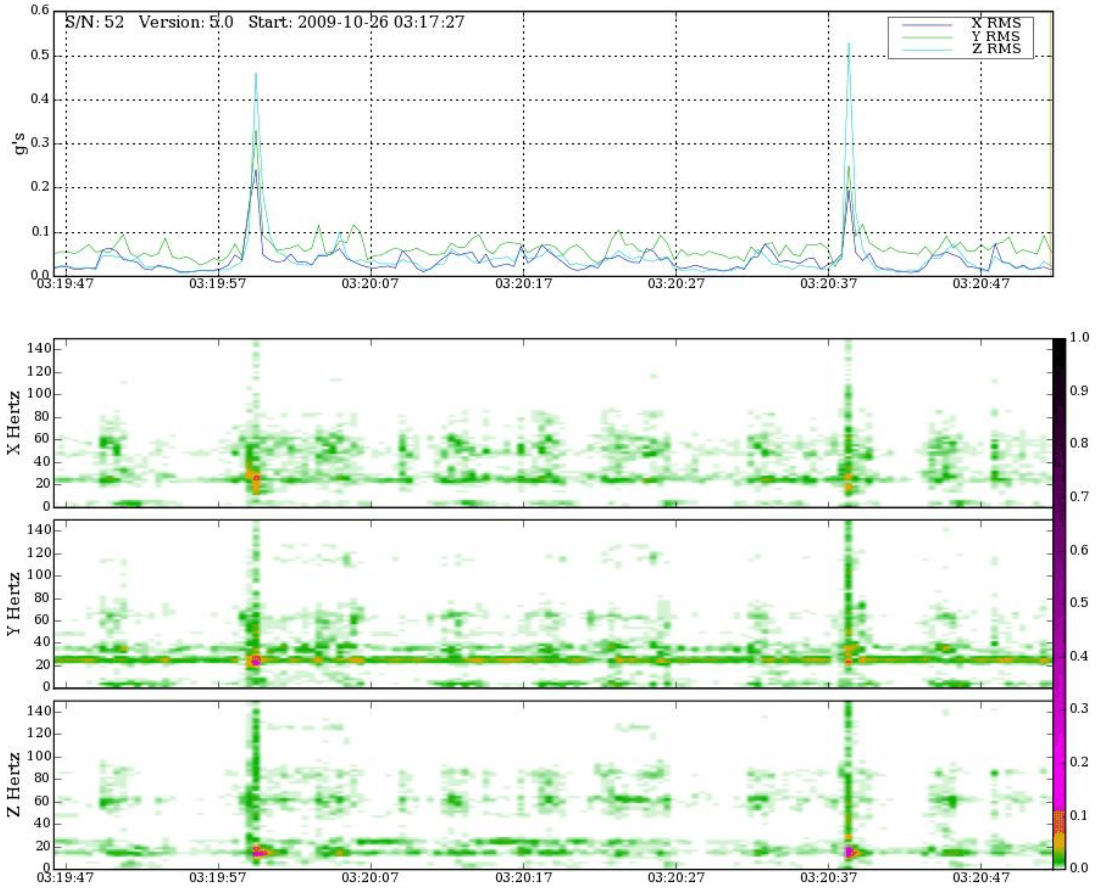

Figure 27 - 3D Spectrograms

4.3.3   Set Y-Axis Limits

The Set Y-Axis Limits option can be used to set the displayed Y-Axis limits for each graph type. When this option is selected, a dialog box is displayed showing the current Y-Axis limits for each graph type. An "Auto-Scale" check-box is displayed to the right of each value.

To use the system calculated limit values for a specific graph type, set the appropriate "Auto-Scale" check-box.

To use a different limit value, enter the desired value in the edit field, and clear the "Auto-Scale" check-box.
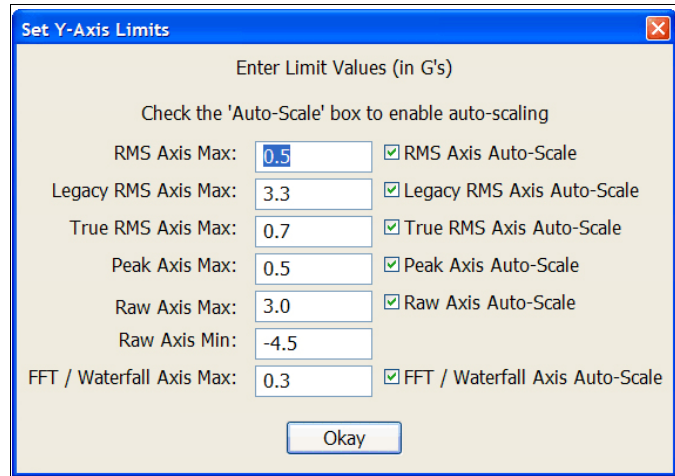

Figure 28 - Set Y-Axis Limits Dialog

All displayed graphs are refreshed when this dialog box is closed.

4.3.4   Refresh

The Refresh option forces all graphics windows to be updated. Some graphics cards may require this.

4.4   *Analysis Menu*

The Analysis Menu provides options that either affect the way time-domain data is analyzed, or displayed.

4.4.1   *Overlap FFT Windows*

Overlap processing is useful when the time-domain data contains transients. VibPlot provides 2/3 overlapping. Overlap processing computes the half second averages and frequency-domain data on one-sixth second time-slices by overlapping each half second average window on one-sixth second intervals. This results in one-sixth second time slices with triple the number of averaged points than non-overlapped calculations. Enable overlap processing by selecting Overlap FFT Windows from the Analysis Menu.
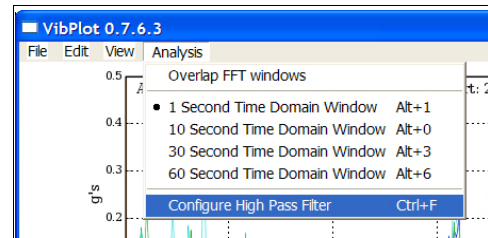
Figure 29 - Analysis Menu

Note that legacy Tri-Axial Accelerometer Test Tools do not support overlap processing.

4.4.2   1 Second Time Domain Window

When this option is set, VibPlot displays one full second of time-domain data in the Time-Domain Window. The Time-Domain Window includes the 1/4 seconds of time-domain data from before and after the current time-slice (shaded gray).

Figure 30 - 1 Second Time Domain Window

4.4.3 *10 Second Time Domain Window*

When this option is set, VibPlot displays ten seconds of time-domain data in the Time-Domain Window. The Time-Domain Window includes the 4 3/4 seconds of time-domain data from before and after the current time-slice (shaded gray).

Figure 31 - 10 Second Time Domain Window

4.4.4   *30 Second Time Domain Window*

When this option is set, VibPlot displays 30 seconds of time-domain data in the Time-Domain Window. The Time-Domain Window includes the 14 1/4 seconds of time-domain data from before and after the current time-slice (shaded gray).
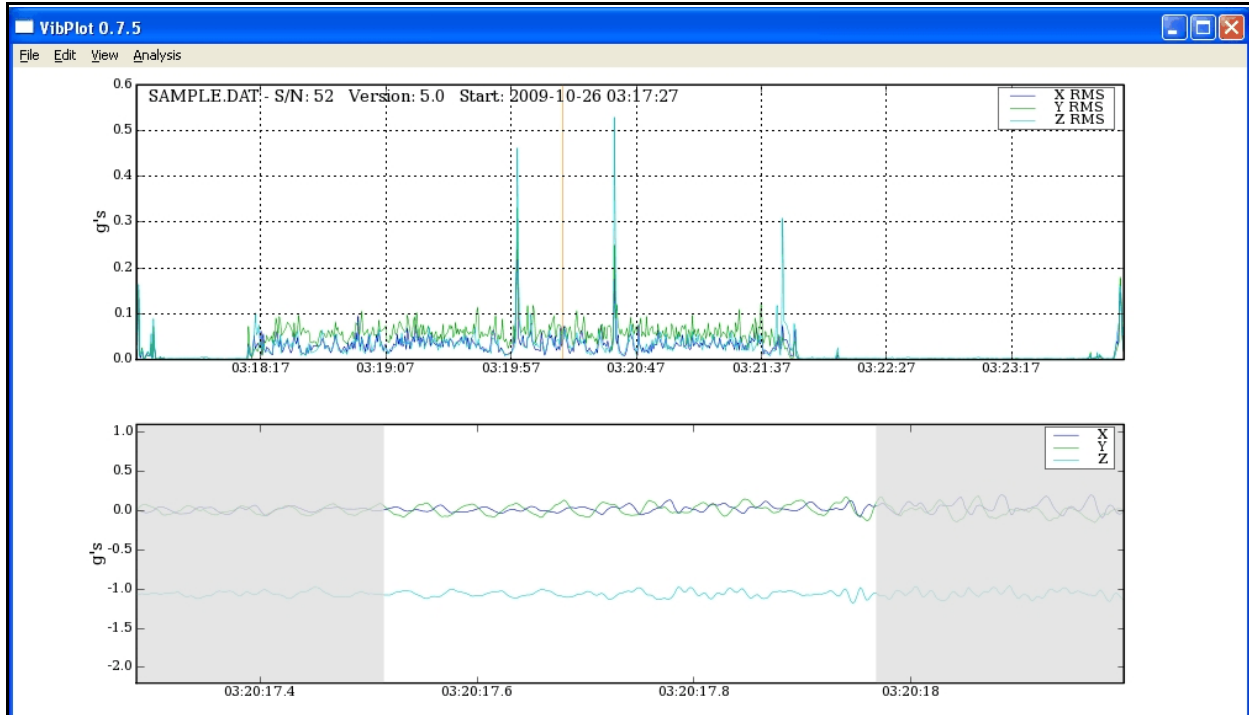

Figure 32 - 30 Second Time Domain Window

4.4.5   *60 Second Time Domain Window*

When this option is set, VibPlot displays 60 seconds of time-domain data in the Time-Domain Window. The Time-Domain Window includes the 29 1/4 seconds of time-domain data from before and after the current time-slice (shaded gray).
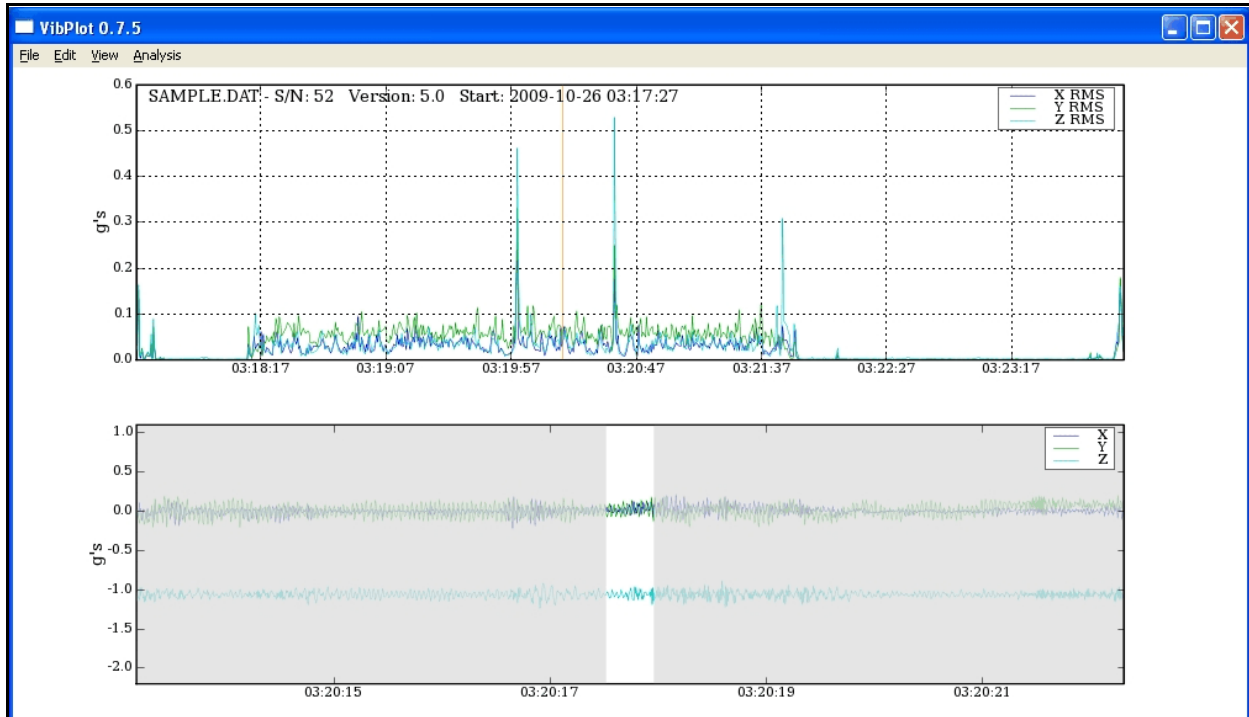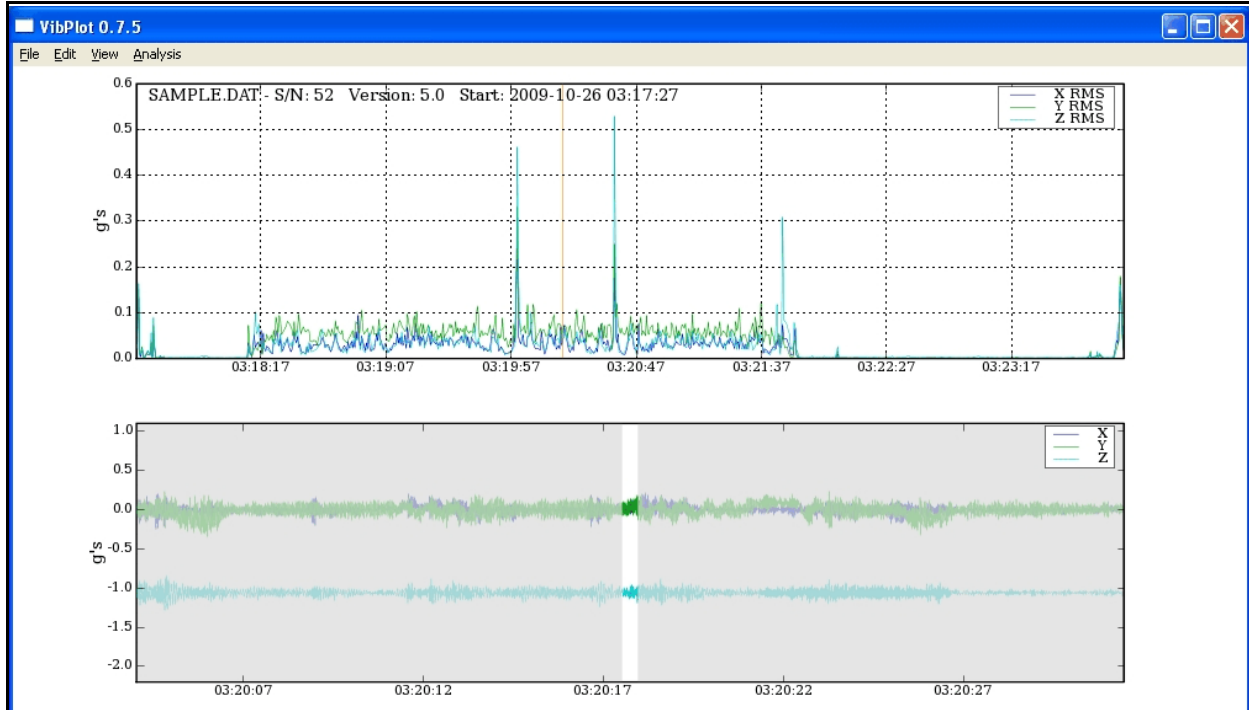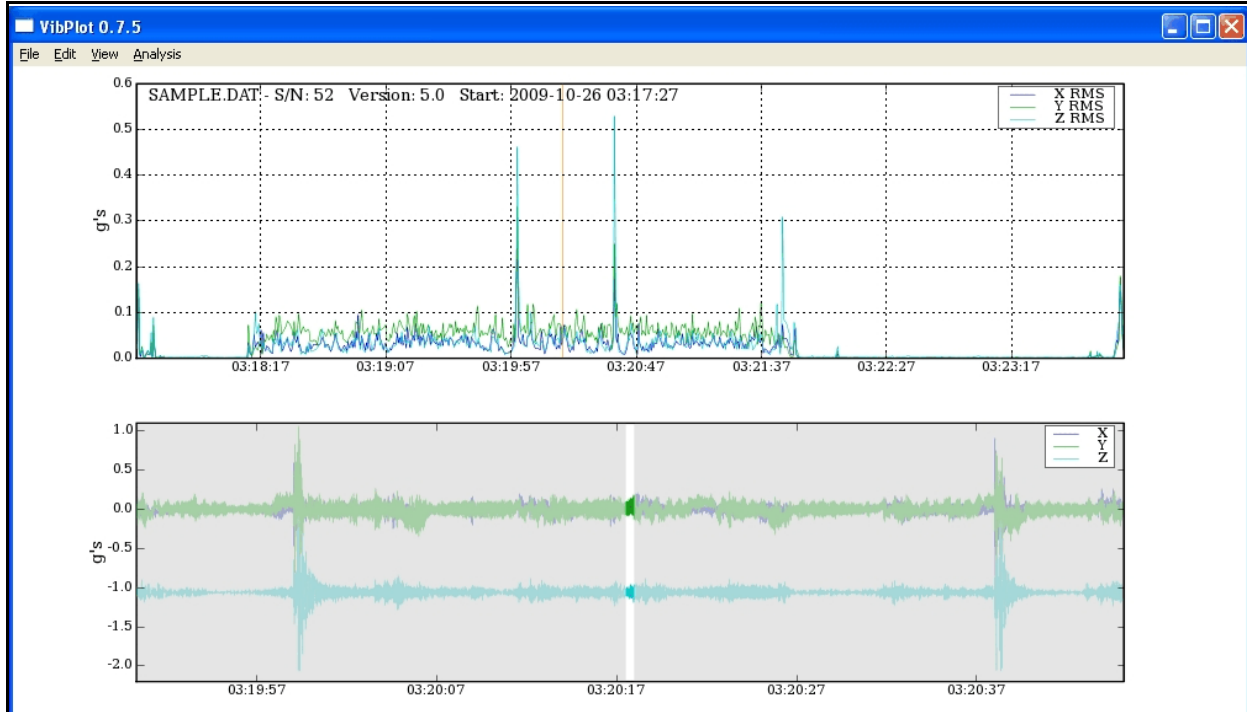

Figure 33 - 60 Second Time Domain Window

4.4.6   *Configure High Pass Filter*

The Define High Pass Filter (HPF) option can be used to filter out low frequency data from displayed graphs. When this option is selected, the Define High Pass Filter dialog box is displayed.

Entering a value from 2 and 20 Hz will enable the high pass filter, and null out the amplitude data from frequencies between 0 and the entered value.

Entering a zero will disable the high pass filter.

Figure 34 - Define High Pass Filter

All graphs are refreshed when this dialog box is closed.

When the high pass filter is enabled, a prompt is displayed in the top graph indicating the frequency range that has been removed. This same prompt is also written into exported text or .CSV files.

All graphs showing calculated results are affected by the high pass filter setting. The Time Domain Window shows raw data acquired in the time-domain and is not affected by the HPF.
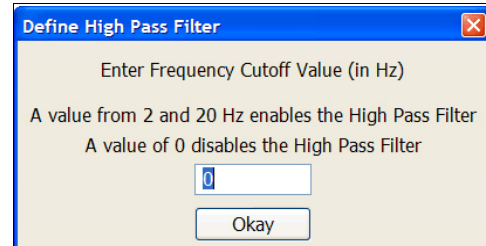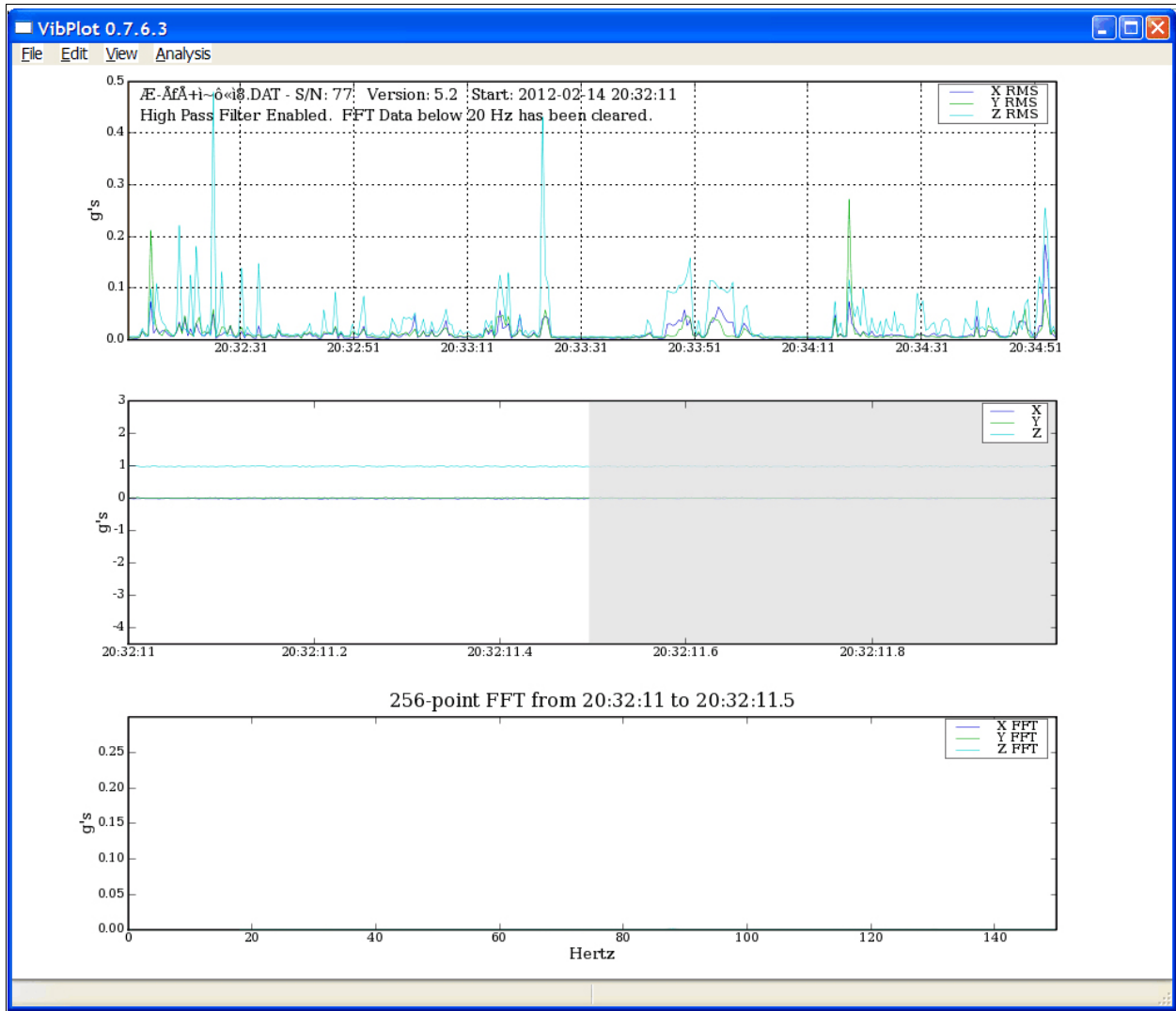
Figure 35 - High Pass Filter Enabled

5 Excel Application Note

The VibPlot Application provides several graphical tools that can be used to analyze recorded time-domain data. Some customers may have legacy analysis tools in place that use Microsoft Excel.

This application note shows how to use Excel to read and display a text file containing data saved in legacy forma (using the *File Menu - Save Reduced Data* option).

From Excel, select the File/Open menu as shown in **Figure 36**. At the bottom of this menu, select the file type as Text Files in the *Files of type:* drop down box.

Select the file containing the tool data. In this example, we select vib2.txt.

Figure 36 - File/Open Menu

Excel's Text Import Wizard is a three step process consisting of three dialog boxes. The first dialog box, *Step 1*, is shown in **Figure 37**. Click the *Delimited* radio button. Verify the *Start import at row* field is *1* and the *File origin* is set to *Windows (ANSI)*. Click *Next* to proceed to step 2.
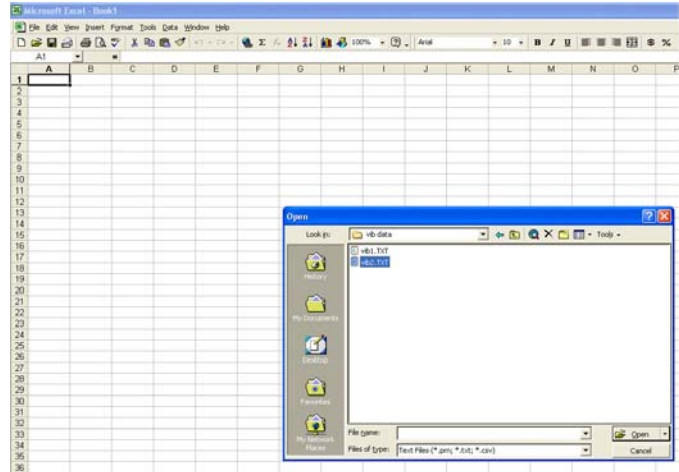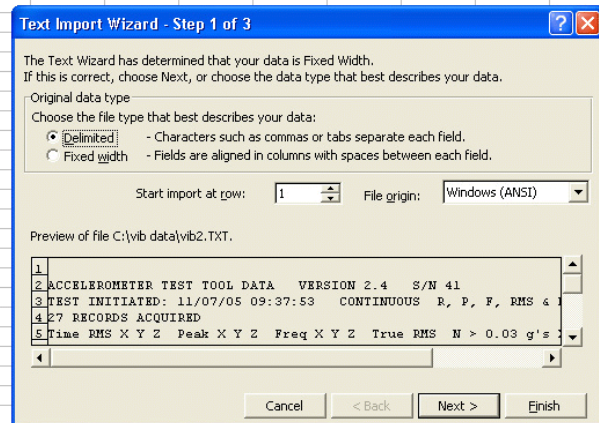
Figure 37 - Import Step 1

The *Step 2* dialog box is shown in **Figure 38**. Check the *Space* box in the *Delimiters* window. Verify the *Treat consecutive delimiters as one* box is checked and the *Text qualifier* is set to *"*. Click next to proceed to step 3.

Using the vertical slider on the right side of the *Data preview* window, scroll down to display the data. Verify that the data is properly aligned in columns.

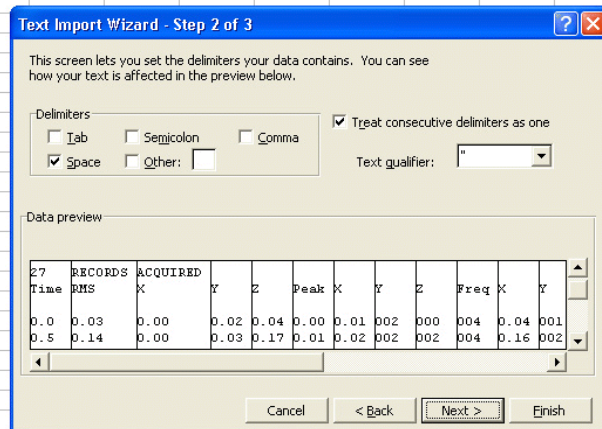**Figure 38** - Import Step 2

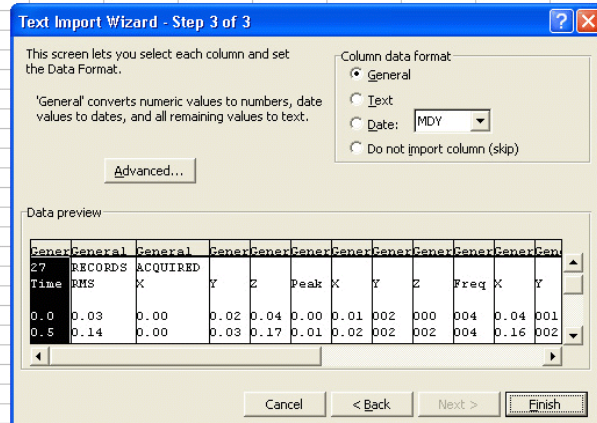The *Step 3* dialog box is shown in **Figure 39**. Click the *Finish* button.

Figure 39 - Import Step 3

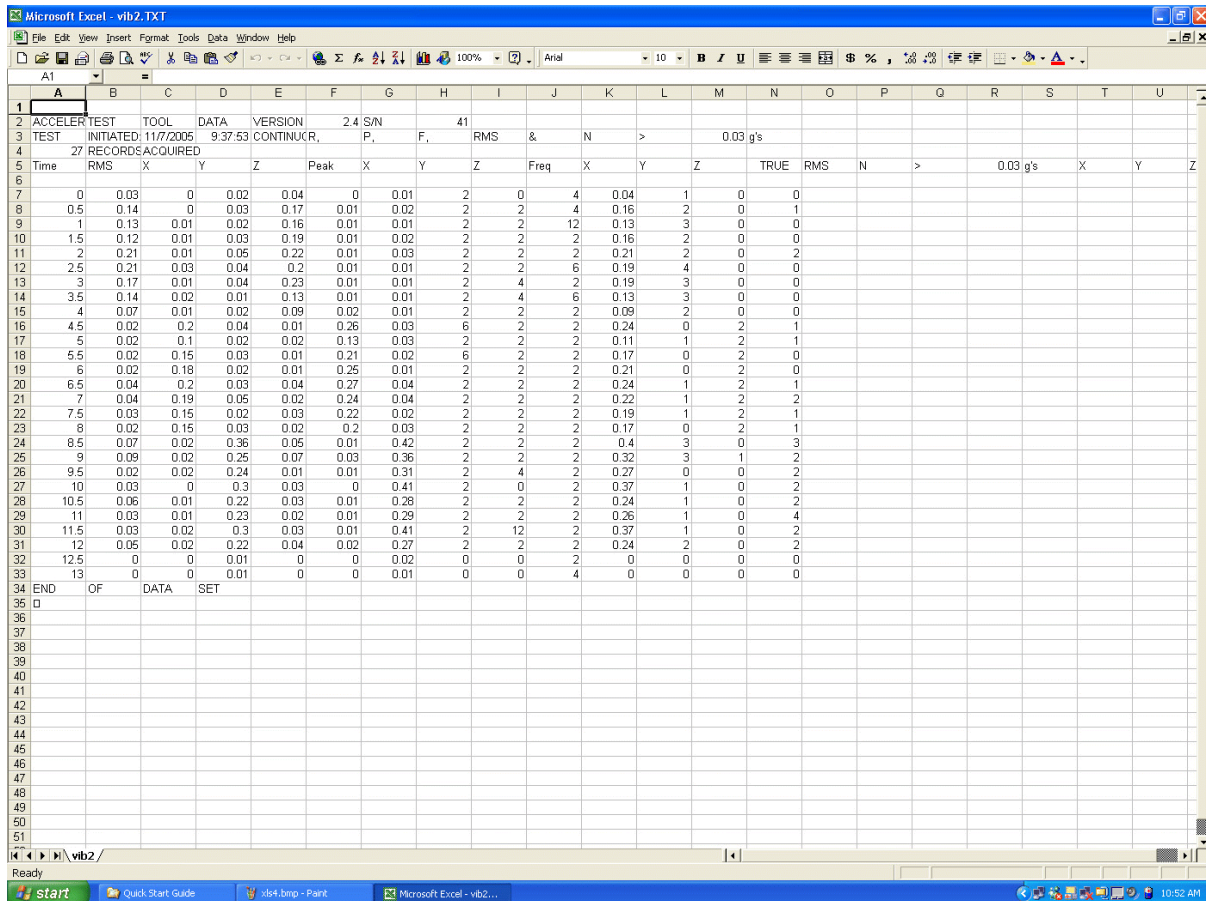**Figure 40** shows the data after it is imported into Excel.

Figure 40 - Imported Data in Spreadsheet

In **Figure 41**, the header in rows 5 and 6 have been rearranged to match the data in each column as highlighted in yellow.

The example data was recorded while the tool was being held by hand. We moved the test tool back and forth in a linear motion in the X, Y and Z directions for about 5 seconds in each axis. We were careful to avoid rolling, rocking, or tipping the test tool as these motions generate data on multiple axis simultaneously

The significant RMS data for the X, Y, and Z has been highlighted in blue. The data in these columns matches our test.

Microsoft Excel - vib2.TXT

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
1															
2	ACCELER	TEST	TOOL	DATA	VERSION	2.4	S/N	41							
3	TEST	INITIATED:	11/7/2005	9:37:53	CONTINUO(	R,	P,	F,	RMS	&	N	>	0.03	g's	
4	27	RECORDS	ACQUIRED												
5	Time	RMS			Peak			Freq			TRUE	N	>	0.03 g's	
6		X	Y	Z	X	Y	Z	X	Y	Z	RMS	X	Y	Z	
7	0	0.03	0	0.02	0.04	0	0.01	2	0	4	0.04	1	0	0	
8	0.5	0.14	0	0.03	0.17	0.01	0.02	2	2	4	0.16	2	0	1	
9	1	0.13	0.01	0.02	0.16	0.01	0.01	2	2	12	0.13	3	0	0	
10	1.5	0.12	0.01	0.03	0.19	0.01	0.02	2	2	2	0.16	2	0	0	
11	2	0.21	0.01	0.05	0.22	0.01	0.03	2	2	2	0.21	2	0	2	
12	2.5	0.21	0.03	0.04	0.2	0.01	0.01	2	2	6	0.19	4	0	0	
13	3	0.17	0.01	0.04	0.23	0.01	0.01	2	4	2	0.19	3	0	0	
14	3.5	0.14	0.02	0.01	0.13	0.01	0.01	2	4	6	0.13	3	0	0	
15	4	0.07	0.01	0.02	0.09	0.02	0.01	2	2	2	0.09	2	0	0	
16	4.5	0.02	0.2	0.04	0.01	0.26	0.03	6	2	2	0.24	0	2	1	
17	5	0.02	0.1	0.02	0.02	0.13	0.03	2	2	2	0.11	1	2	1	
18	5.5	0.02	0.15	0.03	0.01	0.21	0.02	6	2	2	0.17	0	2	0	
19	6	0.02	0.18	0.02	0.01	0.25	0.01	2	2	2	0.21	0	2	0	
20	6.5	0.04	0.2	0.03	0.04	0.27	0.04	2	2	2	0.24	1	2	1	
21	7	0.04	0.19	0.05	0.02	0.24	0.04	2	2	2	0.22	1	2	2	
22	7.5	0.03	0.15	0.02	0.03	0.22	0.02	2	2	2	0.19	1	2	1	
23	8	0.02	0.15	0.03	0.02	0.2	0.03	2	2	2	0.17	0	2	1	
24	8.5	0.07	0.02	0.36	0.05	0.01	0.42	2	2	2	0.4	3	0	3	
25	9	0.09	0.02	0.25	0.07	0.03	0.36	2	2	2	0.32	3	1	2	
26	9.5	0.02	0.02	0.24	0.01	0.01	0.31	2	4	2	0.27	0	0	2	
27	10	0.03	0	0.3	0.03	0	0.41	2	0	2	0.37	1	0	2	
28	10.5	0.06	0.01	0.22	0.03	0.01	0.28	2	2	2	0.24	1	0	2	
29	11	0.03	0.01	0.23	0.02	0.01	0.29	2	2	2	0.26	1	0	4	
30	11.5	0.03	0.02	0.3	0.03	0.01	0.41	2	12	2	0.37	1	0	2	
31	12	0.05	0.02	0.22	0.04	0.02	0.27	2	2	2	0.24	2	0	2	
32	12.5	0	0	0.01	0	0	0.02	0	0	2	0	0	0	0	
33	13	0	0	0.01	0	0	0.01	0	0	4	0	0	0	0	
34	END	OF	DATA	SET											

Figure 41 - Post Import Cleanup and X, Y, Z Data

Figure 42 provides an example of graphing the data. The X data is Series 1 (blue), Y data is Series 2 (violet), and Z data is Series 3 (yellow).

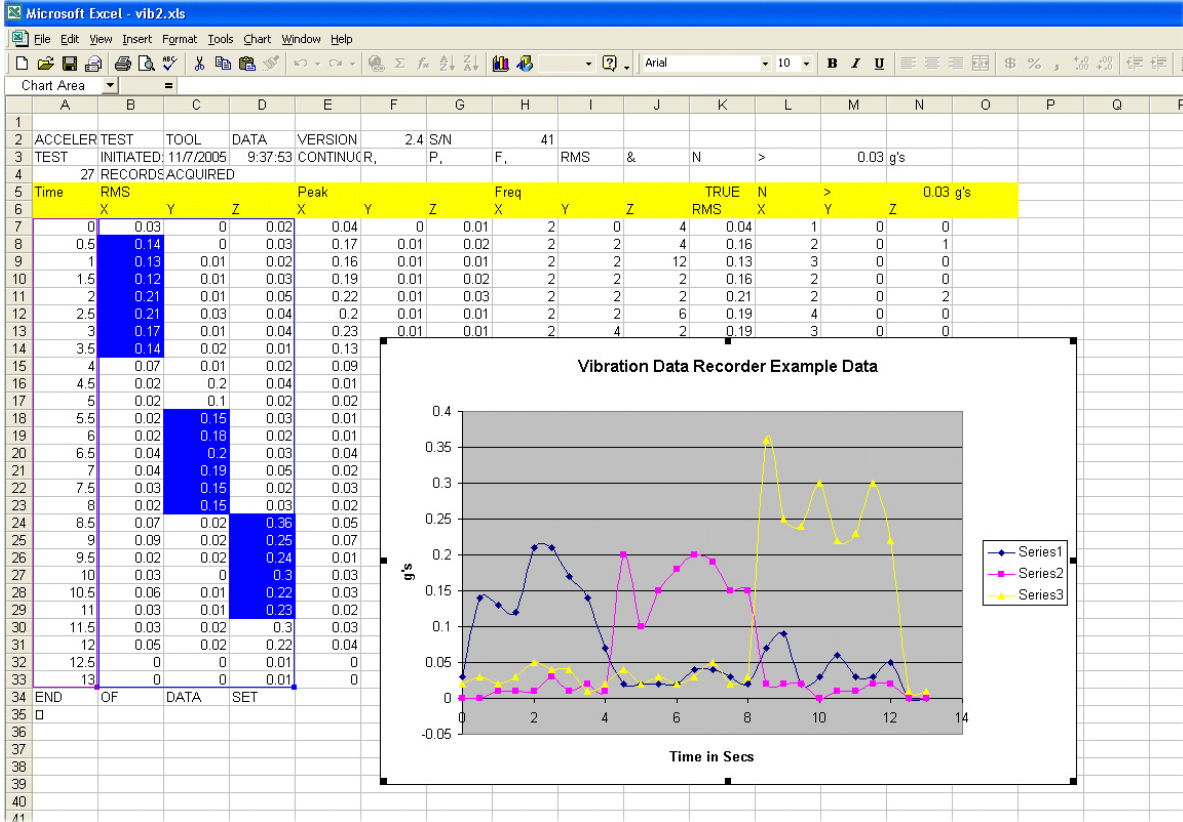Refer to the Excel help for information on graphing data in Excel.

Figure 42 - Graphing Example