

Accelerometer Test (Vib) Tool

User's Guide

Version 7.8a

with

InfoCenter Application



VibPlot Application

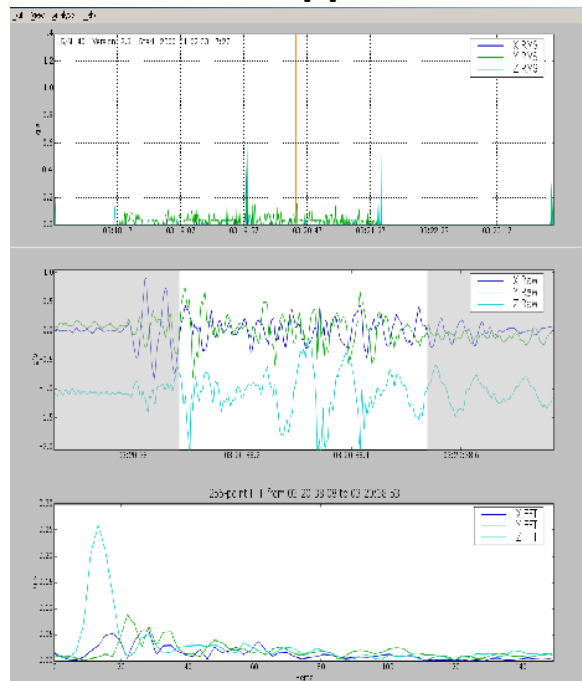


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Vibration Accelerometer Test Tool

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 a tri-axial accelerometer, the Vib Tool simultaneously acquires and records data on the X, Y, and Z axis. Two recording modes are available: Time-domain and On-Board Reduction.

The Vib Tool acquires time-domain data at a rate of 512 Hz (512 samples per second, for each axes). When recording in Time-domain mode, this data is streamed directly into internal flash memory. When recording in On-Board Reduction mode, the Vib Tool reduces this data in real time to generate two sets of data points per second. Recorded data files can be uploaded to the PC for analysis using the GCI InfoCenter Desktop Application.

The Vib Tool provides two packaging options, one for use in wafer carriers and FOUPS, and 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 (maximum 9 hours per recording session).

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.

VIBCOM Radios

When connected to a VIBCOM Radio, and paired with an AMHS Vehicle containing an AMHS Radio, the Vib Tool can record fab location tag information. This information is written into the vibration data stream and provides a way for the user to know the physical location of vibration records that are out of spec. Additionally, with the VIBCOM Radio attached, the Vib Tool can link up with an InfoCenter for



Figure 1 - Vib Tool mounted in 300 mm FOUP



Figure 2 - Vib Tool packaged for Reticle Pod

automatic data upload and recording. Additional details on the InfoCenter App can be found in the section below titled **InfoCenter Application – OHT**.

Modified FOUP / Reticle / EUV Pod

When equipped with a VIBCOM Radio for use with the InfoCenter, the Vib Tool must be installed in a modified carrier (FOUP, Reticle or EUV Pod). The required modifications provide charge contacts that align with the InfoCenter’s charge pins. This allows the InfoCenter to maintain proper Vib Tool battery voltage. It is also used as one of the required load port (placement) sensors, which allows the InfoCenter App to verify that a Vib Tool is present in the carrier placed on the InfoCenter load port.

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.

Control Panel

The Vib 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 InfoCenter Desktop Application. The power entry plug is used to charge the internal nickel-metal hydride battery pack using a 15 VDC wall transformer.

Menu Structure

Figure 3 and Figure 4 show a flowchart of the Vib Tool’s menu 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.

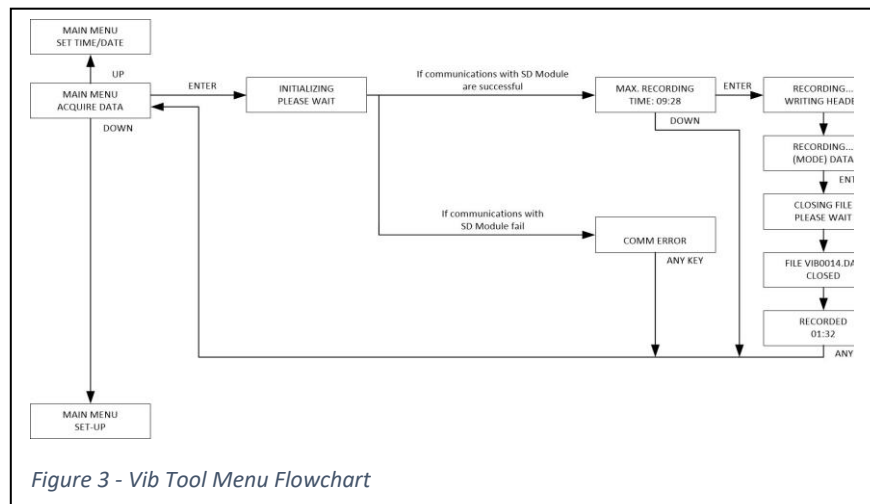


Figure 3 - Vib Tool Menu Flowchart

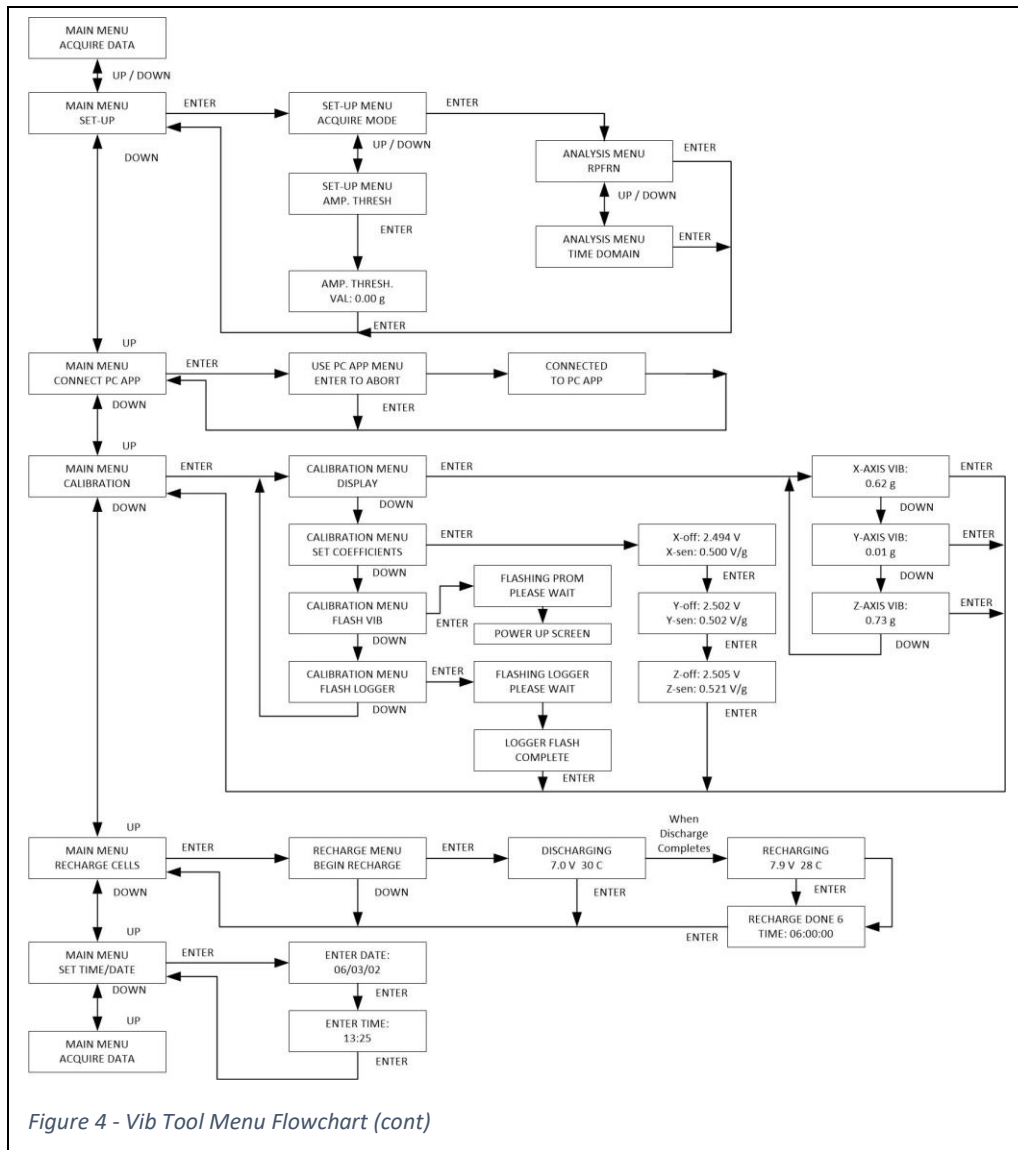


Figure 4 - Vib Tool Menu Flowchart (cont)

Numeric Data Entry

The Vib Tool accepts numeric entry using the up and down arrow keys. Use numeric entry to set the Accelerometer coefficients and the Vib 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.

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 initialization 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, Setup, Connect PC App, 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. The following sections describe the six main menu options and their functions.

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 the selected recording method and begins streaming recorded data to the data file. The display changes to **RECORDING... / TIME DOMAIN DATA** (when time domain mode is selected) or **RECORDING... / Reduced Data** (when reduced mode is selected). Recording mode is selected using the Setup Menu, described below.

While this message is displayed, the system is continuously recording vibration data to internal flash memory.

To terminate the recording session, press the ENTER key. The Vib Tool displays several messages while it halts its 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 data recorded (**RECORDED / 00:10:32**). Press the ENTER key to clear this message and return to the Main Menu.

Note, when connected to a VIBCOM Radio and linked to an InfoCenter, recording can be manually started through the InfoCenter App GUI, or automatically started as a result of an AMHS Unload Cycle.

Main Menu – Set-up

Press ENTER at the **MAIN MENU / SETUP** message to define recording options. The Vib Tool displays **SET-UP MENU / ACQUIRE MODE**. Press ENTER at this prompt to define the recording mode, either RPFNRN or Time Domain. Press the DOWN arrow to display the **SET-UP MENU / AMP. THRESH** screen.

Note, when connected to a VIBCOM Radio and linked to an InfoCenter, all configuration options are set through the InfoCenter App GUI. The Vib Tool keypad is not used.

Set-up Menu – Acquire Mode

The RMS, Peak, Frequency, True RMS, and N (RPRFN) conversion calculates and stores the RMS, peak, and maximum frequency with two additional values; True RMS and N. True RMS calculates the total root-sum-mean-square of all amplitude data points for all three axis X, Y, and Z. It combines all three axes into one data point. N analysis reports the number of frequency amplitudes exceeding the user defined amplitude threshold. Press the Enter key to select the RMS, peak, frequency, true RMS, and N conversion type. Press the Down arrow to advance to the Time Domain analysis type menu.

When recording in Time Domain mode, on-board conversions are disabled and postponed until after recording. All recorded time domain data is streamed to internal flash memory. Press the Enter key to select Time Domain Recording. Press the Down arrow to return to the RPRFN conversion type menu.

Set-up Menu – Amplitude Threshold

Specify the Amplitude Threshold for each axis in g's. The Amplitude Threshold defines the amplitude for the N recording mode. Frequencies with amplitudes greater than or equal to the Amplitude Threshold will be accumulated in N. Enter the Amplitude Threshold using the Up, Down and Enter keys as described in 'Numeric Data Entry'.

Main Menu - Connect PC App

Press ENTER at the **MAIN MENU / CONNECT PC APP** message to prepare the Vib Tool for uploading data files to the PC using the InfoCenter Desktop Application. The Vib Tool displays the **USE PC APP 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 InfoCenter Desktop Application and use the **Connect to Vib Tool** dialog box to upload recorded data files. See the **InfoCenter Desktop App** later in this document for details on the InfoCenter Desktop 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. If for any reason, the PC cannot terminate the connection, and the Vib Tool remains in the **Connected to PC App** screen, cycle power to recover.

After connecting with the InfoCenter Desktop Application, the Vib Tool displays **CONNECTED / TO PC APP** 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.

Note, when connected to a VIBCOM Radio and linked to an InfoCenter, data is automatically uploaded wirelessly to the InfoCenter PC. No serial cable is required and the Vib Tool keypad is not used.

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 are modified during the Vib Tool calibration process, which is valid for one year.

Calibration Menu - 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. 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.

Calibration Menu - Set Accelerometer Coefficients

The Set Accelerometer Coefficients option provides a method to change the accelerometer's factory coefficients. This is only necessary during the Vib Tool calibration process, which must be performed by GCI. The coefficients must match those defined by the GCI calibration process. A calibration report is shipped with each Vib Tool documenting the programmed coefficients.

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.

Calibration Menu - Flash Vib

The Vib Tool firmware is field ungradable. The Flash Vib menu option allows the user to upgrade the Vib 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.

Calibration Menu - 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 SD 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.

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.

Complete fast charging of the battery pack takes approximately four 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.

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. If the Vib Tool battery voltage becomes too low to successfully turn the system on, plug the charger into the Vib Tool for a short period (30 minutes) to refresh the batteries. Once the tool powers up, run a full charge cycle.

Note, when connected to a VIBCOM Radio and linked to an InfoCenter, battery charge is maintained automatically by the InfoCenter App. No additional charge cable is required and the Vib Tool keypad is not used.

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 on numeric entry for instructions. After entering the Date and Time, the Tool returns to the Main Menu.

The Vib Tool contains a built-in real-time clock. The Vib 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 Vib Tool provides the year with a two-digit counter. It does not provide century information.

Note, when connected to a VIBCOM Radio and linked to an InfoCenter, the Vib Tool time and date are automatically updated each time recording is started. The Vib Tool keypad is not used.

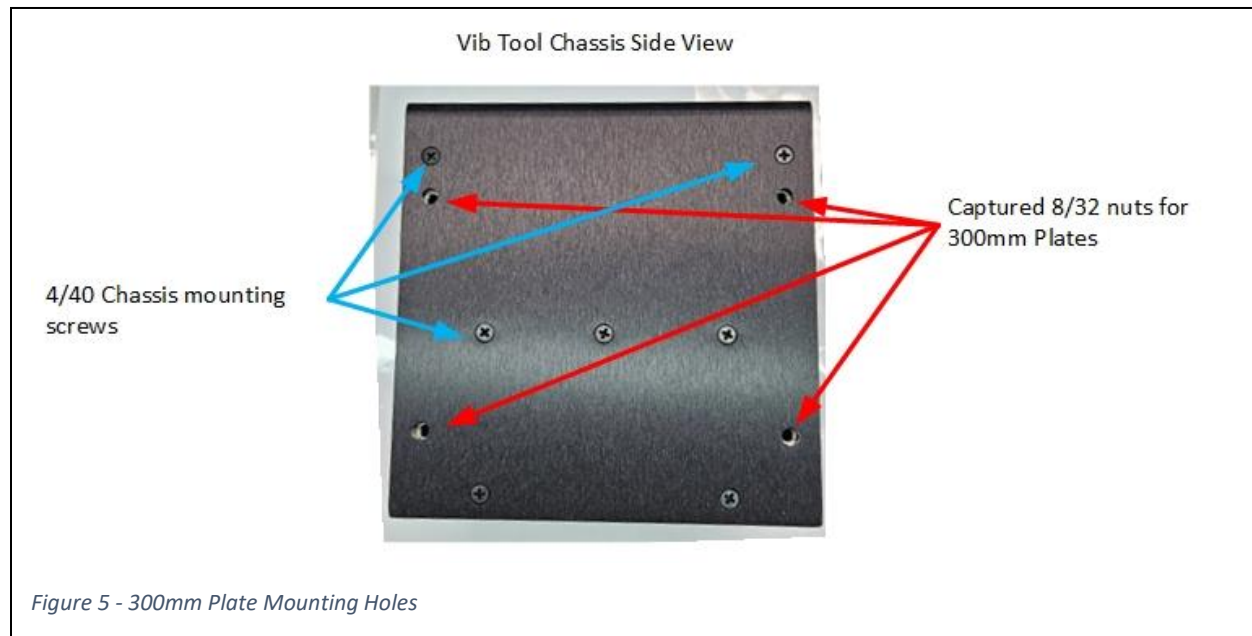
Mechanical

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 Vib Tool using the supplied hardware.

Figure 5 shows mounting-hole locations for 300 mm plates. These mounting holes are on each side of the Vib Tool. To attach 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.

To attach the top 300mm mounting plate, use the included 8/32 x 1" socket head screws, washers and springs (as detailed 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.



Mounting Kit Hardware

The Vib Tool ships with all necessary hardware to attach the two 300 mm Mounting Plates. Kit contents are listed to the right.



Figure 7 below 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 a 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, but do not over-tighten, as this may damage the FOUP and/or the Vib Tool.



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.

Mounting Brackets for 200 mm carrier Installation

If necessary, the standard FOUP Vib Tool can be mounted in a 200 mm carrier using factory supplied mounting brackets. Contact GCI for more information.

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.

Charge Unit

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

Note, when connected to a VIBCOM Radio and linked to an InfoCenter, battery charge is maintained automatically by the InfoCenter App. The InfoCenter provides the power supply used to recharge the Vib Tool batteries. No additional charge cable is required and the Vib Tool keypad is not used.

Low-Battery Sense

The Vib Tool continuously monitors the nickel-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.

RS-232 Cable

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

Note, when connected to a VIBCOM Radio and linked to an InfoCenter, data is automatically uploaded wirelessly to the InfoCenter PC. No adapter cable is required and the Vib Tool keypad is not used.

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 its own data file that is used to store recorded vibration 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 Vib Tool's S/N and firmware version information.

Note, when connected to a VIBCOM Radio and linked to an InfoCenter, automatic recording sessions use a single, specific filename. When recording has completed, the data file is automatically uploaded, then deleted from the Vib Tool.

Software

Data Acquisition

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

Data Recording

The Vib Tool continuously streams recorded data, in the selected recording mode, to internal flash memory. The Vib Tool stores the initial start time and date and begins recording time domain or reduced data at the acquisition rate of 512 points per second on each channel. Data recording continues until the onboard flash memory fills (up to 9:28 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 date are properly set before initiating a recording session.

Note, when connected to a VIBCOM Radio and linked to an InfoCenter, the system time and date are set automatically when recording begins. Recording terminates automatically when the Vib Tool is returned to one of the InfoCenter load ports. The Vib Tool keypad is not used.

Data Reduction

Data reduction of time-domain data is handled on-board when reduced data mode is selected. If time domain mode is selected, the recorded time domain data is analyzed using the VibPlot Application running on a PC. VibPlot is a companion application associated with the InfoCenter Application, and is described in a separate section below.

The InfoCenter Application is used to upload recorded data from the Vib Tool. If the uploaded data file was recorded in Reduced Mode, this same application is used to graph and analyze the data. Information about the InfoCenter Application (and its Desktop version) is provided in separate sections below.

If the data file was recorded in Time Domain mode, it is automatically reduced during the upload process (by the InfoCenter App), which can then be used to graph and analyze the reduced data. The VibPlot application is used to graph and analyze the raw time domain data.

Please see the section below on the VibPlot Application for additional details on available data reduction options.

On-Board Reduction

When configured for on-board data reduction, the Vib Tool utilizes Digital Signal Processing (DSP) to perform real-time analysis as data is recorded. Five types of data reduction are performed: RMS, Peak, Frequency, True RMS, and N Mode

The analysis modes are described using an example signal. The example signal contains three sinusoidal frequency components as follows:

Component 1: 0.8g @ 8 Hz

Component 2: 0.4g @ 16 Hz

Component 3: 0.2g @ 32 Hz

Figure 8 contains a graph of two seconds of the example signal (amplitude versus time).

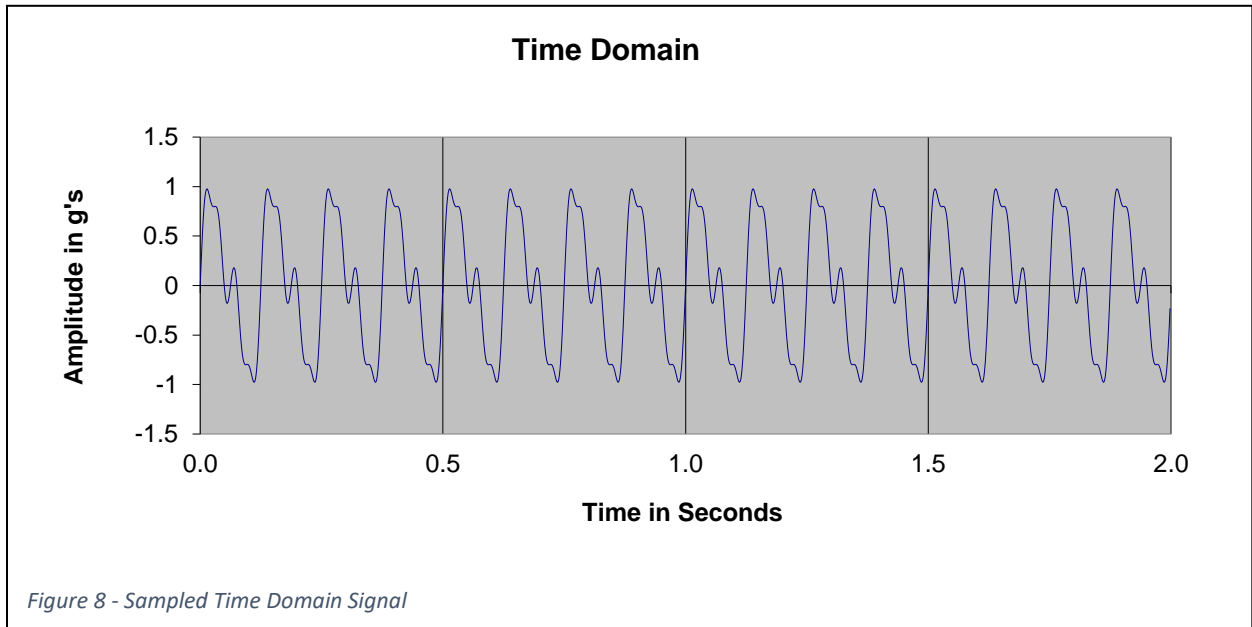
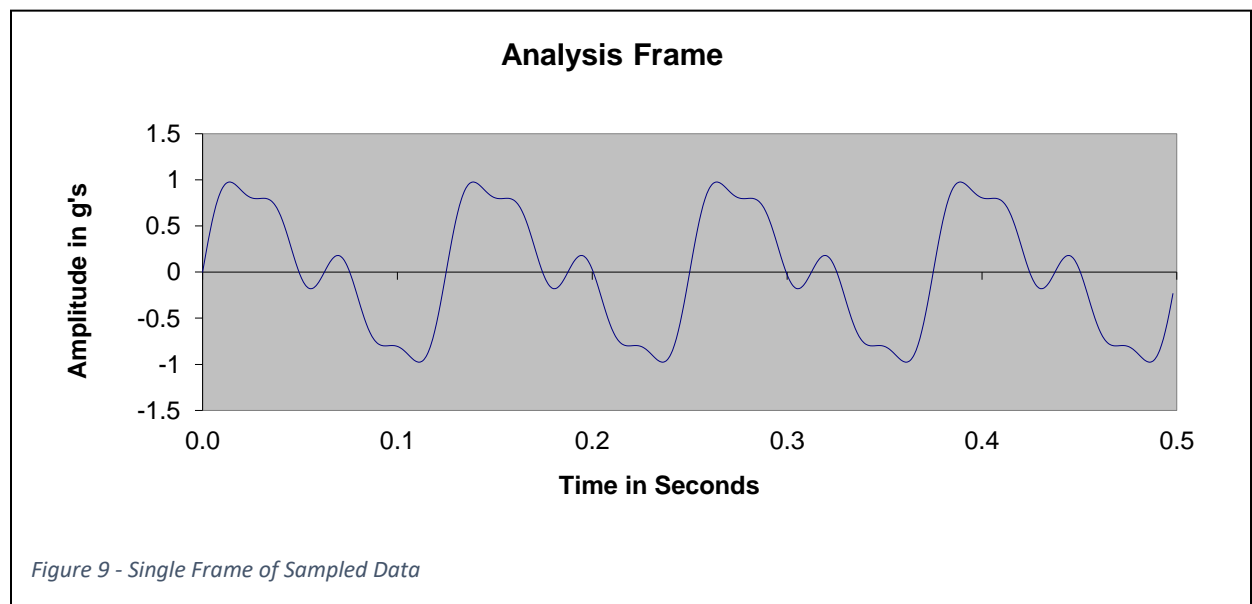


Figure 9 contains a single frame of the sampled data.



The Vib Tool performs the following procedure for on-board analysis mode:

Samples the analog data converting it to a 10-bit digital quantity at a rate of 512 samples per second (512 Hz).

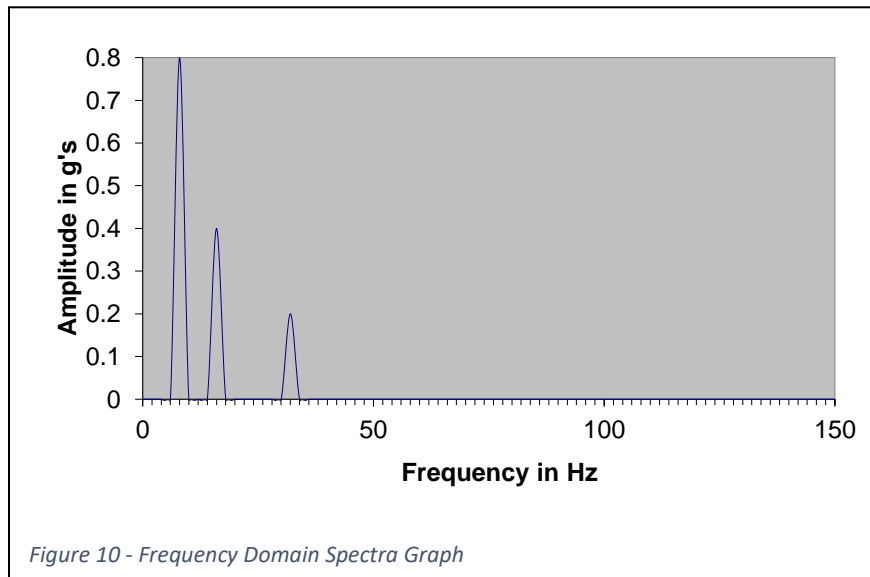
Forms a frame containing 256 digital data samples every half second of recording. The Tool captures two frames per second which equates to four frames over our two second interval (the four frames are shown in Figure 8 by the vertical grid lines - Figure 9 expands a single frame of data).

Performs a Fast Fourier Transform (FFT) algorithm to convert each 256-point time-domain frame to a 75-point frequency domain spectrum. The frequency domain spectrum represents the amplitude of each signal component in 2Hz frequency bands from 2 Hz to 150 Hz.

Table 1 contains the amplitude and frequency of our example signal in tabular format. Figure 10 shows a graph of the frequency domain spectrum.

Table 1 - Frequency Domain Spectra Table

Frequency (Hz)	Amplitude (g's)
2	0
4	0
6	0
8	0.8
10	0
12	0
14	0
16	0.4
18	0
20 – 28	0
30	0
32	0.2
34	0
36 – 150	0



The five data reduction types reduce the frequency domain spectra as follows:

RMS (Summing)

This mode records the sum of the amplitudes of the frequency domain spectra. An RMS value is recorded for each axis X, Y, and Z. The following equation computes the RMS value:

$$\text{RMS} = \text{SUM (Amplitude [f]) for } f = 2, 4, \dots, 150$$

For the example signal, the RMS is the sum of the amplitudes at 8 Hz, 16 Hz, and 32 Hz. The amplitudes at all other frequencies are zero and sum to zero. The following RMS value is reported for the example signal:

$$\text{RMS} = 0.8g + 0.4g + 0.2g = 1.4g$$

Peak

This mode records the maximum amplitude in the frequency domain spectra. A Peak value is recorded for each axis X, Y, and Z. The following equation computes the Peak value:

$$\text{Peak} = \text{MAX (Amplitude [f]) for } f = 2, 4, \dots, 150$$

For the example signal, the Peak amplitude is 0.8g at 8 Hz. The amplitudes at all other frequencies are less than 0.8g.

Frequency

This mode records the frequency of the Peak amplitude. If the same peak value exists at more than one frequency, the Tool records the lowest frequency. For the example signal, the maximum amplitude occurs at 8 Hz and the Tool records 8 Hz for the frequency.

True RMS and Number Exceeding Amplitude

This mode records both the true RMS and the number of occurrences that the amplitude exceeded a user-defined amplitude threshold (N). The user defined amplitude threshold is defined in the setup menu. Note, when connected to a VIBCOM Radio and linked to an InfoCenter, the amplitude threshold is defined using the InfoCenter App GUI.

The True RMS value is the root mean square of the amplitudes in the frequency domain spectra of all three axis, X, Y, and Z. The following equation computes the True RMS value:

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

where: $f = 2, 4, \dots, 150 \text{ Hz}$

True RMS Equation

The following calculation uses the example signal for the X axis. All amplitudes for the Y axis and Z axis are zero. The True RMS value of the example signal is:

$$TrueRMS = \sqrt{\sum (0.8)^2 + \sum (0.4)^2 + \sum (0.2)^2}$$

True RMS Example

For our example signal, the user-defined amplitude threshold is set to 0.3g. Two amplitudes exceed the 0.3g level. The Tool records the value of N as two.

Data Retrieval

The Vib Tool supports data uploading to a Host PC via a standard RS-232 communications port. Using the InfoCenter Desktop 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.

Note, when connected to a VIBCOM Radio and linked to an InfoCenter, automatically recorded data files are uploaded wirelessly to the InfoCenter PC. No upload cable is required.

Please see the following sections for details on using the InfoCenter Desktop Application to upload data from a Vib Tool.

Please see the following sections for details on using the VibPlot Application to analyze time domain data uploaded using the InfoCenter Application.

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 axes 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. 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 Vib Tool's Calibration Coefficients are set to the calibration data sheet specifications provided with your tool (default nominal is 2.500 V offset and 0.500 V/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.

Using the *Calibration Display* menu, orient each axis of the Vib Tool perpendicular to earth gravity and verify its ability to sense this 1g constant. This function is only used for the purpose of verifying Vib Tool operation. It is not used for calibration and the Vib Tool does not record earth gravity during normal operation.

Several factors affect this measurement including:

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

Note that the images shown below are of a slightly older revision of the Vib Tool hardware that used a DB-25 connector instead of the DB-9 connector used now.

X Axis

Orient the Vib Tool so that its front is facing up, the positive X axis is parallel to earth gravity as shown at right.

Verify that the Vib Tool reads **+1.00g +/-0.10**.



Figure 11 - X Axis Positive Orientation

Orient the Vib Tool so that its front is facing down, the negative X axis is parallel to earth gravity as shown at right.

Verify that the Vib Tool reads **-1.00g +/-0.10**.



Figure 12 - X Axis Negative Orientation

Y Axis

Press the *Down Key* to advance to display the Y Axis.

Orient the Vib Tool so that its right side is facing up, the positive Y axis is parallel to earth gravity as shown at right.

Verify that the Vib Tool reads **+1.00g +/-0.10**.



Figure 13 - Y Axis Positive Orientation

Orient the Vib Tool so that its right side is facing down, the negative Y axis is parallel to earth gravity as shown at right.

Verify that the Vib Tool reads **-1.00g +/-0.10**.

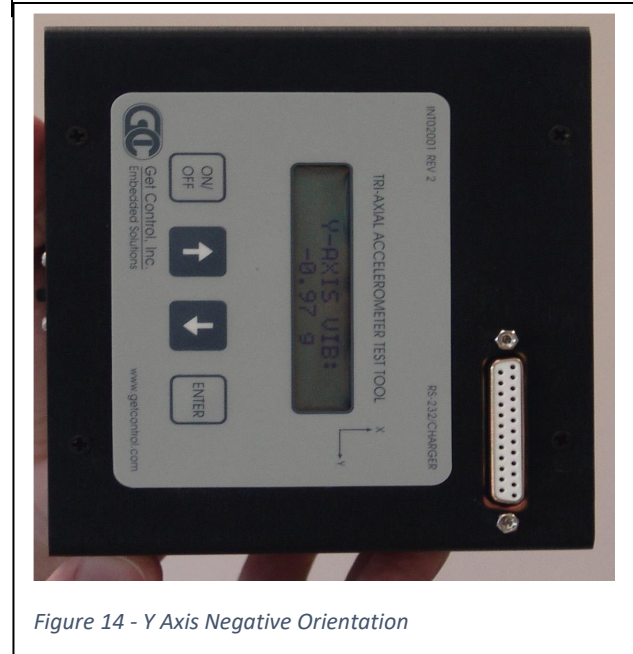


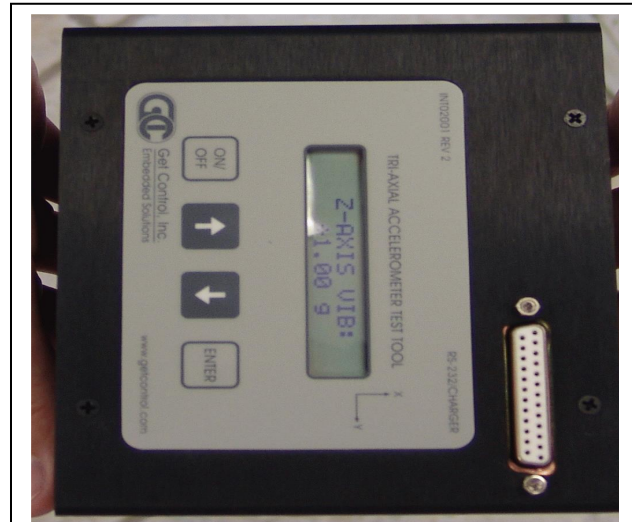
Figure 14 - Y Axis Negative Orientation

Z Axis

Press the *Down Key* to advance to display the Z Axis.

Orient the Vib Tool so its top is facing up, the positive Z axis is parallel to earth gravity as shown at right.

Verify that the Vib Tool reads **+1.00g +/-0.10**.



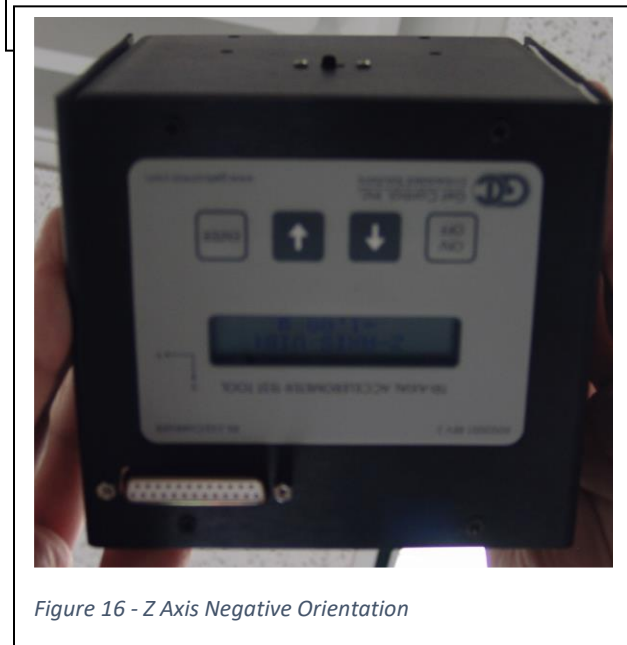
Orient the Vib Tool so that its top is facing down (lift the Tool over your head), the negative Z axis is parallel to earth gravity as shown at right.

Verify that the Vib Tool reads **-1.00g +/- 0.10**.

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

GCI recommends yearly calibration to ensure proper vibration measurements. During calibration, GCI personnel use a vibration table with a known excitation vibration to adjust system offset and sensitivity values.

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.



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, between 9:00 am – 5:00 pm Mountain Standard Time. Note that Arizona does not observe Daylight Savings Time.

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

GCI InfoCenter and InfoCenter App

Introduction

The GCI InfoCenter is comprised of a set of hardware that is used to automate the recording of vibration data in semiconductor fabs.

The GCI InfoCenter App is a Windows based application for use with the GCI Vibration Accelerometer Test Tool (Vib Tool). The application has two operational modes – OHT and Desktop. Both versions graphically display reduced vibration data recorded by the GCI Vib Tool.

The OHT version runs on dedicated PC installed in the GCI InfoCenter hardware. The Desktop version runs on any Windows PC and is used to interface with Vib Tools that are used manually.

The InfoCenter hardware is described in the following section. See below for additional sections on using the OHT and Desktop versions of the InfoCenter App.

InfoCenter Hardware

The InfoCenter provides two standard load ports (LP), each configured with a Zigbee radio controller used to communicate with instrumented FOUPs containing GCI Vib Tools. Each LP also provides a GCI E84 SPC device used for automated AMHS transfers. A PC running the InfoCenter App (OHT) acts as the main controller for the InfoCenter.

E84 SPC

Each LP provides a fully compliant E84 interface port, along with an E84 optical transceiver. These are used to provide automated E84 transfers between the LP and the fab AMHS.

Status LEDs

The SPC provides status LEDs showing the current state of all E84 related signals, along with Placement and Presence sensor status. The SPCs are mounted inside the InfoCenter enclosure, so these status LEDs are not visible during normal operation. They can be used for trouble-shooting purposes.

Load Port Controller

The two LPs are controlled by separate Zigbee radio control boards. These controllers provide a set of LEDs that show LP status. They also provide two option buttons.

Status LEDs

- Auto Mode
 - When lit, indicates the LP is in Automatic Mode. In this mode, the LP interfaces with the AMHS for E84 controlled loads and unloads. FOUPs should not be placed on or removed from the LP while in Auto Mode.
- Manual Mode
 - When lit, indicates that the LP is in Manual Mode. In this mode, the AMHS treats the LP as offline. It will not attempt to transfer FOUPs from / to the LP. Manual loads and unloads are permitted in this mode.
- Load Ready
 - When lit, indicates the LP is empty and ready to process an automated load from the AMHS. Load Ready is only possible when the LP is in Auto Mode.
 - When flashing, indicates the LP is processing an AMHS load cycle.

- Unload Ready
 - When lit, indicates the LP contains an instrumented FOUP with a linked Vib Tool and is ready to process an automated unload from the AMHS. Unload Ready is only possible when the LP is in Auto Mode.
 - When flashing, indicates the LP is processing an AMHS unload cycle.
- Presence
 - When lit, indicates both Presence sensors are blocked. Presence sensors are reflective sensors that detect the base of a FOUP.
 - When off, indicates one or both Presence sensors are clear.
- Placement
 - When lit, indicates the control board detects Vib Tool battery voltage from a Vib Tool in an instrumented FOUP placed on the LP.
 - When off, indicates the absence of Vib Tool battery voltage, either because the LP is empty, or because a non-instrumented FOUP has been placed on the LP.
- Data
 - When lit, indicates a new data file has been uploaded and is ready to transfer to the host server.
 - When flashing, indicates that a data upload process is in progress.
- Battery
 - When lit, indicates a charge cycle is in progress on the Vib Tool sitting on the LP. The LP is not available for an AMHS unload during a charge cycle.
- Maint. Mode
 - This LED is currently a debug LED only and is not used for normal operation. It remains off unless the Maintenance button is pressed. When pressed, this button causes the Maint. Mode LED to flash. It can be used as a test to verify that the LP control board is functioning. It currently has no other purpose.
- Alarm
 - When lit, indicates an alarm condition was detected on the LP. The specific error message is displayed on the InfoCenter GUI which will include recovery steps.

Option Buttons

- Auto / Manual
 - This button is used to switch the LP between Automatic and Manual Modes.

- When in Automatic Mode, pressing this button will cause the **Enter Manual Mode** password entry dialog box on the InfoCenter GUI. Enter a correct PW to move the LP to Manual Mode. Use the Cancel button to leave the LP in Automatic Mode.

- Use Manual Mode to manually place / remove FOUPs from the LP without triggering error conditions.

Additionally, some configuration options first require that both LPs are in Manual Mode before continuing.

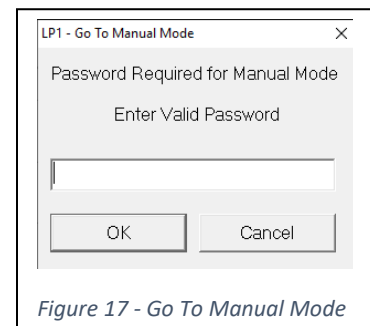


Figure 17 - Go To Manual Mode

- When in Manual Mode, pressing this button will immediately move the LP back to Automatic Mode. No PW is required.
 - If an instrumented FOUP containing a Vib Tool is in place on the LP when it is switched back to Automatic Mode, the system will start a discovery process to link the Vib Tool to the LP.
 - Maint. Mode
 - The Maint. Mode button does not have any specific functional purpose in the current system. Its only function is to trigger a verification test on the LP control board. If the control board is running normally, pressing the Maint. Mode button will cause the control board firmware to flash the Maint. Mode LED.
 - Other functionality could be assigned to the Maint. Mode button if desired. Contact GCI for more information.

Load Port Reticle Adaptor

The InfoCenter provides two E15 / E84 compliant 300mm load ports. An alternate load port interface is available for 200mm pods. Contact GCI for more information.

An adaptor plate is available for use with instrumented Reticle Pods. This adaptor plate is placed on one of the LPs, and re-routes the kinematic pins from FOUP to Reticle Pod locations. It also re-routes the charging contacts.

Instrumented FOUP / Reticle Pod

An instrumented FOUP (or Reticle pod, when using the GCI Reticle Adaptor Plate) provides internal wiring to connect the charge circuit of a Vib Tool with customized contacts on the InfoCenter LP. These contacts provide battery level detection and charging capabilities to the LP control board. They are also used as the FOUP Placement sensor.



Figure 18 - Reticle Pod Adaptor

FOUPs / Reticle Pods can be modified by GCI using customer supplied carriers. GCI representatives in certain countries are also authorized to modify carriers.

Vib Tool Radio

Vib Tools must be configured with a Vib Tool Radio (VIBCOM) to communicate with the InfoCenter LPs. The Vib Radio is a Zigbee radio board in a small enclosure with an RS232 cable that attaches to the female DB-9 on top of the Vib Tool. The Vib Tool provides power to the radio board through this connection as well as a communications path.

When an instrumented FOUP containing a Vib Tool configured in this way is placed on one of the InfoCenter LPs, the App performs a discovery process to wirelessly link the Vib Tool to the LP control board. This process is designed to uniquely discover the Vib Tool sitting on the associated LP, ignoring those other Vib Tools that may be within range of the Zigbee radios. In this way, two Vib Tools can be placed on the two system LPs and have the App discover each in turn.

Once linked, Vib Tool status is continuously requested by the App. This allows the App to monitor battery levels and start charge cycles when necessary. Additionally, the link provides a mechanism for

the App to send a start recording message to the Vib Tool when an AMHS unload is triggered. This allows vibration recording to be automated simply by scheduling an AMHS unload through the factory automation software.

AMHS Radio

To complete the automation of vibration recording, and to add fab location information, the AMHS vehicle picking up the instrumented FOUP should be configured with a GCI AMHS Radio (AMHSCOM). This is a small Zigbee radio board that gets connected to an RS232 port inside the vehicle. The vehicle must be modified to send bar code / location packets to the AMHS Radio as the vehicle moves around the fab.

When recording starts (by the vehicle picking up the Vib Tool from one of the InfoCenter LPs), the Vib Radio synchronizes with the AMHS Radio. Any bar code / location packets received by the AMHS Radio are wirelessly transmitted to the Vib Radio, which sends them to the Vib Tool. The Vib Tool records these bar code / location packets in real time along with the vibration data being acquired by the Vib Tool. In this way, the physical location of specific vibration events can be determined by analyzing the resultant data file.

Main System Power

The InfoCenter provides a single AC power cord extending out the back panel. This power cord should be connected to filtered AC power (either 110 or 220 VAC). This power cord provides power to an unswitched power strip where the PC and Monitor are powered. A second internal power strip is switched through the front panel EMO button.

EMO Button

A single EMO button is provided in the left-hand door, behind a protective shield. An access hole in the shield allows the EMO button to be pressed without lifting the shield. The shield itself helps prevent accidental EMO activation. To release the EMO button, lift the shield and rotate the button slightly clock-wise.

Pressing the EMO button removes power from the two LP control boards and the two LP SPCs.

Additionally, this causes a communications interruption with the InfoCenter PC. The App attempts to detect this event and displays a dialog box indicating power has been removed. Once power is restored by releasing the EMO button, click the "OK" button on this dialog box to instruct the App to re-establish communications with the system hardware. If this attempt fails, the App may need to be shut down and re-started.

E-Stop Buttons

One E-Stop button is provided for each LP. LP1 E-Stop button is positioned just to the right of the EMO button in the left-hand door. LP2 E-Stop button is positioned in the right-hand door. These buttons behave differently than the EMO button in that they are toggle type buttons. Press once to engage; press a second time to disengage.

These can be used to force a LP into an unavailable state without physically removing power. When pressed, the App displays a warning message that the LP is in an E-Stop state. The LP remains unavailable until the E-Stop button is release.

Access Panels

An access hole is provided in the back panel of the InfoCenter. This can be used to route network or other cables into the InfoCenter enclosure. The InfoCenter PC is placed inside the enclosure, behind the right-hand door. A second access hole is provided on the right-hand panel near the monitor arm and keyboard tray. This is used to route monitor and keyboard cables into the enclosure.

Internal Connections

There are several cable connections inside the InfoCenter enclosure. Most are pre-wired by the factory before shipping and should not be modified. All cables are labelled or color coded. Note that the InfoCenter App should be shut down and power removed from the InfoCenter (using the EMO button) before doing any wiring changes inside the InfoCenter enclosure.

Power Strips

There are two power strips mounted on the left-hand panel inside the InfoCenter enclosure. The rear power strip connects to the external power entry cord. It is always live and is used to power the PC and Monitor. Power cords for the PC and Monitor should be routed along the base towards the back of the enclosure. A third power cable is attached to this power strip. It is routed internally to the EMO button mounted in the left-hand door. This powers the front power strip.

The front power strip is switched by the EMO button. It has one power cord that runs to the main system power supply mounted on the right-hand side of the back-panel. Two standard wall chargers are also plugged into this strip and are connected to the two LP control boards.

PC Connections

The PC is placed inside the enclosure on the base behind the right-hand door. Connect its power cable to the rear power strip on the left-hand panel. Route the monitor power cable through the access hole in the right-hand panel to this same power strip. This power strip is always on. Power the PC and monitor using their individual power buttons.

Route the monitor DisplayPort to HDMI cable through the access hole on the right-hand panel and connect it to the labelled DisplayPort port on the back of the PC. Connect the HDMI end to the HDMI port supplied on the back of the monitor.

Route the keyboard cable through this same access hole and connect it to the labelled USB port on the back of the PC.

A USB-to-Serial adaptor is mounted to the rear panel. Connect the supplied USB cable between it and the labelled USB port on the back of the PC.

Control Board Connections

There are several wires connected to each of the two LP control boards. These are pre-connected by the factory and should not be removed. If any become disconnected in shipping, return them to their proper location.

A standard 9-Pin D-Sub cable connects to the DB-9 connector at the left side of the control board. This is the communications link with the PC. The other end of this cable is connected to one of the USB-to-Serial ports on the back-panel of the enclosure. These ports are labelled on both the adaptor and the cables. They should not be moved.

A 4-pin power adaptor is connected to the right, back side of the control board. There is only one connector that matches this wiring harness. It supplies power to the control board.

A 2-pin wiring harness is connected to an un-shrouded connector towards the middle back of the control board. This cable provides sensor status exchange with the GCI SPC mounted on the back-panel. There are two similar connectors for this cable. It should be connected to the left hand one. The right hand one has a jumper installed, which should not be removed.

A standard wall charger is connected, sideways, to a port towards the left, rear of the control board. This wire runs to one of the two wall chargers plugged into the front power strip. These provide power to the charging circuit when a Vib Tool requires a battery charge.

InfoCenter PC

The InfoCenter PC is a Windows 10 Professional PC, preloaded with the GCI InfoCenter and VibPlot Applications, along other GCI related applications. The PC contains two 1TB hard drives that are RAIDed together as RAID 1. C:\ and D:\ drives are configured. The OS and all applications are stored on the C drive. The D drive is reserved for application data storage.

There are two users defined:

- VTIC – PW: Get1Control2
 - This user has Administrator level rights
- Operator – no password
 - This user has Standard User level rights

The system is configured to auto-boot into the Operator account.

The system is configured to auto-start the InfoCenter Application (App) at boot.

Data Storage

App data is stored in a fixed folder structure at D:\Data. Separate folders are provided for CSV file output (further separated by LP number and bar code format), Debug files, Logs, Raw uploaded data and Reduced data files.

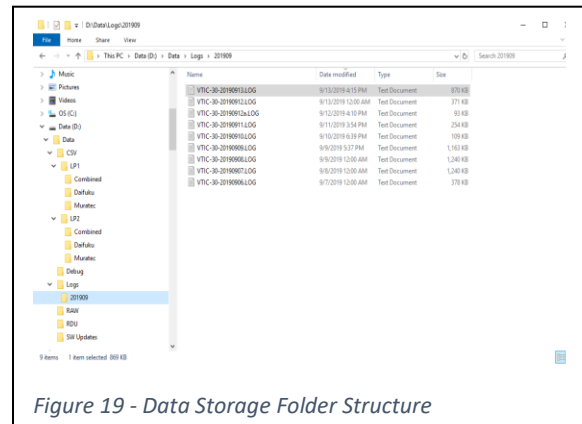


Figure 19 - Data Storage Folder Structure

InfoCenter App – OHT

The OHT version of the InfoCenter App runs on a PC installed in the InfoCenter enclosure. This version of the App will not function properly in a stand-alone configuration. Use the Desktop version of this app for stand-alone operation.

GUI



Figure 20 - InfoCenter Application GUI

When the App is started, it displays graphs from the last data file viewed. The GUI is split into three graph windows. The top graph displays Legacy Mode RMS data. The middle graph displays Peak Mode data. The bottom graph shows True RMS data. Each data type is described in more detail in the Vib Tool Manual section above.

The bottom of the screen is split into two sections, one for each system load port. These LP Windows are used to display status information for LP1 (left) and LP2 (right), along with details about any Vib Tool linked to the LP.

Location Tags

Location tags received by the Vib Tool (through the Vib Radio) are written into the vibration data stream and graphed on all three plots. Location tags are shown by a vertical line, with the location tag information displayed near the top of the graph.

Zoom

The Y-Zoom slide bar can be used to adjust the Y Axis of the three graphs. The default setting for the Y-Axis is 2.0 g's.

The X-Zoom slide bar can be used to adjust the X Axis of the three graphs. When a data file is opened, the full data set is displayed, with the start recording time stamp shown as the X Axis origin. The X-Zoom slide bar zooms in on the center point, expanding the X Axis time scale.

The Center Point slide bar can be used to adjust the center point of the X Axis. This adjust the center point of the graph, moving zoomed data left or right.

File Menu

Options in the File Menu provides options to save the current data (in multiple formats) and open new data files.

File Menu - Save Recorded Data

A standard Windows save file dialog box is displayed. The currently graphed data set will be saved to the entered filename.

File Menu - Open Data Set

A standard Windows open file dialog box is displayed. The selected data file is loaded and graphed.

InfoCenter Application data files are stored with a .VIB file extension. Data files uploaded from a connected Vib Tool are automatically stored in the D:\Data\RDU folder.

File Menu - Connect to Vib Tool

This menu option is disabled in the OHT version of the InfoCenter App. This option is used in the Desktop Version to connect to a Vib Tool through a serial port for data upload.

File Menu - Save Graph As Bitmap

This option displays a standard Windows Save As dialog box and allows the user to save the currently displayed graph as a bitmap using either the Windows Metafile format (WMF) or Enhanced Metafile format (EMF).

File Menu - Export Data to CSV File

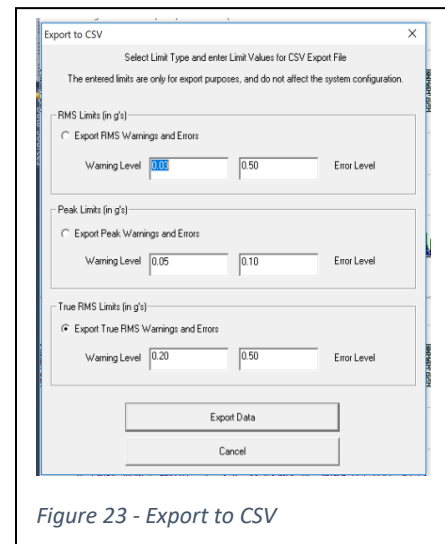
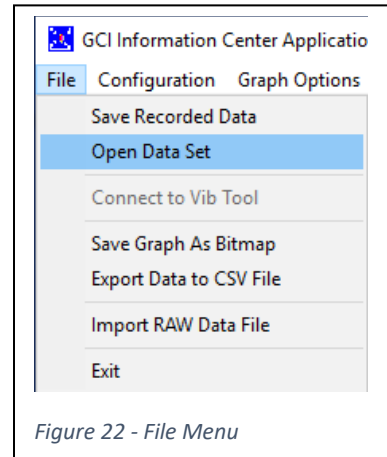
This option displays the Export to CSV dialog box. This box is used to set export options related to Location Tag processing.

Location tags are recorded at the rate they are received from the AMHS vehicle, typically at 10 times per second. Reduced data is recorded at a rate of 2 samples per second. This means there can be a large number of location tags associated with each data point.

To limit the amount of location tag information, the user can set separate Warning and Error levels. When the Location tag associated with a data point that is below the Warning level, it is hidden (not graphed / not written into the CSV file). Tags associated with data above the Warning level but below the Error level are displayed in Black on the graphs. Tags associated with data above the Error level is displayed in Red.

Global settings for Warning and Error levels are made using the 'Set Vib Limits' option under the 'Configuration' menu. The Export to CSV dialog box allows the user to adjust those settings specifically for the stored CSV file.

See the section below for the 'Set Vib Limits' option for details on setting these levels.

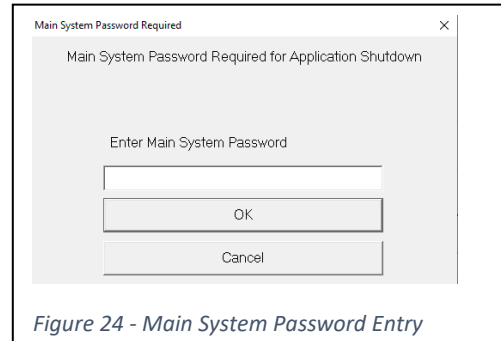


Once the 'Export Data' button is clicked, a standard Windows Save As dialog box is displayed.

File Menu - Exit

The Exit option allows the user to close the InfoCenter App. The application can also be closed using the close window icon (x) located in the upper right corner of the application window.

When exiting, the user must enter the main system password. To maintain normal operation, the App should be running continuously. To prevent unauthorized application shut down, a password entry dialog box is displayed.



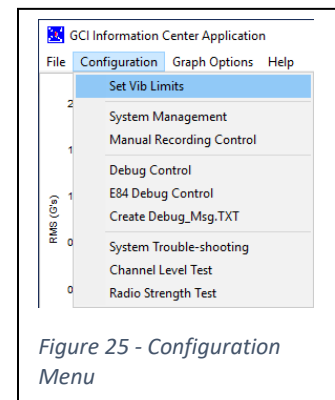
Configuration Menu

The Configuration menu contains options for setting vibration Location Tag display limits, and System Management fields. Additional options are disabled and unavailable in the current release.

Configuration Menu - Set Vib Limits

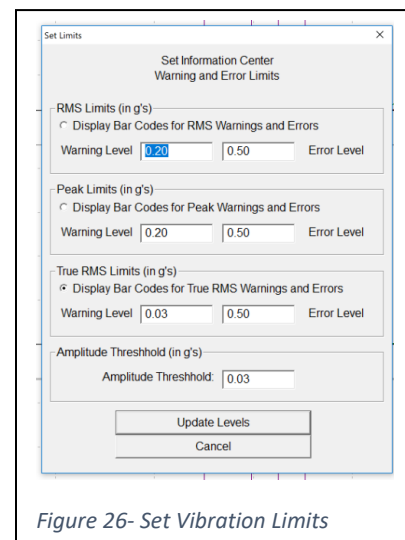
The Set Vib Limits option brings up a dialog box that can be used to set vibration limits that are used while displaying location tag information.

Location tags can be recorded at a rate up to ten per second. Graphing all received tags would muddy the graph window and not provide any helpful information. This screen allows the user to define the vibration Warning and Error levels, which limit the number of tags displayed. The user can also select which reduction type is used to limit tag display.



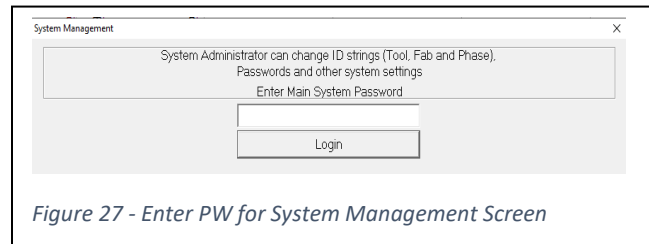
Select the reduction type by clicking one of the three radio buttons – RMS / Peak / True RMS. Then, enter a value in the associated fields for Warning and Error levels (minimum of 0.03). Tags associated with data points of that reduction type that are below the Warning level and not displayed. Tags associated with data points that are between the Warning and Error levels, are displayed in Black. Tags associated with data points equal to or greater than the Error level are displayed in Red.

The Amplitude Threshold value is used to compute the 'N' reduction type (which is not graphed, but is included in the associated .CSV file). This data type represents the number of frequency bins for that sample period that exceed this setting.



Configuration Menu - System Management

The **System Management** option requires entry of the main system password. Once the correct password is entered, the full System Management dialog box is displayed. This dialog box is used to define most system options.



Note: there are different versions of the InfoCenter App that provide different features (based on end customer requests). This document describes all features, some of which may not be available in all versions.

ID Strings

The App provides three fields to define the InfoCenter hardware – **Tool**, **Fab** and **Phase ID**. These are free-format text fields that can be used to identify the physical location where the InfoCenter is installed.

These ID strings are included in all CSV files exported by the system. Additionally, the system log file is named using the Tool ID string. The **Fab ID** is defaulted to 'Fab' and the **Phase ID** is defaulted to 'Phase'. The **Tool ID** is defaulted to the InfoCenter serial number. Adjust these to match the physical location where the InfoCenter is installed.

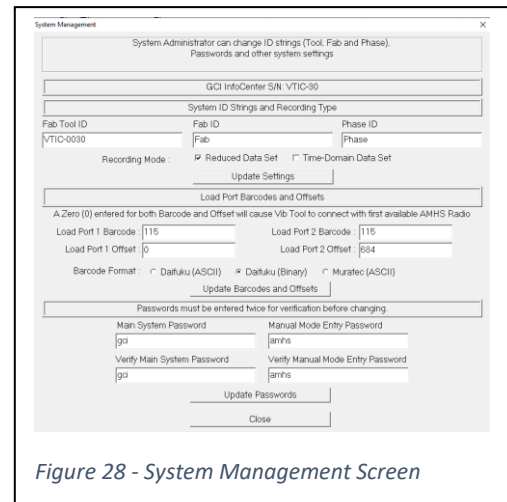
When enabled for **Time Domain Recording**, the App displays a pair of radio buttons just below the system ID strings. These buttons are used to set the desired recording type.

The GCI Vib Tool can record vibration data in one of two modes: **Reduced** or **Time Domain**. In either mode, the Vib Tool acquires 512 samples per second on each of the X, Y, and Z axes.

In **Reduced** mode, time domain data is reduced to frequency domain data records on the Vib Tool in real-time during recording. In this mode, the time domain data is discarded and is not available for analysis on the PC. Two data records are produced each second containing X, Y, and Z axes values for Legacy RMS (upper graph), Peak Vibration (middle graph) and True RMS (lower graph). Also calculated are the frequency where the peak vibration occurred and the current battery levels. While these values are not available to graph directly, they are included in CSV output files.

In **Time Domain** mode, the 512 samples per second of vibration data are directly streamed into the data file. No on-board reduction is performed. In this mode, the battery levels are not recorded. When a time domain data file is uploaded to the PC, the data is reduced using the same process provided by the on-board reduction. The same set of reduced data points are then graphed. Additionally, the time domain data is written to a legacy file compatible with the GCI VibPlot Application. This is a stand-alone application provided by GCI that allows time domain data to be analyzed graphically. VibPlot comes pre-installed on the InfoCenter PC.

Default recording mode is set to **Reduced**. Data is recorded in the selected mode until changed.



If any of the above options are changed, the user should click the 'Update Settings' button to save the changes.

Load Port Barcodes

When enabled for **LP Location Details**, the App will display a section showing Load Port Barcode and Offset details. When recording is started (by the AMHS unloading a Vib Tool from one of the LPs), the Vib Radio attempts to synchronize with an AMHS Radio installed in the vehicle. If more than one AMHS Radio is within range, there is a risk that the Vib Radio will sync with the wrong AMHS Radio. To prevent this, the InfoCenter provides a way of defining the Bar Code and Offset associated with each LP. Note: this feature only works if the AMHS is configured to continuously send location information to the AMHS Radio. During the unload cycle, the AMHS vehicle is stationary over the InfoCenter load port, and should be sending the same location information until the unload completes.

The AMHS must have location details defined for each load port in the fab. These location details allow the AMHS vehicle to stop at the correct position along the track to interface with the desired load port. When the InfoCenter is positioned in the fab, and the two LP positions are taught to the AMHS vehicle, the location details should be entered into this dialog box. This only has to happen once following installation of the InfoCenter (and each time the InfoCenter is physically moved within the fab).

Load port location is defined by a Barcode and an Offset. The Barcode is a physical bar code detected by the AMHS vehicle as it moves around the fab. The Offset is a physical distance since the last Barcode was scanned, in millimeters.

The InfoCenter sends the appropriate LP location details to any Vib Tool placed on one of the LPs. When recording starts, the vehicle picking up the Vib Tool is sending bar code packets to the AMHS Radio, which in turn sends the packets to the Vib Tool during the syncing process. The Vib Tool will know the barcode and offset of the LP it is being picked up from, so it can filter out barcode packets from other AMHS radios in range and sync to the correct vehicle.

Barcode Format

Just below the barcode and offset fields is a set of radio buttons that are used to define the barcode format to expect from the AMHS Radios used by the fab. AMHS Radios are configured by GCI for use with a single type of vehicle. The Vib Radio can receive any of three different barcode formats. The InfoCenter uses this information to inform the Vib Radio of which barcode format to expect. It must match the format defined in the AMHS Radios used by the fab. This feature is tied to the **LP Location Details** option.

If the Barcode and Offset fields for a specific LP are set to zero (0), the Vib Tool will not be able to filter out multiple AMHS Radios when attempting to sync at the start of recording. In this case, the Vib Radio will sync to the first AMHS Radio that responds in the syncing process. If there is only one AMHS Radio in range, it is almost certain that the Vib Radio becomes sync'd to the correct AMHS Radio. If there are multiple AMHS Radios in range, there is a high likelihood that the Vib Radio will sync to the wrong AMHS Radio. This becomes a serious problem in two ways.

First, the location packets received (and recorded) will not exactly match the physical location of the vehicle carrying the Vib Tool. This will make analysis of the resultant vibration data very difficult.

Second, the Vib / AMHS Radio pair has a fixed range. Once the two vehicles (the one actually carrying the Vib Tool, and the one with the AMHS Radio improperly sync'd) start to move away from each other,

the link between them will be broken and no additional location packets will be received by the Vib Radio. This in turn will result in a vibration data file containing valid vibration data, but no location tags.

Default Barcode and Offset values for both LPs are set to zero (0). This will work for initial setup, as the Vib Tool will sync to the first AMHS Radio that responds in the sync'ing process. If they are left at their default values, ensure there is only one AMHS Radio in range when starting recording. The Barcode Format type is defaulted to match the AMHS Radio format ordered with the system.

Use the 'Update Barcodes and Offsets' button to save any changes.

Passwords

There are two passwords used by the system. The first is the Main System Password. Entry of this password is required to shut down the App and to open certain configuration dialog boxes.

The second password can be used when moving a LP into Manual Mode. Each LP can run in two main modes, Automatic and Manual. When in Automatic Mode, the LP is available for automated AMHS loads and unloads. Changes to the LP FOUP status sensors (Presence / Placement) outside of an automated AMHS transfer are considered an error event. This moves the LP into an error state but leaves it in Automatic Mode.

When switched to Manual Mode, the LP is no longer available for automated AMHS transfers. FOUPs can be manually loaded / unloaded without triggering an error condition.

As the primary function of the InfoCenter is automated recording, having both LPs in Automatic Mode is essential. There may be times when manual intervention with the InfoCenter is required, but unauthorized changes to Manual Mode should be avoided. To prevent this, any attempt at switching a LP to Manual Mode will trigger the display of a password entry dialog box. Either the Main System or the Manual Mode Entry password must be entered before the LP is switched to Manual Mode. No password is required to move a LP from Manual to Automatic mode.

Main System Password is defaulted to **gci**. Manual Mode Entry Password is defaulted to **amhs**. Change them as desired.

If a change is desired for either password, the new value should be entered twice, once in the top password field and once in the **Verify** password field. Use the 'Update Passwords' button to save any changes.

Use the 'Close' button to close the dialog box. Note that changes are not saved unless the associated 'Update' button is pressed prior to closing the dialog box.

Configuration Menu - Manual Recording Control

This option provides a mechanism for the user to manually start recording sessions on Vib Tools that are sitting on the InfoCenter LPs. Normally, recording sessions are started when the AMHS picks up the Vib Tool during an automated unload process. This is the preferred method as vibration recording sessions can be scheduled through the fab control software.

There are times, especially during initial setup, where it is desired to start a recording session without the AMHS. As this process removes the LP from normal operation, a password is required. When this option is selected, the Manual Recording Control window is displayed. The main system password is required.

Once a valid password is entered, additional buttons are added to the dialog box, one for each LP that is in the **Ready to Unload** state. When clicked, the 'Start Recording On...' button starts a manual unload cycle and triggers the Vib Tool to start recording. The LP is switched to Manual Mode, allowing the FOUP to be removed manually. The LP remains in Manual Mode after the FOUP is removed.

The FOUP can then be carried / transported to the area where vibration data is to be recorded.

Note that when recording starts, the Vib Radio attempts to sync with an AMHS Radio. If the Vib Tool is being moved around the fab by a vehicle that contains an AMHS Radio, the barcode and offset will likely not match that defined in the App. Under normal operation, the Vib Tool will only synchronize to an AMHS Radio whose vehicle is at the barcode and offset location defined in the App System Management dialog box (unless they are set to zeros [0]).

Manual Recording assumes that the AMHS is not unloading the FOUP from the InfoCenter LP. This means that the vehicle will be at a different barcode / offset location. If the Vib Radio is configured to use a specific location, it will never sync to the AMHS Radio. To ensure that the Vib Radio can sync with the AMHS Radio in a vehicle at any location, the barcode and offset values are reset to zero, which will allow the Vib Radio to sync with the first AMHS Radio in range.

Care must be taken that only the desired AMHS Radio is within range when starting manual recording. Once the Vib Radio is sync'd with an AMHS Radio, it remains sync'd until recording has completed. If the Vib Radio syncs with the wrong AMHS Radio, the location tags from that vehicle will be recorded, as long as the two vehicles are within range of each other. Once they move out of range, no additional location tags will be recorded.

When ready to complete recording, place the FOUP back on one of the InfoCenter LPs. If the LP has been switched to Automatic Mode, it should first be returned to Manual Mode.

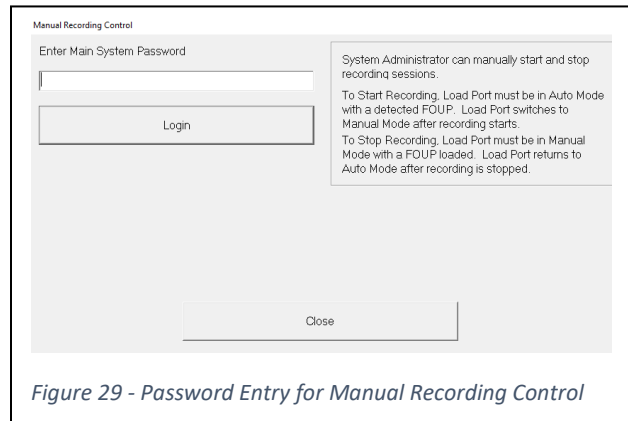


Figure 29 - Password Entry for Manual Recording Control

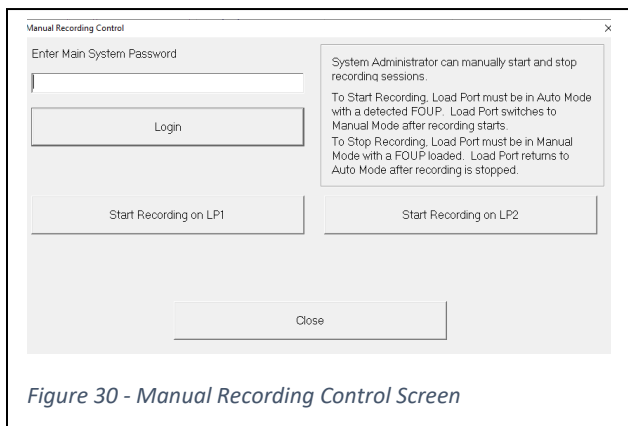


Figure 30 - Manual Recording Control Screen

Once back on the LP, the Vib Tool automatically terminates recording. The user switches the LP back to Automatic Mode (using the Auto / Manual button on the LP). The InfoCenter runs a discovery process to link the Vib Tool to the LP. When that process completes, the recorded data file is automatically uploaded and processed. The LP remains in Automatic Mode, but is unavailable for AMHS transfers until the upload process completes.

Use the 'Close' button to close this dialog box.

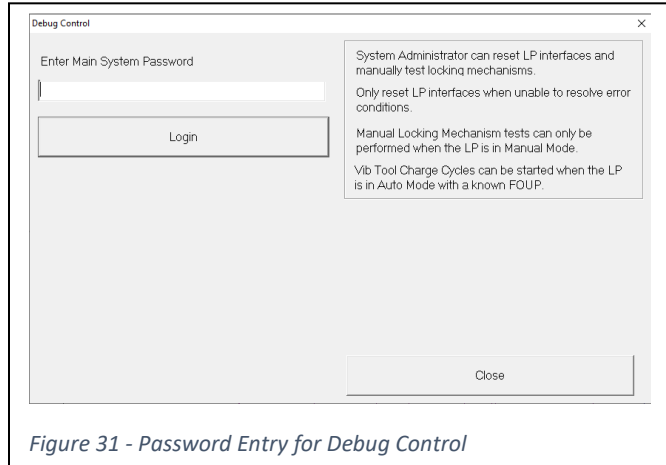


Figure 31 - Password Entry for Debug Control

Configuration Menu - Debug Control

The **Debug Control** option provides the user with options to start or stop a charge cycle for a given Vib Tool. It also provides a method of resetting the LP communications interface. These options require the entry of the Main System password.

Once the password has been entered, buttons are added to the dialog box for each option available at that time (based on Vib Tool status). If Vib Tools are present (and idle) on a LP, a 'Start Vib Tool Charge' button is displayed. If a Vib Tool is currently running a charge cycle, either started by the system or started manually using this dialog box, a 'Stop Vib Tool Charge Cycle' button is displayed.

The system will automatically maintain proper battery levels on any linked Vib Tools, so these options should only be used when it is absolutely necessary. Batteries can be damaged, causing a shortened life, if they are repeatedly charged when a charge cycle is not required. Additionally, charge cycles that are terminated prematurely may leave battery levels below their full potential, which may decrease recording time.

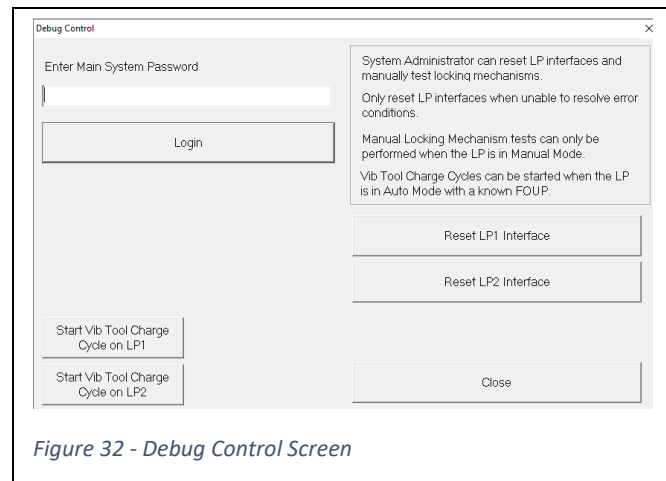


Figure 32 - Debug Control Screen

Reset LP Interface

Two option buttons are always displayed on the right side of the dialog box. These provide a mechanism for resetting the communications interface for either LP1 or LP2. These buttons do a full functional reset on the LP communications and control boards. They can be used for recovery attempts if one of the LPs becomes locked in an unrecoverable error state. These options are last-ditch efforts to recover the system, short of doing a full system shut down and restart.

While provided, and functional, there is no guarantee that an LP interface reset will recover the system. If problems persist, close down the App, then power down the InfoCenter using the EMO button. Re-power the InfoCenter (by releasing the EMO button) then re-start the App. If the system does not initialize properly, do a full shut down including the PC and restart.

Any time there is a need to restart the system in this way, detailed notes should be made about the situation that triggered the problem. This should be shared with GCI support (support@getcontrol.com).

Configuration Menu - E84 Debug Control

This menu option provides a dialog box that can be used to set E84 timeout parameters used by the AMHS system, and to manually trouble-shoot the E84 Interface. Both LPs must first be switched to Manual Mode and the Main System Password must be entered.

The **E84 Debug Control** window provides entry fields for the five TP and three TA timeout values defined by the SEMI® E84 specification. These values govern the behavior of timeout errors during E84 transfers (automated loads and unloads). If any values are modified, use the 'OK' button to close the window and save the changes.

Default values are provided for all timeouts based on the defaults defined by the SEMI® E84 Specification.

LED icons are displayed for the eight E84 inputs and eight E84 outputs for each LP. They are displayed showing their current state (on or off). Inputs are labelled using the E84 defined signal names (VALID, CS_0, CS_1, AM_AVBL, TR_REQ, BUSY, COMPT, CONT) as well as the GO signal, which indicates optical transceiver communications with a second transceiver. Outputs are also labelled, and each provided an option button that will change their state. Buttons are included for all defined E84 outputs (L_REQ, U_REQ, VA, READY, VS_0, VS_1, HO_AVBL, and ES).

This screen is supplied solely as a debug option if E84 problems ever occur.

Configuration Menu - Create Debug_Msg.TXT

This option can be used to gather debug information into a special folder that can then be placed in a compressed file (.ZIP) and emailed to GCI for analysis. When selected, this option copies the following files into the **D:\Data\Debug** folder (replacing all files currently located there):

- System configuration files (settings.cfg / system.cfg)
- System Log files for today and yesterday
- Raw upload files used during data upload (LP1_UPLOAD.* / LP2_UPLOAD.*) from the main application folder (C:\GCI-InfoCenterApp (OHT))

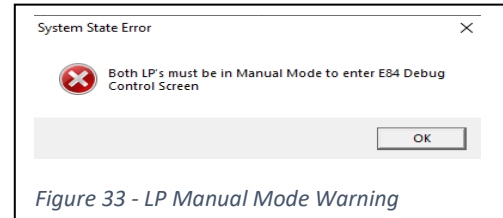


Figure 33 - LP Manual Mode Warning

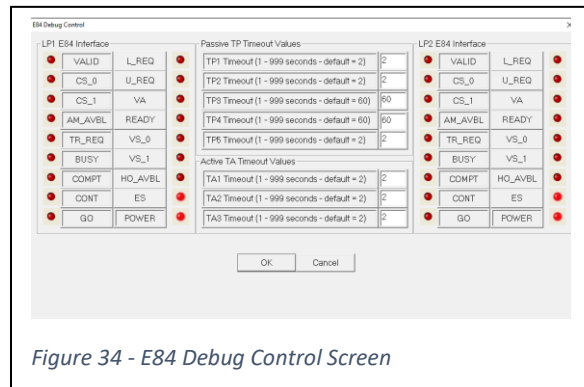


Figure 34 - E84 Debug Control Screen

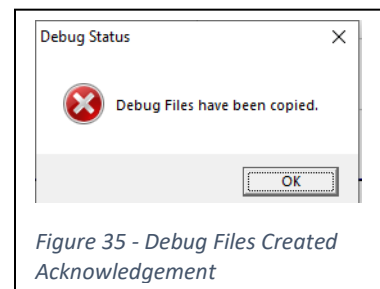


Figure 35 - Debug Files Created Acknowledgement

- All data files from today and yesterday, from the main data file folder (D:\Data\RDU)

If problems occur that require support from GCI, first generate the file set using this menu option. Then, send the folder to a compressed file (using the Windows Explorer option **Send to Compressed (zipped) folder**). Open Windows Explorer and navigate to the **D:\Data** folder. Right mouse-click on the Debug folder and select the **Send To >** option from the drop down menu, then select the **Compressed (zipped) folder** option. Windows will prompt for a filename. Make note of the filename and location.

Locate the file created and email it to support@getcontrol.com. Include details about the problem discovered.

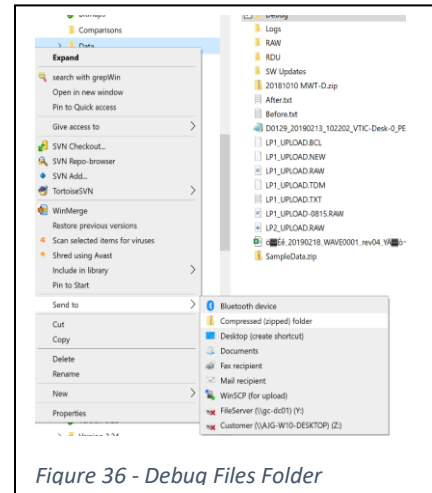


Figure 36 - Debug Files Folder

Configuration Menu - System Trouble-shooting

This option provides some basic trouble-shooting features that can be used to verify operation of the LP control boards. The Main System password is required and both LPs must be in Manual Mode.

This is a beta level trouble-shooting screen. It is not fully formatted for release, but is included in the event it can be helpful. It provides option buttons that will force the illumination of each control board status LED. If, during normal operation, a status LED isn't lit when expected, this screen can be used to verify that the LED itself is working.

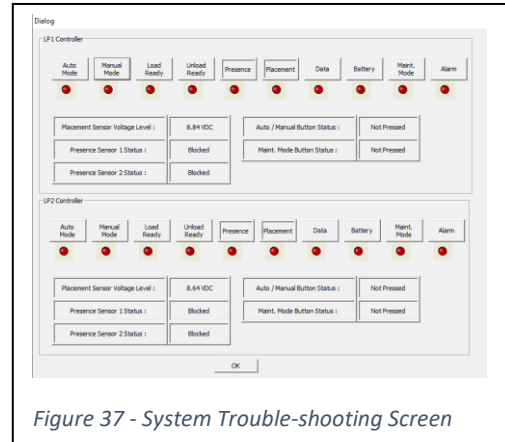


Figure 37 - System Trouble-shooting Screen

Click the button shown above each LED indicator to turn the associated LED on and off. Separate LED indicators and buttons are available for each LP. Note that the Placement and Presence LEDs are not controllable via option buttons. These LEDs are directly tied to the status of FOUP placement and presence sensors. Block the two Presence sensors to test the Presence LED. Place an instrumented FOUP containing a Vib Tool to test the Placement sensor LED.

Status information is displayed for each LP:

- Placement Sensor Voltage Level
 - The current voltage level measured on the LP charge contacts is displayed. This value will be close to zero when the LP is empty, and should be in the range of 7 to 9 VDC when an instrumented FOUP with a Vib Tool is present.
- Presence Sensor 1 Status
 - The current status of the front Presence sensor is shown. Block and unblock the sensor to see this value change.
- Presence Sensor 2 Status
 - The current status of the rear Presence sensor is shown. Block and unblock the sensor to see this value change.

- Button Status
 - The current state of the **Auto / Manual** and **Maint. Mode** buttons are displayed. Press one of the buttons to see its state change.

Configuration Menu - Channel Level Test

This option is disabled. It is reserved for trouble-shooting at the factory.

Configuration Menu - Radio Strength Test

This option is disabled. It is reserved for trouble-shooting at the factory.

Graph Options Menu

The **Graph Options** menu provides access to graph configuration settings. The current version of the App supports reduced data graphs for Legacy RMS, Peak and True RMS vibration data. Future releases will also support several time domain data graphs. This menu shows a set of disabled options related to those options that will be added to future versions.

The App supports recording vibration data in either Reduced or Time Domain mode. When time domain data is uploaded, a separate application is required for analysis. The VibPlot Application is pre-installed on the InfoCenter PC (and is available from GCI for stand-alone PCs). This application displays several types of graphs based on the recorded time domain data.

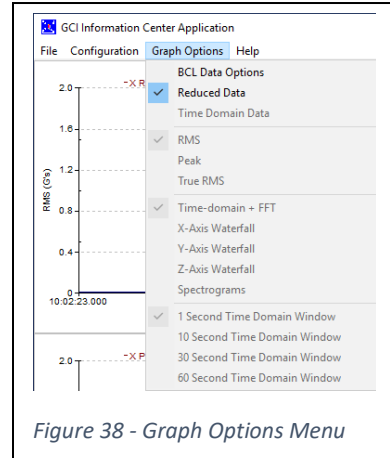


Figure 38 - Graph Options Menu

Future releases of the App will incorporate those graphs provided by VibPlot. When a time domain data file is uploaded or opened, the graphing options on this menu will become enabled. The main option will switch between Reduced Data and Time Domain graphs. Currently, only the Reduced Data option is available.

In Reduced Data mode, three graphs are available: Legacy RMS, Peak and True RMS. These three are always displayed in the graphing window, and are the only graphs available for data recorded in Reduced Data mode. When a Time Domain data file is open, the user can switch between Reduced and Time Domain graphs. When Time Domain graphs are selected, the user has the additional option of selecting which graphs are displayed, to match those options in VibPlot.

BCL Data Options

One additional menu option is available in preparation for a future release. This option, BCL Data Options, allows the user to configure barcode packet data and select how it is graphed.

AMHS Radios that are configured for Daifuku (Binary) format receive a customized 16-byte data packet from the AMHS Vehicle. This packet includes several data fields that record vehicle information. This option is only available when the barcode format is set to 'Daifuku (Binary)'. When selecting this menu option, the **BCL Data Options** window.

This window can be used to set axes limits for each supported data type, along with a conversion factor used to convert the binary data to the desired units.

Target Speed and ACS Input have individual settings for Minimum, Maximum, Axis Label and Conversion factor. The four Analog data fields (F1, F2, R1, R2) use a common set of Minimum, Maximum, Axis Label and Conversion factor fields.

Barcode information is always graphed on each of the three standard plots (RMS, Peak, and True RMS). All other data types can be individually selected to graph on any (or all) of the three plots. Mark the checkbox next to each data type for the graph type to display on.

Additionally, line colors can be selected for each data type.

Save any modifications by using the “OK” button. This button will save the current settings and close the window. The “Cancel” button will undo any changes and close the window.

When the next InfoCenter release is ready, settings on this window will affect the display of BCL data on the three main graphs in the Graphing Window.

Help Menu

This menu provides an option to display the About dialog box.

This dialog box shows the version number for the currently running App.

Load Port Status Window

The App displays text strings in the LP Windows for each LP, describing the LP status. These status messages provide an indication of the current LP state. The following list describes status messages displayed in the LP Window, along with a more detailed description of the associated LP state. Note that this list is based on the current release of the App and could change in future releases.

- LP# Initializing
 - The LP is going through an initialization process. Communication links are being established between the App and the LP hardware.
- System Initialization Error
 - An error has occurred while initializing the LP control board or SPC. Specific error messages are displayed in a dialog box. An EMO power cycle and App restart may be required to return the system to normal operation.
- LP# Controller Error
 - A more specific indicator that communications problems exist between the App and the LP control board.

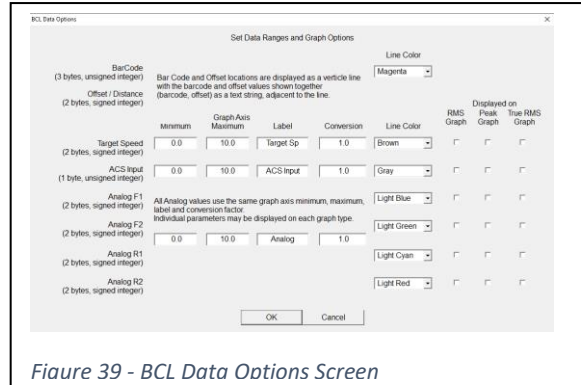


Figure 39 - BCL Data Options Screen

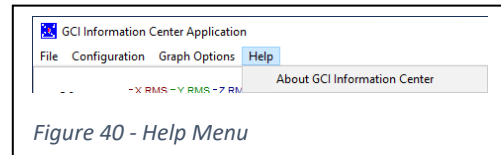


Figure 40 - Help Menu

- LP# SPC Error
 - A more specific indicator that communications problems exist between the App and the LP SPC.
- LP# Disabled
 - Due to an initialization error, the LP is disabled. The App is unable to establish communications with the LP hardware.
- Mis-Positioned or Non-Instrumented FOUP
 - FOUP Presence sensors are blocked but no Vib Tool battery is detected on the Placement sensor contacts. Only instrumented FOUPs (or Reticle Pods) containing GCI Vib Tools should be placed on the InfoCenter LPs.
- Identifying FOUP: #####
 - Discovery attempt is in progress. The App is attempting to link to a FOUP containing Vib S/N #####
- S/N ##### Connected to LP#
 - Successfully linked S/N ##### to LP. This is the successful completion point of the discovery attempt.
- Start of Upload Routine
 - Once linked to the Vib Tool, the App checks to see if it has recorded data to upload. This message indicates the upload process has started.
- Upload Complete - Converting Data File
 - The upload process has completed successfully and the data file is being processed.
- S/N ##### - Battery Voltage: #.## V ##.# C
 - When a Vib Tool is linked to a LP, its battery level and temperature values are updated twice a minute.
- Failed to Sync to FOUP: #####
 - This indicates that the discovery attempt has failed for the given Vib S/N. The App retries the discovery attempt on ten (10) second intervals.
- Go To Manual Mode to disable retry attempt.
 - The App has been unable to establish a link to the Vib Tool. Discovery retries are schedule every ten (10) seconds. If discovery failures continue, this message is informing the user that the discovery process can be terminated by switching the LP to Manual Mode (using the Auto / Manual button).
- Starting Charge Cycle
 - The App has detected that the linked Vib Tool battery levels are low so a charge cycle has started.
- LP# Ready for Unload
 - There is a properly positioned, instrumented FOUP on the LP, and the App has linked to the Vib Tool it contains. The LP is ready to process an unload request from the AMHS.
- LP# Unload Started
 - An automated unload is in progress with the AMHS. Recording is initiated.
- LP# Unload Completed
 - The FOUP has been successfully unloaded from the LP. The LP immediately advances to the Ready to Load state.

- LP# Ready for Load
 - The LP is empty and enabled and ready to process a load request from the AMHS.
- LP# Load Started
 - An automated load is in progress with the AMHS.
- LP# Load Completed
 - The FOUP has been successfully loaded onto the LP. Recording will terminate at this time. The LP advances to attempt discovery of the Vib S/N.
- Manual Mode
 - The operator has moved the LP to Manual Mode. In this mode, the LP is not available for AMHS transfers. This is the only mode where a FOUP can be placed on or removed from the LP.
- Returning to Auto Mode
 - The operator has pressed the Auto / Manual button to move the LP from Manual Mode back to Auto Mode.
- ESTOP Switch Active
 - The LP E-Stop switch has been activated. This makes the LP unavailable for automated AMHS transfers.

Work Flow

This section attempts to describe the standard work flow when using the InfoCenter. This is a high-level description of the sequence of events taken during normal operation.

Startup

The InfoCenter is powered up, with or without FOUPs / Reticle Pods in place on the LPs. The InfoCenter App is started. The App initializes communications with the LP hardware. If sensors indicate there is a FOUP / Reticle Pod on LP1, a discovery attempt is started. The PC runs through an algorithm designed to uniquely identify the Vib Tool sitting on LP1 (as opposed to a Vib Tool on LP2 or sitting nearby). Once the Vib Tool has been identified, it is linked to LP1. Its serial number and battery information is displayed and the LP moves to the 'Ready to Unload' state. Once discovery (if necessary) is complete on LP1, the same process is repeated on LP2.

The final step of the discovery process is to upload any data file present on the Vib Tool. As this is a system startup sequence, it is not likely that the Vib Tool has any data to upload. See discussion of data upload process below.

If either LP is empty, instead of the discovery process, the LP is immediately moved to the 'Ready to Load' state.

If either LP detects an error condition (partially blocked FOUP sensors / non-instrumented FOUP found / communications problems with LP hardware), the LP will display an error message and enter the 'Error' state.

Assuming no errors have occurred, both LPs are now in Automatic Mode and are ready to interface with the AMHS for loads / unloads.

Automated Unload Cycle

At some point, the fab automation software will schedule an E84 unload of a FOUP sitting on the InfoCenter LP. When the vehicle arrives and starts the E84 transfer, the InfoCenter PC switches the LP to 'Unloading', which causes the 'Unload Ready' status LED to start flashing. The Vib Tool is instructed to start recording, using the recording mode defined in the **System Management** dialog box.

The Vib Tool initiates recording and the Vib Radio attempts to connect with an AMHS Radio for location tag processing. If the LP's **Barcode** and **Offset** values have been set to non-zero values (in the **System Management** dialog box), the Vib Radio will expect the AMHS Radio to be sending a matching barcode / offset packet, and will sync up with only that AMHS Radio. If these values are left at zero (0), the Vib Radio will sync up with the first AMHS Radio to respond to the sync request. This may not be the closest AMHS Radio.

When the E84 Unload has completed, the Vib Tool will be held by the AMHS vehicle, and the LP will switch to the 'Ready to Load' state. It is then immediately available for an AMHS Load Cycle.

The Vib Tool will be recording vibration data in the defined mode and will write any location packets received from the AMHS Radio into the data stream.

Automated Load Cycle

When the route defined by the fab automation software is complete, the vehicle will return to one of the InfoCenter LPs to deliver the FOUP. If a **Reticle Pod Adaptor** plate has been installed on one of the LPs, the destination LP must match the carrier type (FOUPs must be delivered to the standard LP / Reticles must be delivered to the LP containing the **Reticle Pod Adaptor**). If neither LP contains an adaptor, the FOUP can be delivered to either LP. It does not need to be delivered to the same LP it was picked up from.

Note: the InfoCenter does not distinguish between an LP with an adaptor and one without. It will not deny delivery of a FOUP onto a LP with the **Reticle Pod Adaptor** in place. The E84 Load Cycle will be allowed to start, but it will fail during the placement stage because the LP Placement sensor will never trip. The E84 cycle will terminate in an error condition. It is the responsibility of the fab to ensure that the delivery destination matches the carrier type.

When the vehicle arrives at the destination LP, the E84 Load Cycle will begin. The LP will move to the 'Loading' state and begin flashing the 'Load Ready' LED. When the load cycle completes (without error), the Vib Tool will automatically close the recording session. The LP then begins a new discovery attempt to link the Vib Tool to the LP. When the discovery attempt has completed, the Vib Tool informs the App that it has new data to upload.

Data Upload Process

If a newly discovered Vib Tool indicates that it has new data to upload, the LP remains unavailable for an AMHS Unload. The App initiates the data upload process. During the upload, status information is displayed in the LP Window showing the progress of the upload. The number of packets received is continuously updated.

The upload process can take a while. For long recording sessions, there is a large data file to upload. Due to limitations on packet sizes in the Zigbee protocol, the data file must be broken into a long series of small packets. It is not uncommon to have an upload process of thirty (30) minutes or longer. The upload time is directly related to the length of the recording session. It is also dramatically affected by

the recording mode. **Reduce Mode** records approximately 300 bytes per second. **Time Domain Mode** records nearly 2.5 kB per second.

Once data upload has completed, the raw data file is converted into several formats and the vibration data is displayed in the Graph Window. Details on data files is provided below in the section titled **Data Files**.

The current version of the App maintains all converted data files on the system hard drive (in the **D:\Data** file folder structure). Future releases will automatically connect to a network FTP server to upload selected data files.

Vib Tool Charge Cycle

Once data conversion is completed, the App queries the Vib Tool battery levels and determines if a charge cycle is required. If battery levels are below a specific level, the App initiates an automated charge cycle. This keeps the LP unavailable for an AMHS unload. During the charge cycle, the App continuously monitors and displays Vib Tool battery levels. Charging algorithms in the Vib Tool firmware automatically terminate the charge cycle when the batteries have reached their charge limit.

The Vib Tool notifies the App when charging has completed. At that time, the App switches the LP to the 'Ready to Unload' state, making the Vib Tool available for a new recording session.

Manual Mode

When the LP is in Automatic Mode and is either 'Ready to Load' or 'Ready to Unload', it can be switched to Manual Mode using the LP **Auto / Manual** button. There may be situation where the user needs to interface with the LPs manually. If FOUPs are placed on or removed from LPs while in Automatic Mode, error events will be triggered.

When manual interaction is needed, switch to Manual Mode. This disables AMHS transfer support and properly closes the link between the LP and a connected Vib Tool.

When manual interaction with the LP is complete, it should be switched back to Automatic Mode using the **Auto / Manual** button.

Data Files

When the data file upload has completed, the App converts the data into several formats. The data format uploaded is not directly compatible with the graphing functions in the App. All data files created as a result of the upload process share the same file naming convention. The files are placed in various folders in the D:\Data folder structure. The filename format is:

[BCL Type][Vib S/N]_[Date]_[Time]_[VTIC S/N]-[LP Num].[File Type]

where:

- [BCL Type] is the bar code format time recorded. This can be one of the following codes
 - D – Daifuku BCL format, either ASCII or Binary
 - M – Muratec BCL format
 - N – No BCLs recorded in the data file
 - C – Combined BCL format. The data file is likely corrupted because the App found different types of BCL packet data in the uploaded file. While the Vib Radio will record any of three formats of BCL packets, different types should never exist in the same data file.

- [Vib S/N] is the serial number of the Vib Tool that recorded the data file. This can be used once data files are transferred onto a main server, to determine which Vib Tool was used.
- [Date] is a date stamp of when the recording session started, in the form yyyyymmdd.
- [Time] is a time stamp of when the recording session started, in the form hhmmss.
- [VTIC S/N] is the serial number of the InfoCenter that uploaded the data. This can be used once data files are transferred onto a main server, to determine which InfoCenter was used.
- [LP Num] is the load port number where the upload process was performed.
- [File Type] is a file extension that defines the data format used in creating the file.

Raw Data File

The raw uploaded file is copied to the D:\Data\RAW folder and saved with a .RAW file extension. This file represents an exact copy of the file uploaded from the Vib Tool. This file is not in a format that can be graphed or imported into any other applications. It is saved for archival purposes only. The App converts this raw data file into several different data types as follows.

Legacy VibPlot File

When uploading **Time Domain Mode** data files, an additional raw data file is created for use with the VibPlot Application. The current release of the InfoCenter App does not support graphical analysis of time domain data. Instead, the GCI VibPlot Application is used.

While the InfoCenter App supports location tag records in recorded data files, the current version of VibPlot does not. A raw data file opened by VibPlot will produce erroneous vibration data plots. To correct this, the App converts the raw time domain data file to a file format compatible with VibPlot. Location tag records are removed and the time domain data is written in the VibPlot format.

Legacy raw files are given a .DAT file extension and have '-Legacy' appended to their file name.

Raw Debug Text File

During the initial conversion process, a debug text file is generated based on the raw data file. It is created in the D:\Data\RAW folder and takes a .TXT file extension. It provides an ASCII text-based analysis of the reduced vibration data and location packets from the uploaded data file. For files recorded in **Reduced Mode**, this is a direct conversion from the raw data file to ASCII. For **Time Domain Mode** files, this is a record of the data following PC based data reduction.

The file starts with header information recorded about the Vib Tool recording session. This is followed by separate lines detailing each data record, shown as a series of hex bytes. Location records are appended by a text string conversion of the actual barcode and offset values.

This file is only used for debugging uploaded data files that appear to have conversion errors. It is not used for normal data processing.

InfoCenter Reduced Data File

The raw data file is then converted into a format compatible with the InfoCenter graphing routines. This reduced data file is created in the D:\Data\RDU folder and given a .VIB file extension. This is a proprietary binary formatted data file only compatible with the InfoCenter App (both Desktop and OHT versions). It cannot be read using any other application.

This becomes the main InfoCenter data file. When the **File / Open Data Set** menu option is selected, the App opens the D:\Data\RDU folder and displays a list of .VIB files.

CSV Files

The App automatically generates as many as four types of CSV files. These files are written into the D:\Data\CSV file structure, under separate folders for each InfoCenter LP and each BCL format type. All CSV files are given a .CSV file extension. CSV Format 1 uses the standard filename format. Format 2 files get a '-2' appended to the filename. Format 3 files get a '-3' appended to the filename. Time Domain Format files get a '_TimeDomain' appended to the filename.

CSV Format 1

The first CSV format file provides one line for each vibration data record in the data file. The first line contains header details for columns in the data file:

- Fab ID – from the text defined on the **System Management** dialog box.
- Phase ID – from the text defined on the **System Management** dialog box.
- Tool ID – from the text defined on the **System Management** dialog box.
- Tool S/N – Fixed value defined by the factory.
- Vib S/N – Serial number of the recording Vib Tool
 - The above five columns are included in every data line
- Vib Ver. – Firmware version of the recording Vib Tool
- Start Date – Recording session start date
- Start Time – Recording session start time
- Limit Type – Data type selected for Warning and Error limits
- Warning Limit – Vibration level that triggers a Warning indicator
- Error Limit – Vibration level that triggers an Error indicator
- # Records – the total number of ½ second reduced vibration data records
- # Location Tags – the total number of barcode / location tags in the data file
- # In Spec. – total number of vibration data records that fall below the Warning Limit value
- # Warnings – total number of vibration data records that fall between the Warning and Error Limit values
- # Errors - total number of vibration data records that fall above the Error Limit value
 - The above eleven columns define the recording session. They are listed only on the first line following the header details.
- Record Type – V: Vibration data in Spec. W: Vibration data above Warning Limit. E: Vibration data above Error Limit
- Time – Timestamp of the data record. Note: when importing the CSV file into Excel®, the cell format needs to be set to Custom (mark cells, right mouse click and select **Format Cell...** Select **Custom** from the **Category:** list. Enter the text string (no quotes) "hh:mm:ss.0" in the **Type:** field.). This will force display of the proper time and include the ½ second decimal.
- X, Y, Z RMS – Three columns, holding the X, Y, and Z RMS calculations for the data record.
- X, Y, Z Peak – Three columns, holding the X, Y, and Z Peak calculations for the data record.
- X, Y, Z True RMS – Three columns, holding the X, Y, and Z True RMS calculations for the data record.
- X, Y, Z > #.## g's – Three columns, holding the number of frequency bins (out of 75) that contain vibration levels that exceed the Amplitude Threshold value entered in the **Set Limits** dialog box. The threshold value is displayed in the column header.

- Bar Code – Barcode value of the BCL packet received closest in time to the data record. This and all subsequent columns dealing with the BCL are taken from the same packet. If multiple packets are received during the 500 milliseconds of time domain acquisition that make up this reduced data record, the last received just prior to the reduced data is listed. This reduces the number of BCL packets listed in the CSV file to a maximum of one per vibration data record.
- Offset – The offset, in millimeters, reported in the BCL packet.
- Target Speed, ACS Input, Analog F1, Analog F2, Analog R1, Analog R2 – Six columns of data fields from the BCL packet.
- Battery – Vib Tool battery level measured at the time of the data record. This is only provided for **Reduced Mode** data file. **Time Domain Mode** recordings do not record battery levels.

CSV Format 2

The second CSV format file duplicates all fields from the first CSV Format. It adds additional columns for up to five BCL packets for each vibration data record. Instead of reporting the last BCL packet received just prior to the reduced data record, all BCL packets (up to five) received during the 500 milliseconds of time domain acquisition are listed, in order. In place of the BCL columns provided in Format 1, Format 2 provides:

- Bar Code 1 – Data from the first barcode packet received during the 500 milliseconds of time domain acquisition.
- Bar Code 2 – Data from the second barcode packet received during the 500 milliseconds of time domain acquisition.
- Bar Code 3, 4, & 5 – Data from the next three barcode packets received (if available).
- Battery – Vib Tool battery level measured at the time of the data record.

For binary formatted barcode data, the five barcode packet columns are expanded to include separate fields for:

- Target Speed 1, ACS Input 1, Analog F1 1, Analog F2 1, Analog R1 1, Analog R2 1

These six columns show the ascii values of the binary data for each data field.

CSV Format 3

The third CSV format condenses recording details from extra columns in each data record to a set of header lines at the top of the file. Instead of each record having a column for Fab ID, Phase ID, etc. that information is listed first as a file header. A Record Type Legend is added, describing the four record types (V, W, E, and B). The following is an example:

Fab ID	Phase ID	Tool ID	Tool S/N	Vib S/N	Vib Ver.	Start Date	Start Time
Fab	Phase	VTIC-0030	VTIC-30	186	7.8	9/9/2019	10:02:23
Limit Type	Warning Level	Error Level	# Records	# Loc. Tags	# In Spec.	# Warnings	# Errors
TRUE RMS	0.1	0.5	123433	150197	123405	24	4
Record Type Legend							
V	Vibration Record Below Warning Level						
W	Vibration Record Above Warning Level, Below Error Level						
E	Vibration Record Above Error Level						
B	Barcode Data						

This header is followed by a column header line. With common details displayed in the header, data columns change to include only data record details. Additionally, instead of reporting BCL packet data

along with vibration data records, they are shown on separate lines, in the order they were received during recording. This provides a clearer picture of the order of BCL and data records written into the recorded data file.

- Record Type
 - V: Vibration data in Spec.
 - W: Vibration data above Warning Limit.
 - E: Vibration data above Error Limit.
 - B: Bar Code Packet.
 - Note – because of this separation, vibration data records only show vibration data and BCL records only show BCL data.
- Time
 - Timestamp of the data record. Note: when importing the CSV file into Excel®, the cell format needs to be set to Custom (mark cells, right mouse-click and select **Format Cell...** Select **Custom** from the **Category:** list. Enter the text string (no quotes) "hh:mm:ss.0" in the **Type:** field.). This will force display of the proper time and include the ½ second decimal.
- X, Y, Z RMS
 - Three columns, holding the X, Y, and Z RMS calculations for the data record.
- X, Y, Z Peak
 - Three columns, holding the X, Y, and Z Peak calculations for the data record.
- X, Y, Z True RMS
 - Three columns, holding the X, Y, and Z True RMS calculations for the data record.
- X, Y, Z > ### g's
 - Three columns, holding the number of frequency bins (out of 75) that contain vibration levels that exceed the Amplitude Threshold value entered in the **Set Limits** dialog box. The threshold value is displayed in the column header.
- Bar Code
 - Barcode value of a received BCL packet
 - The offset, in millimeters, reported in the BCL packet.
 - If binary formatted barcode packet:
 - Target Speed, ACS Input, Analog F1, Analog F2, Analog R1, Analog R2 – Six columns of data fields from the BCL packet.
- Battery
 - Vib Tool battery level measured at the time of the data record. This is only provided for **Reduced Mode** data file. **Time Domain Mode** recordings do not record battery levels.

CSV Time Domain Format

The final CSV format is only generated when a **Time Domain Mode** data file is uploaded. This format provides a condensed header section, showing the following:

Fab ID	Phase ID	Tool ID	Tool S/N	Vib S/N	Vib Tool Version	Start Date	Start Time
Fab	Phase	VTIC-0030	VTIC-30	188	7.8	8/10/2019	21:15:51

Immediately following this is a line of column headers describes the rest of the data records:

- Time Offset
 - decimal time since the start of recording. Time domain data is acquired at 512 Hz, so the time offset increments at a fixed 0.001953125 seconds (1 / 512 seconds). This value, along with the Start Time value from the header section, defines the time this particular record was recorded.
- X, Y, Z Axis
 - three columns, holding the X, Y, and Z time domain vibration levels recorded for the given time offset.
- Bar Code
 - Barcode and Offset from a BCL packet received at this time offset.
 - If binary formatted barcode packet:
 - Target Speed, ACS Input, Analog F1, Analog F2, Analog R1, Analog R2 – Six columns of data fields from the BCL packet received at this time offset.
- Note – not Vib Tool Battery level is recorded in **Time Domain Mode**.

Trouble-Shooting Guide

There are several issues related to the wireless communications used by the InfoCenter that can cause intermittent problems. This section attempts to explain those issues and offer suggestions on the steps to take to resolve them. While

InfoCenter App to Vib Tool Communications

Discovery

When a Vib Tool is first presented on a LP, before communications have been established, the system must go through a discovery process to link the tool with the LP. Because there is no direct link between the Vib Tool and the LP control boards, the system must verify that it is communicating with the correct Vib Tool. For example, at initial power up, if both LPs have Vib Tools present, the system needs a method of determining which Vib Tool is on which LP.

This discovery process attempts to isolate each Vib Tool and link the correct S/N with each LP. This process involves a set of command and response radio packets. The Zigbee radio implementation attempts to self-correct and account for wireless interference, which is on the same 2.4GHz band as standard wireless internet. While error checking is implemented, it is not a completely lossless system. This means that there is no guarantee that radio packets sent are properly received. Timeouts and retries attempt to correct for this, but there are times when a command / response cycle fails.

The discovery process is the most critical command / response period. If the PC fails to properly discover the Vib Tool, the LP will remain unavailable for AMHS transfers, making the Vib Tool unavailable for recording sessions.

Additionally, if the Vib Tool is physically powered off, it cannot respond to the discovery commands. This can happen if the Vib Tool is sent on an extended recording session with partially full battery status. The Vib Tool firmware monitors battery levels and forces a tool shutdown if levels drop below a specific threshold. This prevents the tool batteries from discharging past their usable state. The current generation of Vib Tools are configured to automatically power on (if off) when initially placed onto the InfoCenter LP. Even so, if discovery fails, verify that the Vib Tool is powered on. When on, the Vib Tool LCD displays the current tool status, and the attached Vib Radio will have lit status LEDs.

If discovery fails, the system will automatically retry the process every ten seconds. If discovery continues to fail, a power cycle on the Vib Tool may be needed. It is possible for the firmware in the Vib Tool or attached Vib Radio to become locked. A power cycle should return the firmware to normal operation.

Use the Auto / Manual button to switch the LP to Manual Mode during the ten second timeout period. Once in Manual Mode, open the FOUP and power cycle the Vib Tool. Once the Vib Tool completes its initialization process, close the FOUP and return the LP to Automatic Mode (again using the Auto / Manual button). Generally, a Vib Tool power cycle will recover the system and allow the next discovery attempt to complete successfully.

The final option if discovery continues to fail is a complete system shutdown and restart. Exit the App then power down the InfoCenter hardware (using the EMO button). Cycle power on all Vib Tools present. Re-power the InfoCenter (by releasing the EMO button) and restart the App.

Status Failures

Once a Vib Tool is properly linked to one of the LPs, the system requests status information twice a minute. This provides the App with the Vib Tool battery level along with other status information. If the Vib Tool fails to respond to the status request command, the system retries up to five times. If all five retries fail, the LP is temporarily switched to unavailable (HO_AVBL signal is dropped) to prevent an AMHS unload from starting. This is done to ensure that the Vib Tool is communicating properly when an unload starts so when the App sends the Start Recording command, the Vib Tool is in a condition where it will receive and process it properly.

The App requests status again thirty seconds later, which typically succeeds and the LP is returned to its ready state. If communications fail to re-establish, the LP will remain unavailable. It may be necessary to repeat the steps outlined above for discovery failures (switch to Manual Mode / power cycle Vib Tool / return to Automatic Mode).

While this type of communications failure is uncommon, it can happen if there is significant wireless interference near the InfoCenter. If this occurs frequently, and a wireless internet router is nearby, it might be necessary to move the InfoCenter to another location in the fab.

Failed Recording Session

While GCI has never had a report of a failed recording session, the possibility does exist. When the FOUP is unloaded by the AMHS, the App sends a Start Recording command to the Vib Tool. If this command fails to be properly received by the Vib Tool, recording will not start. Error checking and command retries drastically lowers the possibility of this occurring. If radio interference causes the Start Recording command to fail to reach the Vib Tool, it could be unloaded and moved out of range of the InfoCenter without it initializing a recording session.

If this occurs, no vibration data file will be available to upload after the FOUP is loaded back on the LP. There is no recovery from this error. If the Vib Tool successfully links to an InfoCenter LP during discovery, but no upload occurs, the Tool will be once again available for recording sessions.

AMHS to Vib Radio Communications

When recording is started, the Vib Radio attempts to sync with the AMHS Radio installed in the AMHS vehicle picking up the Vib Tool. If multiple AMHS Radios are within range, the Vib Radio uses barcode and offset data (if defined in the App) to select the correct AMHS Radio. Once linked, the two radios use a filtering algorithm to prevent cross talk from other AMHS / Vib Radio pairs.

As the vehicle moves around the fab, bar code packets are sent at a maximum rate of 10 times a second. Buffering, timeout and retry attempts are made to ensure that all bar codes sent by the vehicle are received by the Vib Radio and recorded in the vibration data file. If excessive wireless interference is present, these attempts may not be fully successful. In that case, it is possible for the resultant vibration data file to have missing bar code packets.

Packet numbers included in the data stream allow the App to cleanup these missing packets by adjusting the received bar code packet to the appropriate time slot in the recorded data file. There are no user interventions that can prevent lost packets.

InfoCenter Application - Desktop

The Desktop App is used to graphically display reduced data recorded by the Vib Tool. The Vib Tool can record data in two formats – **On Board Reduction** and **Time Domain**. Data recorded in **On Board Reduction** mode is graphed directly following the data upload process. **Time Domain** data is reduced during the upload process, and the reduced data is then graphed. Use the VibPlot Application to analyze the time domain portion of the data set. See the following section for information on the VibPlot Application.

The App provides options to connect to a GCI Vib Tool, display a list of recorded data files residing in the tool's internal memory, and select individual files for upload or deletion.

GUI

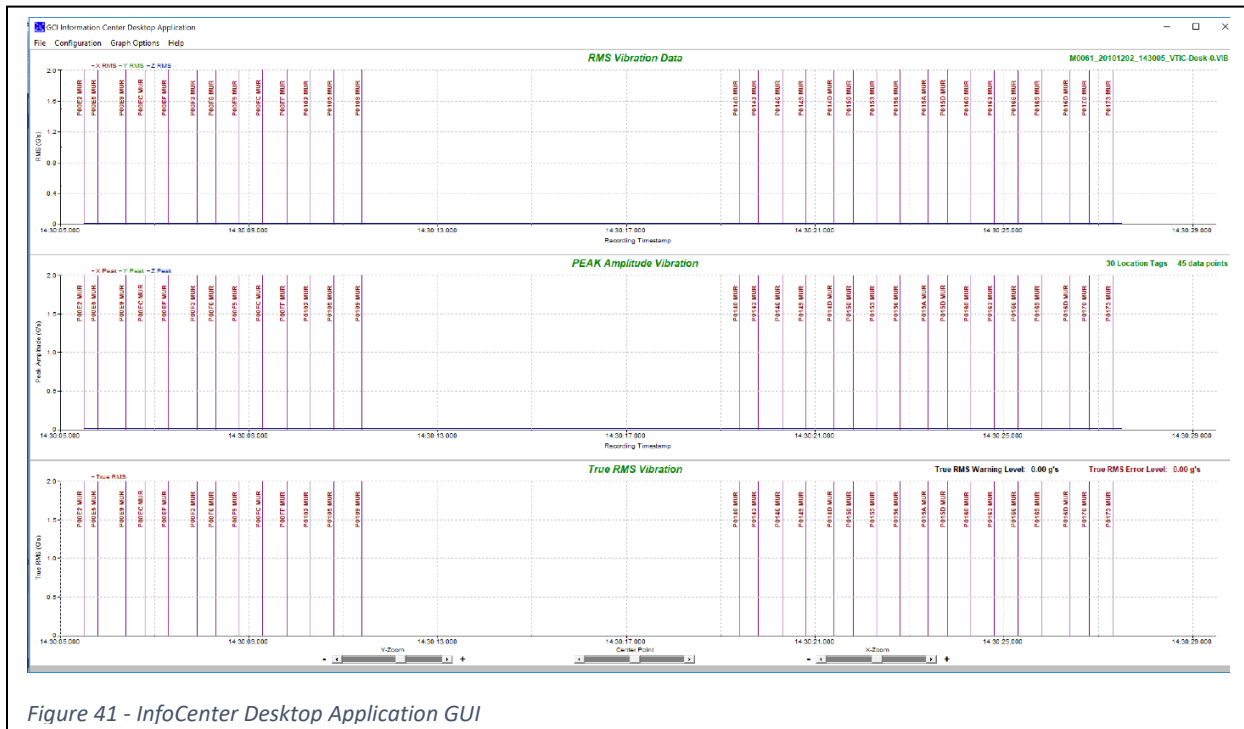


Figure 41 - InfoCenter Desktop Application GUI

When the App is started, it displays graphs from the last data file viewed. The GUI is split into three graph windows. The top graph displays Legacy Mode RMS data. The middle graph displays Peak Mode data. The bottom graph shows True RMS data. Each data type is described in more detail above.

Location Tags

The Vib Tool can be equipped with a radio that allows it to record fab location information supplied by AMHS vehicles that are configured with the GCI AMHS Radio. The AMHS radio receives location information from the AMHS vehicle through a serial port. It then transmits the location information to the Vib Radio connected to the Vib Tool (using a Blue Tooth wireless protocol). Contact GCI for additional information about the VibCom location recording.

When a data file has been recorded with an attached Vib Radio, location information is displayed along with vibration data. Location tags are shown by a vertical line, with the location tag information displayed near the top of the graph.

Zoom

The Y-Zoom slide bar can be used to adjust the Y Axis of the three graphs. The default setting for the Y-Axis is 2.0 g's.

The X-Zoom slide bar can be used to adjust the X Axis of the three graphs. When a data file is opened, the full data set is displayed, with the start recording time stamp shown as the X Axis origin. The X-Zoom slide bar zooms in on the center point, expanding the X Axis time scale.

The Center Point slide bar can be used to adjust the center point of the X Axis. This adjust the center point of the graph, moving zoomed data left or right.

File Menu

Options in the File Menu provides options to save the current data (in multiple formats), open new data files, and connect to the Vib Tool for data upload.

File Menu - Save Recorded Data

A standard Windows save file dialog box is displayed. The currently graphed data set will be saved to the entered filename.

File Menu - Open Data Set

A standard Windows open file dialog box is displayed. The selected data file is loaded and graphed.

InfoCenter Desktop Application data files are stored with a .VIB file extension. Data files uploaded from a connected Vib Tool are automatically stored in the Data \ RDU file under the installation folder (typically C:\GCI-InfoCenterApp (Desktop)).

File Menu - Connect to Vib Tool

The Connect to Vib Tool option first displays a password request dialog box. When the correct password is entered, the InfoCenter Desktop App provides additional option buttons that can be used to download firmware files to a connected Vib Tool. This is only used when a new firmware version is released by GCI and emailed to the end user, along with instructions for reprogramming the Vib Tool in the field. For normal operations, simple press the 'Cancel' button on the password request dialog box.

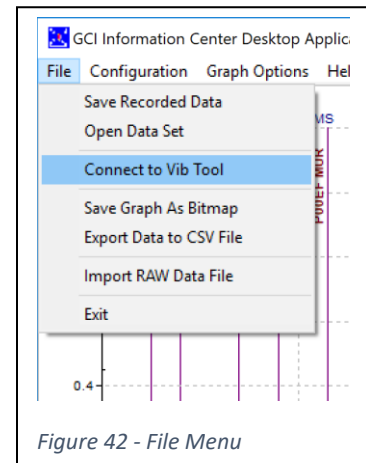


Figure 42 - File Menu

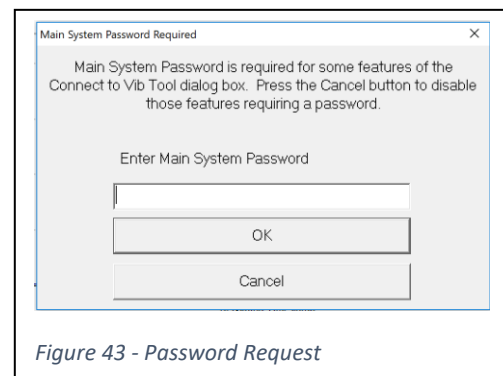


Figure 43 - Password Request

When the password request dialog box is cleared, the Connect to Vib Tool dialog box is displayed. This box shows a drop-down list of available communications ports. Connect the Vib Tool to an available port using the supplied 9-Pin, M/F cable. Power on the Vib Tool and navigate its menu system to the **Connect PC App** menu. Press the Enter key to display **Use PC App Menu / Enter to Abort**.

Select the port from the drop-down list and click the 'Connect' button.

If the PC fails to connect to the attached Vib Tool within a short timeout period, an error message is displayed. If this happens, verify that the Vib Tool is powered up and displaying the **Use PC App Menu / Enter to Abort** message. Also verify that the Vib Tool is connected to the selected communications port and that the cable is connected properly.

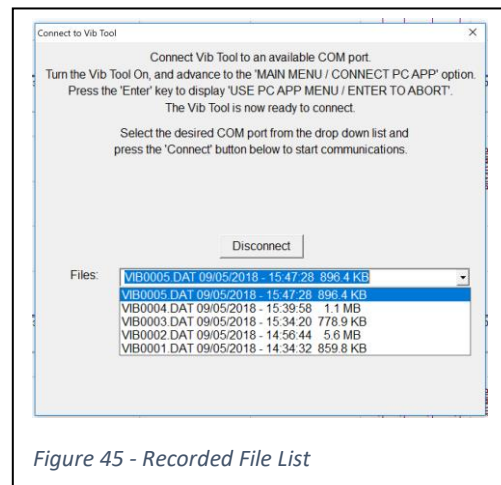
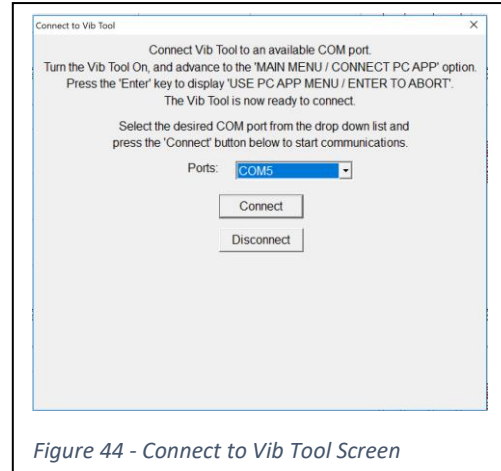
Once connected, the PC requests a list of recorded data files from the Vib Tool. This list is displayed in a drop-down list, sorted by file date. Note: file date is based on the Vib Tool's internal clock setting at the time recording was started. If the internal clock was not configured properly at that time, the file time / date stamp may show a file date of 01/01/2000 (or similar).

Connect to Vib Tool - Upload Data File

To upload a recorded data file, select it from the drop-down list and press the 'Upload' button. A message is added to the dialog box showing the estimated upload time.

Long **Reduced Mode** recordings create large data files, and even short **Time Domain** mode recordings can get very large. Upload baud rate is set to 115200, which is the fastest serial communications speed supported by most PC com ports, but large files can still take a long time to upload. Make sure you wait for at least the length of time displayed before assuming the upload is locked.

The Vib Tool monitors battery levels during recording and automatically powers off when levels become too low. When this happens, the recording data file is closed. Older versions of the Vib Tool firmware had a problem with properly closing the data file in this situation, causing an invalid file size to be reported.



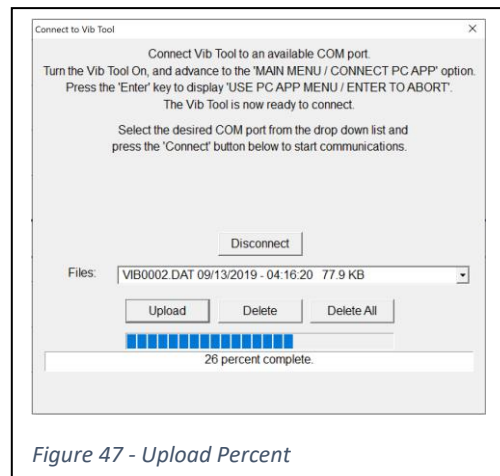
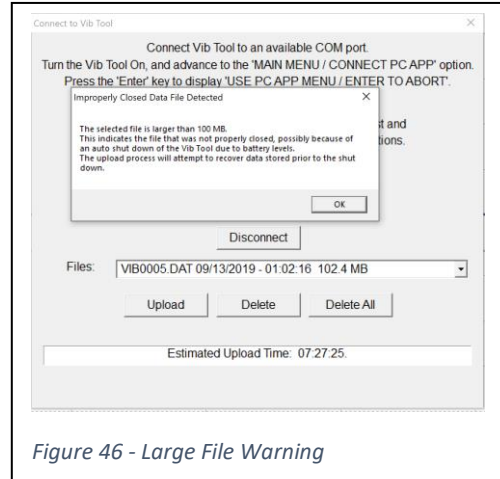
The App detects files selected for upload that have this size issue and warn the user that the upload process will attempt to fix the data file. Normally, data files are completely uploaded. For an improperly closed file, that would be 100+ MB, most of which does not contain valid vibration data. Instead, the upload process terminates the upload (and closes the file) when the uploaded data indicates no additional vibration data is present. An extra warning dialog box is displayed for this situation.

Once the upload process begins, a progress bar is displayed while the data file is uploaded. The width of the bar does not reflect the full upload. Instead, upload progress is shown by the bar repeatedly filling from left to right. This will continue until the data file has been completely uploaded. An upload percent indicator is displayed below the progress bar. This will count up from zero to 100 percent. Note that for very large data files, it may take some time to go for the estimated upload message to be replaced with the first percent complete message.

Data files from an upload session are automatically named by the InfoCenter Desktop App. Reduced data is stored in **Data\RDU** folder. Raw uploaded data files are stored in the **Data\RAW** folder. Filenames start with the Vib Tool's four-digit serial number, followed by a date and time stamp code, followed by the InfoCenter Desktop App ID (typically VTIC-Desk). The raw uploaded file will have the same name as that listed on the Vib Tool file drop down list, and will be of the form VIB####.DAT.

Additional data files are automatically generated, in the **Data\CSV** folder. These files duplicate the CSV file formats described in the OHT version above.

Once the data file has been uploaded, one or two dialog boxes are displayed, depending on the mode of recording used for the selected data file.



After uploading a **Time Domain** recorded file, a dialog box is displayed asking if the user wants to launch the VibPlot App to analyze the data. If directed to, the Desktop App attempts to launch the VibPlot App. If VibPlot cannot open for any reason, an error message is displayed. If this happens, manually launch VibPlot from the Start menu and load the data file from the VibPlot File menu. See the section below for information on running VibPlot.

When a **Time Domain** mode data file is uploaded, the InfoCenter Desktop App immediately reduces the data using the same techniques used during **On Board Reduction**. The reduced data is graphed within the InfoCenter Desktop App.

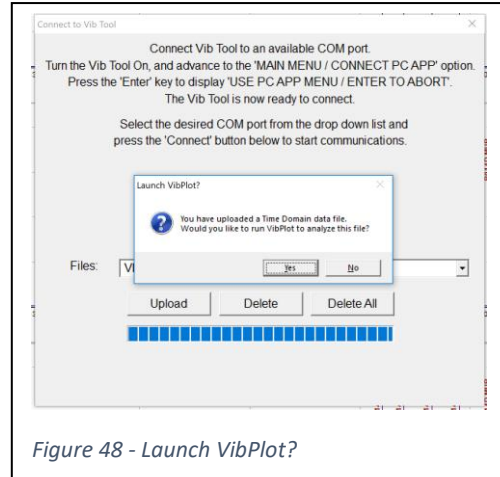


Figure 48 - Launch VibPlot?

Multiple files are saved on the PC following a Time Domain mode file upload. The reduced data is stored in the **Data\RDU** folder. Raw uploaded data files are stored in the **Data\RAW** folder. Raw files include a legacy time domain data file that is compatible with VibPlot. The raw uploaded file is not directly compatible with VibPlot. The Desktop App converts the uploaded file to one compatible with VibPlot. It appends the string '-Legacy' to the file name, and saves it with a .DAT file extension.

When using VibPlot to directly open a time domain data file uploaded by the Desktop App, only those files with '-Legacy' in the file name can be opened.

Finally, the filename for the reduced data set, either directly uploaded from the Vib Tool, or calculated from time domain data uploaded from the Vib Tool, is displayed. The graphs are updated to show the uploaded reduced data.

Two additional option buttons are included on the Connect to Vib Tool screen.

Connect to Vib Tool - Delete Data File

The Vib Tool has a limited amount of internal flash memory to store vibration recordings. While there is plenty of room to record several data sets, it may become necessary to clean off old data files. There are two options for doing this.

The first is the 'Delete' button. It is used to delete a single data file from the Vib tool. Select the desired data file from the drop-down list and press the 'Delete' button. Note that there is no confirmation warning. The selected file is deleted as soon as the 'Delete' button is clicked. After the deletion is completed, a message is displayed and the file list is updated.

Connect to Vib Tool – Delete All Data Files

The second option for deleting files removes all files from the Vib Tool. Again, this option does not display any confirmation warnings. As soon as the 'Delete All' button is clicked, the delete process begins.

It takes a few seconds to delete multiple data files. Please wait until the completed message is displayed. The drop-down list will then show a message saying the Vib Tool contains no data files.

Connect to Vib Tool - Disconnect

There is only one option to disconnect the Vib Tool from the PC. Once connected to the Desktop App, the Vib Tool keypad is locked. You must use the 'Disconnect' button. Once clicked, this closes communications with the Vib Tool, which returns to the Main Menu.

If something happens that locks communications between the Vib Tool and the PC, and the 'Disconnect' button does not function properly, cycle power on the Vib tool to break the connection. You may have to terminate the Desktop App using Windows Task Manager if this happens.

File Menu - Save Graph As Bitmap

This option displays a standard Windows Save As dialog box and allows the user to save the currently displayed graph as a bitmap using either the Windows Metafile format (WMF) or Enhanced Metafile format (EMF).

File Menu - Export Data to CSV File

This option displays the Export to CSV dialog box. This box is used to set export options related to Location Tag processing.

Location tags are recorded at the rate they are received from the AMHS vehicle. This can happen as often as 10 times per second. Reduced data is recorded at a rate of 2 samples per second. This means there can be a large number of location tags associated with each data point.

To limit the amount of location tag information, the user can set separate Warning and Error levels. When the Location tag associated with a data point that is below the Warning level, it is hidden (not graphed / not written into the CSV file). Tags associated with data above the Warning level but below the Error level are displayed in Black on the graphs. Tags associated with data above the Error level is displayed in Red.

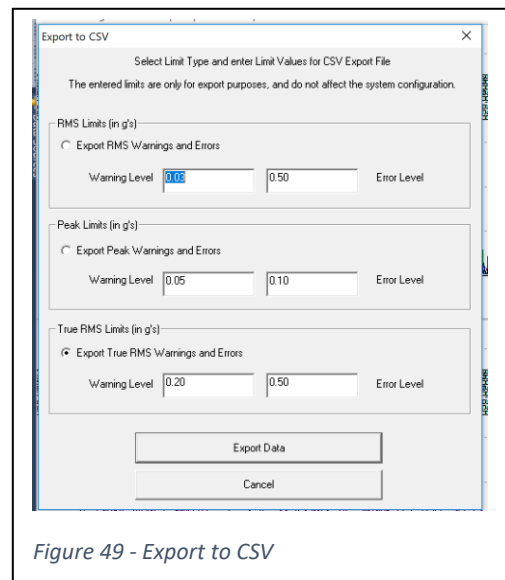


Figure 49 - Export to CSV

Global settings for Warning and Error levels are made using the 'Set Vib Limits' option under the 'Configuration' menu. The Export to CSV dialog box allows the user to adjust those settings specifically for the stored CSV file.

See the section below for the 'Set Vib Limits' option for details on setting these levels.

Once the 'Export Data' button is clicked, a standard Windows Save As dialog box is displayed.

File Menu - Exit

The Exit option allows the user to close the InfoCenter Desktop App. The application can also be closed using the close window icon (x) located in the upper right corner of the application window.

Configuration Menu

The Configuration menu contains options for setting vibration Location Tag display limits, and System Management fields. Additional options are disabled and unavailable in the current release.

Configuration Menu - Set Vib Limits

The Set Vib Limits option brings up a dialog box that can be used to set vibration limits that are used while displaying location tag information.

Location tags can be recorded at a rate up to ten per second. Graphing all received tags would muddy the graph window and not provide any helpful information. This screen allows the user to define the vibration Warning and Error levels, which limit the number of tags displayed. The user can also select which reduction type is used to limit tag display.

Select the reduction type by clicking one of the three radio buttons – RMS / Peak / True RMS. Then, enter a value in the associated fields for Warning and Error levels (minimum of 0.03). Tags associated with data points of that reduction type that are below the Warning level and not displayed. Tags associated with data points that are between the Warning and Error levels, are displayed in Black. Tags associated with data points equal to or greater than the Error level are displayed in Red.

The final option field on this screen is for the Amplitude Threshold value. This value is used to compute the 'N' reduction type (which is not graphed, but is included in the associated .CSV file). This data type represents the number of frequency bins for that sample period that exceed this setting.

Configuration Menu – System Management

Selecting the System Management option brings up a password request screen. This screen prevents unauthorized changes to system settings. The password for this screen is 'gctest' (without the ' characters).

Only authorized personnel should be given the password.

When the correct password is entered, and the 'Login' button is clicked, the System Management dialog box is displayed.

This dialog box allows the user to set three system parameters. These parameters are used primarily with the OHT version of the InfoCenter App to define the ID and

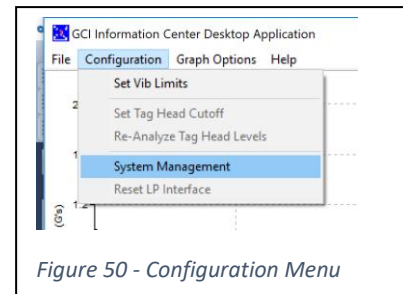


Figure 50 - Configuration Menu

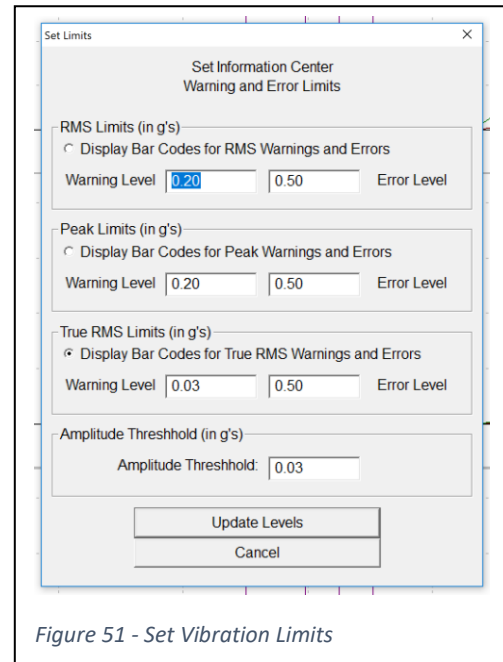


Figure 51 - Set Vibration Limits

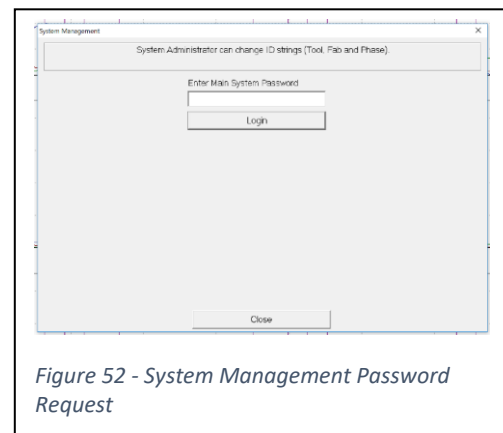


Figure 52 - System Management Password Request

location of the InfoCenter dual load port tool. They can also be set in the Desktop version, though only the Fab Tool ID is used. All three are free-format text fields. The three settings are updated when the screen is closed, using the 'Close' button.

Fab Tool ID

Fab Tool ID is an identifier that defines the ID of this installation of the Desktop Application. It is included in all filenames saved during the data file upload process.

Fab ID

This setting is used to define the Fab where the InfoCenter dual load port tool is installed. This field is not used in the Desktop version.

Phase ID

This setting is used to define the Fab Phase (or floor) where the InfoCenter dual load port tool is installed. This field is not used in the Desktop version.

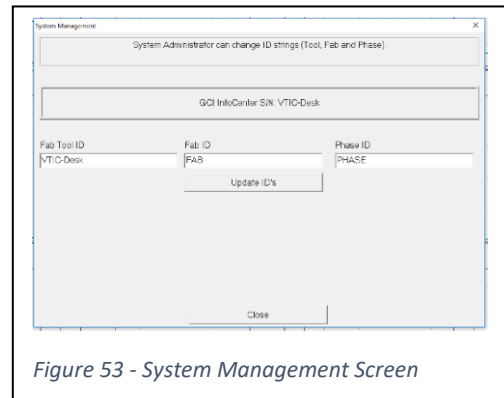


Figure 53 - System Management Screen

Graph Options Menu

The Graph Options menu contains a set of display options that are reserved for a future release. The current release of the Desktop Application supports graph options for reduced data only. Graphing options for Time Domain data are handled by the separate VibPlot Application (described later in this manual). A future release is planned that will combine these two applications. The graph options in this menu are reserved for that release.

Help Menu

The Help menu contains a single option – About GCI Information Center. This option brings up a dialog box that displays the application version number along with the path to the folder containing the Data folder structure (typically the installation folder).

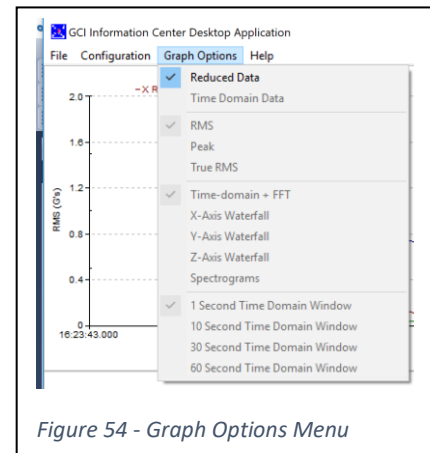


Figure 54 - Graph Options Menu

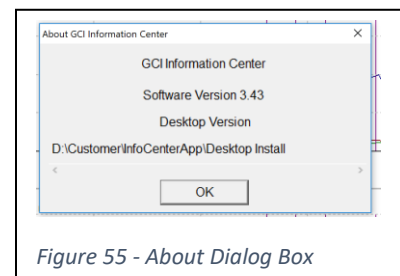
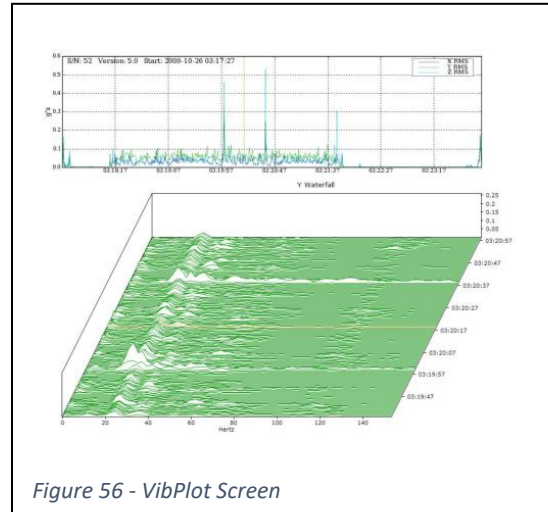


Figure 55 - About Dialog Box

VibPlot Application

Introduction

The GCI Vib Tool provides the option to record time domain data. The VibPlot App provides PC based graphing options to analyze this data. The VibPlot App 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.



This section provides details on using the VibPlot Application.

Vib Tool Version Differences

There are two main Vib Tool firmware versions. The first version is compatible with the InfoCenter App. This version can record data in both Time Domain and On-Board Reduction mode. The InfoCenter App (OHT or Desktop) is used to upload data from this version. Time domain data files compatible with VibPlot are automatically generated during the upload process, and are marked with a ‘-Legacy’ filename. This Vib Tool firmware has a version number in the 6.0 – 8.x range.

The second Vib Tool version is a standalone version that only records time domain data. On-Board Reduction mode is not supported. This version interfaces directly with the VibPlot App for data upload, and the data file can be named by the user. This Vib Tool firmware has a version number in the 5.x range.

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.

GCI VibPlot Licensing

The VibPlot App 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 a key file has not yet been assigned. A second dialog box is displayed asking to request an authorization key.

Press the **Yes** button to generate an authorization file. The file **“Request for VibPlot Key.bin”** will be created on the PC desktop. This file contains a unique identifier based on the PC where VibPlot is installed.

Email this file to GCI. GCI will respond with an Authorization Key file.

When the Key file is received, copy it to the PC desktop and launch VibPlot. When the initial dialog box is displayed asking if a key file is available, press the **Yes** button. A prompt is displayed to locate the VibPlot Key File using a standard Windows file open dialog box.

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

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

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.

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**

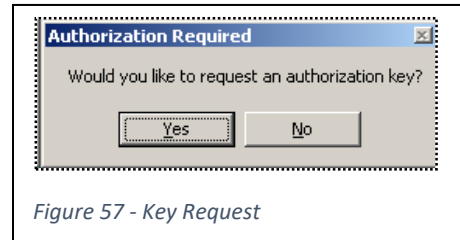


Figure 57 - Key Request

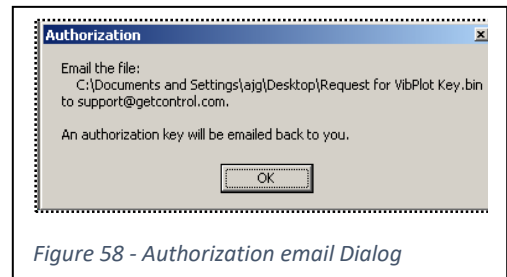


Figure 58 - Authorization email Dialog

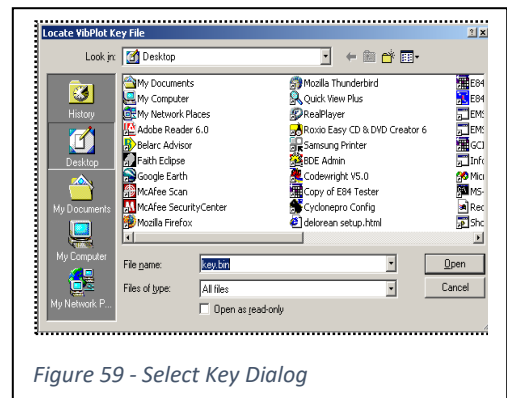


Figure 59 - Select Key Dialog

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.

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 in On-Board reduction mode.

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 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.

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.

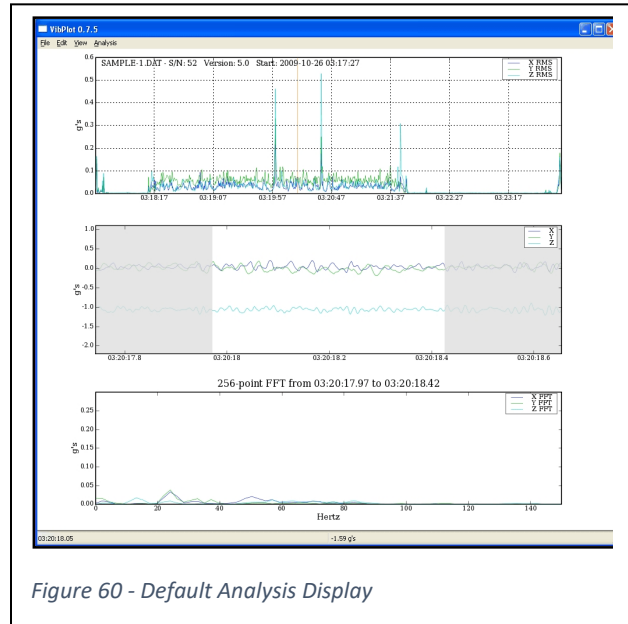


Figure 60 - Default Analysis Display

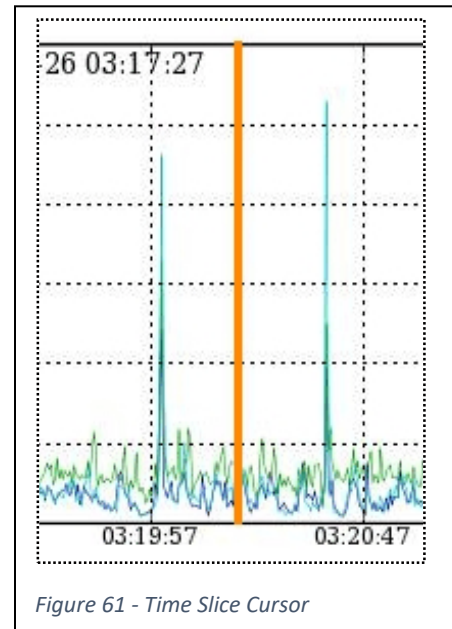


Figure 61 - Time Slice Cursor

The zoom area is highlighted in red as shown in Figure 62. 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.

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.

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.

VibPlot Menu Options

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

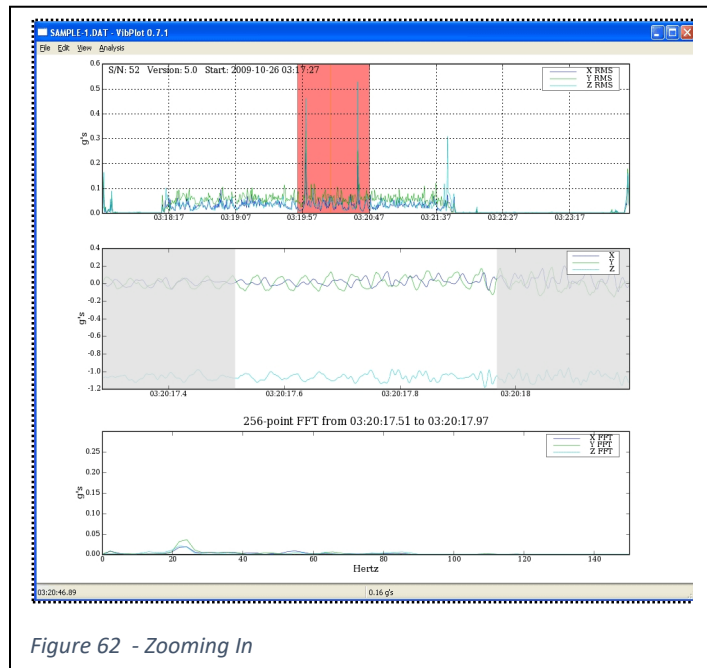


Figure 62 - Zooming In

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.

File Menu - 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 above.

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 hour 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

D0144_20180907_112525_Tool-ID-0-Legacy.DAT

might be divided into two files named:

D0144_20180907_112525_Tool-ID-0-Legacy-20180907083313.DAT

(data recorded at 09/07/18 - 08:33:13)

and

D0144_20180907_112525_Tool-ID-0-Legacy-20180907092813.DAT

(for continuing data at 09:28:13).

Note the example file used above was from the InfoCenter version of the Vib Tool, which adds the 'Legacy' text to the filename.

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.

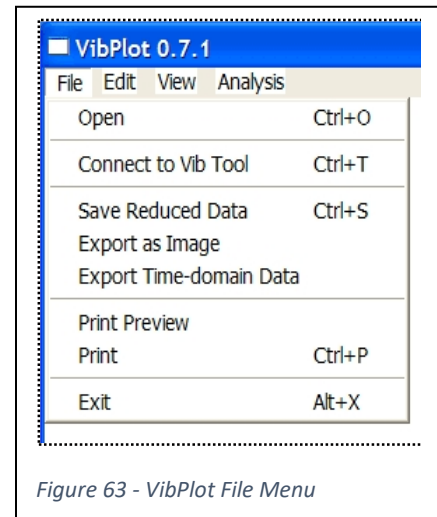


Figure 63 - VibPlot File Menu

File Menu - Connect to Vib Tool

This option provides a connection between the VibPlot App and GCI Vib Tools running firmware version 5.x. VibPlot supports connection only to this Vib Tool firmware. For all other Vib Tool firmware, use the InfoCenter Desktop App to manage the Vib Tool's internal flash memory.

Refer to sections in the manual above for information on connecting to the Vib Tool. The same menu options and settings are used in both VibPlot and the InfoCenter Desktop App.

File Menu - 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.

This file format is no longer used. It is identical to the file format used in legacy Vib Tool's running firmware version older than 5.0.

File Menu - 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 Save as type: drop-down list to select the desired graphics file format.

File Menu - 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).

File Menu - Print Preview

Displays a print preview of the current graphics view.

File Menu - Print

Prints the current graphics view to any available printer.

File Menu - Exit

Exits the VibPlot Application.

Edit Menu

Edit Menu - Copy

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

View Menu

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

View Menu - 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).

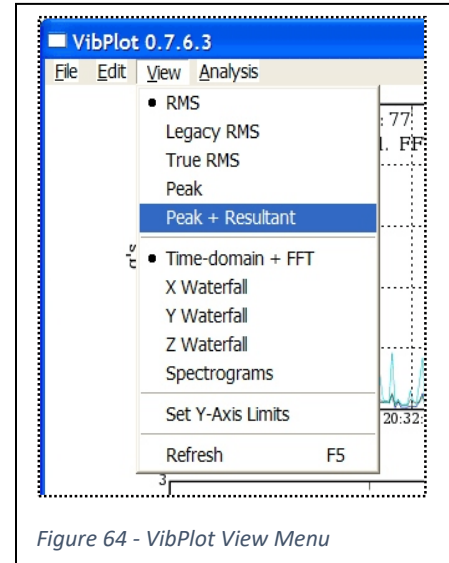


Figure 64 - VibPlot View Menu

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.

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 axis, for each 75-point frequency spectrum.

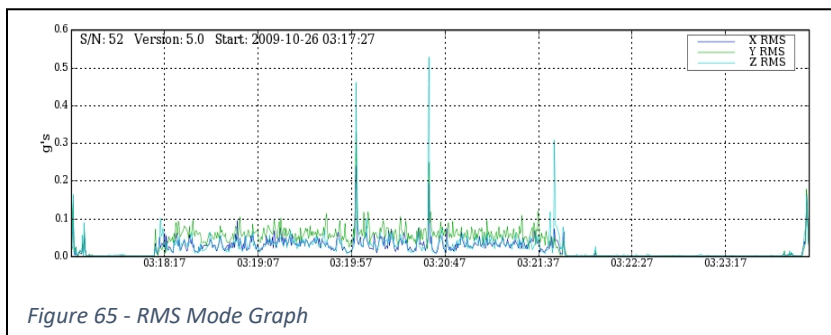


Figure 65 - RMS Mode Graph

$$RMS_x = \sqrt{\frac{\sum (A_x[f])^2}{75}}$$
$$RMS_y = \sqrt{\frac{\sum (A_y[f])^2}{75}}$$
$$RMS_z = \sqrt{\frac{\sum (A_z[f])^2}{75}}$$

RMS Calculation

Legacy RMS Mode

Legacy RMS Mode duplicates the RMS reduction provided by On-Board data reduction. *Legacy RMS Mode* displays a single legacy RMS (summing) value (in g's) for each axis, for each 75-point frequency spectrum.

$$LRMS_x = \sum A_x[f]$$

$$LRMS_y = \sum A_y[f]$$

$$LRMS_z = \sum A_z[f]$$

Legacy RMS Calculation

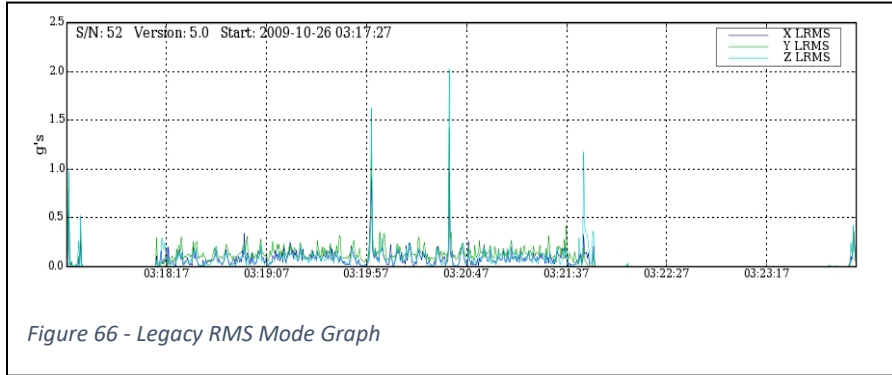


Figure 66 - Legacy RMS Mode Graph

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.

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

True RMS Calculation

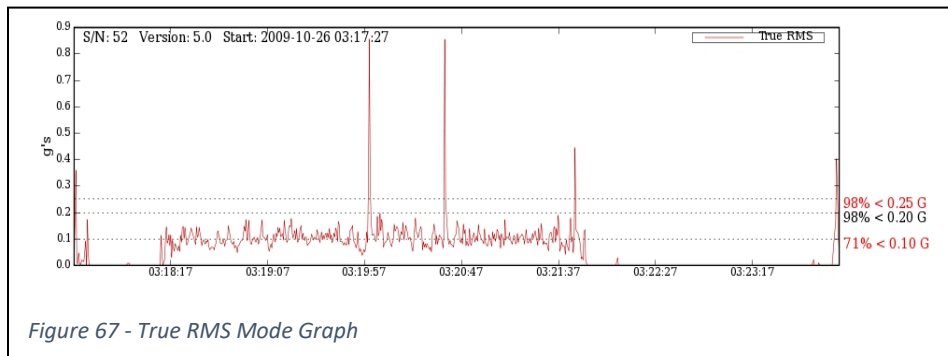
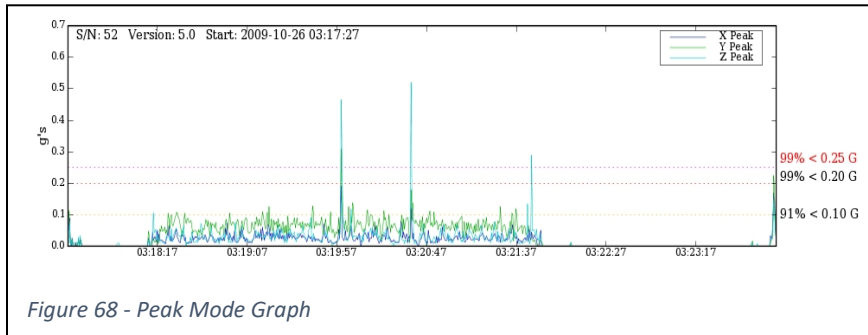


Figure 67 - True RMS Mode Graph

Peak Mode

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



$$Peak_x = MAX(A_x[f])$$

$$Peak_y = MAX(A_y[f])$$

$$Peak_z = MAX(A_z[f])$$

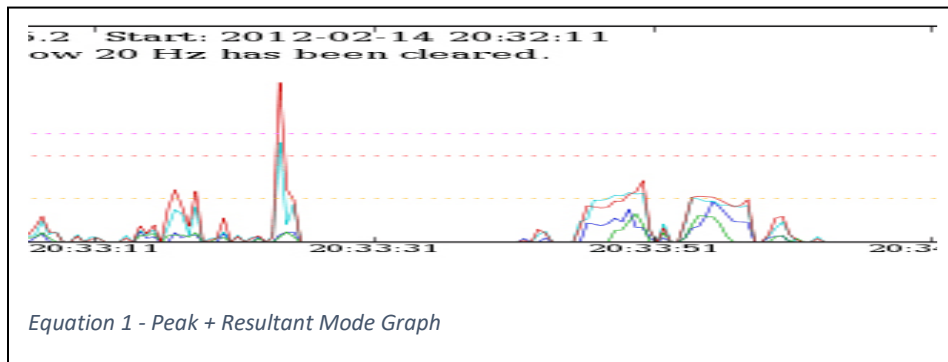
Peak Calculation

Peak + Resultant Mode

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

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

Resultant Calculation



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 above). 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.

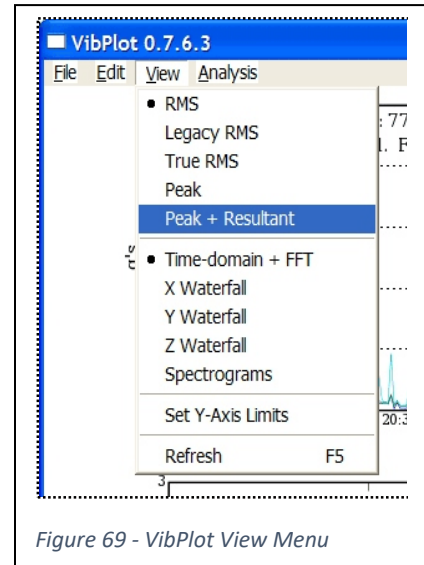


Figure 69 - VibPlot View Menu

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

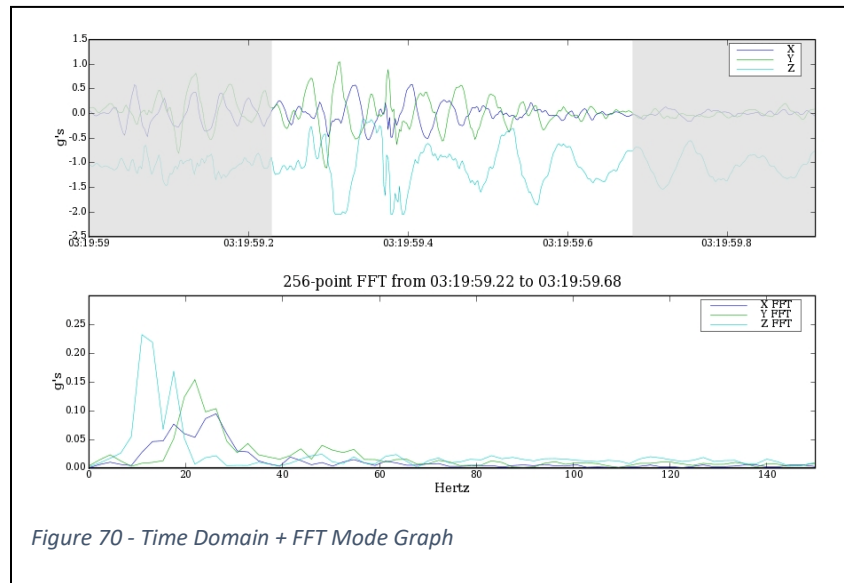
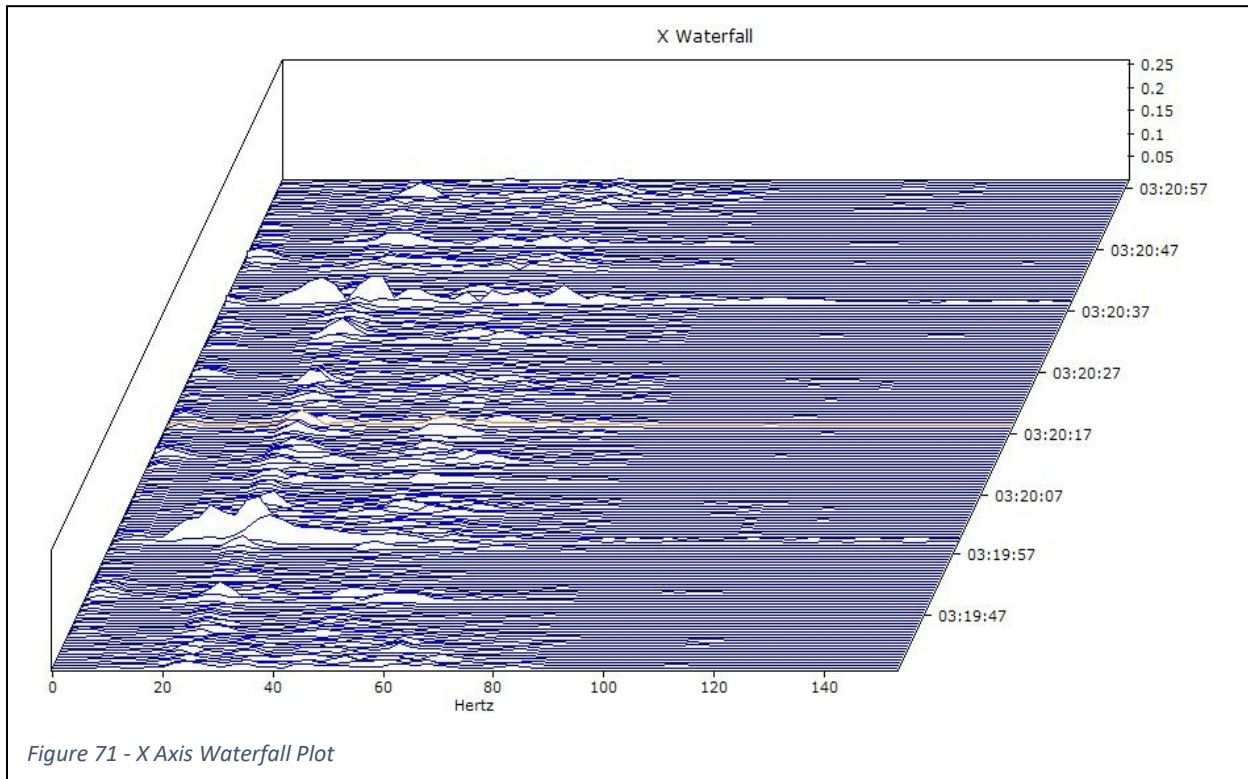


Figure 70 - Time Domain + FFT Mode Graph

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.



Spectrograms

Spectrograms displays the X, Y, and Z data in three dimensional spectrograms. Frequency and Time are the two axes, 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.

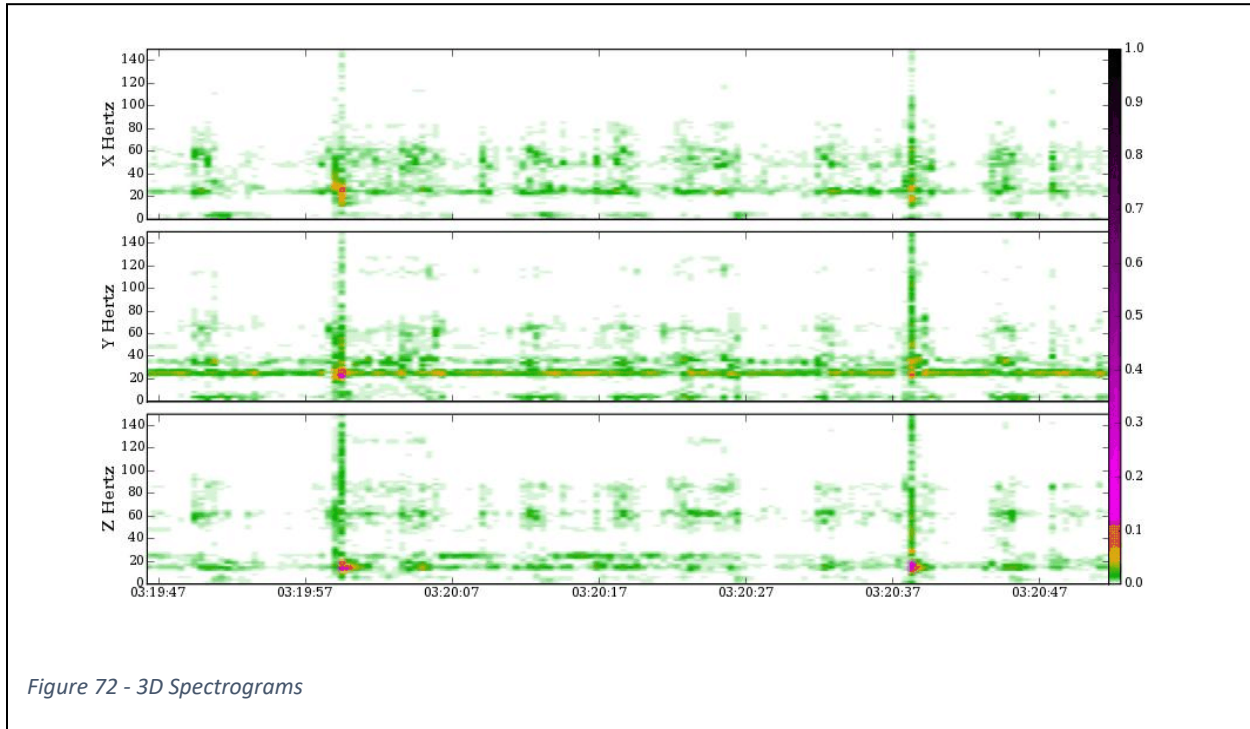


Figure 72 - 3D Spectrograms

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.

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

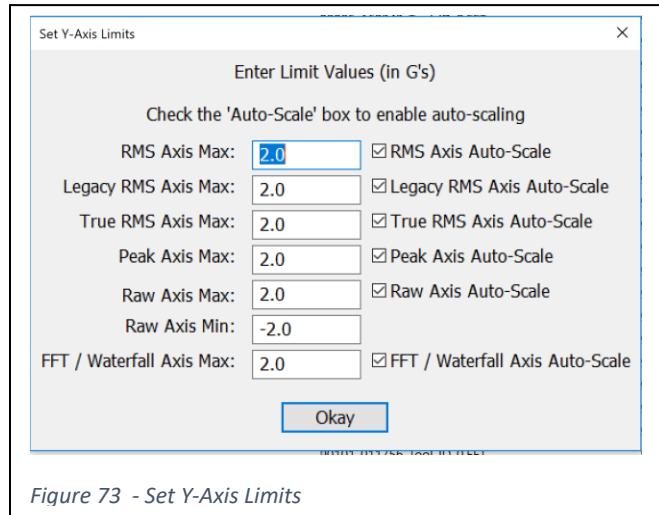


Figure 73 - Set Y-Axis Limits

Refresh

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

Analysis Menu

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

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.

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).

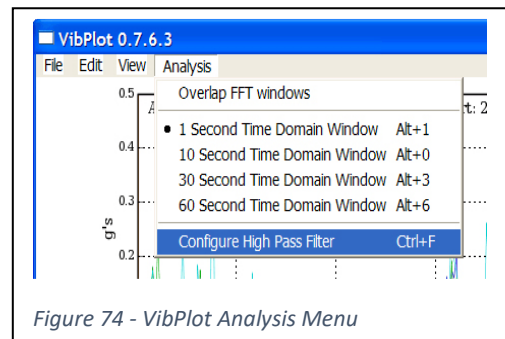


Figure 74 - VibPlot Analysis Menu

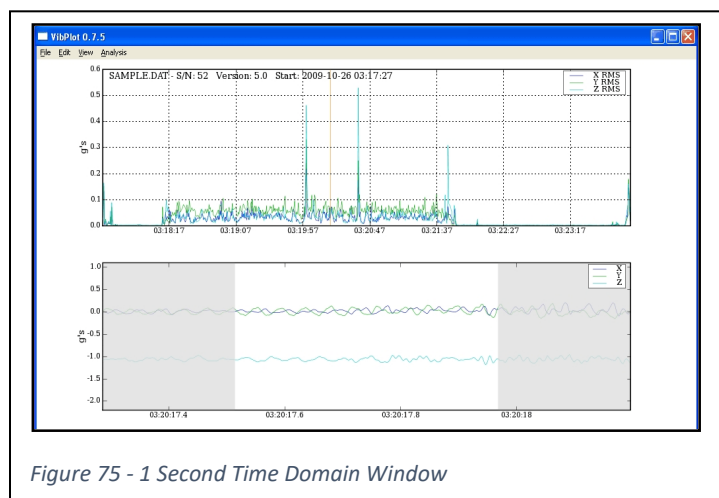


Figure 75 - 1 Second Time Domain Window

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).

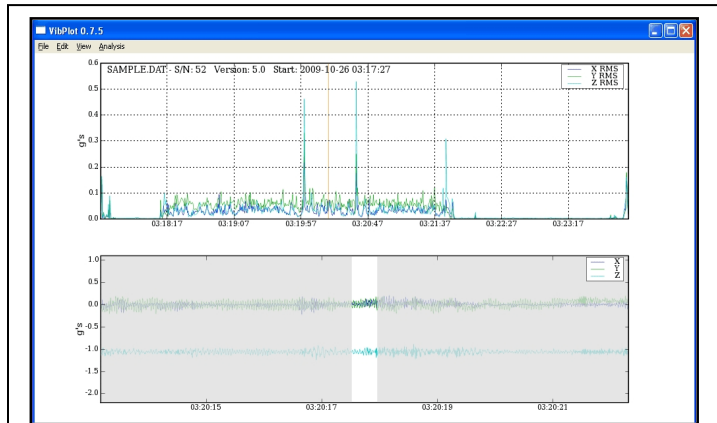


Figure 76 - 10 Second Time Domain Window

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).

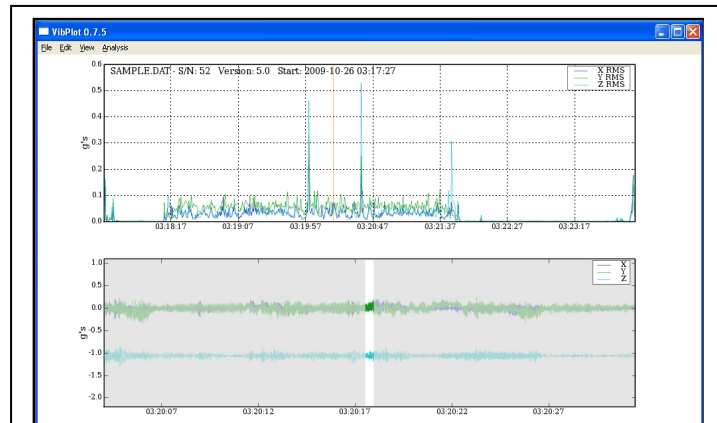


Figure 77 - 30 Second Time Domain Window

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).

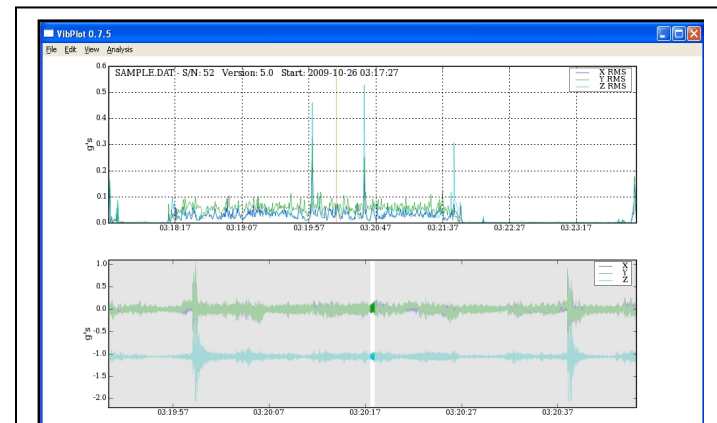


Figure 78 - 60 Second Time Domain Window

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.

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.

