HI-903 PRO HARDY SHAKER

Installation Manual

CE

1. OVERVIEW

The METRIX Model HI-903 PRO Hardy Shaker provides a field tested method for on-the-spot dynamic verification of accelerometers, velocity pickups and non-contact displacement transducers. Optional mounting fixtures and hardware needed to connect transducers to the HI-903 PRO mounting platform are available upon request.

A closed-loop control algorithm provides enhanced stability and accuracy of frequency and amplitude levels.

The HI-903 PRO incorporates a built-in sine wave oscillator, power amplifier, electrodynamic shaker, NIST traceable reference accelerometer, digital display, and internal memory. The HI-903 PRO is completely self-contained and operates on battery or AC power.

The built-in reference accelerometer is attached permanently to the shaker armature, maximizing the accuracy between the reference accelerometer and the test transducer. The HI-903 PRO is designed to provide long-term reliable performance over the frequency range of 7 Hz to 10 kHz. The HI-903 PRO can be used for a variety of applications that include:

- Verification and calibration of vibration transducers and related vibration test systems
- Verification of connector and cabling integrity

Confirm machine vibration alarm trip points are set properly and ensure end-to-end functionality of vibration monitoring systems.

Notes

- *Loads of up to 800 gram (28.3 oz) can be mounted directly to the HI-903 PRO mounting platform. Larger loads may be applied to the platform, however, if prolonged testing of a heavy load is planned, we recommend using an external transducer suspension system. Under these conditions the vibration waveform should be viewed on the oscilloscope to aid in*

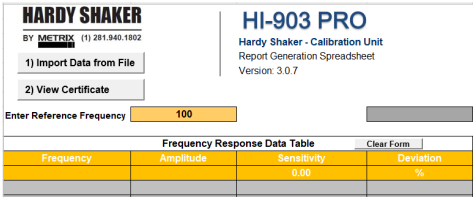
positioning the test transducer and platform to reduce distortion that can occur with very heavy weights.

- *The HI-903 PRO should always be operated on a stable, flat surface.*
  The HI-903 PRO is designed for field test applications but care must be taken to maintain the integrity of the mounting platform assembly
- Hearing protection recommended when operating the HI-903 PRO for an extended amount of time

Accessories

Accessories included in the HI-903 PRO Shaker can be found in the Datasheet (doc 1667493) and in HI-937 Hardy Shaker Accessory Kit (doc 2018662). Accessories will come in the Accessory Pouch shown below.

Accessory Pouch



USB Flash Drive Pre-Loaded with Report Generating Worksheet

2. BASIC OPERATION

For the basic operation of the HI-903 PRO, a vibration sensor and appropriate cable are needed. Typically the HI-903 PRO is used as a vibration excitation source and as a readout device with the vibration sensor connected to the HI-903 PRO's Test Sensor BNC Input. Alternatively, the HI-903 PRO unit can be used to test different types of vibration equipment (i.e. a vibration meter or vibration monitoring system), in which case the sensor will be directly connected to the vibration measurement equipment and the HI-903 PRO is used just as a controlled excitation source.

Test Setup

1. Mount your sensor to the HI-903 PRO mounting platform
    - The HI-903 PRO sensor mounting platform is threaded for a ¼-28 stud. Select an appropriate adaptor for mounting the sensor.
    - While tightening the sensor, secure the HI-903 PRO mounting platform with the supplied wrench to prevent damage from torque
2. Connect sensor under test (SUT) to "Test Sensor In." Make sure that connections are secure.
3. Power the unit ON by pressing and holding the **FREQUENCY** dial for 3 seconds.

NOTE: It is good practice to perform calibrations on battery power. Disconnecting from line power ensures a power surge will not cause the calibrator to power down during test. If excess current is detected during use, the portable calibrator shuts down to prevent damage.

Selecting Input Mode

4. The HI-903 PRO can accept ICP® as well as AC voltage and AC current output sensors. Press and hold the **AMPLITUDE** dial to select between ICP®, Voltage Mode or Modulated Current mode. Modulated Current mode is only available if the 9110-MC firmware option is ordered, otherwise user will not see this mode as an option.

    Note: ICP® (or IEPE) mode sensors are the most popular type of accelerometer transducers and require a 2 mA to 20 mA constant current supply to operate. The HI-903 PRO unit supplies the necessary constant current to power this class of sensors. Voltage output sensors are typically moving coil velocity sensors but can also be the voltage output of a signal conditioner associated with any type of vibration transducer such as the output from the probe driver in a proximity probe system. Refer to the Sensor Signal Measurement Electronics (SUT Input Characteristics and Considerations) for details.

Setting the Frequency and Amplitude Units

5. Select the correct Frequency Units for your test by pressing the **FREQUENCY** dial to enter into the **CALIBRATION OPTIONS** menu:
    - Use the **FREQUENCY** dial to highlight **TEST SETTINGS** then press.
    - Within the Test Settings Menu rotate the **FREQUENCY** dial to highlight **FREQUENCY UNIT** then press to toggle between Hertz and CPM.
6. Select the correct Amplitude Units for your test by pressing and releasing the **AMPLITUDE** dial. The following options are available:

Acceleration	Velocity	Displacement
g's pk g's RMS m/s2 pk m/s2 RMS	in/s pk in/s RMS mm/s pk mm/s RMS	mils p-p µm p-p

7. Select the desired vibration amplitude and frequency for testing by turning the **AMPLITUDE** and **FREQUENCY** dials clockwise to increase or counter clockwise to decrease the setting.

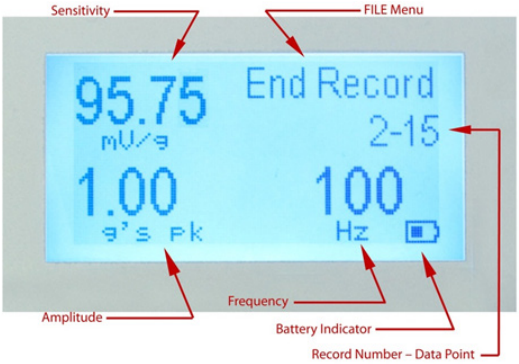
- Slow Turns – settings will increase or decrease by single steps
- Fast Turns – settings will increase or decrease by larger increments

Record and Save Calibration Points

8. Once the frequency and amplitude are set to desired values, with the file menu set to "Save Point," press the **FILE** dial to store the calibration data point.
9. Repeat steps 7 through 9 to set the frequency and amplitude to increment to the next calibration data point and save.

Completing and Storing Record to Memory

10. Once all data points have been saved in a record and record is complete, rotate **FILE** dial and press it to select "End Record."
    - The screen will prompt with:



11. Rotate the **FILE** dial to "Edit" to enter the model number, serial number and axis. The **FILE** menu for this screen also includes the tools "Next" and "Back."
    - Push the **FILE** dial to choose "Next," which goes to the next save screen.
12. To "Save" the record without inputting an annotation, press the **FILE** dial two more times.

13. Rotate the **FILE** dial to "Edit" and press to store any annotations or additional notes (such as technician initials, etc):
    - Turn the **FILE** dial to the left and right to select each individual letter or number you wish to input as part of an annotation. Push the **FILE** dial to save each character.
    - Rotate the **FILE** dial and select "Save." This will save all data points in the listed record number. The record number shown on the screen increments automatically.

Transfer Records to USB Flash Drive

14. Rotate **FILE** dial and press to select “Tools.”
15. Rotate **FILE** dial and press to select “USB Menu.”
    - A USB flash drive must be connected to the unit. The USB must be formatted to FAT32. You can use the HI-903 PRO or a PC to format the flash drive.
16. To copy all data points and records to a USB Flash Drive, rotate **FILE** dial and press to select “Copy All Records.”
    - This will leave current records on unit memory and also create a copy on the USB.
17. To move all data points and records to USB, rotate **FILE** dial and press to select “Move All Records.”
    - This will remove current records on unit memory and move onto the USB.

Note: The USB hardware may not always recognize a USB flash drive if it is plugged into the USB port while the HI-903 PRO is in sleep mode. Metrix recommends connecting the USB drive while the HI-903 PRO is on and operational.

Powering Off

18. *Suggested Best Practice:* Before powering the unit OFF, reduce the vibration amplitude. The HI-903 PRO retains the settings used prior to shutdown when it is powered back ON. Reducing the amplitude prior to shutdown ensures the sensor under test will not be jarred when the HI-903 PRO is powered ON.
19. Power the unit OFF by pressing and holding the **FREQUENCY** dial for approximately 3 seconds.
    - To preserve battery charge, the HI-903 PRO will automatically power off after 20 minutes of inactivity when not plugged in to the charger.

After Testing

20. *Suggested Best Practice:* Plug the HI-903 PRO into an AC power source when not in use. This will ensure the batteries are fully charged for your next test and also help to maximize the lifespan of the batteries.
21. Periodic calibration checks are recommended:
    - A dedicated “verification sensor” can be used to check the system readings and results. By using a dedicated sensor, you can ensure that the system is providing the same result during each test. Metrix offers Model 9105D for this purpose. (The 9105D includes a transfer standard reference accelerometer and ICP sensor signal conditioner, for system verification of portable vibration calibrators).
    - The HI-903 PRO should be returned to Metrix for regular recalibration (recommended annually - Service Code 9100-CAL01) or for any maintenance or repair. The most current factory calibration date or the calibration due date is displayed on the LCD screen during the HI-903 PRO boot up sequence. The default due date is set for 12 months after the last factory calibration, but the calibration interval can be user defined to be anywhere from 1 to 72 months, or set up to never expire.
    - NOTE: The aforementioned Model 9105D allows users to duplicate Metrix’s calibration process without returning the shaker to the factory.

Report Generation Workbook

Calibration data can be saved into the HI-903 PRO's internal memory and easily exported to a personal computer using a USB Flash Drive. The HI-903 PRO Portable Vibration Calibrator includes a pre-formatted USB Flash Drive with a Microsoft Excel Report Generation Workbook for the creation of customizable calibration certificates. The Excel file provides an intuitive interface which allows a user to create and print a calibration certificate with just a few mouse clicks. In order to use the file, make sure macros are enabled, otherwise Excel won't be able to load data and create the certificates.

The Excel workbook consists of the following worksheets or tabs:

- **FRData** – Use this tab to create a frequency response certificates in just 2 steps:

1. Clicking on **Import Data from File** button prompts the user to select and import a .pvc calibration data file previously created by the HI-903 PRO
2. Once data is loaded into the table, click **View Certificate** to see and print a calibration certificate containing the frequency response data (the reference frequency for the calibration certificate is 100Hz and can be changed by the user as needed)

   Note: If testing a charge-mode accelerometer and calibration certificate in pC units is desired, click the box at top left of the FRData tab and enter the sensitivity of the charge amplifier in the "mV/pC" box *located at cell D8. See the section "Calibrating Charge-Mode Accelerometers" for more information.*

- **LINData** – Use this tab to create linearity response certificates. The worksheet applies linear regression to interpolate the data. The **Max Linearity** is calculated for the worst deviation of a particular point from the best-fit straight line (BFSL) of all tested points. The table also displays the specific results at each test level.

The LINData worksheet has 2 tables. The left table should be used for creating dynamic linearity data calibration certificates in just 2 steps:

1. Click on **Import Data from File** to select and import a .pvc calibration data file previously created by the HI-903 PRO
2. Once data is loaded into the table, click **View Certificate** to see and print a calibration certificate containing the linearity response data. The worksheet expects the data points to be taken at the same frequency (speed). A checkbox option labeled **Set Y-intercept to zero** is available to force the interpolation to go through the origin point.

The right table in the LINData worksheet is used to create a DC proximity probe curve or linearity certificate for 4-20 mA vibration transmitter. Creating a DC proximity probe curve requires the proximity probe adaptor kits and a DC voltmeter (not included). Creating a linearity certificate for a 4-20 mA vibration transmitter requires DMM set to DC current input. A 24 VDC power supply may also be needed:

1. Select the appropriate vibration scale (Acceleration, Velocity or Displacement) by clicking in cell H12 and selecting from drop down menu.
2. Select the appropriate units (g's pk, g's RMS, m/sec^2 pk, m/sec^2 RMS, in/sec pk, in/sec RMS, mm/sec pk, mm/sec RMS, mils p-p or µm p-p) in cell H13. Make sure cell H12 is set to the right scale first.
3. Enter known amplitude and output for the first test point next to "Starting Point" and repeat for each additional test point moving down the table. Once data is entered into the table, click **View Certificate** to see and print a calibration certificate containing the linearity response data.

- **FRCert** - Displays the frequency response calibration certificate using the current data and information from FRData.

- **LINCert** - Displays the linearity response calibration certificate using dynamic linearity data from LINData.
- **SLINCert** - Displays the linearity response calibration certificate using static linearity data from LINData.
- **Route Creator** – If firmware option HI-903 PRO CALROUTE is ordered, this tab can be used to create semi-automated tests with instant pass/fail notification for almost any vibration sensor. See "Calibration Route" for more information.

Additional Features
Delete
The "Delete" feature can be found under the **FILE** dial > "Delete." When "Delete" is selected, the shaker will stop moving and four options will appear:
1. "Delete Point" will delete a current point.
2. "Delete Record" will delete the entire current record.
3. "Delete All" will delete all data points and all records that are stored on the internal unit memory.
4. "Back" will return to the main screen.

USB Options
The "USB Options" feature can be found under the **FILE** dial > "Tools" > "USB Menu" > "USB Options." When "USB Options" is selected, the following information will appear on the screen:
- "Status" – USB flash drive connected or not connected.
- "Partition" – Format of USB flash drive connected to the unit.
- "Available" – Memory space available on USB flash drive.
- "Required" – Space required to save all records on USB flash drive.

And the following actions are available:
- "Eject Drive" will safely eject the USB flash drive from the unit.
- "Format USB" for formatting the USB flash drive. (FAT32 partition)
- "Back" to go back to the USB Menu.

Date and Time
The "Date and Time" feature can be found under the **FILE** dial > "Tools" > "Options" > "Date and Time."
1. Press the **FILE** dial to select "Adjust."
2. Turn the **AMPLITUDE** dial to the select the current month, day and year and push the **FREQUENCY** dial to confirm or the **AMPLITUDE** dial to change.
3. Press the **AMPLITUDE** dial to select "yes" this is correct.
4. Turn the **AMPLITUDE** dial to select the current hours and minutes then push the **FREQUENCY** dial to confirm the time is correct.
5. Press the **AMPLITUDE** dial to select "yes" this is correct.

Calibration Interval
The "Calibration Interval" can be adjusted under the **FILE** dial > "Tools" > "Options" > "Calibration Interval."
1. Select "Adjust" and press **FILE** dial.
2. Turn **AMPLITUDE** dial to select number of months for Calibration Interval.
   - *Suggested Best Practice: 12 months*. The calibration interval can be defined to be anywhere from 1 to 72 months, or set up to never expire.
3. Press **FREQUENCY** dial to confirm selected Calibration Interval.

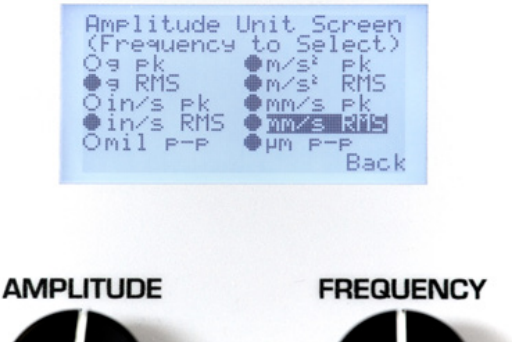
Traceability
The “Traceability” feature can be found under **FILE** dial > “Tools.”

1. Press **FILE** dial to select “Traceability.” A screen with the following information will appear:
    - Model
    - Serial Number
    - Firmware Revision Number
    - Calibration Date
    - Reference Sensor Sensitivity
    - PRD-P
    - NIST Traceability Number
    - PTB Traceability Number
2. Press **FILE** dial to go back to main screen and shaker will go back to shaking.

Test Settings
The “Test Settings” menu can be found by pressing **FREQUENCY** dial > “Test Settings.” A screen with the following will appear, use the **FREQUENCY** dial to highlight and toggle all settings:

- Back – returns user to “Calibration Options” menu
- Cal Route: N/A, Active or off
    - N/A indicates the Calibration Route firmware option has not been purchased. Calibration Route allows users to program semi-automated test points with instant pass/fail notification. See “Calibration Route” section for more information. Contact Metrix to unlock this feature.
- Source: Internal or External
    - If external is selected the shaker can be controlled with an external source. See “Input/Output” for more information.
- Frequency Unit: Hertz or CPM (cycles per minute)
- Sensor Type: ICP®, Voltage or Modulated Current
    - Use ICP® for most accelerometers, Voltage for proximity probes and moving coil sensors, Modulated Current for high-temp turbine vibration sensors with AC current output. See “Selecting the Input Mode” for more information. Modulated current is optional; contact Metrix to unlock this feature.
- Sensor Readout: mV/EU or mV
    - Changes the display to show the sensor under test’s sensitivity (output voltage divided by input vibration, mV/EU) or the sensor under test’s raw AC output voltage.

Amplitude Units
Amplitude units that are seldom or never used can be turned off by using the “Amplitude Units” feature, found by pressing **FREQUENCY** dial > “Amplitude Units.” The “Amplitude Unit Screen” shows all 10 available amplitude scales on model HI-903 PRO Portable Vibration Calibrator. Use the **FREQUENCY** dial to highlight each scale and press the dial to toggle the scale on or off. A filled circle next to the scale indicates it is active. An empty circle next to the scale indicates it is inactive. Inactive scales do not appear when cycling through scales using the **AMPLITUDE** dial during normal operation.



To go back to the “Calibration Options” menu use the FREQUENCY dial to highlight “Back” then press.

Calibration Route
Firmware Option: HI-903 PRO CALROUTE
Model HI-903 PRO must be ordered with firmware option 9110-CALROUTE for the Calibration Route features to be available. This firmware can be added at any time. Contact Metrix for ordering and installation information.

The Calibration Route firmware allows users to create and run semi-automated frequency response and amplitude linearity tests for vibration sensors on model HI-903 PRO with instant pass/fail notification. Tests or “routes” are created in the Report Generation Workbook then uploaded to the HI-903 PRO via supplied USB drive. Once uploaded the test is activated. But the test can also be de-activated at any time, putting the HI-903 PRO back into manual operation mode. When a Calibration Route is active the HI-903 PRO can only adjust to the pre-defined amplitude and frequency points that have been programmed.

Creating A New Test (Route)
Version 2010 or later of Microsoft Excel® is required for the CalRoute features in Report Generation Workbook to operate correctly. Drop-down arrows for frequency and amplitude units may not appear if using older versions of this software.

1. Open the Report Generation Workbook (version 3.0.2 or later required) using Microsoft Excel®
2. At bottom, select the **Route Creator** tab
3. **Route Name:** Enter the name of the test in cell B7 next to “Route Name”. When the test file is created and saved the file name will be this value followed by “_Route.pvc”.
4. **Frequency Unit:** Use the drop down arrow to choose the frequency unit (Hertz or CPM) in cell B8. One cannot toggle between Hertz and CPM during the test.
5. **Amplitude Unit:** Use the drop down arrow to choose the amplitude unit (g pk, g RMS, m/sec2 pk, m/sec2 RMS, in/sec pk, in/sec RMS, mm/sec pk, mm/sec RMS, mils p-p or µm p-p) in cell D7.
6. **Amplitude:** If desired, enter the amplitude for all test points in cell B9 next to “Amplitude”. This is useful for a frequency response test where all test points will have the same amplitude value. If creating a linearity test leave this cell blank since the amplitude values will change for each test point.

7. **Sensor Type:** Use the drop down arrow in cell F7 to select the sensor type (ICP®, Voltage or Modulated Current).
8. **Sensor MN:** if desired, enter the sensor model number in cell F8. This is optional. The sensor model number that is entered will print on the calibration certificate. It can be changed at any time. If the model number is not consistent leave this cell blank.
9. **Lower Bound:** in cell D8 enter the minimum sensitivity value for the sensor under test at each test point that will pass calibration test. For example, the minimum acceptable sensitivity for 100 mV/g accelerometer with +/- 5% sensitivity tolerance is 95 mV/g, thus lower bound would be: 95.00.
10. **Upper Bound:** in cell D9 enter the maximum sensitivity value for the sensor under test at each test point that will pass calibration test. For example, the maximum acceptable sensitivity for 100 mV/g accelerometer with +/- 5% sensitivity tolerance is 105 mV/g, thus upper bound would be: 105.00.
11. Press **Table Auto-Fill.** The grey cells in the table will automatically populate with the values chosen in steps 3-10. All cells will populate. The table is capable of creating a 30-point test. But any number of test points can be programmed. Before creating the route file user must delete values in cells for test points that should not be created (see example).
12. Enter the desired **Frequency** values for each test point in column A beginning with cell A13. The test will be conducted in the exact order as programmed. The first test point will be as programmed in row 13; the next will use row 14 values and so on.
    a. The HI-903 PRO can only simulate vibration in CPM values that are multiples of 60. I.e. 1800 CPM, 3600 CPM, 4200 CPM, etc. If a value is entered that is not a multiple of 60, the HI-903 PRO will adjust down to the nearest CPM value that is a multiple of 60.
    b. *Example: 1900 CPM is entered as a test point. The HI-903 PRO will adjust to 1860 CPM and 1860 CPM will be displayed.*
13. Enter the desired **Amplitude** values for each test point in column B beginning with cell B13. Skip this step if all amplitude values have been automatically populated using the Table Auto-Fill button.
14. Modify any individual test point as desired. For example, most accelerometers have a wider sensitivity tolerance at extreme low and high frequencies. User may wish to expand the upper and lower bounds for certain test points.
15. Delete undesired test points. For example, a 10-point test only requires rows 13-22. The Table Auto-Fill feature saves typing but one must delete data from cells that are not needed. For a 10-point test rows 23-42 should be blank thus they can be highlighted and cleared.
16. Press **Create Route File.** A .pvc file will be created, save this file to the USB drive in the **Calibration_Route** folder.
    a. When prompted to save, open the USB Disk
    b. Open the METRIX_PVC folder
    c. Open the Calibration_Route folder
    d. Press save

Example Accelerometer Test (Route)

HARDY SHAKER
BY METRIX (1) 281.940.1802

HI-903 PRO
Hardy Shaker - Calibration Unit
Calibration Route Generation Spreadsheet
Version: 3.0.7

1) Table Auto-Fill
2) Create Route File

Route Name		Amplitude Unit		Sensor Type	
Frequency Unit		Lower Bound		Sensor MN	
Amplitude		Upper Bound			

Reset Form

Frequency	Amplitude	Amplitude Unit	Lower Bound	Upper Bound	Sensor Type
10	1.00	g pk	95.00	105.00	ICP
50	1.00	g pk	95.00	105.00	ICP
100	1.00	g pk	95.00	105.00	ICP
300	1.00	g pk	95.00	105.00	ICP
500	1.00	g pk	95.00	105.00	ICP
1000	1.00	g pk	95.00	105.00	ICP
2000	1.00	g pk	95.00	105.00	ICP
3000	1.00	g pk	95.00	105.00	ICP
4000	1.00	g pk	95.00	105.00	ICP
5000	1.00	g pk	95.00	105.00	ICP

An example of a 10-point accelerometer test, created in the Report Generation Workbook, is shown above. Some helpful notes…

- When run, this test will shake the accelerometer at 1g pk at all points. If the shaker cannot generate 1g pk it will output the maximum vibration possible given the sensor's weight and test speed. The shaker will not allow user to program points that can damage the shaker.
- The test will begin at 10 Hz and end at 5000 Hz, with test points at 50,100, 300, 500, 1000, 2000, 3000 and 4000 Hz as well.
- If the sensor under test's sensitivity is above 105 mV/g or below 95 mV/g the HI-903 PRO will alert the user that test point failed.
- The file name will be CaseAccel_Route.pvc, when uploading to the HI-903 PRO one would choose this file.
- ICP® power is active for all test points. If this test were applied to a self-powered sensor data would be invalid. One would select "Voltage" for a self-powered sensor such as a moving coil velocity transducer.

Example Proximity Probe Test (Route)

HARDY SHAKER
BY METRIX (1) 281.940.1802

HI-903 PRO
Hardy Shaker - Calibration Unit
Calibration Route Generation Spreadsheet
Version: 3.0.7

1) Table Auto-Fill
2) Create Route File

Route Name		Amplitude Unit		Sensor Type	
Frequency Unit		Lower Bound		Sensor MN	
Amplitude		Upper Bound			

Reset Form

Frequency	Amplitude	Amplitude Unit	Lower Bound	Upper Bound	Sensor Type
3600	1.0	mil p-p	190.00	210.00	Voltage
3600	2.0	mil p-p	190.00	210.00	Voltage
3600	3.0	mil p-p	190.00	210.00	Voltage
3600	4.0	mil p-p	190.00	210.00	Voltage
3600	5.0	mil p-p	190.00	210.00	Voltage
3600	6.0	mil p-p	190.00	210.00	Voltage
3600	7.0	mil p-p	190.00	210.00	Voltage
3600	8.0	mil p-p	190.00	210.00	Voltage
3600	9.0	mil p-p	190.00	210.00	Voltage
3600	10.0	mil p-p	190.00	210.00	Voltage

An example of a 10-point proximity probe test, created in the Report Generation Workbook, is shown above. Some helpful notes…

- This test will simulate vibration at 3600 CPM for all test points.
- This is a linearity test. Vibration will start at 1.0 mils p-p and escalate to 10.0 mils p-p. The sensor will be evaluated every 1.0 mils.
- The test is designed for a 200 mV/mil proximity probe with 5% tolerance. Thus sensitivity of 190-210 mV/mil passes calibration. If outside those values the HI-903 PRO will indicate the test point has failed.
- The sensor type is voltage. This means ICP® power is turned off. The proximity probe is being powered by its probe driver. To run this test the technician must connect the output of the probe drive to “Test Sensor In” on the HI-903 PRO.
- The name of the file will be ProxProbe_Route.pvc.
- The model number 330101 will print on each test report created using this route. It can be modified on the certificate if desired to add thread lengths, cable length, etc.

Loading & Activating a Calibration Test (Route)

With the calibration test saved as a .pvc file to the Calibration_Route folder on the USB and the USB inserted into the port on the HI-903 PRO the following instructions detail how to upload to model HI-903 PRO and activate:

1. Press the **FREQUENCY** dial to enter “Calibration Options” menu, rotate to highlight **TEST SETTINGS** and press again to enter “Test Settings” menu.
2. Use **FREQUENCY** dial to highlight and click selection next to “Cal Route:”. Selection will be “Off” or “Active” depending upon previous status. When clicked user will enter into “Route Option” menu.
    a. If display indicates “Cal Route: n/a” the HI-903 PRO-CALROUTE firmware has not been purchased. Contact Metrix to add this firmware to the HI-903 PRO.
3. Use **FREQUENCY** dial to highlight and click on **LOAD FILE FROM USB**
4. Up to six route files (tests) are shown. Use **FREQUENCY** dial to highlight

and click on desired file.

5. Display will indicate “Route Load Successful Activate Now?” To activate press the **AMPLITUDE** dial.
    a. To load to memory but not activate the test press **FREQUENCY.**

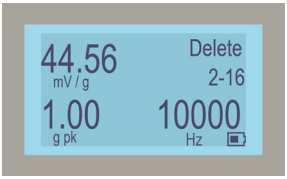
The calibration test is now loaded and active. Rotating the **FREQUENCY** dial allows user to scroll through programmed test points without saving data.

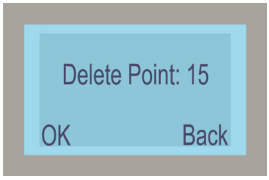
Executing the Semi-Automated Calibration Test (Route)

The calibration test has been created and saved to the USB. It has also been uploaded and activated in the HI-903 PRO using the previous section. The following instructions detail usage of the HI-903 PRO while the pre-programmed test is active. To use the HI-903 PRO in manual mode again the calibration route must be de-activated (see next section).

- With a Calibration Route active the HI-903 PRO will only cycle to the pre-programmed test points. The **FREQUENCY** dial can be used to cycle and preview test points without saving data.
- Pressing the amplitude dial will not change amplitude scales while route is active.
- Data is still stored to internal memory when Calibration Route is active if **FILE** dial is pressed while “Save Point” is displayed. Delete, Save, Tools and End Record functions operate as previously detailed in “Basic Operation” section.

1. Once the Calibration Route is activated shaker will vibrate at first pre-programmed test point. Use **FILE** dial to display “Save Point” then press the dial.
2. A pass/fail indication is displayed. The frequency, amplitude, sensitivity of sensor under test, upper and lower bounds are shown. If sensitivity is between upper and lower bounds **“Pass”** is shown at top right. If sensitivity is outside of bounds **“Fail”** is displayed. Press **FILE** dial to continue to next test point.
    a. If test point fails technician can delete the point and try again by using **FILE** dial to display “Delete” then press and make appropriate selection. Deleting the point will step the test back to the previously failed test point.





3. Continue the test point-by-point by pressing the **FILE** dial with “Save Point” displayed. The pass/fail screen will appear after each point.
4. When test is complete the model and serial number entry screen is displayed. Enter data as outlined in “Basic Operation” section or skip by pressing **FILE** with “Next” displayed.
5. A final data entry screen is displayed, with “Save” displayed press **FILE** to save the calibration test results to internal memory and begin next test.

Creation of print-able test reports is done as previously mentioned. Follow instructions in “Basic Operation” section to create frequency response and linearity calibration certificates in Microsoft Excel®.

Route Option Menu

The Route Option menu is accessed by pressing **FREQUENCY** dial then using the dial to highlight and click on **Test Settings**, then using the dial to highlight the text next to **Cal Route:** and clicking on it. The menu has the following functionality and the **FREQUENCY** dial is used to navigate and select:

- **Back –** returns to Test Settings menu
- **Activate Route –** activates the calibration test stored in memory
- **Deactivate Route –** returns the HI-903 PRO to manual operation, de-activates semi-automated test
- **Load File From USB –** shows a list of up to six pre-programmed tests (routes) read from Calibration_Route folder on USB drive
- **Delete Route –** returns the HI-903 PRO to manual operation and also deletes the pre-programmed test from memory
- **File Information –** displays name of semi-automated test, number of test points and date it was created. If no test is active pressing file while this option is highlighted does nothing.
- **Eject USB –** allows user to safely remove the USB drive from HI-903 PRO

Definition of Frequency Units

- Hertz (Hz) is defined as the number of periodic cycles per second and it is a standard unit for measuring signal frequency.
- CPM stands for Cycles Per Minute. CPM is commonly used for testing industrial sensors that monitor rotational vibration. 1 Hz=60 CPM

Definition of Amplitude Units

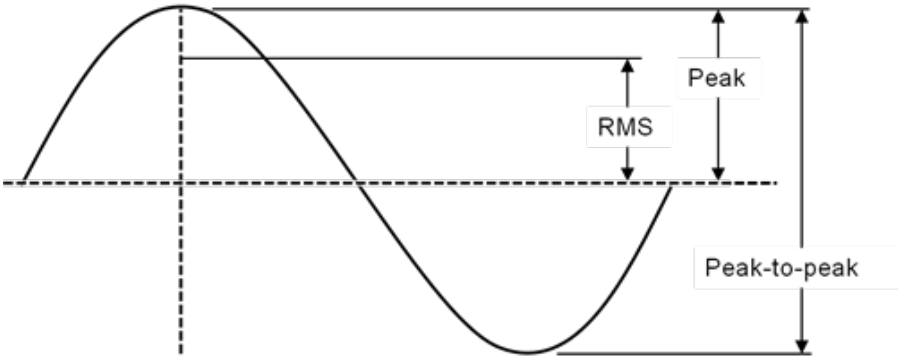


Figure: Sinusoidal Wave

- Root Mean Square (RMS) is a calculation that takes the square root of the average of the squared amplitudes from a set of data. This type of measurement takes all amplitudes of a signal into account rather than just one, making it an accurate tool for an overall calculation.
- Peak (pk) bases calculations on the highest value of the signal generated during testing. For a sinusoidal wave (as is produced by the HI-903 PRO), the peak value is calculated by RMS*$\sqrt{2}$. The HI-903 PRO does not

measure a true peak value, but instead estimates the value mathematically based upon the RMS value.

- Peak to Peak (p-p) is a calculation of the difference between the highest positive peak and the lowest negative peak of a recorded sine wave. The p-p value is calculated as two times the peak value.
- Gravitational acceleration (g) is the acceleration experienced naturally by objects in earth's gravitational field. It is approximately equal to 9.80665 m/s^2.

Mounting Basics

Connecting Sensor to HI-903 PRO Platform

1. Mating surfaces of the mounting platform and sensor should be flat, parallel and free of dirt, paint, epoxy, scratches, etc.

2. Threads in platform, sensor and adaptor (if needed) must match to ensure a proper fit and that testing is free of errors. Clean any worn threads with a tap or die and coat them in silicone grease for best results.

3. An adaptor may be needed to connect the sensor to the armature. The HI-903 PRO platform requires a ¼-28 thread.

4. Silicone grease can be applied to the mating surfaces and threads to ensure good mechanical coupling. This is particularly important when testing at high frequencies.
5. For threaded sensors, please follow the sensor manufacturer's torque recommendation.

Tightening and Loosening Connections

1. When tightening or loosening the connection between the sensor and the HI-903 PRO mounting platform, secure the mounting platform with the supplied wrench.

2. It is important to keep sensors and fixtures centered and straight when attaching them to the HI-903 PRO mounting platform. This will ensure a stable, even connection and eliminate potential alignment issues.

Input / Output

EXTERNAL SOURCE IN Input BNC

It is possible to drive the HI-903 PRO by using an external signal source or a function generator. First, connect a signal source to the **EXTERNAL SOURCE IN** BNC Input located on the top left corner of the unit. To enable the **EXTERNAL SOURCE IN** input, press the **FREQUENCY** dial to enter the "Calibration Options" menu then rotate **FREQUENCY** dial to highlight and click on **TEST SETTINGS**. Next, use **FREQUENCY** dial to highlight selection next to "Source:" and toggle between "Internal" and "External" by pressing the dial, select "External".

1. When in **Ext Sig** mode, the vibration amplitude is measured and displayed on the screen, however, the frequency and amplitude of the shaker is controlled by the external source, not by the HI-903 PRO. The frequency of the input signal is not displayed on this mode.
2. The amplitude and sensitivity values displayed on the screen are for reference only. The measurements are not accurate while in **Ext Sig** mode and do not fall under the published specifications for the product.

Do not exceed 1V RMS! Overdriving the unit may cause clipping, unwanted distortion and damage to the unit

MONITOR REFERENCE OUT Output BNC
The HI-903 PRO is controlled by an internal shear mode quartz reference accelerometer. The voltage output of the reference accelerometer can be monitored through the available **MONITOR REFERENCE OUT** BNC output by connecting it to a readout device (e.g. voltmeter or oscilloscope).

Diagnostic Screen
The diagnostic screen can be displayed by holding down the file button for approximately 2 seconds. This screen displays information about the operation of the HI-903 PRO. The information found in this menu is displayed in real time:

Reference ICP Bias Voltage
Test Sensor Bias Voltage
Test Sensor Type: Voltage, ICP® or Modulated Current
Signal Type: Internal or External
Reference THD
Sensor THD

Exit the diagnostic screen by pressing the file button.

TEST SENSOR IN Input BNC
The HI-903 PRO provides the capability to measure the test sensor's voltage signal, replacing the need for an external DMM or data acquisition. The input electronics can be configured for Voltage, ICP® or Modulated Current mode as described in Step 4 of Basic Operation earlier in this manual.

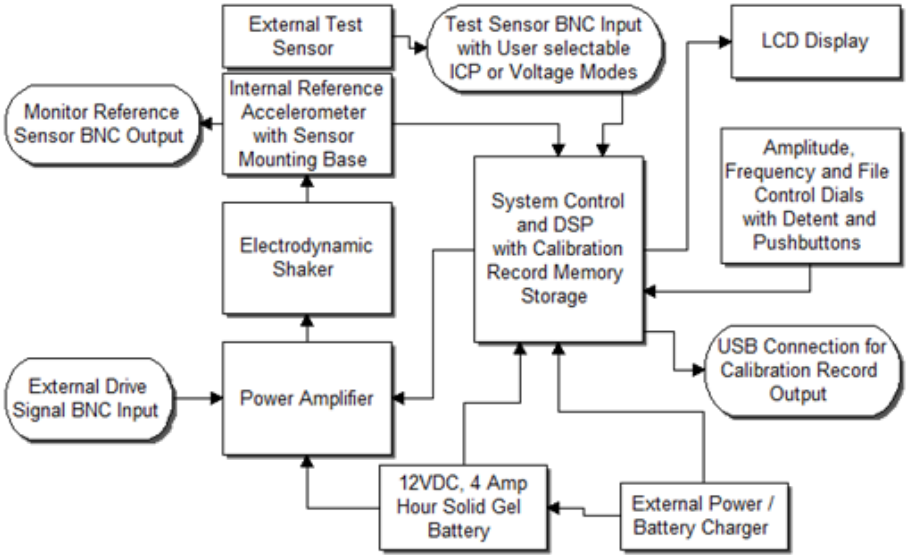
The **TEST SENSOR IN** input BNC is capable of measuring a voltage input of up to 10V AC pk-pk. As an ICP® sensor signal conditioner, it measures up to 10V pk-pk AC signal while supplying 5mA ICP® constant current at 25V DC. While in ICP® mode, the input circuit is also monitoring the ICP® sensor Bias Voltage and will indicate a Bias Fault when the DC voltage is below 2V DC or above 15V DC. The open circuit voltage of the ICP® supply will be 25V DC. This open circuit and the ICP® Bias Voltage may be checked using the diagnostic menu.

3. THEORY OF OPERATION

Instrumentation
The Model HI-903 PRO Portable Vibration Calibrator internal electrical system is comprised of several different mechanisms:

- *Electrodynamic Shaker*
- *Power Amplifier*
- *Reference Accelerometer*
- *Signal Generation Electronics*
- *Sensor Signal Measurement Electronics*
- *LCD Digital Display*

- *3 Dials with Detent and Integrated Pushbuttons*
- *12 VDC, 4 Amp Hr Solid Gel Battery*
- *External Charger*
- *Three different BNC ports: "External Source In," "Monitor Reference Out" and "Test Sensor In"*
- *USB Flash Drive Port*



The LCD display continuously shows the frequency of the shaker drive signal and the vibration amplitude of the mounting platform as measured by the reference accelerometer.

The reference accelerometer is a PCB Piezotronics ICP® quartz shear sensor, integrated into the mounting platform. A calibration "standard" maintained by METRIX is used to calibrate the HI-903 PRO as a complete system and provides NIST traceability. Traceability information can be viewed under the tools menu as described in the previous section.

The power amplifier is specifically designed to provide the current required to drive the electrodynamic shaker. The electronic signal processing system produces a variable frequency sine wave to the power amplifier, which becomes the source of the driving signal to produce the vibration at the mounting platform.

The frequency of the shaker drive signal is controlled by the front panel **FREQUENCY** dial. The amplitude of the shaker drive signal is controlled through a feedback loop, to maintain the stability of the actual motion. Adjusting the front panel **AMPLITUDE** dial adjusts the target vibration amplitude.

Pressing the **AMPLITUDE** dial toggles the amplitude measurement units through the following choices if all units are active:

	Acceleration	Velocity	Displacement
	g's pk g's RMS m/s2 pk m/s2 RMS	in/s pk in/s RMS mm/s pk mm/s RMS	mils p-p µm p-p

Users can de-activate amplitude scales by using the "Amplitude Units" menu. See the section "Amplitude Units" for more information. If desired scale is not appearing while pressing **AMPLITUDE** to cycle through scales, then it has likely been turned off in the "Amplitude Units" menu.

Turning the **FILE** dial activates the file menu. Turn the **FILE** dial to toggle between the below options and press the dial again to select.

Save Point	End Record	Delete	Tools
	Next Edit Back	Delete Point Delete Record Delete All Back	USB Menu Options Traceability Back

Below are the options to choose from when the USB Menu is selected. Turn the **FILE** dial to the proper option and press it to select.

Copy All Records	Move All Records	USB Options
		Eject
		Format USB
		Back

Below are the options to choose from when the USB Menu is selected. Turn the **FILE** dial to the proper option and press it to select.

Date and Time	Calibration Interval	Set Resistance Value
Adjust	Adjust	Adjust
Back	Back	Back

Pressing and holding the file button will return the main calibration screen from any new level.

Battery and Charger

The Model HI-903 PRO can be operated from AC line power or from its internal rechargeable battery. When the external power supply is connected, it becomes the primary power source, operating the unit while simultaneously charging the battery.

NOTE: It is good practice to perform calibrations on battery power. Disconnecting from line power ensures a power surge will not cause the calibrator to power down during test. If excess current is detected during use, the portable calibrator shuts down to prevent damage.
Battery power is supplied by a sealed solid gel lead acid 12 VDC rechargeable battery. The battery can be permanently damaged if completely drained. To prevent damage, the HI-903 PRO will automatically shut off when the battery power level gets too low. *Suggested Best Practice: Keeping the battery fully charged ensures the unit is always ready for use.*

Under mild operating conditions (lower mass transducers at lower test amplitudes), a fully charged battery will allow the HI-903 PRO to operate for up to 18 hours. The charge life of the battery depends on both the length of use and the amount of power (dependent upon payload, frequency and amplitude) required for a particular test. When testing requires high vibration levels, the charge life will be shorter than during less rigorous testing. For example, continuous testing of 100 gram payload at 10 g pk will drain the battery charge in approximately 1 hour.

A Battery Charge Indicator is displayed on the LCD screen to approximate the unit's remaining charge life. Replacement batteries (Model 9100-BAT01) and power supplies/chargers (Model Number 9100-PS01) are available from Metrix.

The HI-903 PRO calibrators continuously monitor the state of battery charge during operation, storage and charging. During operation, if the battery capacity falls near minimum, the unit will shut off after approximately 2 minutes of inactivity rather than the usual 20 minutes. During storage, if the battery voltage falls near the minimum, the unit will go into deep sleep, requiring connection of AC power and reset of time and date before resumption of operation. During charging, the unit continuously displays charging indication and state of charge, depending upon operation level and time of charge.

Battery Information and Care

- *The unit is delivered in a partially charged state. Fully charge unit for 20 hours before using for the first time. (The unit cannot be overcharged by keeping it plugged into the power supply.)*
- *To recharge the unit, use only the universal power supply included. All batteries lose energy from self-discharge over time and more rapidly at higher temperatures. A full charge cycle can take up to 20 hours.*
- *If not used for a prolonged period of time, recharge every 2 months.*
- *Suggested Best Practice: Charge unit fully prior to field use. Recharge the unit as soon as possible after use.*

4. SPECIFICATIONS AND PERFORMANCE

General

Frequency Range (for acceleration) (operating, 100 gram payload)	7 Hz - 10 kHz	420 CPM - 600k CPM
Maximum Amplitude (100 Hz no payload)	20 g pk 15 in/s pk 50 mils pk-pk	196 m/s^2 pk 380mm/s pk 1.27mm pk - pk
Maximum Payload[1]	800 gram	

[1] Operating range reduced at higher payloads. Reference manual for full details

Accuracy of Readout

MEASURED WITH 10 GRAM QUARTZ REFERENCE ACCELEROMETER

Acceleration (30 Hz to 2 kHz)	± 3%
Acceleration (7 Hz to 10 kHz)	±1 dB
Velocity (10 Hz to 1000 Hz)	± 3%
Displacement (30 Hz to 150 Hz)	± 3%
Amplitude Linearity (100 gram payload, 100 Hz)	< 1% up to 10 g pk
Waveform Distortion (100 gram payload, 30 Hz to 2 kHz)	< 5% THD (typical) up to 5 g pk

Units of Readout

Acceleration (peak/RMS)	g	m/s^2
Velocity (peak/RMS)	in/s	mm/s
Displacement (peak to peak)	mils	µm
Frequency	Hz	CPM
Test Sensor Sensitivity	mV/EU[2]	

[2] EU can be [g], [m/s^2], [in/s], [mm/s], [mils] or [µm].

SUT Specifications

SUT input Voltage range	10V AC pk-pk
SUT ICP current	5mA
SUT Bias offset measurement range	0-25 V DC
SUT Bias Fault Voltage limits	2V/15V DC

Power Requirements

Internal Battery (sealed solid gel lead acid)	12 VDC, 4 amp hours	12 VDC, 4 amp hours
AC Power (for recharging battery)	110 – 240 Volts, 50 - 60 Hz	110 – 240 Volts, 50 - 60 Hz
Operating Battery Life[3]		
100 gram payload, 100 Hz, 1 g pk	18 hours	
100 gram payload, 100 Hz, 10 g pk	1 hour	

[3] As shipped from factory in new condition

Temperature

Operating	32° - 122 °F	0° - 50 °C

Physical

Dimensions (H x W x D)	8.5 in x 12 in x 10 in	22 cm x 30.5 cm x 28 cm
Weight	18 pounds	8.2 kg
Sensor Mounting Platform Thread Size	¼ - 28	

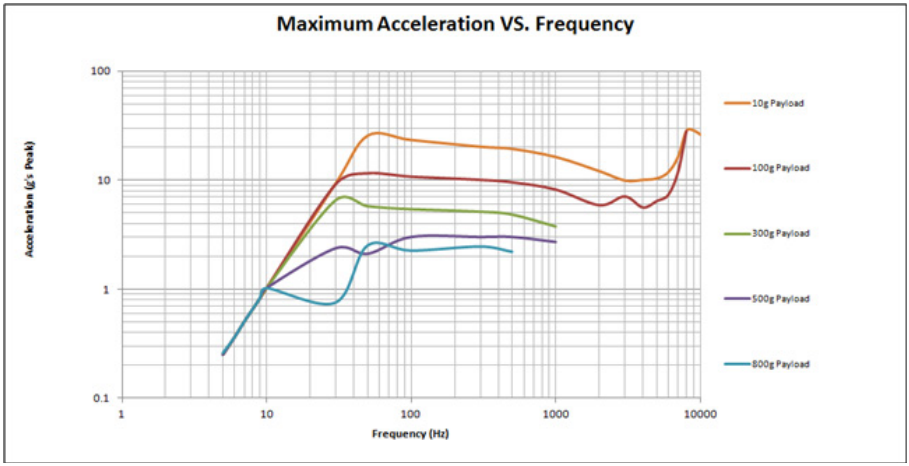
Shaker Loading

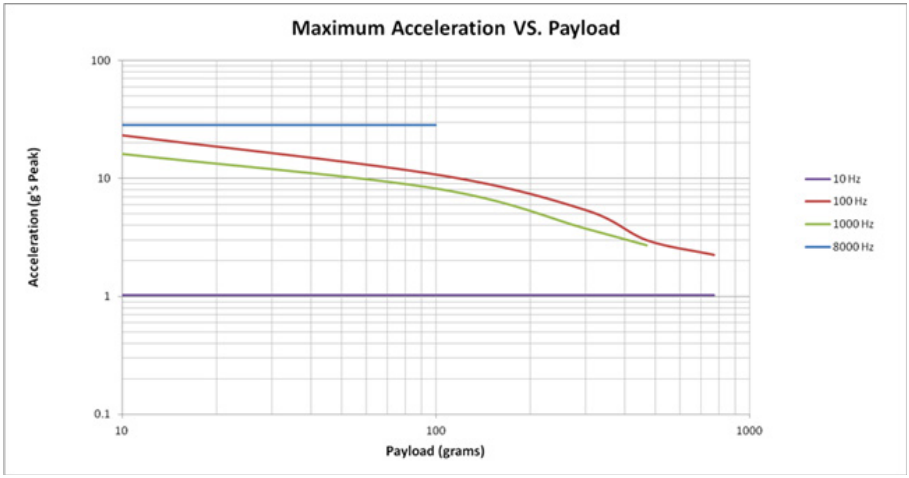
Maximum advisable vibration levels are dependent upon the maximum frequency of operation and the payload. The chart below shows the maximum vibration levels as a function of both frequency and payloads. Payloads exceeding 800 gram should not be tested on the Model HI-903 PRO.

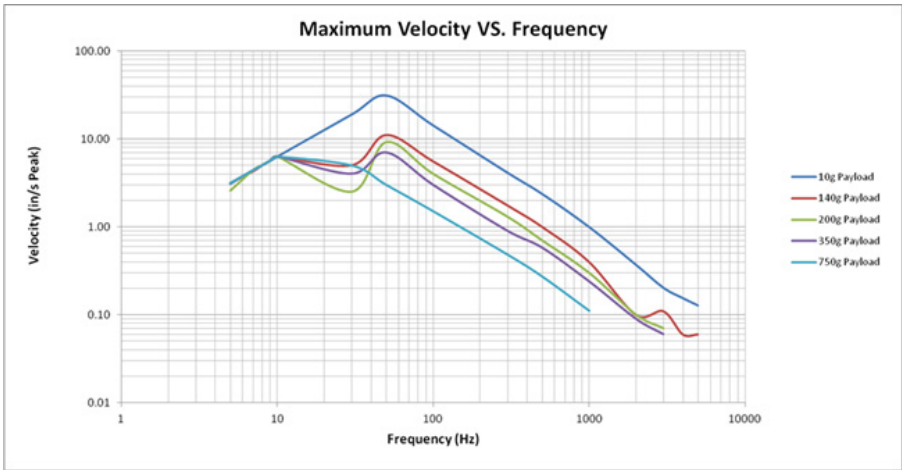
Excessive loads may result in damage to the moving coil and flexure. Care must be taken when testing payloads with large footprints, particularly those with an offset center of gravity. Severe rocking modes can produce high transverse motion and lateral loads on the moving coil and flexure, resulting in damage. When fitting test transducers and fixtures onto the mounting platform, aim to keep the center of gravity directly above, and in line with the center axis of the ¼-28 threaded hole. This is a safeguard against side loading the shaker.

In some cases of extremely heavy shaker payloads at high vibration levels (depending on the frequency), the HI-903 PRO may exhibit both frequency and amplitude instabilities. In this case, please reduce the excitation amplitude and/or the payload to eliminate the effect.

The HI-903 PRO electronics incorporates a shaker power amplifier with thermal protection. If the shaker payload amplitude and run time exceed safe thermal ranges, the shaker table power amplifier will protect itself and shut off. The unit should be turned off and allowed to cool before resuming operation.


Maximum Acceleration VS. Frequency
Acceleration (g's Peak)
100
10
1
0.1
1
10
100
1000
10000
Frequency (Hz)
10g Payload
100g Payload
300g Payload
500g Payload
800g Payload


Maximum Acceleration VS. Payload
Acceleration (g's Peak)
100
10
1
0.1
10
100
1000
Payload (grams)
10 Hz
100 Hz
1000 Hz
8000 Hz


Maximum Velocity VS. Frequency
Velocity (in/s Peak)
100.00
10.00
1.00
0.10
0.01
1
10
100
1000
10000
Frequency (Hz)
10g Payload
140g Payload
200g Payload
350g Payload
750g Payload

5.RECOMMENDED PRACTICES

Operational Verification and Recalibration
As with all calibration systems, periodic verification of the system's performance is strongly recommended. This is best done by calibrating a dedicated verification accelerometer each day that the unit will be used. This practice confirms proper calibration of the equipment at the time of use. A precision accelerometer with a quartz sensing element is recommended for performing operational verification, available from Metrix .

Results of the verification should be compared to previous results obtained with that dedicated, controlled accelerometer. If the calibration result of the verification sensor changes, the HI-903 PRO should be evaluated further to determine the root cause of the discrepancy.

Field repair of the HI-903 PRO is not possible, so if performance of the HI-903 PRO is out of specification, it should be sent back to Metrix for evaluation, repair and recalibration. Please contact Metrix at info@metrixvibration.com or +1-281-940-1802 for a Return of Material Authorization (RMA) number.

Standard Checks for Transducers
Linearity and frequency response checks should be performed periodically to validate vibration transducer functionality.

Linearity is checked by submitting the sensor to different vibration levels while frequency is kept constant (typically at 100 Hz or any other frequency specified by the transducer's manufacturer). The vibration is set to different levels within the dynamic range of the sensor, trying to cover (as much as possible) from low to high operating levels. The sensor output is recorded and checked if it remains proportional (linear) to the sensor excitation input. Alternatively, the sensor sensitivity can also be recorded and its deviation observed for the different test points (it should not vary too much for sensors that are linear).

The frequency response of a vibration transducer can be tested by checking the sensor output across different frequency points within the operational frequency range of the transducer. Typically, the vibration level of the unit is set at a constant value ($10 m/s^2$ and 1g are common choices for accelerometers) and the sensor output (or the sensor sensitivity) is observed and recorded at different frequency points.

Typical Accelerometer & Velocity Sensor Checkout
Accelerometers & velocity sensors are tested by performing a frequency response calibration. This is done by measuring the sensitivity of the sensor at a variety of frequencies within its linear range. Per the ISO 16063-21 accelerometer calibration standard, the amplitude at each frequency is at the discretion of the user and need not be kept consistent. Best practice is to use amplitude safely above the noise floor and but low enough not to create distortion on the shaker. Thus 1.0 g's peak is the most common amplitude used for 100 mV/g accelerometers.

The ISO 16063-21 standard recommends testing at the center frequencies of the 1/3 octave bands. For accelerometers with 10 kHz high frequency response that would mean 29 different test points, which can be time consuming. Accelerometer manufacturers test at far less points. In general as long as the test covers the

practical usage of the sensor and the test points are evenly dispersed through the test range the user will perform a good and thorough test of an accelerometer.

A good practice within industrial applications is to follow the American Petroleum Institute Standard 670 “Machinery Protection Systems” recommendations for accelerometer and velocity sensor test points. Standard 670 recommends testing at the following frequencies for both accelerometers and velocity sensors:

- 10, 20, 50, 60, 100, 200, 500, 1000, 2000, 5000 and 10000 Hz
    - Model HI-903 PRO is not capable of 61.44 Hz, only integer numbers such as 61 or 62.

For accelerometers the recommended amplitudes in API 670 are:

- 0.15 g’s peak (1 m/sec^2 RMS) for 10 Hz
- 1 g peak (7 m/sec^2 RMS) for 20-1000 Hz
- 4 g’s peak (30 m/sec^2 RMS) for 2000-10000 Hz
-

For velocity sensors the recommended amplitudes in API 670 are:

- 0.92 ips peak (15.92 mm/sec RMS) for 10 Hz
- 3.08 ips peak (55.70 mm/sec RMS) for 20 Hz
- 1.23 ips peak (22.28 mm/sec RMS) for 50 Hz
- 0.62 ips peak (11.14 mm/sec RMS) for 100 Hz
- 0.31 ips peak (5.57 mm/sec RMS) for 200 Hz
- 0.12 ips peak (2.23 mm/sec RMS) for 500 Hz
- 0.06 ips peak (1.11 mm/sec RMS) for 1000 Hz
- 0.12 ips peak (2.39 mm/sec RMS) for 2000 Hz
- 0.05 ips peak (0.95 mm/sec RMS) for 5000 Hz
- 0.02 ips peak (0.48 mm/sec RMS) for 1000 Hz
    - Note that velocity is not recommended as a vibration measurement scale at frequencies greater than 1000 Hz. Thus many sensor manufacturers install low-pass filters on velocity sensors at 1000 Hz or lower.

Practical Industrial (Predictive Maintenance) Testing Recommendations

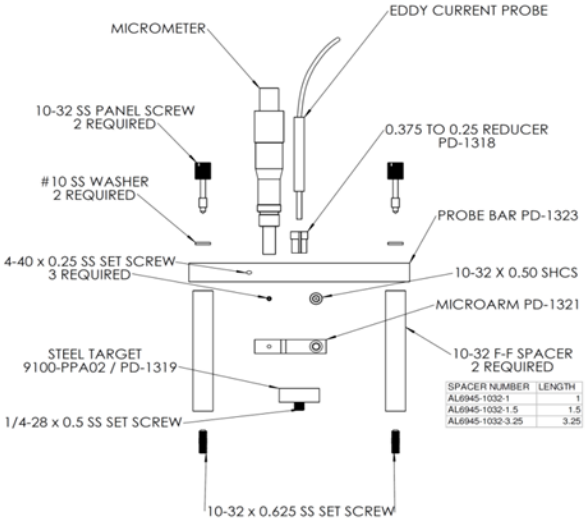
While testing to the API 670 or ISO 16063-21 standard is certainly thorough it is not always practical and is time consuming especially for the predictive maintenance user. Thus Metrix makes the following recommendations for industrial vibration:

- For permanent mount accelerometers/velocity sensors routed to an online monitoring system or junction box, at least test the sensors at 1x and 2x running speed and confirm both the vibration alert (high) and alarm (high-high).
- For route-based predictive maintenance where one sensor is magnetically mounted on many machines at many points, perform a complete frequency response test of the accelerometer. Its accuracy is important at many frequencies. Test to Fmax on the vibration analyzer. If high frequency bearing fault detection methodologies are in use, test the sensor to the highest possible bearing defect frequency.

Tip: Magnetically mounting sensors greatly reduces high frequency response. A ferrous magnet target, mounting pad, is included with the HI-903 PRO. One can install this pad on the shaker and mount accelerometers magnetically. Always rock the sensor in place as one would on the machine. Test the accelerometer to Fmax

on the analyzer to see if response is amplified at relevant high frequencies.

Non-Contact Displacement Sensor Calibration
Non-contact displacement sensors, also known as proximity probes, eddy current probes or displacement probes, can be checked for accuracy, linearity, and frequency response. Proximity probe systems require the use of the optional HI-223-9M (Metric Units) and HI-223-9E (English Units) proximity probe adaptor kit, shown on the next page. The following sections detail the procedure for performing linearity and frequency response checks on a non-contact displacement sensor.



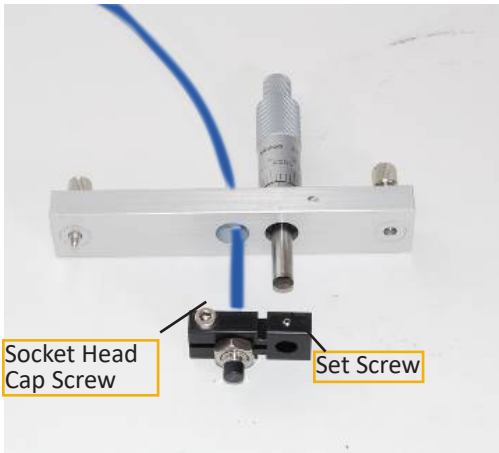
SPACER NUMBER	LENGTH
AL6945-1032-1	1
AL6945-1032-1.5	1.5
AL6945-1032-3.25	3.25

Non-Contact Displacement Sensor Test Setup
Note: The calculations in these instructions are based on a 200 mV/mil eddy current proximity probe to provide an example based on nominal sensitivity. In most cases, the proper proximity probe, extension cable, and driver (proximitor®) must be matched in order to obtain the expected output from this type of transducer.
[Proximitor is a registered trademark of Bently Nevada.]

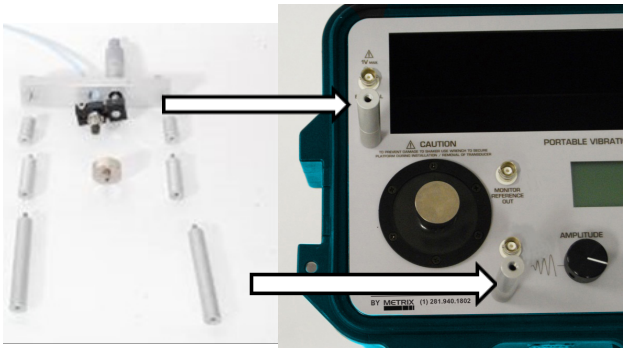
1. Remove the (2) 10-32 pan head screws on the user panel of the portable vibration calibrator (white arrows in picture below).

2. Install the AISI 4140 steel target into the shaker on the mounting platform.

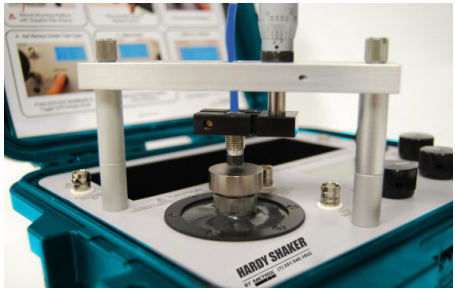
3. Install the non-contact displacement sensor in the microarm after stringing the probe through the probe bar as shown in the picture below. Please note: An 8 mm probe tip non-contact displacement sensor with 3/8-24 threaded case will mount directly while a 5 probe tip mm non-contact displacement sensor with a ¼-28 threaded case requires the supplied bushing. Slide the non-contact displacement sensor into the microarm. Tighten the socket head cap screw inside the microarm to lightly squeeze the probe to ensure the probe is held securely.



4. Carefully lay out the assembly to resolve the required spacer or spacers to hold the non-contact displacement sensor the proper distance from the target as shown below. The non-contact displacement sensor will need to be held so that the sensor will contact the target and must be capable of traveling 100 mils before the micrometer runs out of travel. (for 200 mV/mil probe with 10-90 mils range). Non-contact displacement sensors come in various lengths so adjustability has been designed into the assembly. Attach selected spacer or spacers using setscrews provided, leaving threaded holes exposed.



5. Finalize the assembly by attaching probe bar, microarm, non-contact displacement sensor, and micrometer on top of the spacers and secure with provided panel screws.



Proximity Probe Dynamic Linearity Calibration & Confirmation of Vibration Alarms

IMPORTANT: The HI-903 PRO powers up at the unit's previous frequency and amplitude settings. Prior to using the HI-903 PRO for calibrating non-contact displacement sensors, set amplitude to a low level to avoid striking the tip of the probe with the target due to previously set large displacements.

1. **Mount** the proximity probe to the shaker facing the target by following instructions in the previous section.
2. **Gap the probe**. With the non-contact displacement sensor powered up and the output from the probe driver wired to a voltmeter set to DC voltage, adjust the micrometer so the gap between the probe tip and the steel target is around 50 mils. If you are using a 200 mV/mil proximity probe the voltmeter should read between -8 and -11 Volts DC, typically ~-9 Volts DC is 50 mils. Fifty mils is the typical recommended gap setting for non-contact displacement sensors, ensuring the sensor is in the center of its dynamic range. If the probe is 50 mils from target (or rotating equipment before start-up) it can accurately measure up to 80 mils peak-to-peak vibration. Consult your non-contact displacement sensor's user manual for additional information.
3. **Power-on** the shaker by pressing and holding the **FREQUENCY** dial.
4. **Test the probe at running speed of the machinery it protects.** Primary vibration issues occur at running speed. Thus ensuring the proximity probe is accurate at running speed is the most practical and confidence-building test. Test speed can be set in Hz or CPM (see Section 2: Operation Guide for instructions) by turning the **FREQUENCY** dial.
5. **Confirm vibration alarms**. Press the **AMPLITUDE** dial to cycle through vibration scales until either mils p-p or µm p-p is displayed. Choose the appropriate scale for your vibration monitoring system. Turn the **AMPLITUDE** dial, adjusting vibration to the lowest vibration alarm threshold (sometimes called "alert"). Confirm with control room that displayed amplitude on model HI-903 PRO equals value read on monitoring system. Confirm vibration alarm is triggered, making sure to wait long enough for programmed time delays to expire. Repeat the process for each vibration alarm threshold.
6. **Create a linearity test report for auditing purposes**. Connect the output of the probe driver to the **TEST SENSOR INPUT** BNC. Make sure model HI-903 PRO is in "voltage mode" by pressing and holding the **AMPLITUDE** dial or using the **TEST SETTINGS MENU**. Sensitivity of the probe, extension cable and driver is at top left of the LCD screen. Keep the same speed throughout this test, ideally running speed of the machine on which the probe is installed. Use the **AMPLITUDE** dial to adjust vibration displacement level. The typical test is from 1.0 to 10.0 mils p-p, recording sensitivity every 1.0 mils (1.0, 2.0, 3.0 mils pk–pk, etc.). The test can be modified to suit the needs of the application. To save each test point to memory rotate the **FILE** dial until **SAVE POINT** appears at top right, then press the **FILE** dial to save data to memory. When complete, rotate **FILE** dial to display **END RECORD** then press **FILE** dial.

   Note: if "Bias Fault" appears at top left on display, the HI-903 PRO is supplying ICP power to the proximity probe. This will not damage the probe. But ICP power must be turned off by pressing and holding the ***AMPLITUDE*** *dial.*

   Note 2: Visit metrixvibration.com for helpful videos
7. **Export the test(s) to the supplied USB drive**. For detailed instructions, see Section 2: Operation Guide
8. **Create, save and print test report using Microsoft® Excel®**. Connect the USB to any computer with Excel®. Open the **REPORT GENERATION WORKBOOK**. Click

on the **LINData** tab. Press **Import Data from File** then choose the desired test data from the appropriate folder on the USB drive. Each time tests are exported from HI-903 PRO to USB they are saved within a folder representing the date and time they were exported. Once data is imported press **View Certificate.** Enter any desired notes or comments into the report, save and/or print.

Note: Macros must be enabled for buttons to respond when clicked in Report Generation Workbook.

Troubleshooting the proximity probe system

If the vibration alarms did not activate at desired vibration thresholds the most common reason when using proximity probes is incorrect cabling. Advice on troubleshooting follows below. Be sure to read the previous section on confirming vibration alarms by dynamic linearity testing.

- Connect the output of the probe driver to **TEST SENSOR INPUT** BNC on model HI-903 PRO while simulating vibration at the lowest alarm threshold. For a 5 or 8mm probe, is the sensitivity within 5% of 200 mV/mil? I.e. within 190-210 mV/mil or 7.08–8.66 mV/µm? The monitoring system likely is scaled for 200 mV/mil or 7.87 mV/µm. If alarms did not activate it could be incorrect input sensitivity.
- Incorrect sensitivity is most often caused by incorrect cabling. Check the required length for the probe driver. Then check the length of the extension cable and integral cable on the probe itself. The probe cable length plus extension cable length should equal the required length for the probe driver.
- Make sure the probe was gapped properly prior to the test. See previous section.
- Ensure the proximity probe target is attached to the top of the shaker.
- Does the probe driver have a MOD? If so the probe driver may have been made for a different target material. The standard API 670 recommended target for testing proximity probes is 4140 steel. But custom proximity probe systems, calibrated to alternate materials, require a custom calibration target. Contact Metrix for custom target materials.

Creating a Proximity Probe Curve in Mils

Note: Reference steps 1-5 of "Non-Contact Displacement Sensor Test Setup" section for setup instructions. This test assumes a 5 or 8mm proximity probe with 200 mV/mil output.

1. Power on the probe driver and connect a digital voltmeter to the output. Set the voltmeter to measure DC voltage.
2. Open the Report Generation Workbook and select the **LINData** tab. Choose **Displacement** for cell H12, **Volts** for cell I13 and **mil p-p** for cell H13.
3. Positon the probe over the target using the micrometer such that -1.0 VDC reads on the voltmeter. Enter 10 into cell H14 next to "Starting Point" and enter -1.0 into cell I14 as a place holder. This value will be changed later.
4. Rotate the micrometer so that the proximity probe moves 10 mils further from the target. Each dash on the micrometer is one mil. Enter 20 mils into cell H15 and enter the DC voltage value read on the voltmeter into cell I15.
   a. Pay attention to micrometer looseness. All micrometers have looseness when changing directions where turning the micrometer does not move the probe. The looseness can be felt in your fingers

as resistance is less than normal.

5. Repeat step 4 until the probe is 90 mils from the target. Each time the micrometer is turned 10 mils the probe moves 10 mils further from the target. Record the DC voltage at 10, 20, 30, 40, 50, 60, 70, 80 and 90 mils using column I in the workbook.
6. Once the 90 mils data point is recorded use the micrometer to move the probe 80 mils closer to the target. In this step the 10 mils DC voltage will be re-confirmed. Recall that -1.0 VDC was entered as a placeholder. Move the probe 80 mils closer so that it is 10 mils from target and re-write the DC voltage in cell I14.
    a. One full rotation of the micrometer is 25 mils. To accomplish step 6 quickly, complete three full rotations of the micrometer and then move 5 more mils.
7. All data is now entered, press **View Certificate** to view, edit, save and print the report.

Static Proximity Probe / 4-20 mA Vibration Sensor Calibration Data Table				
			Max Linearity:	0.00 %
Index	Displacement	Output	Sensitivity	Linearity
	mil p-p	mV	mV/mil	%
Starting Point				
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				

Testing 4-20 mA Vibration Transmitters

Loop-powered 4-20 mA vibration transmitters give an overall vibration level reading and interface directly with the plant PLC, DCS or SCADA system just as process instrumentation does. The most important function of these sensors and the control system to which they are connected is the vibration alarms:

1. Remove the vibration transmitter from the machine and mount to the shaker table. Users may need a mounting adaptor such as ¼" NPT available from Metrix. The shaker table should be brought to the sensor.
2. Leave all connections as is this will test the sensor, cable, system, display and alarms.
3. Set the frequency to the running speed of the machine. It may be easier to use the CPM scale than Hz for this test (press frequency dial and enter sub-menu to change)
4. Set the amplitude to the first vibration alert or just greater than first alert, call the control room to confirm alert.
5. Set the amplitude to the second (severe) vibration alarm or just greater, call the control room to confirm alarm.

6. Confirm with control room displayed vibration matches that shown on the HI-903 PRO.
7. Continue testing at any additional vibration alarm points.

Creating a Test Report for 4-20 mA Vibration Transmitters

For safety or insurance audits it may be helpful to have test reports for 4-20 mA vibration transmitters. The HI-903 PRO cannot read DC voltage or current, thus for this test a calibrated multi-meter (capable of measuring current) is required. A 24 VDC power supply must be used to power the sensor. The following instructions include using the 24 VDC Power Supply. If it will not be used skip to step 5.

1. Mount the 4-20 mA vibration transmitter to the shaker table. Users may need a mounting adaptor such as ¼" NPT available from Metrix.
2. Make sure the HI-903 PRO is turned off, connect the sensor's leads to appropriate positions on the 24 VDC Power Supply: +24 VDC, SIG IN and GND (ground). For example, for a Metrix ST5484E cable connect the RED wire to +24 VDC, the BLUE wire to SIG IN and the cable's shield to GND.
3. Connect the DAQ BNC output on the 24 VDC Power Supply to the calibrated multi-meter and set the meter to measure DC current. A BNC jack to banana plug is the simplest method of connection.
4. BNC jack to banana plugs are commercially available from any electrical hardware store (Metrix uses Pomona model 1269 BNC jack to banana).
5. Turn on the shaker table.
6. Open the Report Generation Workbook on a computer and click the LINData tab.
7. Under the "Static Proximity Probe/4-20 mA Vibration Sensor Calibration Data Table" at right, click cell H12 and choose appropriate scale (acceleration, velocity or displacement). For aforementioned model 640B01 "velocity" would be chosen.
8. In cell H13 select the appropriate sub-scale (for velocity: ips pk, ips RMS, mm/sec pk or mm/sec RMS). For Metrix ST5484E, "ips pk" would be chosen.
9. In cell I13 choose "mA" as the output.
10. The starting point should be 0.0, record this in cell H14. Read the mA value on the multi-meter and record in cell I14.
11. For first amplitude test point, read vibration value from display of HI-903 PRO, record in column H then read mA value from multi-meter and record in column I. Repeat until test is complete.
12. When all data has been entered press "view certificate" and print or save. Optionally enter additional test data like model number, serial number, location and notes.

A good test is to take five test points (including zero), evenly spaced through the range. Be sure to confirm operation at vibration alarm points. Example test data for Metrix ST5484E:

Static Proximity Probe / 4-20 mA Vibration Sensor Calibration Data Table				
			Max Linearity:	0.00 %
Index	Displacement	Output	Sensitivity	Linearity
	mil p-p	mV	mV/mil	%
Starting Point				
1				
2				
3				

Maintenance
Recalibration and certification is recommended on an annual basis. Service of internal parts should only be performed by factory personnel. If the unit is removed from the case, the NIST calibration is void. Recertification can only performed after re-assembly.

Note: Metrix is continuously improving our products. Please refer to our website to download the latest version of this document.

© 2026, Metrix Instrument Company, L.P. All rights reserved.

info@metrixvibration.com • metrixvibration.com
8824 Fallbrook Dr. Houston, TX 77064, USA • Tel: 1.281.940.1802