



PORTABLE SHAKER TABLE

PRODUCT MANUAL | MODEL 9100D

PORTABLE SHAKER TABLE

MODEL 9100D

PRODUCT SUPPORT

For answers to questions about this product, consult this manual or the accessory manual. For additional product support, contact The Modal Shop at 800.860.4867 or 513.351.9919, 9 a.m. to 5 p.m. EST. If it is more convenient, fax your questions or comments to The Modal Shop at 513.458.2172 or email our technical staff at info@modalshop.com.

WARRANTY

The Modal Shop, Inc. Series 91X0D Portable Vibration Calibrator & Shaker Table products are warranted against defective materials and workmanship for TWO YEARS from the date of shipment, unless otherwise specified. Damage to equipment caused by incorrect power, misapplication, or procedures inconsistent with this manual are not covered by warranty. If there are any questions concerning the intended application of the product, contact an Applications Engineer. Batteries and other expendable accessory hardware items are excluded.

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SAFETY CONDITIONS

Prior to the installation and use of this product, review all safety markings and instructions. The Modal Shop, Inc. equipment has been designed and manufactured for use in an industrial environment to be operated by trained, qualified personnel.

The following warnings, markings, and cautionary notes are used in the manual and on the equipment:



Denotes a Hazard That May Cause Injury, refer to this product manual for further instructions.

The Modal Shop, Inc. products, like machinery and equipment with live and moving parts, can be a source of serious hazards unless properly used and protected. The level of noise may be unacceptable without protection under certain conditions.



Denotes a Possible Hot Surface, refer to this product manual for conditions that could result in a hot surface temperature



Denotes a Danger of Electrical Shock. The user is committed to ensure that: The handling, assembly, installation, connection, maintenance and repair operations are undertaken by qualified personnel whom by their background, training and experience as well as through their knowledge of statutory regulations, legislation, safety measures and operating conditions are able to carry out any necessary steps avoiding all possible risks to health and damage.

Caution! Denotes a hazard that can damage equipment or data

CAUTIONARY NOTES

- *Loads of up to 800 grams (28.3 ounces) can be mounted directly to the 9100D 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 9100D should always be operated on a stable, flat surface.*
- *The 9100D is designed for field test applications but care must be taken to maintain the integrity of the mounting platform assembly.*
- *Hearing protection is recommended when operating the 9100D for an extended amount of time.*

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1. INTRODUCTION

1.1 Welcome

Thank you for choosing Model 9100D.

The Model 9100D Portable Shaker Table 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 9100D mounting platform are available upon request. A closed-loop control algorithm provides enhanced stability and accuracy of frequency and amplitude levels.

The 9100D incorporates a built-in sine wave oscillator, power amplifier, electrodynamic shaker, NIST-traceable reference accelerometer and digital display. The 9100D 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 9100D is designed to provide long-term reliable performance over the frequency range of 5 Hz to 10 kHz. The 9100D can be used for a variety of applications that include:

- Verification and calibration of vibration transducers and related 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



1.3 Optional Fixturing & Accessories

For operation in certain applications, such as calibration of non-contact displacement sensors, The Modal Shop offers optional mounting fixturing. Reference the table below when ordering these optional adaptors and accessories.

ACCESSORY	DESCRIPTION
9100-MNTKIT	Mounting accessory kit for 9100 Series Portable Shaker Tables, to adapt to ¼-28 threaded mounting platforms. Includes studs/inserts (¼-28, 10-32, 6-32 and 5-40) and bases (for adhesive, magnetic, and custom thread patterns).
9105D	Transfer standard reference accelerometer and ICP® sensor signal conditioner, calibrated as a system per ISO 16063-21, for field calibration and system verification of the 9100 series Portable Shaker Tables. Requires customer supplied digital volt meter.
PROXIMITY PROBE CALIBRATION	
9100-PPA03	Proximity probe adaptor kit, supports probes with common case threads ranging from M6 to ½". Includes Mitutoyo micrometer and 9100-PPA02 nickel plated 4140 steel target.
9100-PPA16	Adaptor kit for mounting 16mm diameter probe tip proximity probes with ¾" or 18mm case thread diameters. Includes probe bar & probe holders. For use with 9100-PPA01 or 9100-MPPA01 proximity probe mounting kit.
9100-MPPA01	Proximity probe adaptor kit, supports probes with common case threads ranging from M6 to ¾". Includes Mitutoyo micrometer (metric) and 9100-PPA02 nickel-plated 4140 steel target.
9100-PPA01	Proximity probe adaptor kit, supports probes with common case threads ranging from M6 to ¾". Includes Mitutoyo micrometer and 9100-PPA02 nickel-plated 4140 steel target.
9100-PPA05	Adaptor kit for mounting 11mm proximity probes with ½", ⅝", 14mm, and 16mm case thread diameters. Includes probe bar & probe holders. For use with 9100-PPA01 or 9100-MPPA01 proximity probe mounting kit.
9100-PPASH	Proximity probe adapter kit for testing probes mounted inside a probe holder. Includes digital micrometer scaled in mils or microns. Fine adjustment via positional micrometer.
MOUNTING	
9155-MNT93	½-20 F to ¼-28 M mounting pad adaptor
9155-MNT43	¼" NPT F mounting adaptor to ¼-28 M
9155-MNT73	⅝-24 M to ¼-28 M mounting stud adaptor
PVC-MNT02	M8 x 1.0 F thru hole mounting pad
081M165	M8 x 1 to ¼-28 mounting stud adaptor
9155-MNT01	Optimized calibration adaptor, triangular bolt pattern on 1.20 inch dia. circle
9155-MNT02	Optimized calibration adaptor, triangular bolt pattern on 1.00 inch dia. circle
9155-MNT03	Optimized calibration adaptor, square bolt pattern on 1.375 inch dia. circle
POWER	
9100-PS02	Modulated current & 4-20 mA vibration sensor USB power supply. Provides voltage output for connection to test sensor input of Portable Shaker Table.
9100-PS02-CBL01	3-socket MIL cable used with 9100-PS02 for testing GE/Bently Nevada® 3-pin MIL case mounted vibration sensors. Spade Lug terminations & BNC output for signal.
9100-PS04-TM	5 VDC Power Supply for testing GE/Bently Nevada® Trendmaster® vibration sensors. USB Powered. Integral 5-pin mating cable. Plug & Play. BNC Output.
9100-PS07-PT	15 VDC power supply for testing Pruftechnik® CLD vibration sensors & other modulated current sensors with the same power scheme. USB Powered. TNC input. Plug & Play. BNC output.
TRAINING	
9100-TRAINING	One day of on-site, hands-on training supporting the Portable Shaker Table. Training is customized for the needs of the customer but is best in groups of 10 techs or less.

1.4 Replacement Accessories

ACCESSORY	DESCRIPTION
9100-PS01	18-Volt, 1-amp power supply/charger for 9100D Portable Shaker Table, universal 100-240 V, 50/60 Hz.
9100-BAT01	Replacement battery for 9100 Series Portable Shaker Tables.
9100-PPA02	Target for 9100-PPA01 or 9100-MPPA01 proximity probe adaptor kit, nickel-plated 4140 steel.
9110-USB	USB flash drive pre-loaded with CALROUTE Programming Workbook
PVC-HTMNT01	Mounting adapter plate for 3 and 4-hole bolt pattern vibration sensors commonly used in high-temp applications. Used for mounting sensors made by Bently Nevada, CEC, Metrix, PCB, Dytran and Endevco to Portable Shaker Tables with ¼-28 F thread
PVC-HTMNT02	Mounting adapter plate for 3 and 4-hole bolt pattern vibration sensors commonly used in high-temp applications. Used for mounting sensors made by Vibro-Meter and PCB to portable vibration calibrators with ¼-28 F thread.
PVC-MNT01	M8 x 1.25 F thru hole mounting pad
M081A63	M8 x 1.25 to ¼-28 mounting stud adaptor
081A08	10-32 to ¼-28 Mounting Stud
081B20	¼-28 to ¼-28 Mounting Stud

1.5 Recalibration Services

ACCESSORY	DESCRIPTION
9100-CAL01	A2LA accredited recalibration of 9100 series Portable Shaker Table.

2. 9100D OPERATION GUIDE

2.1 Basic Operation

Test Set-Up

Step 1 Mount your sensor to the 9100D mounting platform.



- The 9100D sensor mounting platform is threaded for a ¼-28 stud. Select an appropriate adaptor for mounting the sensor.
- While tightening the sensor, secure the 9100D mounting platform with the supplied wrench to prevent damage to the shaker from torque.

Step 2 Connect sensor signal conditioner and readout device as necessary. Make sure that connections are secure.

Step 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.

Setting the Frequency & Amplitude Units

Step 1 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.

Step 2 Select the correct Amplitude Units for your test by pressing and releasing the **AMPLITUDE** dial. The following options are available:

ACCELERATION	VELOCITY	DISPLACEMENT
g pk	in/s pk	mils p-p
g RMS	in/s RMS	µm p-p
m/s ² pk	mm/s pk	
m/s ² RMS	mm/s RMS	

Step 3 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

Completing the Test

Step 1 Verify that the level indicated on the 9100D is the same as the level being shown on the readout of the sensor under the test

Step 2 Before powering the unit OFF, reduce the vibration amplitude. The 9100D 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 9100D is powered ON.

Step 3 Power the unit OFF by pressing and holding the **FREQUENCY** dial for 3 seconds.

- To preserve battery charge, the 9100D will automatically power off after 20 minutes of inactivity when not plugged into the charger.

After Testing

Step 1 Plug the 9100D into an AC power source when not in use. This will ensure the batteries are fully charged for your next test and will also help to maximize the lifespan of the batteries.

Step 2 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. The Modal Shop 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 9100D should be returned to The Modal Shop, Inc. for regular recalibration (recommended annually - Service Code 9100-CAL01) or for any maintenance or repair. The most current factory recalibration date is displayed on the LCD screen during the 9100D boot-up sequence.
- NOTE: The aforementioned Model 9105D allows users to duplicate The Modal Shop’s calibration process without returning the shaker to the factory.

2.2 Additional Features

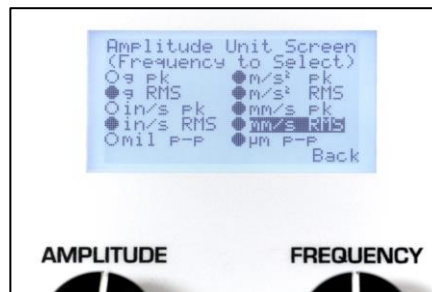
Test Settings

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 activated. Calibration Route allows users to program semi-automated test points. See “Calibration Route” section for more information. Contact The Modal Shop to unlock this feature.
 - Active indicates that the 9100D is currently running a programmed and uploaded CALROUTE. Turning the **FREQUENCY** dial will advance the unit from point to point. Turning the **AMPLITUDE** dial produces no response in this mode.
 - Off indicates that the 9100D is in manual operation mode. The frequency and amplitude will adjust if the user turns their respective dials.
- 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: Hz (Hertz) or CPM (cycles per minute)

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 9100D 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.

Splash Screen Option

Splash Screen Option is used to toggle whether or not the last Modal Shop (or authorized service center) calibration date appears when the 9100D is powered on. To modify, use **FREQUENCY** dial to highlight and click on this menu then press the **AMPLITUDE** dial to enable and press **FREQUENCY** to disable.

2.3 Calibration Route

The Calibration Route firmware allows users to create and run semi-automated frequency response and amplitude linearity tests for vibration sensors on Model 9100D. Tests or “routes” are created in the supplied Microsoft Excel® “Route Generator” workbook then uploaded to the 9100D via supplied USB drive. Once uploaded the test is activated. But the test can also be de-activated at any time, putting the 9100D back into manual operation mode. When a Calibration Route is active the 9100D 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 Route Generator workbook to operate correctly. Drop-down arrows for frequency and amplitude units may not appear if using older versions of this software.

- Step 1** Open the Route Generator workbook using Microsoft Excel.
- Step 2** **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.” The file name must end with _Route.pvc and the file name cannot contain any special characters such as asterisks or exclamation points.
- Step 3** **Frequency Unit:** Use the drop down arrow to choose the frequency unit (Hz or CPM) in cell B8. One cannot toggle between Hertz and CPM during the test.
- Step 4** **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 B10.
- Step 5** **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.
- Step 6** Press **Table Auto-Fill**. The grey cells in the table will automatically populate with the values chosen in steps 3-5. 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).
- Step 7** Enter the desired **Frequency** values for each test point in column A beginning with cell A14. The test will be conducted in the exact order as programmed. The first test point will be as programmed in row 14; the next will use row 15 values and so on.
 - Step 7a** The 9100D 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 9100D will adjust up or down to the nearest CPM value that is a multiple of 60.
 - Step 7b** *Example: 1900 CPM is entered as a test point. The 9100D will adjust to 1800 CPM and 1800 CPM will be displayed.*
- Step 8** Enter the desired **Amplitude** values for each test point in column B beginning with cell B14. Skip this step if all amplitude values have been automatically populated using the Table Auto-Fill button.

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 9100D the following instructions detail how to upload to Model 9100D and activate:

- Step 1** Press the **FREQUENCY** dial to enter “Calibration Options” menu, rotate to highlight **TEST SETTINGS** and press again to enter “Test Settings” menu.
- Step 2** Use **FREQUENCY** dial to highlight and click selection next to “CalRoute:”. Selection will be “Off” or “Active” depending upon previous status. When clicked user will enter into “Route Option” menu.
 - Step 2a** If display indicates “CalRoute: n/a” the 9100-CALROUTE firmware has not been purchased. Contact The Modal Shop to add this firmware to the 9100D.
- Step 3** Use **FREQUENCY** dial to highlight and click on **LOAD FILE FROM USB**
- Step 4** Up to six route files (tests) are shown. Use **FREQUENCY** dial to highlight and click on desired file.
- Step 5** Display will indicate “Route Load Successful Activate Now?” To activate press the **AMPLITUDE** dial.
 - Step 5a** 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. When a calibration test is active users will see “CR PT XX” appear under the displayed frequency, where XX = which test point within the programmed test the user is currently viewing (i.e. “CR PT 2” means it is the 2nd point in the test).

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 9100D using the previous section. The following instructions detail usage of the 9100D while the pre-programmed test is active. To use the 9100D in manual mode again the calibration route must be de-activated (see next section).

- With a Calibration Route active “CR PT XX” will appear under the frequency and the 9100D will only cycle to the pre-programmed test points. The **FREQUENCY** dial is used to cycle through the test points. “CR PT 1” means the user is on the first test point, “CR PT 2” means 2nd test point, etc.
- Pressing the amplitude dial will not change amplitude scales while route is active.
- Once the Calibration Route is activated, shaker will vibrate at first pre-programmed test point and display “CR PT 1”.

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 **CalRoute:** 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 9100D 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 9100D 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 9100D

2.4 SCPI Commands

Portable Vibration Calibrators from The Modal Shop offer a digital interface with programmable capability to control various functions including all ranges, modes, and levels. Model 9100D can be optionally controlled via SCPI commands. All operator functionality – such as changing scales and adjusting the amplitude/frequency of test points – is available via SCPI commands. Optional accessory Model **9100-USB00** is used to connect the 9100D to a computer utilizing SCPI commands to control and read data from the 9100D.

Please contact The Modal Shop to receive a copy of our SCPI Command Reference Guide.

2.5 Model 9100-PS02: 24 VDC USB Power Supply (Optional)

The 9100-PS02 is a +24 VDC power supply for modulated current and 4-20 mA vibration sensors. It uses power supplied by the USB port on model 9100D. The device has an internal 500 ohm precision resistor and the following inputs and outputs:

- **USB** – integral cable that connects to USB port on 9100D, connect after wiring sensor to terminal strip
- **DAQ** – integral cable that terminates in BNC and connects to multi-meter
- **+24V** – on the terminal strip at left, connect the sensor's +24V lead to this terminal making sure the screw is tight to the bare lead
- **GND** - on the terminal strip at center, connect the sensor's ground and/or shield lead to this terminal making sure the screw is tight to the bare lead
- **SIG IN** - on the terminal strip at right, connect the sensor's signal output lead to this terminal making sure the screw is tight to the bare lead



2.6 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

2.7 Amplitude Basics

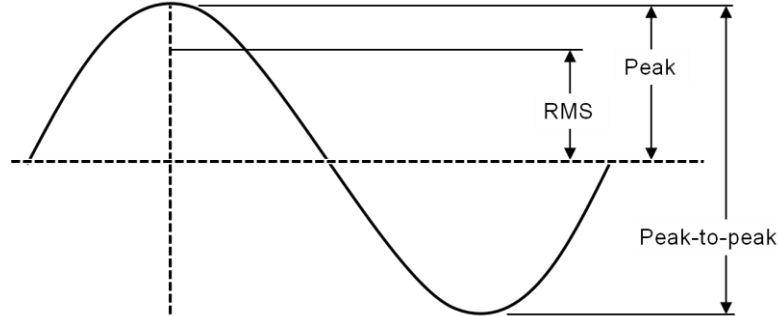


Figure: Sinusoidal Wave

- 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 9100D), the peak value is calculated by $\text{RMS} \times \sqrt{2}$. The 9100D 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 .

2.8 Mounting Basics

Connecting Sensor to 9100D Platform

- Step 1** Mating surfaces of the mounting platform and sensor should be flat, parallel and free of dirt, paint, epoxy, scratches, etc.
- Step 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 a silicone grease for best results.
- Step 3** An adaptor may be needed to connect the sensor to the armature. The 9100D platform requires a $\frac{1}{4}$ -28 thread.
- Step 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.
- Step 5** For threaded sensors, please follow the sensor manufacturer's torque recommendation.

Tightening and Loosening Connections

- Step 1** When tightening or loosening the connection between the sensor and the 9100D mounting platform, secure the mounting platform with the supplied wrench.
- Step 2** It is important to keep sensors and fixtures centered and straight when attaching them to the 9100D mounting platform. This will ensure a stable, even connection and eliminate potential alignment issues.

External Source Input

As an option, it is possible to drive the 9100D by using an external signal source or a function generator. First, connect a signal source to the External Source BNC Input located on the top right 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”.

Step 1 When in external signal 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 9100D. The frequency of the input signal is not displayed on this mode.

Step 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.



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

Monitor Reference Output

The 9100D 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 BNC Output by connecting it to a readout device (e.g. voltmeter or oscilloscope). The nominal sensitivity is 10 mV/g. The exact sensitivity is noted on the calibration certificate of the 9100D.

USB Connection

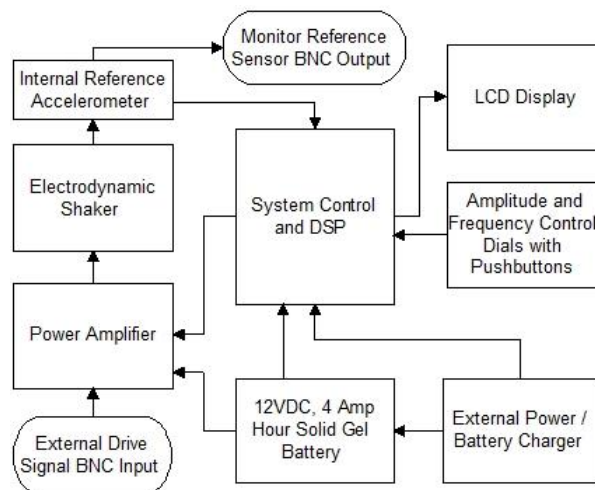
The USB connection serves as a power source for power supply accessories like 9100-PS02 24 VDC power supply, 9100-PS04-TM GE/Bently Nevada® Trendmaster® power supply or 9100-PS07-PT Pruftechnik® CLD sensor power supply. It is also used with the supplied USB flash memory drive to upload CALROUTE pre-programmed tests into the 9100D. The USB connection is used to control the shaker using SCPI commands (see section 2.4). It is used at The Modal Shop, Inc. during the manufacturing and calibration processes.

3. THEORY OF OPERATION

3.1 Instrumentation

The Model 9100D Portable Shaker Table 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*
- *Two Dials with Detent and Integrated Push Buttons*
- *12 VDC, 4 Amp Hour Solid Gel Battery*
- *External Charger*



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 The Modal Shop is used to calibrate the 9100D as a complete system and provides NIST traceability.

The power amplifier is specially designed to provide the current required to drive the electrodynamic shaker.

The electronic signal processing system produces a variable frequency sine wave, 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 **FREQUENCY** dial pauses the shaker and displays the Test Settings menu.

Pressing the **AMPLITUDE** dial toggles the amplitude measurement units through the following amplitude choices:

FREQUENCY	ACCELERATION	VELOCITY	DISPLACEMENT
Hz	g pk	in/s pk	mils p-p
CPM	g RMS	in/s RMS	µm p-p
External Signal	m/s ² pk	mm/s pk	
	m/s ² RMS	mm/s RMS	

3.2 Battery & Charger

The Model 9100D 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 9100D will automatically shut off when the battery power level gets too low. Keeping the battery fully charged ensures the unit is always ready for use.

Under mild operating conditions, a fully charged battery will allow the 9100D 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 a 100 gram payload at 10 g pk will drain the battery charge in approximately 1 hour.

A “Battery Life” 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 **9100-PS01**) are available from The Modal Shop.

The 9100D 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.



Caution! When operating the 9100D at high amplitudes and heavy payloads with the battery charger plugged in, the current draw to the shaker and amplifier can be large enough to overload the charging circuit resulting in an unstable output signal. Operating the 9100D under these conditions can result in damage to the electrical components in the system. In order to re-establish a stable output signal, turn down the amplitude level of the 9100D or unplug the charger.

3.3 Battery Information & 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. SPECIFICATION & PERFORMANCE

4.1 Specifications

MODEL 9100D SPECIFICATIONS		
GENERAL		
Frequency Range (operating) ^[1]	5 Hz–10 kHz	300–600 k CPM
Maximum Amplitude (50 Hz, 10-gram payload)	20 g pk 20 in/s pk 150 mils pk-pk	196 m/s ² pk 500 mm/s pk 3.8 mm pk-pk
Maximum Amplitude (50 Hz, 500-gram payload)	2.5 g pk 3.5 in/s pk	24.5 m/s ² pk 90 mm/s pk
Maximum Payload ^[2]	800 grams	
Test Operation	Manual (Closed Loop) or Semi-Automatic	
Auto-Payload Calculation	Controlled via Reference Accelerometer, No User Entry Required	
Memory	Stores Semi-Automated Test Routine	
Non-Volatile Memory	Storage of Calibration Settings for Accuracy	
Programmability	Up to 30 Test Points per Routine	
ACCURACY OF READOUT^[3]		
Acceleration (10 Hz to 10 kHz)	± 3% ^[4]	
Acceleration (5 Hz to 10 Hz)	± 5% ^[4]	
Velocity (10 Hz to 1000 Hz)	± 3%	
Displacement (30 Hz to 150 Hz)	± 3%	
Amplitude Linearity (100 Hz) ^[1]	< 1% up to 10 g pk	
Waveform Distortion (30 Hz to 2 kHz) ^[1]	< 5% THD (typical) up to 5 g pk	
Accuracy Verification Test	Field Drift Test Procedure Provided ^[5]	
UNITS OF READOUT		
Acceleration (pk and RMS)	g	m/s ²
Velocity (pk and RMS)	in/s	mm/s
Displacement (pk to pk)	mils	µm
Frequency	Hz	CPM
Internal Battery (sealed solid gel lead acid)	12 VDC, 4 amp-hours	
AC Power (for recharging battery)	110–240 VAC, 50–60 Hz	
Input Power Rating from charger	18 VDC, 1 A	
Operating Battery Life ^[6] 100 Hz 1 g pk ^[1] 100 Hz 10 g pk ^[1]	18 hours 1 hour	
INPUT/OUTPUT		
External Source In (Max)	1 VAC RMS	
Monitor Reference Out	10 mV/g (nominal) Quartz Reference Accelerometer, BNC Jack Output	
USB Port	Used for Loading Semi-Automated Test Routines (Model CALROUTE) ^[7]	

MODEL 9100D SPECIFICATIONS (CONTINUED)

PHYSICAL		
Operating Temperature	32° - 122 °F	0° - 50 °C
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 Thread Size	

NOTES

- [1] 100-gram payload.
- [2] Operating range reduced at higher payloads. Reference manual for full details.
- [3] Measured with 10-gram quartz reference accelerometer.
- [4] Calculated by measuring the % difference between the known sensitivity of a reference accelerometer as calibrated by laser primary system per ISO 16063-11 and the measured sensitivity of same reference accelerometer when tested at the same points.
- [5] Test is conducted independently of product firmware with calibrated voltmeter.
- [6] As shipped from factory in new condition.
- [7] Provides power for optional external power supplies.

4.2 Shaker Loading

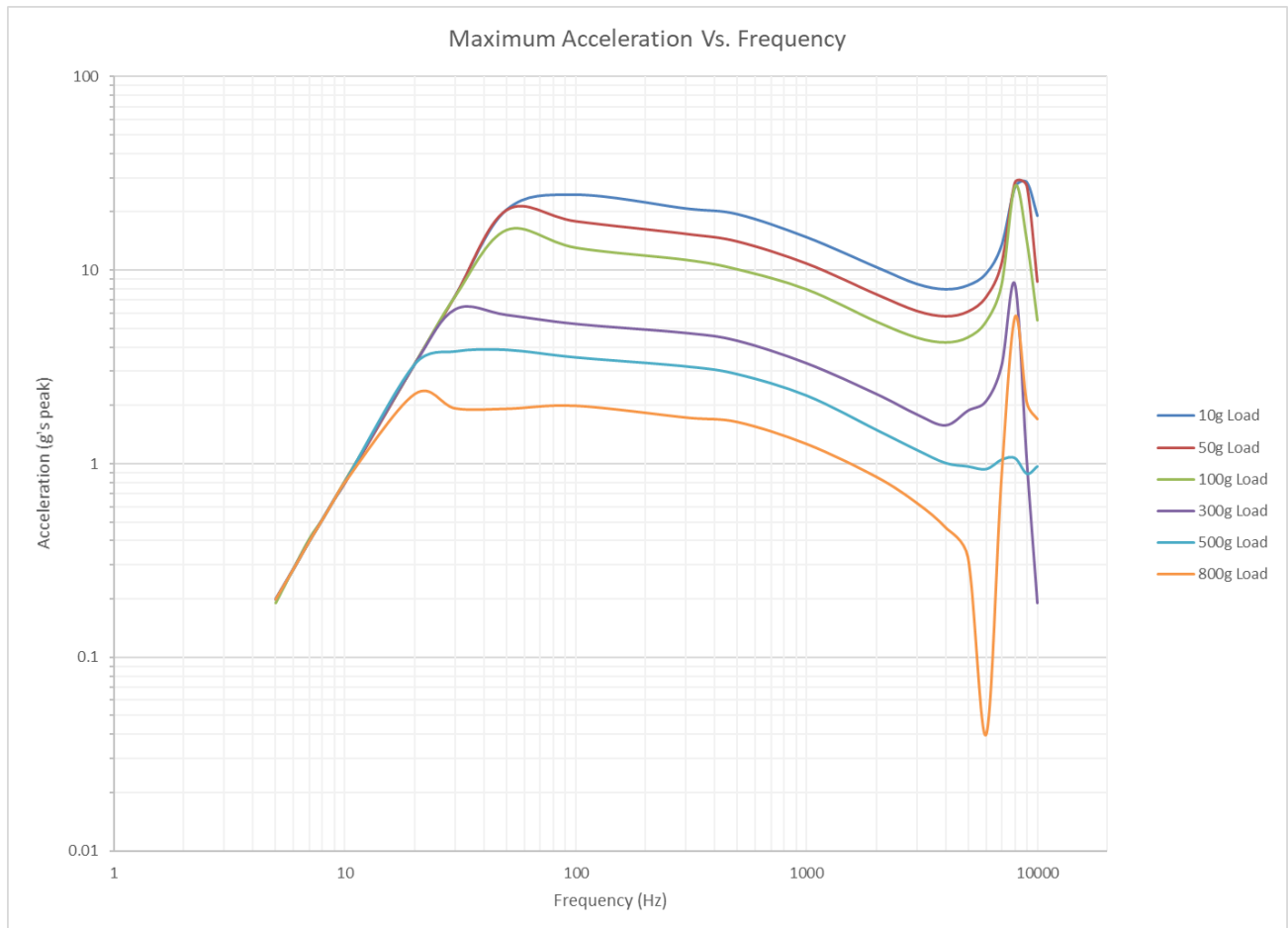
Maximum advisable vibration levels are dependent upon the maximum frequency of operation and the payload. The chart below shows the maximum vibration levels, with the device operating on battery power, as a function of both frequency and payloads. Payloads exceeding 800 grams should not be tested on the Model 9100D.

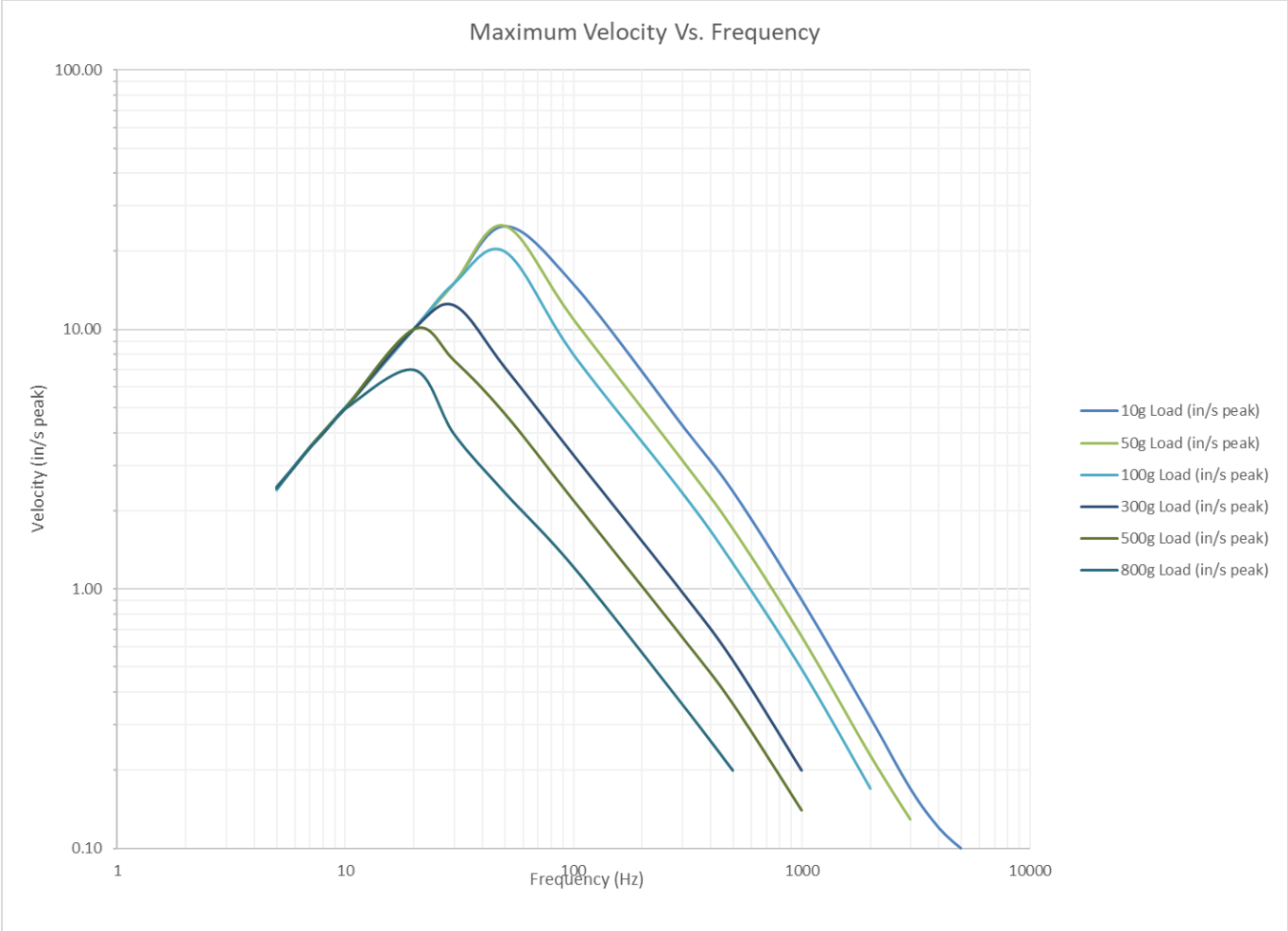
Excessive loads may result in damage to the moving coil and flexure. Care must be taken when testing payloads with large footprints, particularly those with an offset center of gravity. Severe rocking modes can produce high transverse motion and lateral loads on the moving coil and flexure, resulting 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 9100D may exhibit both frequency and amplitude instabilities. In this case, please reduce the excitation amplitude and/or the payload to eliminate the effect.

The 9100D 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 vibration levels can be achieved with the portable shaker table operating on battery power. If the device is operated while charging, the voltage supplied from the amplifier to the shaker is limited and thus maximum amplitudes are slightly decreased.





5. RECOMMENDED PRACTICES

5.1 Testing the Internal Reference Accelerometer for Drift

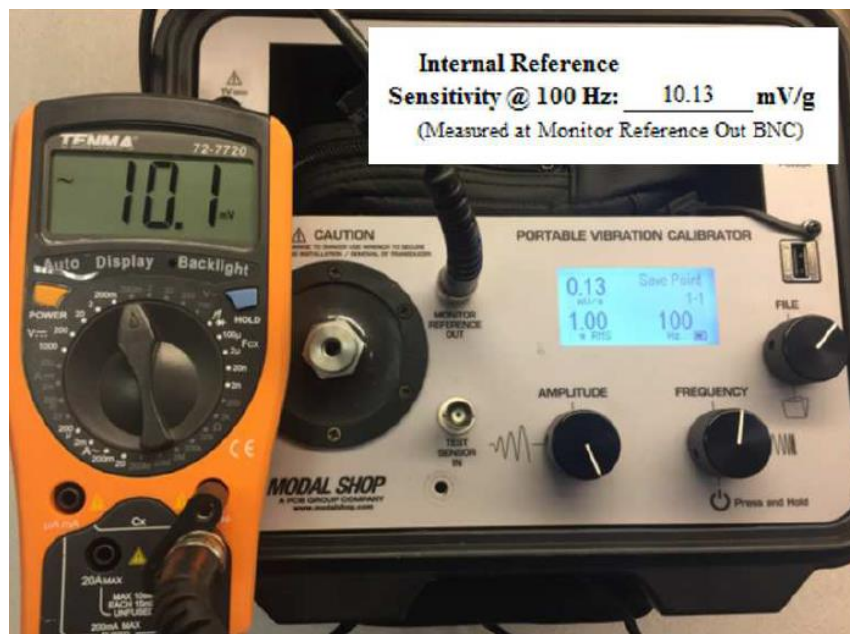
Checking for drift of the internal reference accelerometer inside the portable vibration calibrator is an ideal way to quickly ensure the accuracy of the device. The sensitivity of the reference accelerometer (10 mV/g nominal) should remain very close to its original calibrated sensitivity provided on the device's calibration certificate. Also, this measurement should be stable. If the voltage measurement is fluctuating, it could indicate a damaged shaker.

To perform this test technicians should obtain the following:

- Calibrated digital voltmeter set to measure mV AC.
- BNC male to BNC male cable. Available through PCB Piezotronics & The Modal Shop. Cable series: 012A, 002D, 003D all work equally well. Cables can be any length but ideally less than 10 ft. (3m).
- BNC female to double banana plug (Pomona Model 1269). Makes connection to voltmeter easy.

Procedure:

- Step 1** Turn on the Portable Vibration Calibrator
- Step 2** Set the calibrator to 1.00 g RMS at 100 Hz
- Step 3** Connect the voltmeter to the MONITOR REFERENCE OUT using the BNC-BNC cable and double banana plug and measure mV AC.
- Step 4** Check the Internal Reference Sensitivity at 100 Hz on the last Calibration Certificate for the device.
- Step 5** The measured voltage represents the sensitivity of the Internal ICP[®] quartz internal reference accelerometer. It should be within $\pm 3\%$ of the original calibrated sensitivity at 100 Hz. If it is outside of the $\pm 3\%$ tolerance users should send the portable vibration calibrator back to The Modal Shop for re-calibration and adjustment. Re-calibration and adjustment due to drift are covered under the two-year warranty.



~Certificate of Calibration~

Manufacturer: <u>The Modal Shop</u>	Calibration Date: <u>17-Dec-15</u>
Model Number: <u>9110D</u>	Calibration Due: _____
Serial Number: <u>10475</u>	Temperature: <u>73.5</u> °F
Description: <u>Portable Vibration Calibrator</u>	<u>23.1</u> °C
Test Procedure: <u>PRD-P278</u>	Humidity: <u>28.8</u> %
Calibration Tech: BTH	
Customer: <u>ISOLUX INGENIERIA S.A / Spain</u>	

As found: In Tolerance
As left: In Tolerance

Internal Reference
 Sensitivity @ 100 Hz: 10.22 mV/g
(Measured at Monitor Reference Out BNC)

Reference Equipment:

Manufacturer	Description	Model Number	Serial Number	Due Date
PCB	Standard Sensor	353B02	126967	12-Aug-16
Agilent	DMM	34401A	MY47055365	25-Jun-16

Frequency Hz	Standard Sensor		Unit Under Test		% difference	
	Measured Acceleration (g pk)	Reference Sensitivity (mV/g)	Displayed Acceleration (g pk)	Displayed Sensitivity (mV/g)	Acceleration (Displayed / Measured)	Sensitivity (Displayed / Reference)
7	0.51	20.53	0.50	20.62	0.98%	0.42%
8	0.65	20.67	0.65	20.62	0.29%	-0.27%

5.2 Operational Verification & 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, for example the 9105D transfer standard available from The Modal Shop.

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 9100D should be evaluated further to determine the root cause of the discrepancy.

Field repair of the 9100D is not possible, so if performance of the 9100D is out of specification, it should be sent back to The Modal Shop for evaluation, repair and recalibration. Please contact The Modal Shop at info@modalshop.com or +1.513.351.9919 for a Return of Material Authorization (RMA) number.

5.3 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 (10m/s² and 1g are common choices for accelerometers) and the sensor output (or the sensor sensitivity) is observed and recorded at different frequency points.

5.4 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, 61.44, 100, 200, 500, 1000, 2000, 5000 and 10000 Hz
 - Model 9100D 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/sec² RMS) for 10 Hz
- 1 g peak (7 m/sec² RMS) for 20-1000 Hz
- 4 g's peak (30 m/sec² 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
 - ps 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

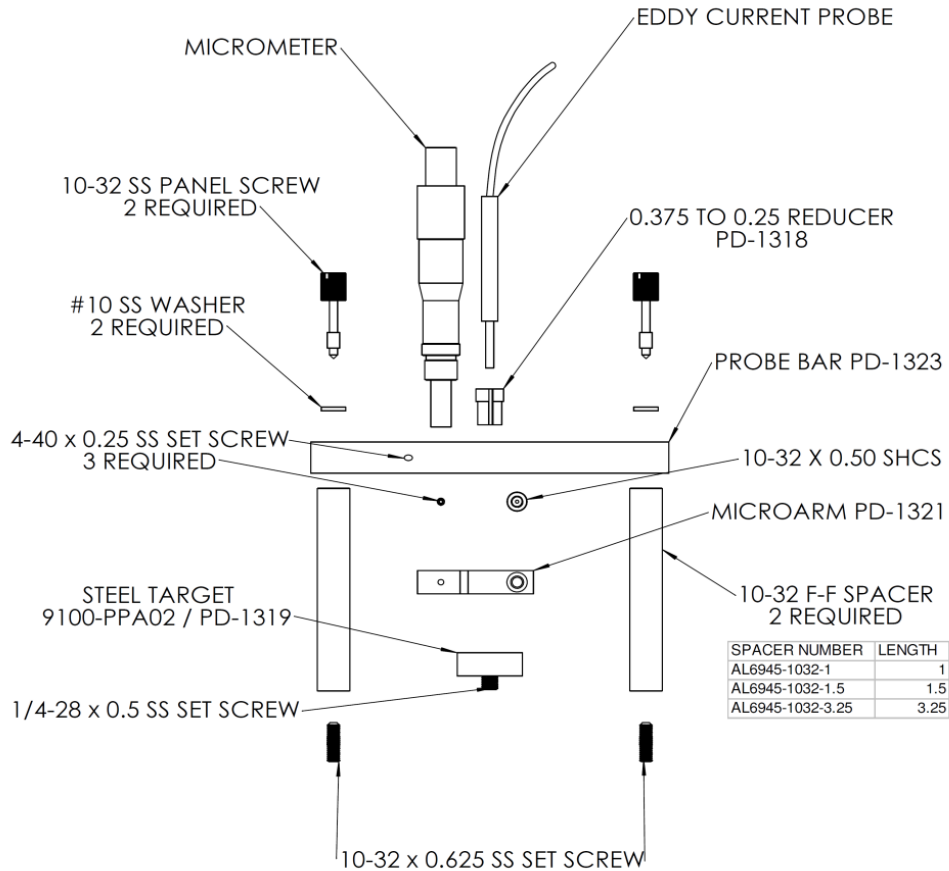
While testing to the API 670 or ISO 16063-21 standard is certainly thorough it is not always practical and is time consuming especially for the predictive maintenance user. Thus The Modal Shop makes the following recommendations for industrial vibration:

- 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 080A118, is included with the 9100D. 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.

5.5 Non-Contact Displacement Sensor Calibration

Non-contact displacement sensors, also known as proximity probes, eddy current probes or simply displacement probes, can be checked for accuracy, linearity and frequency response. Proximity probe systems require the use of the optional 9100-PPA01 (or 9100-MPPA01) proximity probe adaptor kit. The following sections detail the procedure for performing linearity and frequency response checks on a non-contact displacement sensor.



PD-1331 RevB

5.6 Non-Contact Displacement Sensor Test Set-Up

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.]

- Step 1** Remove the (2) 10-32 pan head screws on the user panel of the portable shaker table (white arrows in picture below).



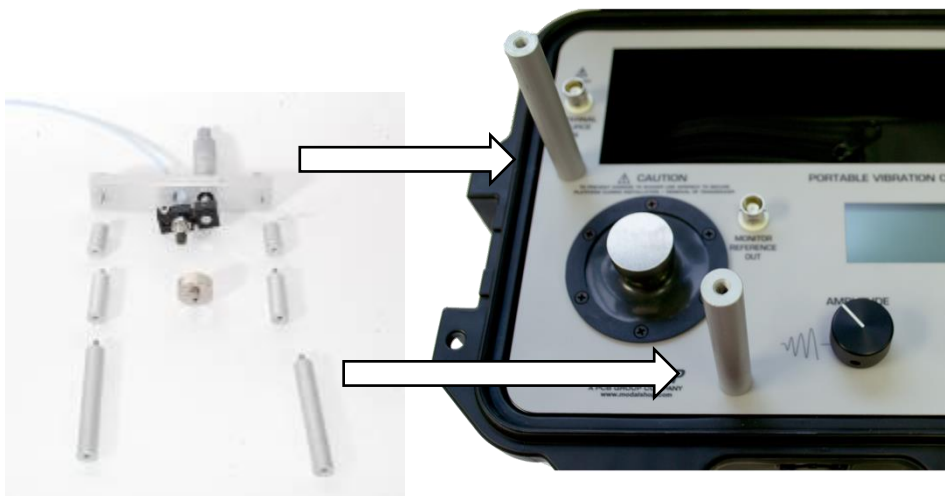
- Step 2** Install the AISI 4140 steel target into the shaker on the mounting platform.



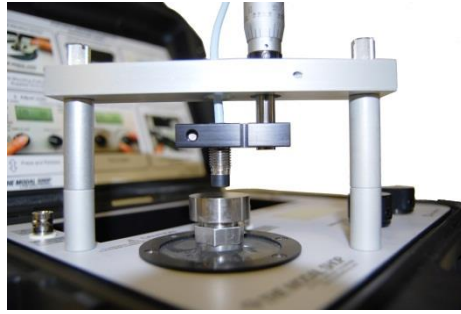
Step 3 Install the non-contact displacement sensor in the microarm after stringing the probe through the probe bar as shown in the picture below. Please note: An 8 mm non-contact displacement sensor with $\frac{3}{8}$ - 24 threaded case will mount directly while a 5 mm non-contact displacement sensor with a $\frac{1}{4}$ - 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.



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.



Step 4 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.



5.7 Proximity Probe Dynamic Linearity Calibration & Confirmation of Vibration Alarms

IMPORTANT: The 9100D powers up at the unit's previous frequency and amplitude settings. Prior to using the 9100D 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.

- Step 1** 1. Mount the proximity probe to the shaker facing the target by following instructions in the previous section.
- Step 2** 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.
- Step 3** 3. Power-on the shaker by pressing and holding the **FREQUENCY** dial.
- Step 4** 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.
- Step 5** 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 9100D shaker 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.

5.8 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 a volt meter measuring AC voltage.
- The volt meter measures in AC voltage RMS. The 9100D simulates displacement vibration in peak-to-peak scale. Thus one must convert the RMS voltage measurement to peak-to-peak. To do so multiply the measurement on the volt meter by 2.828.
 - *Example: when shaking target at 5 mils peak-to-peak and 3600 CPM, volt meter measures 353 mV AC. Multiply this number by 2.828 to get 998 mV ($353 \text{ mV} \times 2.828 = 998 \text{ mV}$). Proceed to next step.*
- Next, divide the voltage measurement by the amplitude displayed on 9100D. This will calculate the sensitivity of the probe.
 - *Example continued from above: divide 998 mV by 5.0 mils peak-to-peak to get 199.6 mV/mil ($998 \text{ mV} / 5.0 \text{ mils p-p} = 199.6 \text{ mV/mil}$)*
- 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 Section 5.7 Proximity Probe Dynamic Linearity Calibration & Confirmation of Vibration Alarms.)
- 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 The Modal Shop for custom target materials.

5.9 Calibration Mounting Adaptors

Mounting adaptors add undesired mass to the sensor under test (SUT). A piezoelectric accelerometer's high frequency response is inversely proportional to its mass. In general, the lighter the accelerometer the greater the high frequency range. The ideal mounting adaptor design is one that is as small and light as possible while made of a hard material to exhibit proper system stiffness.

Models 9100-HTMNT01 and 9100-HTMNT02 multi-hole mounting pads supplied with the Portable Vibration Calibrator are convenient but in some cases not ideal for achieving the best high frequency response for the SUT. Between these two pads, seven of the world's most popular 3- and 4-hole accelerometer bolt patterns are covered. But these pads are heavier than those used in our calibration laboratory. As such, sensors that come close to failing high frequency response under ideal conditions will likely fail calibration on the Portable Vibration Calibrator when mounted with these pads.

The Modal Shop has a wide selection of custom mounting pads optimally designed to achieve the best high frequency response for 3 and 4-hole mount vibration sensors. These pads are custom designed for each SUT bolt pattern and have been validated in our calibration lab. Please contact us for more information.

5.10 Maintenance

Recalibration and certification is recommended on an annual basis. Service of internal mechanical parts related to shaker motion should only be performed by factory personnel or authorized representatives. The battery can be replaced without return to The Modal Shop. Please contact The Modal Shop for more information on battery replacement.

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