



# Model 699A06 Portable Vibration Calibrator

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# MODEL 699A06 Portable Vibration Calibrator User Manual



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## Product Support

For answers to questions about the 699A06 Portable Vibration Calibrator, consult this manual. For additional product support, contact IMI Sensors a 800-959-4464 in the U.S.A. or 716-684-0001, 9 a.m. to 5 p.m. EST. If it is more convenient, fax questions or comments to IMI Sensors at 716-684-3823 or email our sales staff at [imi@pcb.com](mailto:imi@pcb.com).

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# Introduction

## Welcome

Thank you for choosing IMI Model 699A06.

The IMI Model 699A06 Portable Vibration Calibrator 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 699A06 mounting platform are available upon request.

The 699A06 incorporates a built-in sine wave oscillator, power amplifier, electrodynamic shaker, NIST traceable reference accelerometer and digital display. The 699A06 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 699A06 is designed to provide long term reliable performance over the frequency range of 7 Hz to 10 kHz. The 699A06 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*
- *Verification of speed indicator measuring systems*

## Customer Support

IMI Sensors is a PCB Group Company, and we are 100% committed to the PCB Group's pledge of 'Total Customer Satisfaction.' If at any time you have questions or problems with the 699A06 system, please contact an Application Engineer at IMI Sensors:

Telephone: 716-684-0003  
Toll Free: 800-959-4464  
Fax: 716-684-0001  
Email: [imi@pcb.com](mailto:imi@pcb.com)



## Cautionary Notes

- *Loads of up to 800 grams (28.2 ounces) can be mounted directly to the 699A06 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 699A06 should always be operated on a stable, flat surface.*
- *The 699A06 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 699A06.*



## Optional Fixturing and Accessories

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

Accessory	Description
600A22	Proximity probe adaptor kit, supports probes with common case threads ranging from M6 to 3/8". Includes Mitutoyo micrometer and nickel plated 4140 steel target.
600A23	Proximity probe adaptor kit, supports probes with common case threads ranging from M6 to 3/8". Includes Mitutoyo micrometer (metric) and nickel plated 4140 steel target.
600A24	Mounting accessory kit for 699A06 Portable Vibration Calibrators, to adapt to 1/4-28 threaded mounting platforms. Includes studs/inserts (1/4-28, 10-32, 6-32 and 5-40) and bases (for adhesive, magnetic, and custom thread patterns).

## Replacement Accessories

Accessory	Description
600A25	18 Volt, 1 amp power supply / charger for 699A06 Portable Vibration Calibrator, universal 100-240 V, 50/60 Hz.
600A26	Replacement battery for 699A06 Portable Vibration Calibrators.

# 699A06 Operation Guide

## Basic Operation

### Test Setup



1. Mount your sensor to the 699A06 mounting platform
  - The 699A06 sensor mounting platform is threaded for a ¼-28 stud. Select an appropriate adaptor for mounting the sensor.
  - While tightening the sensor, secure the 699A06 mounting platform with the supplied wrench to prevent damage from torque.
2. Connect sensor signal conditioner and readout device as necessary. Make sure that connections are secure.
3. Power the unit ON by pressing and holding the **FREQUENCY** dial for 3 seconds.

### Setting the Frequency

4. Select the correct Frequency Units for your test by pressing and releasing the **FREQUENCY** dial
  - CPM
  - Hertz
5. Select the desired frequency for testing by turning the **FREQUENCY** dial clockwise to increase or counterclockwise to decrease.
  - Slow Turns – setting will increase or decrease by single steps
  - Fast Turns – setting will increase or decrease by larger increments

### Setting the Amplitude

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	in/s pk	mils p-p
g's rms	mm/s pk	mm p-p
m/s <sup>2</sup> pk		
m/s <sup>2</sup> rms		

7. Select the desired amplitude for testing by turning the **AMPLITUDE** dial clockwise to increase or counterclockwise 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**

8. Verify that the level indicated on the 699A06 is the same as the level being shown on the readout of the sensor under test.
  
9. Before powering the unit OFF reduce the vibration amplitude. The 699A06 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 699A06 is powered ON.
  
10. Power the unit OFF by pressing and holding the **FREQUENCY** dial for 3 seconds.
  - To preserve battery charge, the 699A06 will automatically power off after 20 minutes of inactivity when not plugged in to the charger.

**After Testing**

11. Plug the 699A06 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.
  
12. 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 699A06 should be returned to IMI Sensors for regular recalibration (recommended annually - Service Code MCS-26) or for any maintenance or repair. The most current factory recalibration date is displayed on the LCD screen during the 699A06 boot up sequence.

**Definition of Frequency Units**

- CPM stands for cycles per minute. CPM is commonly used for testing industrial sensors that monitor rotational vibration.
- Hertz (Hz) are defined as the number of periodic cycles per second. They are used as a universal measure for signal frequency.  $\text{Hz} * 60 = \text{CPM}$ .



## Definition of Amplitude Units

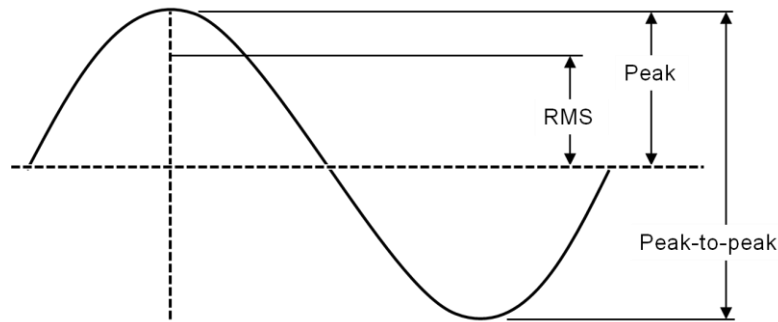


Figure: Sinusoidal Wave

- 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. RMS is calculated as  $pk / \sqrt{2}$ .
- Peak (pk) bases calculations on the highest value of the signal generated during testing. For a sinusoidal wave (as is produced by the 699A06) the peak value is calculated by  $RMS * \sqrt{2}$ . The 699A06 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  $2pk$ .
- Gravity (g) is the acceleration experienced naturally by objects in earth's gravitational field. It is approximately equal to  $9.81 \text{ m/s}^2$ .

## Mounting Basics

### Connecting Sensor to 699A06 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 a light oil for best results.
3. An adaptor may be needed to connect the sensor to the armature. The 699A06 platform requires a  $\frac{1}{4}$ -28 thread.
4. A light oil can be applied to the mating surfaces and threads to ensure good mechanical coupling. This is particularly important when testing at high frequencies.

### **Tightening and Loosening Connections**

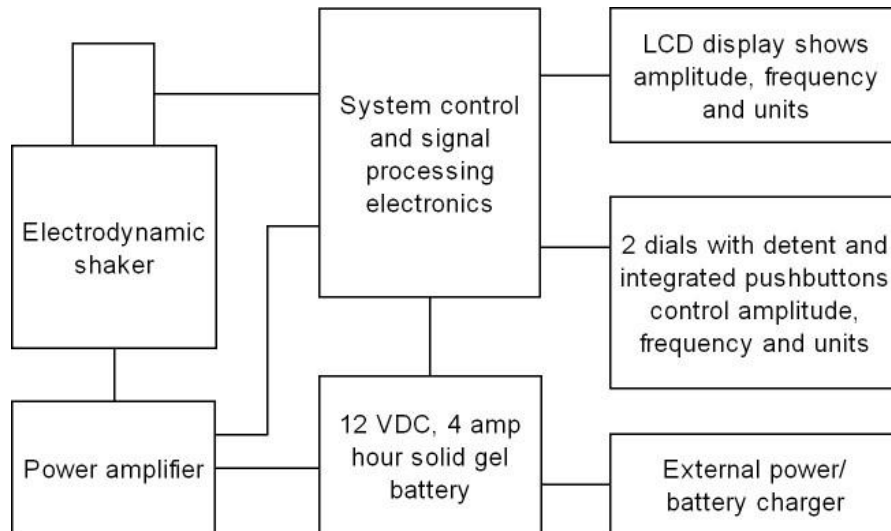
1. When tightening or loosening the connection between the sensor and the 699A06 mounting platform, secure the mounting platform with the supplied wrench.
2. It is important to keep sensors and fixtures centered and straight when attaching them to the 699A06 mounting platform. This will ensure a stable, even connection and eliminate potential alignment issues.

# Theory of Operation

## Instrumentation

The Model 699A06 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*
- *2 Dials with Detent and Integrated Pushbuttons*
- *12 VDC, 4 Amp Hr 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<sup>®</sup> quartz shear sensor, integrated into the mounting platform. A calibration “standard” maintained by IMI is used to calibrate the 699A06 as a complete system and provides NIST traceability.

The power amplifier is specially designed to provide the current required to drive the coil of 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 toggles the frequency units between CPM and Hz. Pressing the AMPLITUDE dial toggles the amplitude measurement units through the following choices:

Frequency	Acceleration	Velocity	Displacement
Hz	g pk	in/s pk	mils p-p
CPM	g rms	mm/s pk	mm p-p
	m/s <sup>2</sup> pk		
	m/s <sup>2</sup> rms		

## Battery and Charger

The Model 699A06 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.

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 699A06 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 699A06 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 Life" indicator is displayed on the LCD screen to approximate the unit's remaining charge life. Replacement batteries (Model # 600A26) and power supplieschargers (Model # 600A25) are available from IMI Sensors.

## Handling and Storage

It is recommended that the unit be kept "on charge" when in storage. The internal battery should provide long-term service under normal operating conditions. The units are securely mounted so that no damage can occur from shipping or normal transportation. No special handling should be required. IMI does not recommend that the battery be removed for shipping or storage for periods of more than 3 months.

# Specifications and Performance

## General

Frequency Range (operating, 100 gram payload)	7 Hz – 10 kHz	420 - 600 k CPM
Maximum Amplitude (100 Hz no payload)	20 g pk	196 m/s <sup>2</sup> pk
	15 in/s pk	380 mm/s pk
	50 mils pk - pk	1.27 mm pk – pk
Maximum Payload <sup>[1]</sup>	800 gram	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 (30 Hz to 500 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 up to 5 g pk

## Units of Readout

Acceleration	g pk	m/s <sup>2</sup> pk
	g rms	m/s <sup>2</sup> rms
Velocity	in/s pk	mm/s pk
Displacement	mils pk – pk	mm pk – pk
Frequency	Hz	CPM

## 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 <sup>[2]</sup>		
100 gram payload, 100 Hz 1 g pk	18 hours	
100 gram payload, 100 Hz 10 g pk	1 hour	

[2] As shipped from factory in new condition

## Temperature

Operating	32° - 122° F	0° - 50° C
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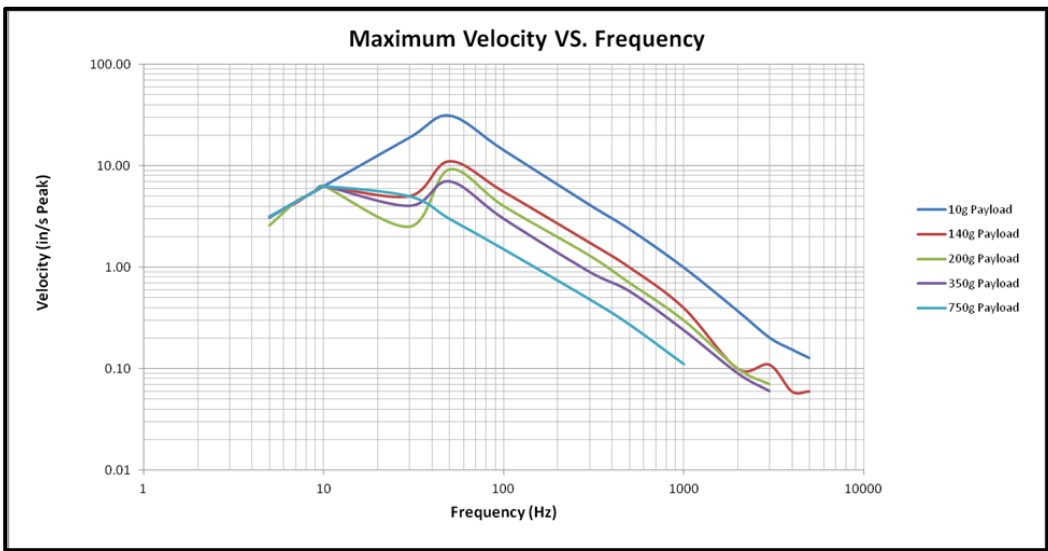
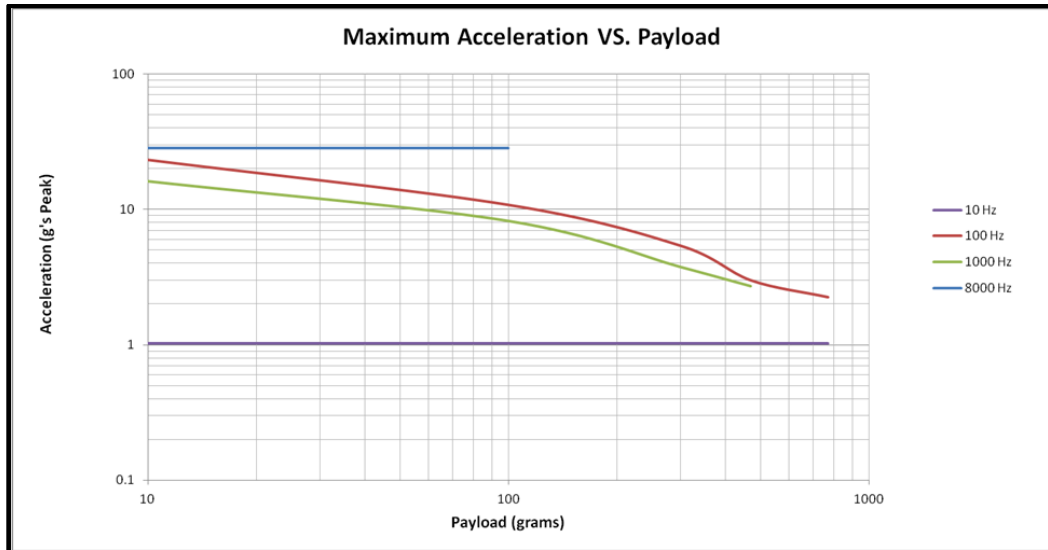
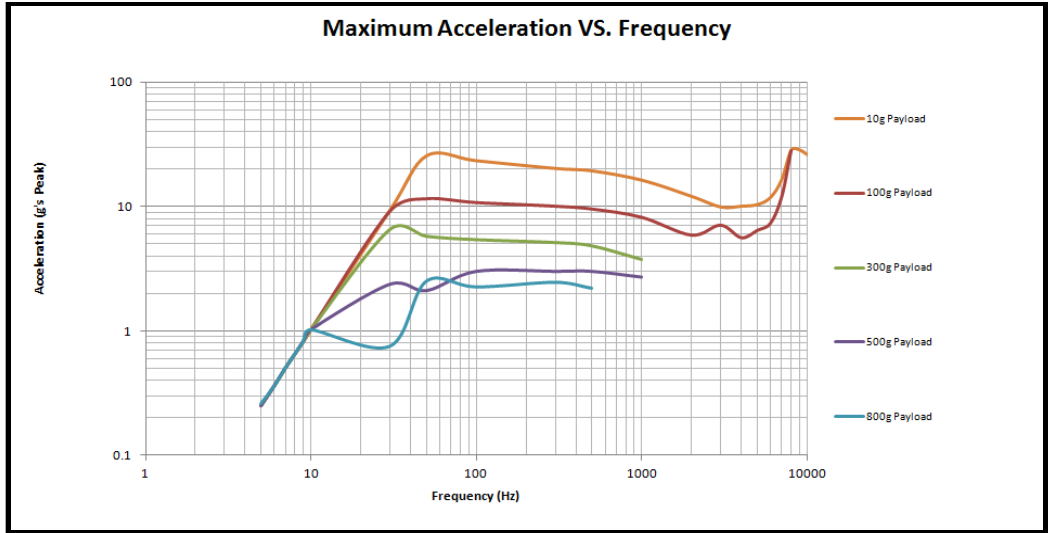
## Physical

Dimensions (H x W x D)	8.5" x 12" x 10"	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 grams should not be tested on the Model 699A06.

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.



# 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, for example the 9105C transfer standard available from the PCB Group.

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 699A06 should be evaluated further to determine the root cause of the discrepancy.

Field repair of the 699A06 is not possible, so if performance of the 699A06 is out of specification, it should be sent back to IMI Sensors for evaluation, repair and recalibration. Please contact IMI at [imi@pcb.com](mailto:imi@pcb.com) or 716-684-0003 for a Return of Material Authorization (RMA) number.

## Standard Checks For Transducers

Linearity and frequency response checks should be performed periodically to validate transducer functionality. Linearity is a check to determine if the output sensitivity (mV/Unit of vibration, i.e., mV/g), remains constant from a minimum operating level to higher operating levels. This check is typically made at 100 Hz. The transducer manufacturer usually specifies this frequency on the transducer's original calibration certificate.

Frequency Response is a check to determine that the output sensitivity (mV/Unit of vibration), or actual reading, is maintained over an expected operating frequency range. The 699A06's integral reference sensor is typically held at a constant level for the frequency response test.

The following typical transducer checkout tables outline typical test frequencies and vibration levels for checking accelerometers and velocity transducers. These should meet most general purpose requirements for verifying the functionality of transducers and measuring systems.



## Typical Accelerometer Checkout

Set the 699A06 to these or similar levels to perform the following checks:

Linearity Check (Typical Test Frequency = 100 Hz)					
699A06 Amplitude (g)	0.5	1.0	2.0	5.0	10.0
Reported Level					

Frequency Response Check (Typical Test Level = 1 g)								
699A06 Frequency (Hz)	50	100	200	500	1000	2000	5000	
Reported Level								

## Typical Velocity Sensor Checkout

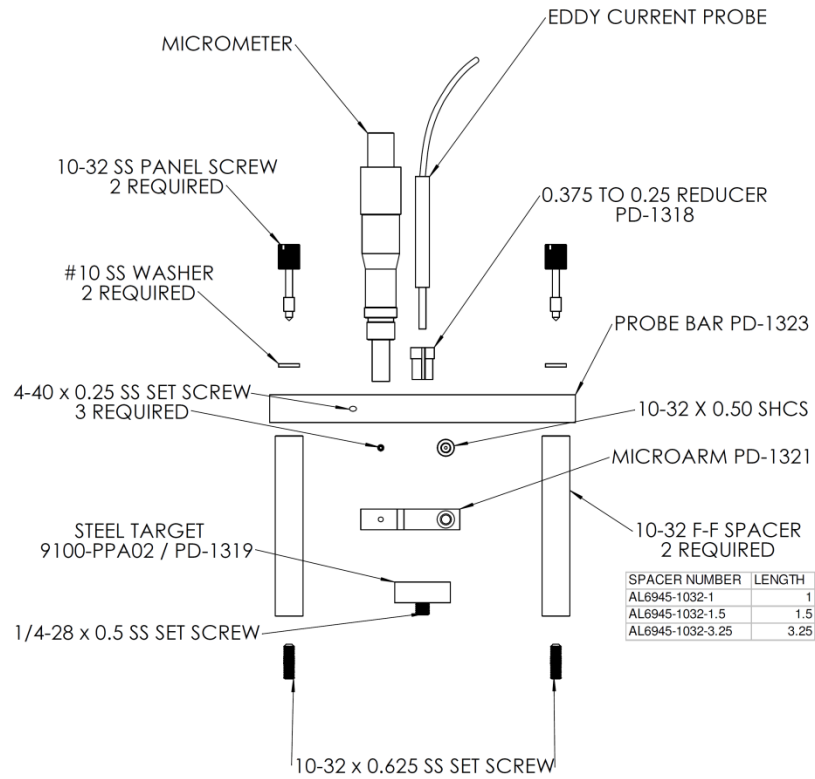
Set the 699A06 to these or similar levels to perform the following checks:

Linearity Check (Typical Test Frequency = 100 Hz)						
699A06 Amplitude (in/s)	0.2	0.5	1.0	2.0	5.0	
Reported Level						

Frequency Response Check (Typical Test Level = 0.2 in/s)						
699A06 Frequency (Hz)	30	50	100	200	500	
Reported Level						

## 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 600A22 proximity probe mounting attachment, shown on the next page. The following sections detail the procedure for performing linearity and frequency response checks on a non-contact displacement sensor.



## 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 some cases the proper proximity probe, extension cable, and proximator must be matched in order to obtain the expected output from this type of transducer.

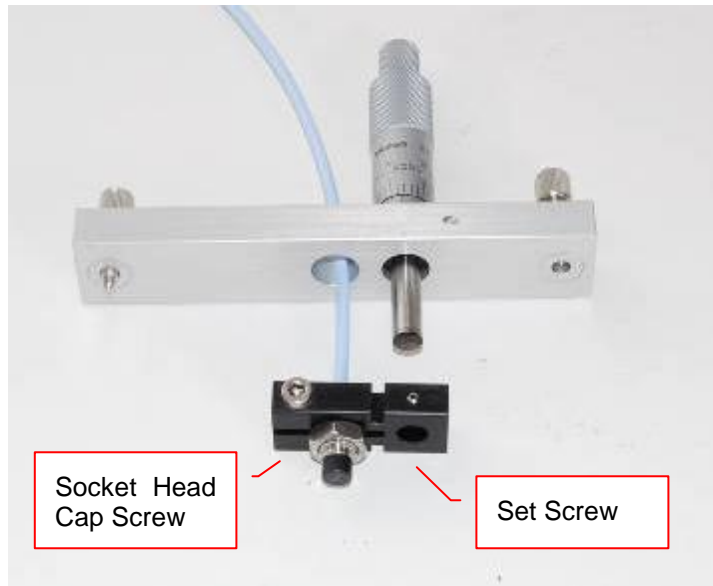
1. Remove the (2) 10-32 pan head screws on the user panel of the portable vibration calibrator (white arrows in picture below).



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



3. Install the non-contact displacement sensor in the microarm after stringing the probe thru the probe bar as shown in the picture below. Please note: An 8mm non-contact displacement sensor with 3/8 - 24 threaded case will mount directly while a 5mm non-contact displacement sensor with a 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.



4. Carefully lay out the assembly to resolve the required spacer or spacers to hold the non-contact displacement sensor the proper distance for 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 200 mils before the micrometer runs out of travel. 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.



## Non-Contact Displacement Sensor Frequency Response Check

**IMPORTANT:** The 699A06 powers up at the unit's previous frequency and amplitude settings. Prior to using the 699A06 for calibrating non-contact displacement sensors, set amplitude to a low level to avoid damaging the sensor with large displacements.

1. Set the micrometer to 0 mils, release the microarm with the set screw and slide the microarm down the barrel of the micrometer. Tighten the set screw to hold the microarm and probe when the probe makes contact with the target.

Note: A piece of paper or metal shim can be used to improve accuracy of zero position. If utilizing this method set micrometer to thickness of paper or shim and lower microarm and non-contact displacement sensor onto the shim until friction is felt between the shim and the target and probe then secure with the set screw.

2. With the non-contact displacement sensor powered up and the output 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. Fifty mils is the typical recommended gap setting for non-contact displacement sensors, and will ensure that you are in the sensors linear output range. Consult your non-contact displacement sensor's user manual for additional information.

3. Press and hold the AMPLITUDE dial to power the unit on and set the test frequency to 100 Hz using the FREQUENCY dial.

4. Increase the vibration level to 5 mils pk to pk using the AMPLITUDE dial. Check the non-contact displacement sensor system output using an AC voltmeter or a vibration monitoring system indicator for the correct level  $\pm 5\%$ . If the displacement system output sensitivity is 200 mV/mil, the AC voltmeter should read approximately 353.5 mV rms ( $70.7\text{mV} \times 5\text{mils}$ ). An oscilloscope should read approximately 1 V pk to pk ( $200\text{ mV} \times 5\text{mils}$ ).

5. Make corresponding measurement checks at other frequencies in the 30 Hz to 100 Hz range.

6. Continue making corresponding measurement checks in the 100 Hz to 150 Hz range.

7. Turn the vibration level to minimum, and turn the Power Off when calibration checks are complete. Remove the displacement sensor and then store the proximity probe fixture and the target.

## Non-Contact Displacement Sensor Linearity Check

Note: Reference steps 1-5 of "Non-Contact Displacement Sensor Test Setup" section earlier in this manual for setup instructions.

1. Power on the probe driver and connect a digital voltmeter to the output.

2. Set the micrometer to the number of mils corresponding to the center of the linear range for the probe being tested.

3. Loosen the set screw holding the probe in the adaptor.

4. Move the probe toward the target until the DC voltage, measured at the driver output, corresponds to the recommended gap voltage for the transducer under test (7.5 to 12 VDC typical).

5. Retighten the set screw.

6. Adjust the micrometer to the specified minimum gap reading and record the voltage on the voltmeter. Do not let the probe touch the target.

7. Increase the gap with the micrometer in either 5 or 10 mil steps and record the voltage at each step.
8. Divide the voltage output at each step by the number of mils per step. This value when converted to millivolts DC corresponds to the transducer sensitivity, typically 200 mV/mil.
9. Upon completion of tests, remove and store the probe adaptor and the target.

**OPTIONAL METHOD:**

Perform the linearity check above except operate the 699A06 at 100 Hz with very low displacement level. This is to create a very low “delta gap” condition for the measurements. The low delta gap sometimes results in a smoother calibration curve.

**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 be performed after re-assembly.

**Declaration of Conformance**

IMI Sensors declares that

- Model 699A06 Portable Vibration Calibrator is in accordance with the following directives:
  - 89/336/EEC The Electromagnetic Compatibility Directive and its amending directives has been designed and manufactured to the following specifications:
  - Generic Emissions Standard (EN 50081-1: 1992 Part 1: Residential, commercial and light industry)
  - Generic Immunity Standard (EN 50082-1: 1977 Part 1: Residential, commercial and light industry and EN 50082-2: 1995 Part 2: Industrial environment).