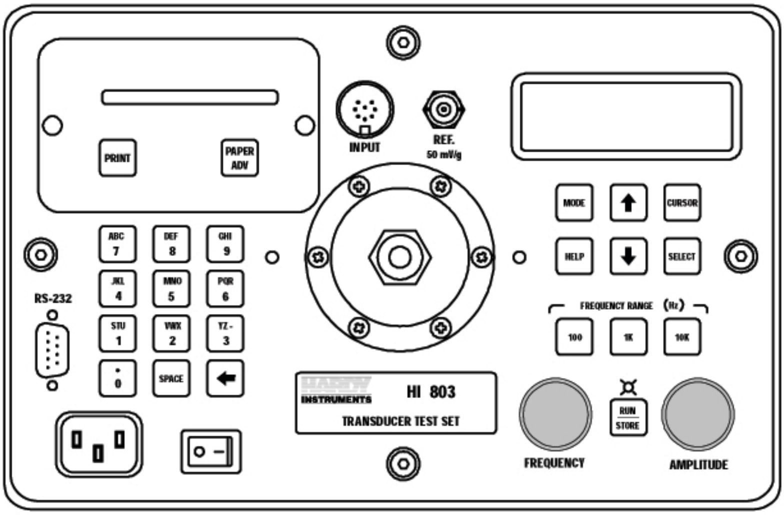
# TRANSDUCER TEST SET (TTS)
# MODEL HI 803

## OPERATION AND INSTALLATION MANUAL




HARDY INSTRUMENTS

8824 Fallbrook Dr.
Houston, TX 77064
Tel: 281-940-1802
Fax: 713-559-9421
vibration@hardyinst.com

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# CHAPTER 1 - OVERVIEW

## A Brief Description of Chapter 1

This manual provides the user and service personnel with a description of the specifications, installation, setup, configuration, operation, communication, maintenance, and troubleshooting procedures for the Hardy Instruments HI 803 Transducer Test Set (TTS). The HI 803 TTS is a totally self-contained battery powered vibration transducer tester. The TTS can be used in the field orin the laboratory. The TTS tests and verifies the performance of most vibration transducers including accelerometers, velocity pickups and displacement probes. The TTS is also used to troubleshoot vibration monitoring systems or vibration analyzers including cabling and associated system alarms and other instrumentation.

## About Hardy Manuals

Every Hardy Installation and Operation manual is organized into easily referenced chapters, that are almost always the same:

- **Chapter 1** - Provides an introduction to the instrument and an **Overview** of the equipment and its capabilities.
- **Chapter 2** - Provides a complete list of **Specifications.**
- **Chapter 3** - Contains information needed to **Install** the HI 803 TTS. (both standard and optional equipment)
- **Chapter 4** - Provides all **Calibration** instructions.
- **Chapter 5** - Pertains to the **Operating Procedures** of the HI 803 TTS.

Hardy Instruments hopes that this manual meets your needs for information and operation. All corrections or suggestions for improvements of this manual are welcome and can be sent to the Technical Publications Department or Customer Support Department at Hardy Instruments Inc.

## Description

The HI 803 TTS performs the following primary functions:

1. Vibration Generator “Shaker” - The vibration generator is used to vibrate or “shake” the Transducer-Under-Test (TUT). The frequency and amplitude of the applied vibration are selectable and digitally displayed. Operation control is maintained and supervised by a microcomputer. A highly accurate reference accelerometer, which is traceable to the Nation Institute of Standards (NIST), is used to provide the measurement signal, ensuring high accuracy of the displayed frequency and amplitude levels.

2. Automatically Calculates Transducer Sensitivities - Internal electronics provide the necessary signal conditioning and drive current for most transducers. By measuring the output signal of the TUT as it is vibrated, and comparing it withan internal reference signal, the

sensitivity (signal out per unit of motion) of the transducer is automatically calculated. This is calculated sensitivity can then be used to determine whether the TUT is within the transducer manufacturer's specifications. A thermal printer is built in to the TTS to provide hard copy printouts of the test parameters and test results.

## Capabilities

**Amplitude Units** Vibration amplitude units are selectable and displayed in acceleration, velocity or displacement. The units are also selectable in English or Metric.

**Frequency Units** Vibration frequency is displayed in hertz (Hz). Ranges are user selectable in 3-100 Hz, 100-1000 Hz and 1000-10,000 Hz, with front panel selections for 100, 1K and 10K respectively.

**Automatic Calculation** Sensitivity calculations (mV/engineering unit or pc/engineering unit) are automatically performed using a microcomputer.

**Phase** During sensitivity calculation when the transducer selected is an accelerometer, the unit displays the phase of the "transducer under test" relative to the internal reference accelerometer.

**Automatic Mass Load Correction** A special algorithm is used to automatically adjust measurements and calculations to compensate for the mass load of the transducer under test.

**Help Screens** Help screens are provided during operation to assist the operator.

**Large Memory** Test parameters, test results and othertest data can be stored in memory for future download via the printer. Information will be retained even though the TTS is turned off.

**Printer** The TTS features a built-in thermal printer, which is used to hard copy data stored in memory.

**Automatic Date/ Time** A built-in real time clock displays date/time and automatically stamps hard copy print outs.

**Battery Powered** Power is provided by two gel cell type batteries. The two batteries are charged via two built-in charging systems that use a 110 VAC 50/60 Hz source. The user can use the TTS while the batteries are being charged. 220 VAC is optional.

**ICP Accelerometers** Selectable current sources (.5 mA, 2 mA, 2.5 mA, 4 mA, 4.5 mA, 6 mA) are provided to power ICP accelerometers.

**Reference Accelerometer Output** A 50 mV/g, low impedance ( $\approx$ 100 Ohms) reference accelerometer output signal is provided.

### Automatic Power Management

A power management and supervisory system is used to optimize power consumption, increasing the time between required charging. The instrument will automatically turn off at the lowest acceptable voltage to ensure the batteries are not subjected to deep discharge which can greatly reduce their operational life.

### Automatic Monitoring and Supervisory Limits

1. Warning - When test amplitude and/or frequency are out of acceptable ranges, the operator is warned of the condition with flashing displays.
2. Shutdown - to prevent damage to the shaker, the TTS is automatically shut down when maximum acceptable displacement limits are exceeded (approximately .125 inch P-P displacement).

## Principles of Operation

The HI 803 Transducer Test Set is comprised of a Signal Generator, Power Amplifier, Electrodynamic Vibrator, Reference Accelerometer, Digital Voltmeter, Microcomputer and Digital Indicator.

### The Signal Generator

The signal generator produces a variable frequency sine wave which becomes the source of the driving signal to produce the vibration at the shaker head. The amplitude of this sine wave signal is controlled by the front panel AMPLITUDE dial controller. The frequency is also controlled by the front panel FREQUENCY dial controller.

### The Power Amplifier

The power amplifier is designed to provide the current required to drive the coil in the Electrodynamic vibrator through an impedance matching circuit. The frequency and amplitude of the shaker are controlled by and are proportional to the frequency and amplitude of the oscillator signal applied to the amplifier input.

### The Electrodynamic Amplifier

The electrodynamic vibrator functions by means of the interaction between the magnetic field in the air gap and the oscillating current flowing in the moving coil. This current generates a force at right angles to the liens of flux in the air gap and to the conductor carrying the current. This force is proportional to the product of the instantaneous current and the magnetic flux density.

### The Reference Accelerometer

The reference accelerometer is used to measure and set the level of vibration at the shaker head (which is the mechanical interface to the test transducer) for calibration. The reference accelerometer is an integral part of the shaker head. It's sensing element is a ferroelectric ceramic crystal that outputs a voltage proportional to compression and extraction forces imposed by a precise mass that is fixed to the crystal assembly. This signal is conditioned and factory calibrate to 50 mV/g. A calibration "standard" is maintained that is used to calibrate the TTS and provide NIST traceability.

The vibration levels can be read in English or Metric units as set by the setup program. Frequency can be read in Hz.

## The Microcomputer

The microcomputer manages the operation of the TTS by interpreting external commands entered from the front panel keys, monitoring operating parameters, measuring the built-in reference accelerometer and the transducer under test, performing calculations and driving the display and printer. A significant benefit in having a microcomputer is its ability to run self tests to insure the TTS is functioning properly.

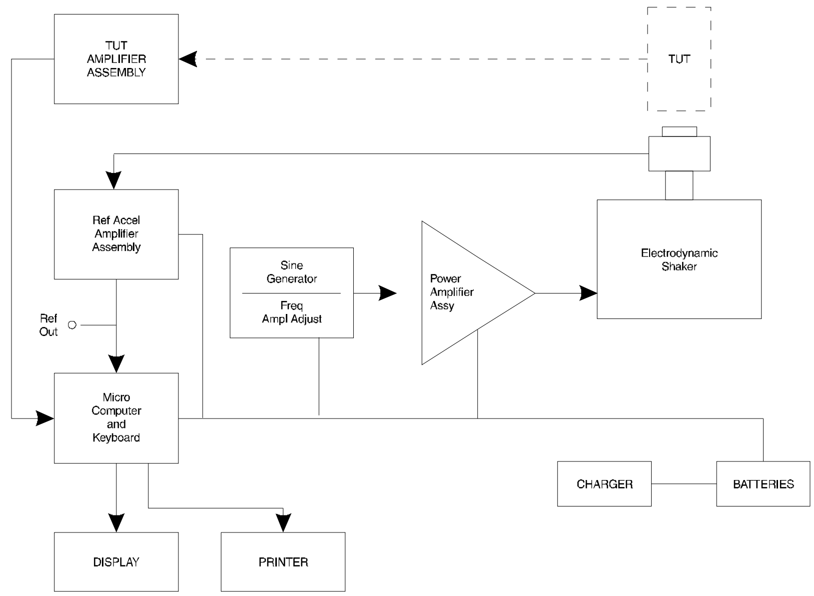



**FIG. 1-1 TRANSDUCER TEST SET (TTS) - BLOCK DIAGRAM**

## Battery Operation

The TTS can be operated using an AC line power source or from its internal rechargeable batteries. No switching is necessary since AC line power is always connect to a built-in battery charger thereby providing a charge whenever connected to power. Maximum charge rate is achieved when the TTS is off.

Battery power for the TTS is supplied by two (2) sealed solid gel rechargeable batteries. The batteries are designed for continuous charging without damage. Batteries should be kept fully charged. Under normal operation, the TTS will operate in excess of 4 hours with fully charged batteries.

Charge life is directly dependent on the power used which is established by the test requirements. When testing requires high force be supplied to drive the test transducer (due to heavy fixturing or transducer size and/or due to high test levels) the charge life will be shortened.

**CAUTION** **A COMPLETE DISCHARGE CAN CAUSE BATTERY FAILURE.**

A protection circuit switches the TTS off automatically. When this occurs, the TTS must be connected to AC power to activate its charger right away.

Under normal conditions batteries will obtain a full charge after (8) hours charge time. If deep discharge occurs, one or more days may be required to reach full charge.

### Special Handling and Storage

The internal batteries are sealed and should provide long term service under normal operating conditions. They are securely mounted heavy duty brackets so that no damage can occur from shipping or normal transportation. No special handling should be required.

## Lithium Battery

There is a Lithium battery that is used to maintain power to internal RAM which stores calibration information for the TTS. This battery is designed to be functional for 6 or 7 years. If it fails, the TTS will display the following message upon start up, indicating a RAM problem:

RAM Error

If this message appears contact your local Hardy Representative right away. The TTS will have to be returned to the factory to have a new lithium battery installed and the software re-entered and functionally checked.

# CHAPTER 2 - SPECIFICATIONS

## A Brief Description of Chapter 2

Chapter 2 lists the specifications for the HI 803 TTS. Specifications are listed for the standard instrument and for optional equipment. The specifications listed are designed to assist in the installation, operation and troubleshooting of the instrument. All service personnel should be familiar with this section before attempting an installation or repair of this instrument.

## Specifications for the HI-803 TTS

### Display

- High Contrast, Wide Viewing Angle
- Displays 5 x 7 dots plus cursor
- 20 characters x 4 lines
- Backlit Screen

### Calibration

Traceable to NIST standard at 100 Hz from 2 to 5 g's

### Measurement Uncertainty

- Acceleration: 10 Hz to 2k Hz +- .3 dB
  2kHz to 10k Hz +- 1 dB
- Velocity: 10 Hz to 500 Hz +- .3 dB
  500 Hz to 2kHz +- .5 dB
- Displacement: 20 Hz to 150 Hz +- .3 dB
  150 Hz to 200 Hz +- .5 dB
- Triax: 30 Hz to 200 Hz +- .3 dB

### Frequency Readout Accuracy

3 Hz to 10 kHz: .001% +- 1 count

### Amplitude Range

- Maximum Acceleration - - - - -10 g (100 m/sec$^2$), PK
- Maximum Velocity - - - - - - -10 in/sec (254 mm/sec), PK
- Maximum Displacement - - - -100 mils (2.54 mm), Pk-PK
- Generates the peak output accelerations at the frequency ranges and loads as follows:

| Frequency Range | 0-100 Grams | 100-240 Grams | 250-500 Grams | 500-750 Grams |
|---|---|---|---|---|
| 10-100 Hz | 10 g | 4 g | 2 g | 1 g |
| 100-1000 Hz | 7 g | 4 g | 2 g | 1 g |
| 1-2 kHz | 3 g | 1.5 g | 1 g | n/a |
| 1-10 kHz | 3 g | 1.5 g | n/a | n/a |

**TABLE 2-1: MAXIMUM LOAD**

**NOTE:**

1. *Limited at lower frequencies to 0.1 inch (2.54mm) PK-PK displacement.*
2. *Care should be taken when mounting the test transducer and its support brackets to reduce the possibility of resonance and decoupling (anti-resonance).*

3. *For maximum output, batteries should be fully charged. Preferably, the TTS should be powered by an external AC power source.*

**Transducer Sensitivity Range**

- Accelerometers:

  ICP - - - - - - - - - - - - - - - 5 mV/g - 200 mV/g
  Charge - - - - - - - - - - - - - - 5 PC/g - 200 PC/g

- Velocity - - - - - - - - - - - - - - - 5 mV/I.P.S. - 1 Volt/I.P.S.
- Displacement - - - - - - - - - - - - 30 mV/Mil - 300 mV/Mil

**Reference Accelerometer Output**

- Sensitivity = 50 mV/g +- .15 dB @ 100 Hz
- Output Impedance = 100 Ohms nominal

**DI-103 & DI-103A Triaxial Mounted Specifications**

Sensitivity: +- 10% @ 100 Hz - - - - - - - - - - - - - - - 10 mV/g

Frequency Range:

Channel: - - - - - - - - -A. +- 1 dB .2 - 2,000 Hz
Channel: - - - - - - - - -B. +- 1 dB .2 - 2,000 Hz
Channel: - - - - - - - - -C. +- 1 dB .2 - 5,000 Hz
Channel: - - - - - - - - -C. +- 3 dB 1 - 10,000 Hz

**Power**

- Battery Powered
- 115 VAC, 50/60 Hz charger (The instrument can be operated during charging)
- HI-803-220 VAC provides 220 VAC, 50 Hz charging capability

**Printer**

- Thermal Type Printer
- Character Format - - - - - - - - - - 5 x 7 dot matrix
- Printing Speed - - - - - - - - - - - - (Line/Sec) 0.9
- Paper Width - - - - - - - - - - - - - 2.3”

**Physical Dimensions**

- Size - 11” (279.4 mm) Long x 7”(177.8 mm) Wide x 10” (254 mm) High
- Weight - 22.7 lbs (10.297 Kgs)

**Environmental Specifications**

$10^0$ to $270^0$ F ($-12^0$ to $+132^0$ C)

# CHAPTER 3 - INSTALLATION

## A Brief Description of Chapter 3

All information contained in Chapter 3 pertains to unpacking, cabling, interconnecting, configuration and installing the HI 803 TTS and Optional Equipment. Alternatives to any procedures contained or implied in this chapter are not recommended. It is very important that the user and service personnel be familiar with the procedures contained in this chapter, before installing or operating the HI 803 TTS. Hardy Instruments appreciates your business. Should you experience any problems installing this equipment, contact your local or Hardy Instruments Inc., Customer Support for assistance.

## Unpacking

Step 1. Before signing the packing slip, inspect the packing for damage of any kind.

Step 2. Report any damage to the carrier company immediately.

Step 3. Check to see that everything in the package matches the bill of lading. You should normally have:

- One Assembled HI 803 TTS Unit
- Power Cord (Prt. #6006-0008)
- Connector, Input to HI 803 (Prt. #2112-0007)
- Special Spanner Wrench (Prt. #0228-0072-01)
- Velocity Transducer Mounting Fixture (Prt. #0228-0071-02) with screw (Prt. #2824-0135)
- Mounting 1/4-28 Stud Adapters:

| | |
|---|---|
| 1/4-28 Stud | 0228-0070-01 |
| 10-32 UNF Stud | 0228-0070-02 |
| 2-56 UNC Threaded Bushing | 0228-0070-03 |
| 6-32 UNC Threaded Bushing | 0228-0070-04 |
| 10-32 UNF Threaded Bushing | 0228-0070-05 |

- Screwdriver (Prt. #0228-0094-01)
- Operation and Installation Manual

**NOTE:** *To tighten the stud adapters to the shaker head mounting hole, use the screwdriver provided (Prt. #0228-0094-01) in the Accessories Kit. Using this screwdriver insures an adequate load on both ends of the adapter. Do not apply more than 6 in/lbs of torque to prevent damaging or breaking the adapter.*

Step 4. Write down the Model and Serial number of the instrument. Store this information in a convenient location for reference when contacting The Hardy Customer Support Department for parts or service.

## Optional Accessories

| | |
|---|---|
| Mounting Bracket DI-103 (Triax) - Prt #0205-0057-01 | Mounting Bolt: Di-103- - - - - - - - - - - - - 0205-0073-01<br>Mounting Screw: Bracket - - - - - - - - - - - 2824-0137 |
| Mounting Bracket DI-103A (Triax) - Prt #0205-0057-01 | Mounting Bolt: Di-103- - - - - - - - - - - - - 0205-0073-01<br>Mounting Screw: Bracket - - - - - - - - - - - 2824-0137 |
| Kit | Displacement Probe Mounting Fixture, 1 1/4” Height - - - - - - - - - - - - - - - - - 0251-0011-01 |
| Kit | Displacement Probe Mounting Fixture, 6” Height - - - - - - - - - - - - - - - - - - - 0251-0019-01 |

Cables for Sensitivity Mode of Operation

- DI-103 Accel - - - - - - - - - - - 0215-0088-01
- DI-108 Accel - - - - - - - - - - - 0215-0088-01
- Micro Dot (10-32), ICP - - - - - 0215-0086-01
- Micro Dot (10-32), ICP - - - - - 0215-0087-01
- Chadwick-Helmuth Velocimeter #7310 - - - - - - - - 0215-0094-01
- 7993 Accel, ICP, 2 Pin- - - - - - 0215-0129-01
- 7993T Accel, ICP, 3 Pin - - - - - 0215-0130-01
- Accel, ICP, BNC - - - - - - - - - 0215-0131-01
- Accel, ICP, Alligator Clips- - - - 0215-0132-01
- Displacement, Alligator Clips - - 0215-0133-01

**NOTE:** *Other TTS to TUT cables and connectors can be purchased from Hardy Instruments Inc. Contact your local Hardy Dealer for information.*

Kit — Mounting Studs/Bushings

- 1/4-28 Stud - - - - - - - - - - - - 0228-0070-01
- 10-32 UNF Stud- - - - - - - - - - 0228-0070-02
- Metric M6 Stud - - - - - - - - - - 0228-0117-01
- 2-56 UNC Threaded Bushing - - 0228-0070-03
- 6-32 UNC Threaded Bushing - - 0228-0070-04
- 10-32 UNF Threaded Bushing - - 0228-0070-05

**NOTE:** *For replacement batteries please contact your local Hardy Representative or the Hardy Instruments Service Center.*

Kit — Spare Fuses (3)

## Installation Procedures

### TTS to TUT Cable Connector Pin Out Diagram (See Fig. 3-1)

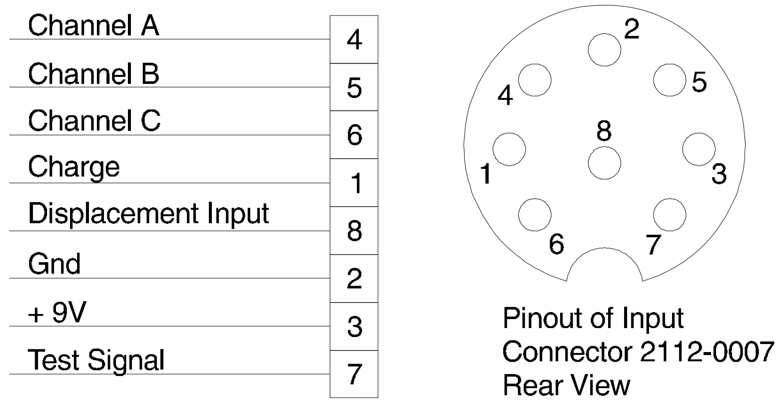



**FIG. 3-1 CABLE CONNECTOR PIN OUT DIAGRAM**

| | |
|---|---|
| Channel A | Input for all transducers that provide voltage outputs. Current can be selected by menu for those transducers requiring current between.5 mA and 6 mA for power. (See Fig. 3-2) |
| Channel B & C | Use **ONLY** when testing triax accelerometer (ICP type) (See Fig. 3-4) |
| Charge | Used for charge accelerometers with a sensitivity between 10 PC/g to 100 PC/g (See Fig. 3-3) |
| Displacement Input | For proximity type displacement transducer with voltage output between 0 and -24 volts. |
| GND | TTS signal ground |
| +5V | Regulated +9V output at 6 mA maximum |
| Test Signal | Test signal output for use with loop back test cable. |

### Accelerometer - ICP Type

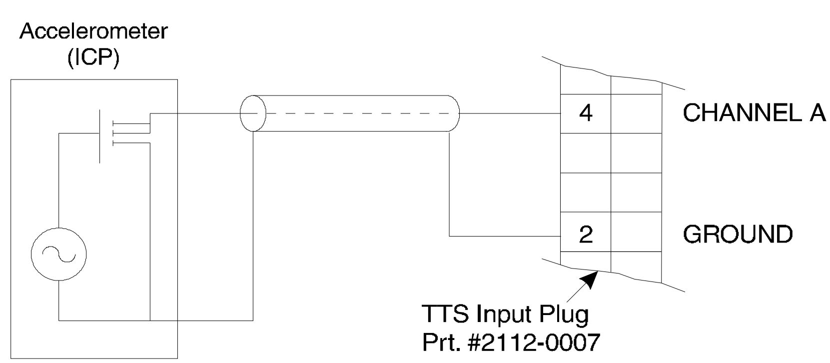



**FIG. 3-2 ACCELEROMETER ICP TYPE**

## Accelerometer (Charge Type)

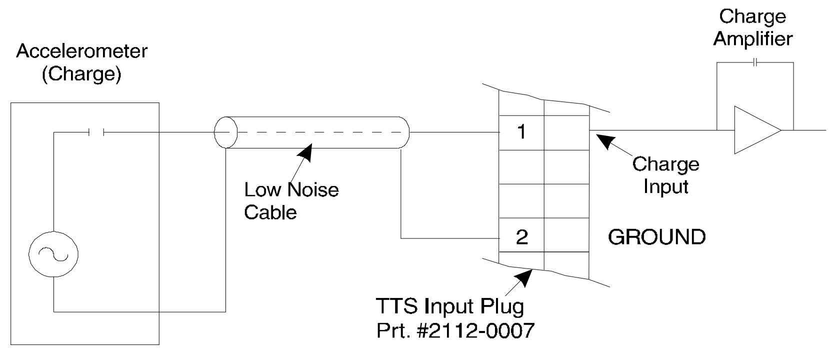



**FIG. 3-3 ACCELEROMETER (CHARGE TYPE)**

## Triax Accelerometer (ICP Type)

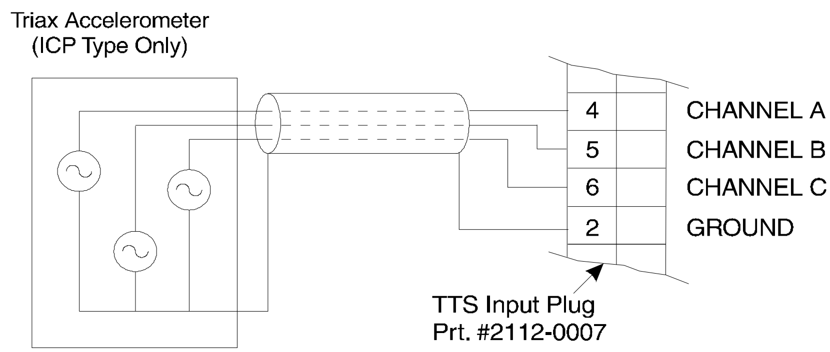
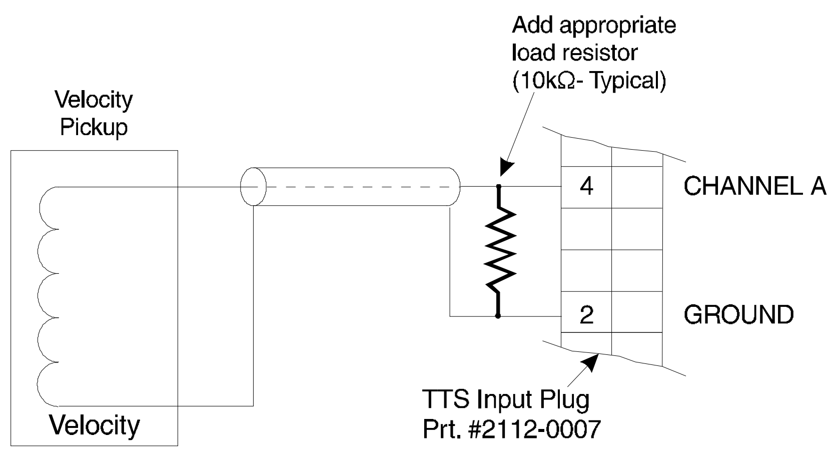



**FIG. 3-4 TRIAX ACCELEROMETER (ICP TYPE)**

## Velocity Pickup




Note: Turn off TTS current

**FIG. 3-5 VELOCITY PICKUP**

Piezoelectric Velocity Transducer

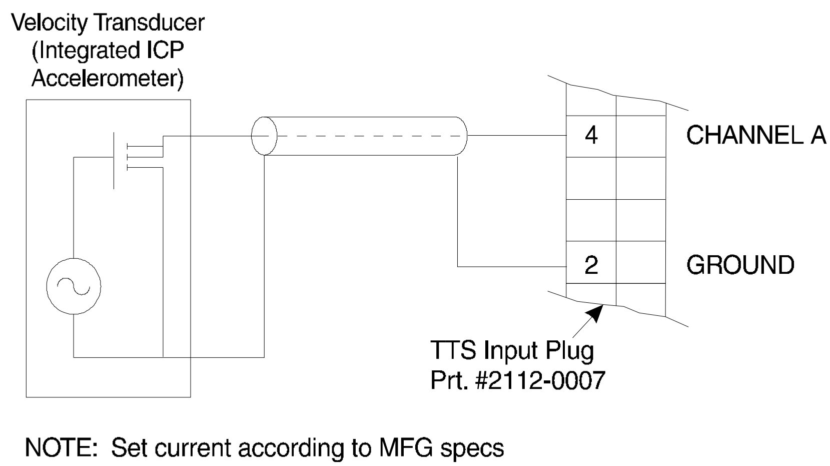



**FIG. 3-6 PIEZOELECTRIC VELOCITY TRANSDUCER**

Displacement Eddy Current Proximity Probe

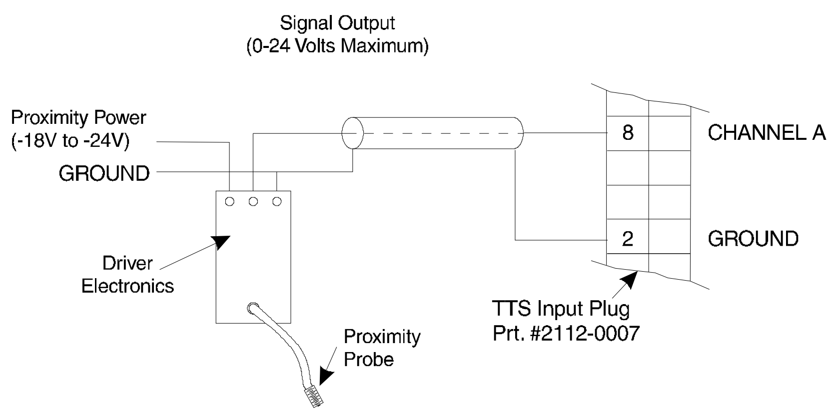



**FIG. 3-7 PROXIMITY PROBE**

Voltage Powered Accelerometers

Some examples of Voltage Powered Accelerometers - Dynamic Instruments DI-151, Wilcoxon 991B and Chadwick-Helmuth 4177B.

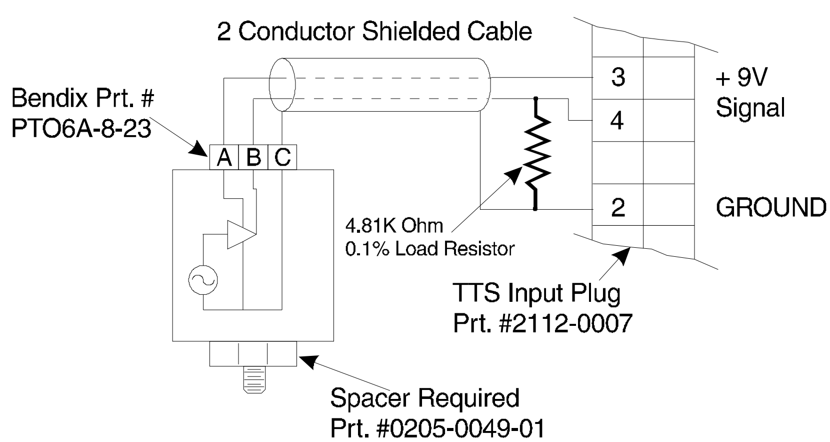



**FIG. 3-8 VOLTAGE POWERED ACCELEROMETERS**

## Chadwick-Helmuth Velocimeter #7310 Test Setup

The following information provides the electrical diagram for connecting the Chadwick-Helmuth Velocimeter #7310 to the TTS. (See Figs. 3-9 & 3-10)

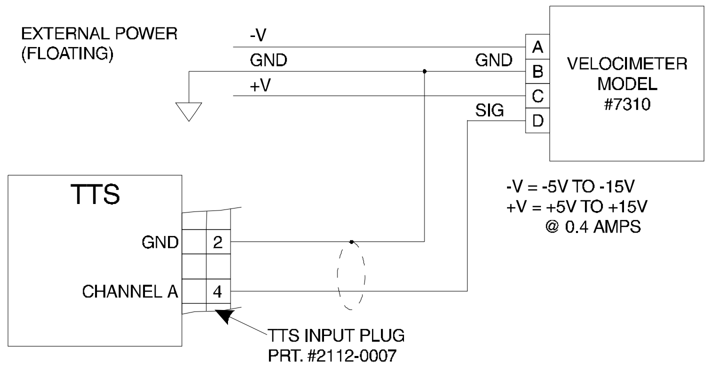



**FIG. 3-9 EXTERNALLY POWERED (FLOATING) ELECTRICAL SETUP**

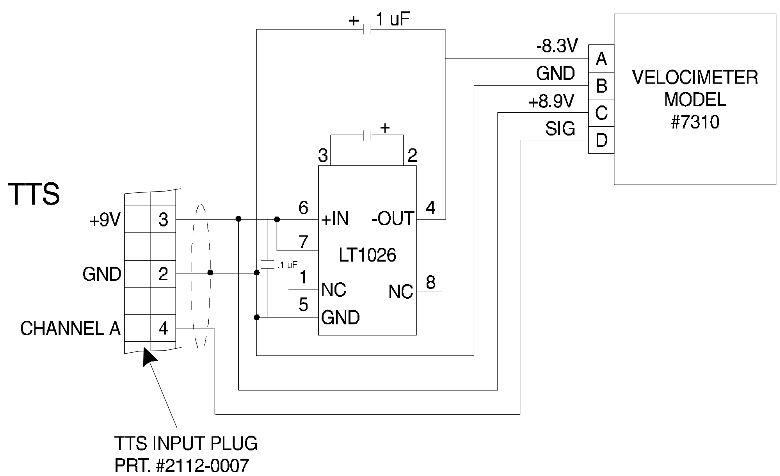



**FIG. 3-10 TTS POWERED ELECTRICAL SETUP USING A SPECIAL CIRCUIT (CONVERTS + TO -) LOCATED IN HOOKUP CABLE PRT. #0215-0102-01**

## Triaxial Accelerometer Installation

### Installation of the Mounting Bracket and Cables

Step 1. **ALWAYS** use the Spanner Wrench (Prt. #0228-0072-01) to prevent damage to the Reference Accelerometer when installing the mounting bracket or a test accelerometer. (See Fig. 3-11)

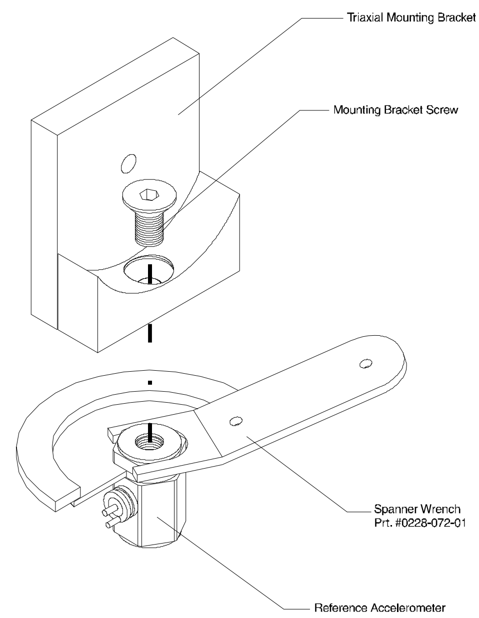



**FIG. 3-11 INSTALLATION OF MOUNTING BRACKET FOR AXIS A & B**

Step 2. While holding the reference accelerometer steady with the spanner wrench, place the mounting bracket (Prt. #0205-0043-01) over the top of the reference accelerometer.

**WARNING** **ALWAYS USE THE SPANNER WRENCH WHEN INSTALLING, REMOVING OR ADJUSTING THE TRANSDUCERS OR MOUNTING BRACKET ON THE REFERENCE ACCELEROMETER.**

Step 3. While still holding the spanner wrench in place, use the allen wrench provided with the bracket kit to screw the mounting bracket socket head screw into the reference accelerometer. (See Fig. 3-11) Tighten the screw so that the bracket is snug against the reference accelerometer. If you want use a torque wrench and torque to 18 inch pounds. Do not over torque the mounting screw. Overtightening the mounting screw can cause bad readings.

Step 4. Install the connecting cable (Prt. # 0215-0088-01) between the Transducer under test (TUT) and the input connector on the top panel. (See Fig. 3-12 & 3-13)

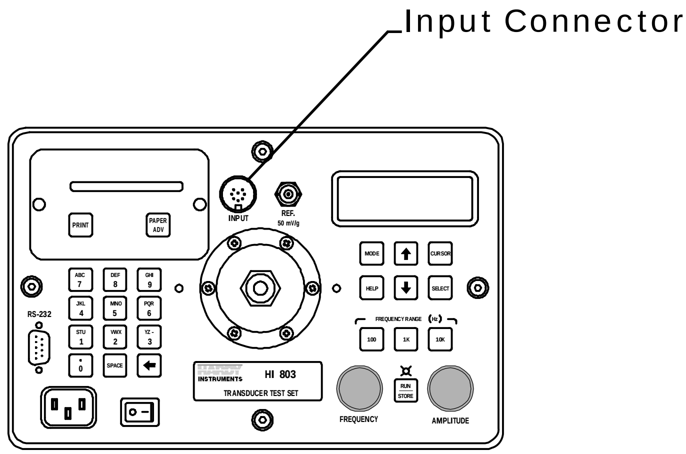



**FIG. 3-12  TOP PANEL/INPUT CONNECTOR**

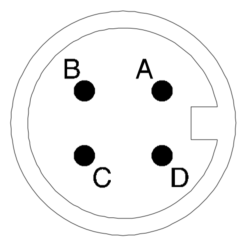



**FIG. 3-13  ACCELEROMETER CONNECTOR PIN OUT DIAGRAM**

| Pin | Function |
|---|---|
| A | SIG A AXIS |
| B | SIG B AXIS |
| C | SIG C AXIS |
| D | GROUND |

**TABLE 3-1: ACCELEROMETER CONNECTOR PIN AND FUNCTION**

DI-103 Installation for A & B Axes

Step 5.    Position the TUT for the A position. (See Fig. 3-14)

**NOTE:** *For Triaxial Mounted Specifications go to Chapter 2, Triaxial Mounted Specifications.*

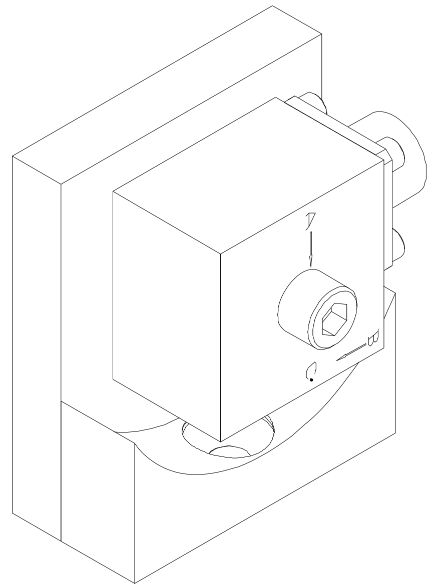


**FIG. 3-14 DI-103 A-AXIS POSITION WITH A ARROW POINTING DOWN**

Step 6. Screw the socket head bolt into the mounting bracket. Use a torque wrench and tighten the bolt that fastens the transducer to the bracket to 18 inch pounds. Do not overtighten.

Step 7. Perform the tests for Axis A.This information can be found in the documentation that comes with the transducer you are testing. We use the DI-103 as an example. Make sure to refer to the test documentation for the transducer you are currently using. This information may differ from manufacturer to manufacturer. If you have more than one transducer to test, complete the test for the A Axis for all the transducers before moving on to Axis B or Axis C. This will save a lot of time.

Step 8. When all the tests are complete, use the allen wrench and loosen the socket head bolt until you can rotate the transducer to the Axis B position. (See Fig. 3-15)

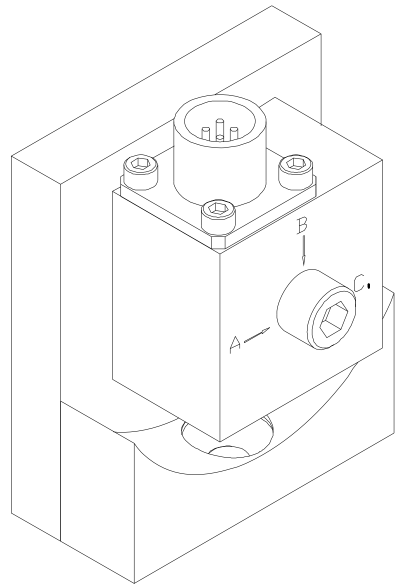



**FIG. 3-15 DI-103 B-AXIS POSITION WITH B ARROW POINTING DOWN**

Step 9. Screw the socket head bolt into the mounting bracket. Use a torque wrench and tighten the bolt that fastens the transducer to the bracket to 18 inch pounds. Do not overtighten.

Step 10. Perform the tests for Axis B. This information can be found in the documentation that comes with the transducer you are testing. We use the DI-103 as an example. Make sure to refer to the test documentation for the transducer you are currently testing. This information may differ from manufacturer to manufacturer. If you have more than one transducer to test, complete the test for the B Axis for all the transducers before moving on to Axis C. This will save a lot of time.

Step 11. When all the tests are complete, use the allen wrench and loosen the socket head bolt until you can remove the accelerometer from the bracket.

Step 12. Use the allen wrench provided and remove the mounting bracket socket head screw. Take the mounting bracket off the reference accelerometer and store it in secure location. Do not store the bracket in the kit bag provided, because it might damage the reference accelerometer when closing the lid.

### DI-103 Installation for the C-Axis Tests

Step 13. Slide the spacer (Prt. #0205-0049-01) over the socket head bolt that fastens the Transducer Under Test (TUT) to the reference accelerometer. (See fig. 3-16)

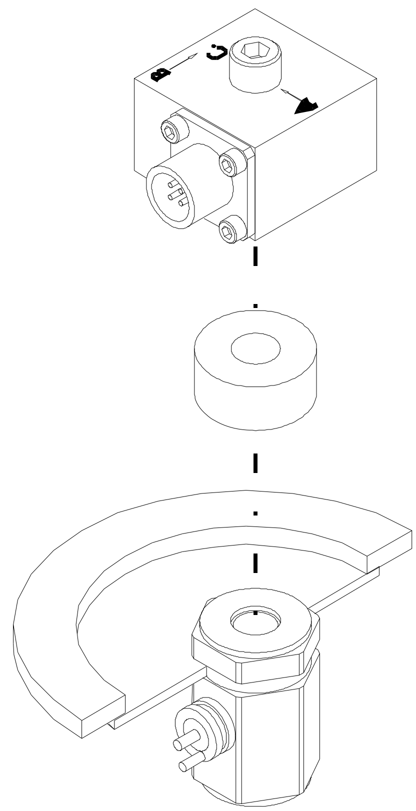



**FIG. 3-16 DI-103 INSTALLATION FOR C AXIS TEST**

Step 14. Use the spanner wrench to hold the reference accelerometer. (See Fig. 3-11)

Step 15. Use a torque wrench to tighten the socket head bolt to the reference accelerometer. Tighten to 18 inch pounds. (See Fig. 3-16)

**NOTE:** *You can position the TUT in any of 1 of four directions.*

Step 16. Perform the tests for Axis C. This information can be found in the documentation that comes with the transducer you are testing. We use the DI-103 as an example. Make sure to refer to the test documentation for the transducer you are currently testing. This information may differ from manufacturer to manufacturer. If you have more than one transducer to test, complete the test for the C Axis for all the transducers. This will save a lot of time.

Step 17. When all the tests are complete, use the allen wrench and loosen the socket head bolt until you can remove the accelerometer.

## DI-103A Installation for A & B- Axes Tests

Step 1. **ALWAYS** use the Spanner Wrench (Prt. #0228-0072-01) to prevent damage to the Reference Accelerometer when installing the mounting bracket or a test accelerometer. (See Fig. 3-11)

**WARNING** **ALWAYS USE THE SPANNER WRENCH WHEN INSTALLING, REMOVING OR ADJUSTING THE TRANSDUCERS OR MOUNTING BRACKET ON THE REFERENCE ACCELEROMETER.**

Step 2. While still holding the spanner wrench in place, use the allen wrench provided with the bracket kit to screw the mounting bracket socket head screw into the reference accelerometer. (See Fig. 3-9) Tighten the screw so that the bracket is snug against the reference accelerometer. If you want, use a torque wrench and torque to 18 inch pounds. Do not over torque the mounting screw. Overtightening the mounting screw can cause bad readings.

Step 3. Install the connecting cable (Prt. # 0215-0088-01) between the Transducer under test (TUT) and the input connector on the top panel. (See Fig. 3-12)

Step 4. Position the TUT for the A position. (See Fig. 3-17)

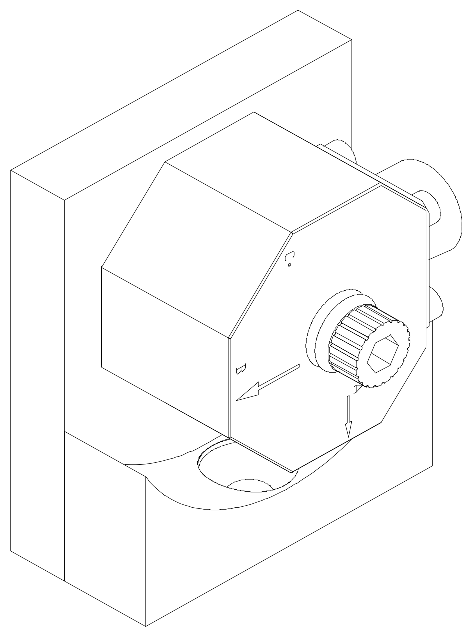


**FIG. 3-17 DI-103A A-AXIS POSITION WITH A ARROW POINTING DOWN**

Step 5. Screw the socket head bolt into the mounting bracket. Use a torque wrench and tighten the bolt that fastens the transducer to the bracket to 18 inch pounds. Do not overtighten.

Step 6. Perform the tests for Axis A.This information can be found in the documentation that comes with the transducer you are testing. We use the DI-103 as an example. Make sure to refer to the test documentation for the transducer you are currently using. This information may differ from manufacturer to manufacturer. If you have more than one transducer to test, complete the test for the A Axis for all the transducers before moving on to Axis B or Axis C. This will save a lot of time.

Step 7. When all the tests are complete, use the allen wrench and loosen the socket head bolt until you can rotate the transducer to the Axis B position. (See Fig. 3-18)

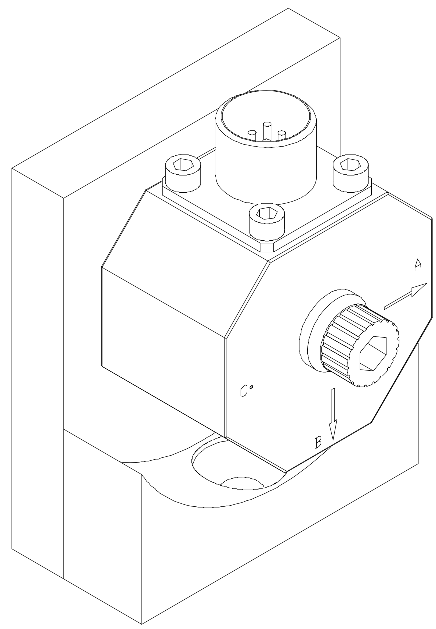



**FIG. 3-18 DI-103A B-AXIS POSITION WITH B ARROW POINTING DOWN**

Step 8. Screw the socket head bolt into the mounting bracket. Use a torque wrench and tighten the bolt that fastens the transducer to the bracket to 18 inch pounds. Do not overtighten.

Step 9. Perform the tests for Axis B. This information can be found in the documentation that comes with the transducer you are testing. We use the DI-103 as an example. Make sure to refer to the test documentation for the transducer you are currently testing. This information may differ from manufacturer to manufacturer. If you have more than one transducer to test, complete the test for the B Axis for all the transducers before moving on to Axis C. This will save a lot of time.

Step 10. When all the tests are complete, use the allen wrench and loosen the socket head bolt until you can remove the accelerometer from the bracket.

Step 11. Use the allen wrench provided and remove the mounting bracket socket head screw. Take the mounting bracket off the reference accelerometer and store it in secure location. Do not store the bracket in the kit bag provided, because it might damage the reference accelerometer when closing the lid.

## DI-103A Installation for the C-Axis Tests

Step 12. Slide the spacer (Prt. #0205-0049-01) over the socket head bolt that fastens the Transducer Under Test (TUT) to the reference accelerometer. (See Fig. 3-19)

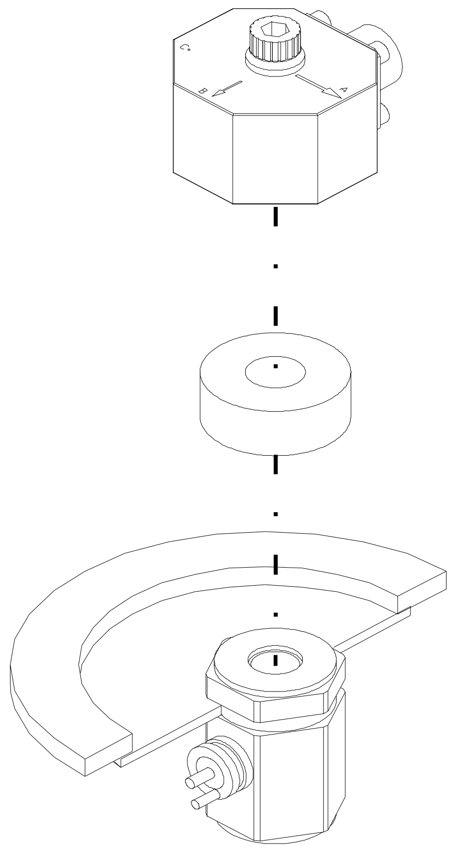


**FIG. 3-19  DI-103A INSTALLATION FOR C-AXIS TEST**

Step 13. Use the spanner wrench to hold the reference accelerometer. (See Fig. 3-11)

Step 14. Use a torque wrench to tighten the socket head bolt to the reference accelerometer. Tighten to 18 inch pounds. (See Fig. 3-19)

**NOTE:** *You can position the TUT in any of 1 of four directions.*

Step 15. Perform the tests for Axis C. This information can be found in the documentation that comes with the transducer you are testing. We use the DI-103A as an example. Make sure to refer to the test documentation for the transducer you are currently testing. This information may differ from manufacturer to manufacturer. If you have more than one transducer to test, complete the test for the C Axis for all the transducers. This will save a lot of time.

Step 16. When all the tests are complete, use the allen wrench and loosen the socket head bolt until you can remove the accelerometer.

## Installing Printer Paper

Step 1. Change the paper roll when a red strip appears on the paper.

Step 2. Remove the printer from the HI-803 chassis. (See Fig. 3-20)

- Loosen the two captive screws and carefully lift the printer out of the chassis.
- Do not detach the cable.

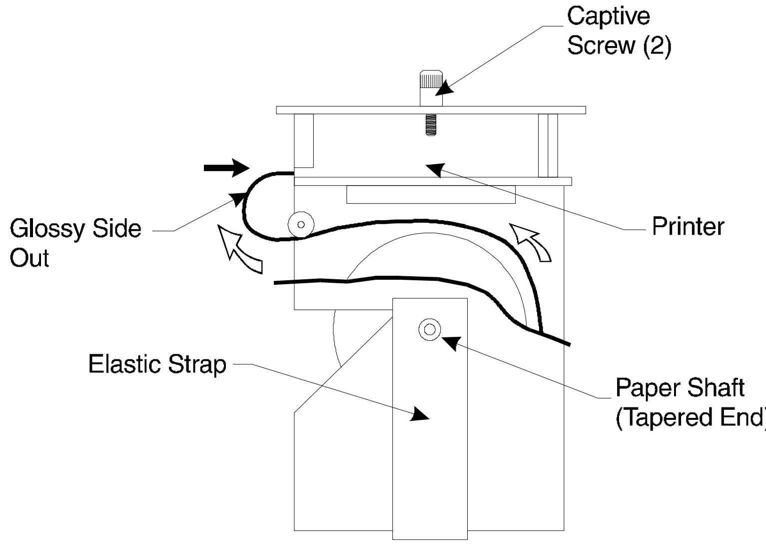



**FIG. 3-20  PRINTER PAPER INSTALLATION**

Step 3. Cut paper in two, fairly close to the printer.

Step 4. Turn on the TTS. Press the Paper Advance (Paper ADV) button to remove the paper from the printer. DO NOT PULL THE PAPER OUT OF THE PRINTER!!!!!

Step 5. From the tapered end of the paper shaft, remove the Elastic Strap that holds the paper roll in the roll carriage. (See Fig. 3-20)

Step 6. Pull the paper shaft out of the paper carriage and off the paper roll.

Step 7. Discard the old paper roll.

Step 8. Get a new roll of paper (Prt. # 1901-0057). You can purchase replacement rolls from Hardy Instruments Inc. An alternate source for the paper rolls is the Seiko Corporation (Prt. #TP201-211-25C).

Step 9. Cut the end of the paper so that it straight.

Step 10. Make sure that the paper orientation is correct. (See Fig. 3-20) Slide the cut end of the paper roll into the printer until it stops. (See Fig. 3-18) Don't force it.

Step 11. Press the Paper Advance (Paper ADV) button to feed the paper into the printer.

**NOTE:** *In the event you have a problem feeding the paper into the printer, cut the paper again so that the edge is straight. Use a straight edge if you have to.*

Step 12. Slide the paper shaft into the paper carriage and through the paper roll.

Step 13. Replace the Elastic Strap onto the tapered end of the paper shaft.
Step 14. Place the printer back into the TTS chassis.
Step 15. Tighten the captive screws.

## Installation of the Serial Interface

The TTS is available with a Serial Interface. The option enables the TTS to transfer collected field data to a host computer. You can use this data with many third party programs to create reports and graphs on your computer. The Serial Interface Kit includes:

- Serial Interface Cable, TTS to PC
- Serial Interface Adapter
- 31/2" TTS XFER Program Disk with Installation Instructions. (Part # 0202-0072-01)

Step 1. Connect the interface cable to the computer RS-232 Serial Port and TTS RS-232 Serial Port. If you are connecting to a USB port be sure to use a RS-232 Connector to USB adapter cable.
Step 2. Turn the TTS power switch on.
Step 3. Follow the instructions in the Installation Instructions for installing the software or see Transfer Program below.

### Transfer Program

A communications program has been provided for transferring data from the TTS to the PC. The program is run from the DOS command line on the PC. The syntax is:

- TTSXFER comport filename
- The comport is either COM1 or COM2 and the file-name is the name of the file you have selected to trans-fer data to, i.e. COM1, TTS, etc.
- COM1 is used for connection to the interface cable.
- The destination file name should be in the form, TTSmmddy.DAT, where mm=month, dd=day and y=year. For example, on Feb 14, 2007, we would use the filename, TTS02147.
- The complete DOS command is as follows:

A:\>TTSXFER COM1 TTS02147 (See Fig. 3-21)

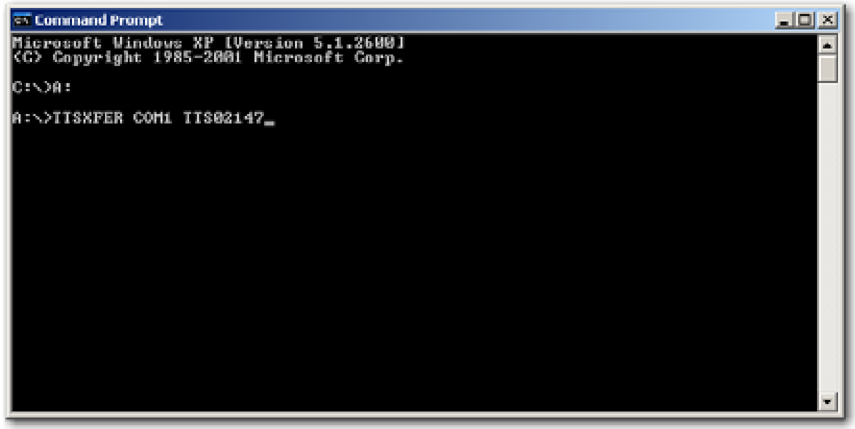



**FIG. 3-21 DOS COMMAND**

Step 1. Put the TTS XFER floppy disk in your floppy disk drive on your desktop or laptop computer.

Step 2. From your Windows® application go tothe Command Prompt display. (See Fig. 3-22)

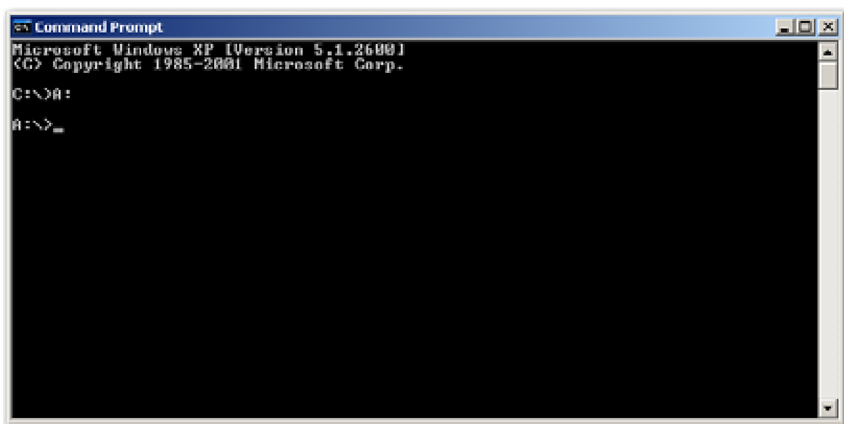



**FIG. 3-22 COMMAND PROMPT DISPLAY**

Step 3. At the Command prompt type “A:”

Step 4. Press the Enter button on your keyboard.

Step 5. The A:\> prompt appears.

Step 6. At the A:\> prompt, type “TTSXFER COM1 TTS02147” without the quotation marks. Pay particular attention to the spaces between command elements. The command is case sensitive, use uppercase letters only. (See Fig. 3-23)

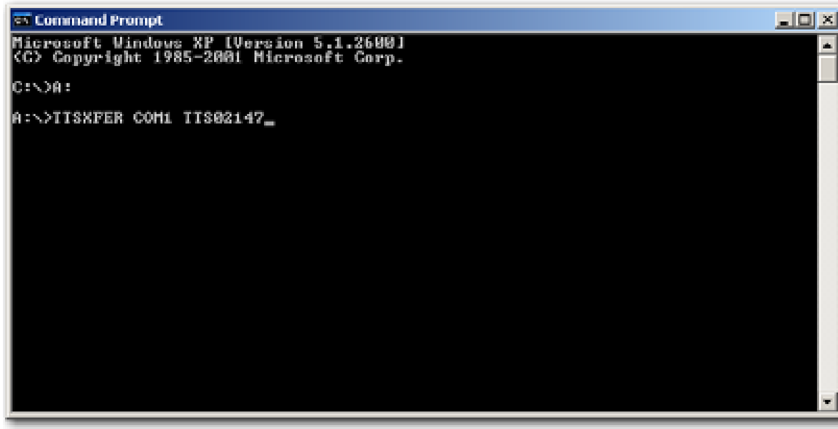



**FIG. 3-23 TTS TRANSFER COMMAND**

Step 7. Press the Enter button. The program reads the test data stored on the HI 803 and transfers it tothe floppy disk, automatically creating a destination data file. (See Fig. 3-24 & 25)

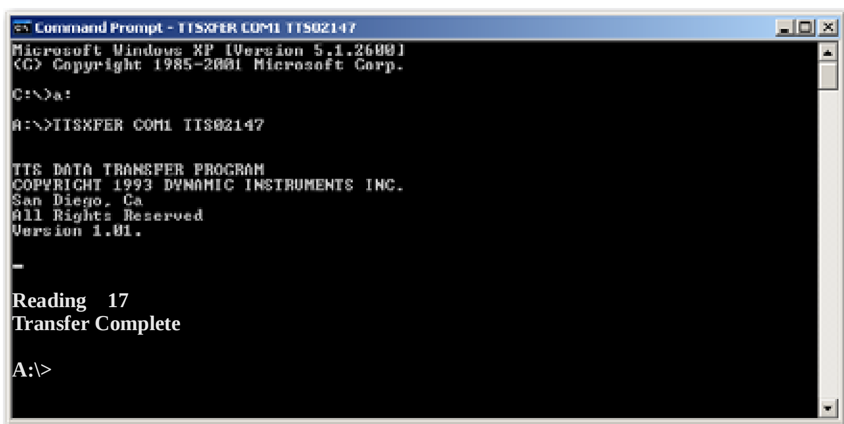



**FIG. 3-24 READING/TRANSFERRING COMPLETE**

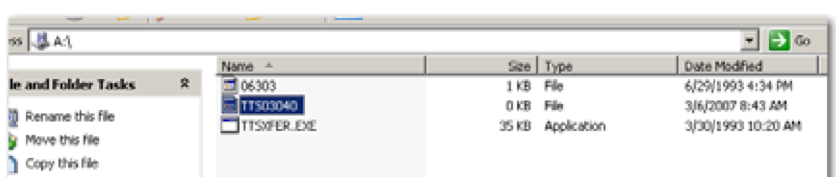



**FIG. 3-25 DATA FILE CREATED ON DRIVE A:**

**NOTE:** *If the destination file already exists, the data in it will be automatically overwritten.*

- Once the data has been uploaded, it can easily be imported into a spreadsheet or database as it is stored in an ASCII format.

Step 8. To read the data, double click on the file on Drive A:. The Open With dialog box appears.

Step 9. Pick the application you want to use to display the data. In our example we selected Microsoft Excel for Windows. (See Fig. 3-26)

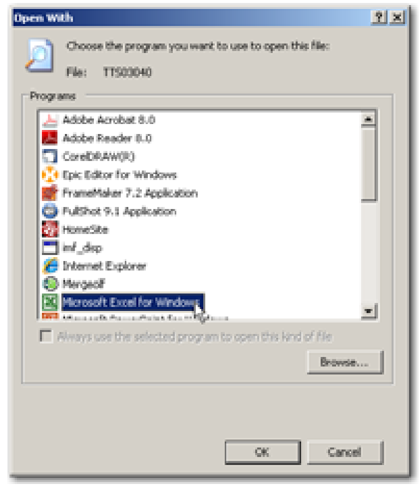



**FIG. 3-26 SELECTING APPLICATION TO DISPLAY DATA**

Step 10. The Excel spreadsheet appears with the data displayed. (See Fig. 3-27)

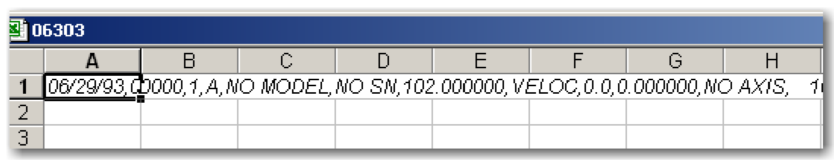



**FIG. 3-27 TEST DATA DISPLAYED IN EXCEL**

## Data Format

The data is transferred as a comma delimited ASCII file. There is one line in the file for each reading made. All readings are in standard English units (G's Peak, IPS Peak, or MILS P-P). Each line has the following fields which appear in the order shown:

1. DATE OF READING
2. TTS SERIAL NUMBER
3. TEST NUMBER
4. TEST PAGE LETTER
5. TRANSDUCER MODEL NUMBER STRING
6. TRANSDUCER SERIAL NUMBER STRING
7. TRANSDUCER MASS IN GRAMS
8. TRANSDUCER TYPE (ACCEL, VEL, DISP, ETC.)
9. TRANSDUCER CURRENT IN MA
10. DC Displacement Voltage (Valid only for displacement probes)

11. AXIS
12. FREQUENCY OF READING
13. AMPLITUDE (in G's, IPS or MILS)
14. SENSITIVITY OF READING
15. PHASE (UP, DOWN, or NONE)

## Example of Download Data

01/26/00, 00067, 1,A, DI-108, 1925, 40.000000, Volt., 2.0, 0.000000, NO AXIS, 50 2.501367. 10.7, UP
01/26/00, 00067, 1,B, DI-108, 1925, 40.000000, Volt., 2.0, 0.000000, NO AXIS, 516 1.586699. 10.7, NONE
01/26/00, 00067, 1,C, DI-108, 1925, 40.000000, Volt., 2.0, 0.000000, NO AXIS, 100 2.549741. 10.7, NONE

| Date of Transfer | TTS Serial Number | Test # | Test Letter | Transducer Model | Transducer Serial Number | Transducer Wght in Grams | Transducer Type |
|---|---|---|---|---|---|---|---|
| 02/22/00 | 00068 | 1 | A | DI-108 | 1925 | 40.000000 | VOLT |
| 02/22/00 | 00068 | 1 | B | DI-108 | 1925 | 40.000000 | VOLT |
| 02/22/00 | 00068 | 1 | C | DI-108 | 1925 | 40.000000 | VOLT |

**TABLE 3-2: EXAMPLE OF DOWNLOAD DATA**

| Transducer Current in MA | D.C. Displacement Voltage | Test Axis if Tri-Axial | Test Frequency | Test Amplitude in Respective Engineering Units, i.e. IPS, MILS, G's | Transducer Sensitivity | Transducer Stack Phase |
|---|---|---|---|---|---|---|
| 2.0 | 0.000000 | NO AXIS | 50 | 2.501367 | 10.7 | UP |
| 2.0 | 0.000000 | NO AXIS | 516 | 1.586699 | 10.7 | NONE |
| 2.0 | 0.000000 | NO AXIS | 100 | 2.549741 | 10.7 | NONE |

**TABLE 3-3: EXAMPLE OF DOWNLOAD DATA**

## Data Protocol

The host PC controls the TTS through the serial communications channel. Commands are sent to the TTS at 9600 Baud, no parity and one stop bit. The TTS will execute a command or will return data to the host.

# CHAPTER 4 - CALIBRATION

## A Brief Description of Chapter 4

Chapter 4 pertains to the setup and calibration of the HI 803 TTS. This chapter lists the equipment necessary, test equipment setup and Calibration test in order to perform acalibration of the TTS. Do not attempt this calibration without proper test equipment. A list is provided of the test equipment required. It is important that all test equipment have a current calibration. All users and service personnel should be familiar with this section before attempting an installation or repair of this instrument.

## Required Test Equipment

- Hewlett Packard 8904A Multi-function synthesizer.
- Keithley 195A digital multi meter, option (A) or equivalent
- Endevco Model 2947B-2 calibration capacitor
- Loopback Cable - Prt. #0215-0096-01
- TTS Input Test Cable - Prt. #0215-0095-01 (See Fig. 4-1)

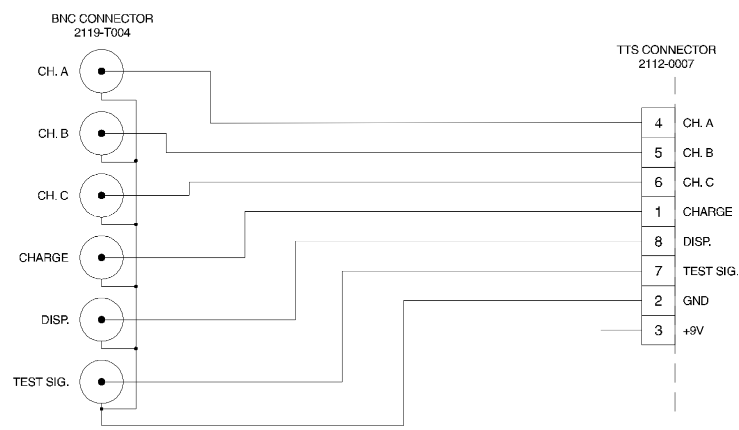



**FIG. 4-1 TTS INPUT TEST CABLE PRT. #0215-0095-01 WIRING DIAGRAM**

- Transfer Standard Accelerometer, Dytran Model 3010M12
- Test Cable 10-32 coaxial connector to BNC Prt. #0215-0097-01
- Test Cable Standard BNC to BNC coaxial cable (approximately 3 ft. in length)

## TTS Calibration Kit Prt. #0251-0009-01

Contains:

- Endevco Model 2947B-2 Calibration Capacitor
- Transfer Standard Accelerometer, Dytran Model 3010M12
- Loopback Cable, Prt. # 0215-0096-01
- TTS Input Test Cable, Prt. #0215-0095-01

- Test Cable 10-32 coaxial connector to BNC, Prt. #0215-0097-01
- To purchase the kit, contact your local Hardy Representative.

## Test Equipment Setup

**NOTE:** *All the test equipment 5 minutes to warm up.*

### Synthesizer Setup

Output - Channel 1
Waveform - Sine wave
Non-Floating

### Clear Memory Procedures

Step 1. If the TTS is on, shut it off.
Step 2. Simultaneously press the SPACE button and the HELP button, then turn the TTS on. Keep holding the SPACE and HELP buttons until a message appears that says “Memory Clears”.
Step 3. Turn off the TTS.

### Calibration Tests

Step 1. Make a copy of the Check-Off Sheet provided at the back of the manual.
Step 2. Press the MODE button until the BIT MODE screen appears.

BIT MODE
PRESS RUN TO
START BUILT
IN TEST

Step 3. Connect the Input Test (Prt. #0215-0095-01) cable to the TTS input and connect the synthesizer output 1 to Channel A (J1).
Step 4. Use the keypad and enter the number “803”. The Calibrate Channel A screen appears.

#### Channel A Calibration

Step 5. Set the synthesizer for a 100 mV 0-peak sine wave at 100 Hz (70.707mV RMS as measured by a Digital Multi Meter).
Step 6. In the lower right corner of the Calibrate Ch. A screen you will see the letters CF and then a number. The CF stands for the Correction Factor. This number should read 1.000.
Step 7. Press the Run button. The reading should be 100 +- .1% between (99.9 - 100.1).

- If the reading between 99.9 - 110.1 and the Correction Factor is 1.00, put a check mark on line 8 of the Check-Off Sheet.
- If the reading is not between 99.9 - 100.1 press the SPACE button. The TTS changes the correction factor and then automatically adjusts itself to within the specified limits.

Step 8. Record the new Correction Factor number on line 8 of the Check-Off sheet.

Step 9. Disconnect the synthesizer from the TTS Channel A input (J1).

### Charge Channel Calibration

Step 10. Press the down arrow button once. The CHARGE CHANNEL Calibration screen appears.

Step 11. Use Input Test Cable (Prt. # 0215-0097-01). Connect the Calibration Capacitor (Model 2947B-2) between the synthesizer output channel 1 and the CHARGE CHANNEL input (J4) BNC on the Input Test Cable.

Step 12. Repeat steps 5 through 8. Then disconnect the synthesizer and calibration capacitor from the TTS.

Step 13. Record the new Correction Factor number on line 12 of the Check-Off sheet.

### Displacement DC Calibration

Step 14. Use the Coaxial Cable (Standard BNC to BNC) and connect the synthesizer Channel 1 output to the Displacement (J5) Input on the Input Test Cable.

Step 15. Set the synthesizer for 1V 0-peak sine wave at 100 Hz.

Step 16. Press the RUN button to see the current input signal. The desired reading is 1000.00 +-.1%.

Step 17. If the reading is not between 999.00 and 1001.0, press the SPACE button. The unit should adjust itself within the limits.

Step 18. Record the Correction Factor number on line 17 of the CHECK-OFF Sheet.

Step 19. Press the down arrow once. The DISPLACEMENT DC screen appears.

Step 20. Set the synthesizer for wave form DC and set the voltage to -10 volts.

Step 21. Press the RUN button to see what input signal the TTS currently reads. The desired reading is -10000 +- .1%.

Step 22. If the reading is not between -9990 and -10010, press the SPACE button. The unit should adjust itself to within the limits.

Step 23. Record the Correction Factor number on 21 of the CHECK-OFF Sheet.

Step 24. Disconnect the synthesizer from the displacement channel (J5).

Step 25. Press the down arrow once. The CALIBRATE C screen appears.

### REF Channel No Integ Calibration

Step 26. Mount the Transfer Standard Accelerometer (Model 2010M12) onto the TTS Reference Accelerometer. Apply a little vacuum grease on the surface of the Standard Accelerometer and the surface of the Reference Accelerometer. (See Installation instructions for Installing Accelerometers in Chapter 3)

Step 27. Connect the Test Cable (Prt. #0215-0097-01) to the Transfer Standard Accelerometer and to the Channel A (J1) input of the Input Test Cable.

Step 28. Get the sensitivity value for the Transfer Standard Accelerometer from the Calibration Documents that come with the standard accelerometer.

Step 29. Press the Cursor button to move to the second line on the screen which reads REF NO INTEG (Reference with no Integration).

Step 30. Use the Left Arrow on the number keypad to remove the numbers. Use the number keypad toenter the sensitivity value from the Standard Acelerometer Documentation.

Step 31. Press the Cursor button to move to the Correction Factor Field.

Step 32. Press the Run button.

Step 33. Turn the Frequency Lock Nut counterclockwise to unlock the Frequency Knob.

Step 34. Turn the Frequency Knob clockwise to see if the frequency increases in value. Mark this step on the Check Off Sheet.

Step 35. Set the frequency to 100 Hz.

Step 36. Turn the Amplitude Lock Nut counterclockwise to unlock the Amplitude Knob.

Step 37. Turn the Amplitude Knob clockwise to see if the amplitude increase in value. Mark this step on the Check Off Sheet

Step 38. Set the Amplitude to 3 G’s and press the SPACE button to calibrate.

Step 39. Record the Correction Factor on line 26 of the Check Off Sheet.

Step 40. Press the down arrow. The CALIBRATE D screen appears.

Step 41. Press the Cursor button to move to the second line on the screen which reads REF ONE INTEG (Reference with One Integration).

- Repeat Steps 30 through 39.
- Press the down arrow button. The CALIBRATE E screen appears.

Step 42. Press the Cursor button to move to the second line on the screen which reads REF TWO INTEG (Reference with Two Integrations).

- Repeat Steps 30 through 39.
- Press the down arrow button. The CALIBRATE 1000 F screen appears.

Frequency Calibration Procedures

Step 43. Press the Cursor button to move to the second line on the screen which reads FREQ. CAL (Frequency Calibration). Enter the sensitivity value that corresponds to the frequency to be set (1000 Hz). You can get the sensitivity value from the Standard Accelerometer documentation.

- Press the RUN button.
- Set the frequency to 1000 Hz and the amplitude (GIR) to 1.0 G.
- Press the SPACE button to calibrate the frequency.
- The Correction Factor should not be less than .85 or greater than 1.15.
- Record the Correction Factor on line 27 of the CHECK-OFF Sheet.
- Press the down arrow button. The CALIBRATE 2000 G screen appears.

Step 44. Press the Cursor button to move to the second line on the screen which reads FREQ. CAL (Frequency Calibration). Enter the sensitivity value that corresponds to the frequency to be set (2000 Hz). You can get the sensitivity value from the Standard Accelerometer documentation.

- Press the RUN button.
- Set the frequency to 2000 Hz and the amplitude (GIR) to 1.0 G.
- Press the SPACE button to calibrate the frequency.
- The Correction Factor should not be less than .85 or greater than 1.15.
- Record the Correction Factor on line 28 of the CHECK-OFF Sheet.
- Press the down arrow button. The CALIBRATE 3000 H screen appears.

Step 45. Press the Cursor button to move to the second line on the screen which reads FREQ. CAL (Frequency Calibration). Enter the sensitivity value that corresponds to the frequency to be set (3000 Hz). You can get the sensitivity value from the Standard Accelerometer documentation.

- Press the RUN button.
- Set the frequency to 3000 Hz and the amplitude (GIR) to 1.0 G.
- Press the SPACE button to calibrate the frequency.
- The Correction Factor should not be less than .85 or greater than 1.15.
- Record the Correction Factor on line 29 of the CHECK-OFF Sheet.
- Press the down arrow button. The CALIBRATE 4000 I screen appears.

Step 46. Press the Cursor button to move to the second line on the screen which reads FREQ. CAL (Frequency Calibration). Enter the sensitivity value that corresponds to the frequency to be set (4000 Hz). You can get the sensitivity value from the Standard Accelerometer documentation.

- Press the RUN button.
- Set the frequency to 4000 Hz and the amplitude (GIR) to 1.0 G.
- Press the SPACE button to calibrate the frequency.
- The Correction Factor should not be less than .85 or greater than 1.15.
- Record the Correction Factor on line 30 of the CHECK-OFF Sheet.
- Press the down arrow button. The CALIBRATE 5000 J screen appears.

Step 47. Press the Cursor button to move to the second line on the screen which reads FREQ. CAL (Frequency Calibration). Enter the sensitivity value that corresponds to the frequency to be set (5000 Hz). You can get the sensitivity value from the Standard Accelerometer documentation.

- Press the RUN button.
- Set the frequency to 5000 Hz and the amplitude (GIR) to 1.0 G.
- Press the SPACE button to calibrate the frequency.
- The Correction Factor should not be less than .85 or greater than 1.15.
- Record the Correction Factor on line 33 of the CHECK-OFF Sheet.
- Press the down arrow button. The CALIBRATE 6000 K screen appears.

Step 48. Press the Cursor button to move to the second line on the screen which reads FREQ. CAL (Frequency Calibration). Enter the sensitivity value that corresponds to the frequency to be set (6000 Hz). You can get the sensitivity value from the Standard Accelerometer documentation.

- Press the RUN button.
- Set the frequency to 6000 Hz and the amplitude (GIR) to 1.0 G.
- Press the SPACE button to calibrate the frequency.
- The Correction Factor should not be less than .85 or greater than 1.15.
- Record the Correction Factor on line 35 of the CHECK-OFF Sheet.
- Press the down arrow button. The CALIBRATE 7000 L screen appears.

Step 49. Press the Cursor button to move to the second line on the screen which reads FREQ. CAL (Frequency Calibration). Enter the sensitivity value that corresponds to the frequency to be set (7000 Hz). You can get the sensitivity value from the Standard Accelerometer documentation.

- Press the RUN button.
- Set the frequency to 7000 Hz and the amplitude (GIR) to 1.0 G.
- Press the SPACE button to calibrate the frequency.
- The Correction Factor should not be less than .85 or greater than 1.15.
- Record the Correction Factor on line 37 of the CHECK-OFF Sheet.
- Press the down arrow button. The CALIBRATE 8000 M screen appears.

Step 50. Press the Cursor button to move to the second line on the screen which reads FREQ. CAL (Frequency Calibration). Enter the sensitivity value that corresponds to the frequency to be set (8000 Hz). You can get the sensitivity value from the Standard Accelerometer documentation.

- Press the RUN button.
- Set the frequency to 8000 Hz and the amplitude (GIR) to 1.0 G.
- Press the SPACE button to calibrate the frequency.
- The Correction Factor should not be less than .85 or greater than 1.15.
- Record the Correction Factor on line 39 of the CHECK-OFF Sheet.
- Press the down arrow button. The CALIBRATE 9000 N screen appears.

Step 51. Press the Cursor button to move to the second line on the screen which reads FREQ. CAL (Frequency Calibration). Enter the sensitivity value that corresponds to the frequency to be set (9000 Hz). You can get the sensitivity value from the Standard Accelerometer documentation.

- Press the RUN button.
- Set the frequency to 9000 Hz and the amplitude (GIR) to 1.0 G.
- Press the SPACE button to calibrate the frequency.
- The Correction Factor should not be less than .85 or greater than 1.15.
- Record the Correction Factor on line 41 of the CHECK-OFF Sheet.
- Press the down arrow button. The CALIBRATE 10000 O screen appears.

Step 52. Press the Cursor button to move to the second line on the screen which reads FREQ. CAL (Frequency Calibration). Enter the sensitivity value that corresponds to the frequency to be set (10000 Hz). You can get the sensitivity value from the Standard Accelerometer documentation.

- Press the RUN button.
- Set the frequency to 10000 Hz and the amplitude (GIR) to 1.0 G.
- Press the SPACE button to calibrate the frequency.
- The Correction Factor should not be less than .85 or greater than 1.15.
- Record the Correction Factor on line 43 of the CHECK-OFF Sheet.

## Unit Setup Procedures

Step 53. Use the numerical keypad and enter the number “308”. The Unit Setup Screen appears.
Step 54. The OEM selection should be flashing. Use the Select button to select the Accelerometer Manufacturer of the Transducer Under Test.
Step 55. Press the CURSOR button until the Serial Number field is blinking. Use the left arrow button to clear the existing number and use the numerical keypadto enter the serial number of the accelerometer you are testing.
Step 56. Press the MODE button until the SENSITIVITY screen appears.
Step 57. Press the Select button to set the transducer for VOLT.
Step 58. Press the Cursor button to select the Current. With the mA field blinking, push the select button and set the Current for 0.0 mA.
Step 59. Connect the REFERENCE OUT to the Channel “A” (J1) input of the TTS.
Step 60. Press the down arrow.
Step 61. Press the RUN button.
Step 62. Set the TTS frequency to 100 Hz and the GIR (G Internal Reference) amplitude to 4.00 G’s.
Step 63. The SF reading should be between 49.8 and 50.2 mV/eu.
Step 64. If the reference output is not within tolerance, use an allen wrench and remove the adjustment plug on the front panel of the TTS. (See Fig. 4-2)
Step 65. Use an adjustment tool or a small screw driver and turn adjustment pot (R113 - Reference Output Adjust) until the TTS is within tolerance. (See Fig. 4-2)
Step 66. Replace the adjustment plug.
Step 67. Disconnect the cable from REF OUTPUT connector and press the up arrow button until the BIT MODE screen appears.
Step 68. Connect the loop back cable to the TTS input.
Step 69. Press the RUN button to perform the BIT MODE test.

Step 70. Make sure all tests are passed. If any tests fail, troubleshoot and recalibrate the TTS.

**NOTE:** *Refer to table 4-1 for a list of bit test code descriptions and values.*

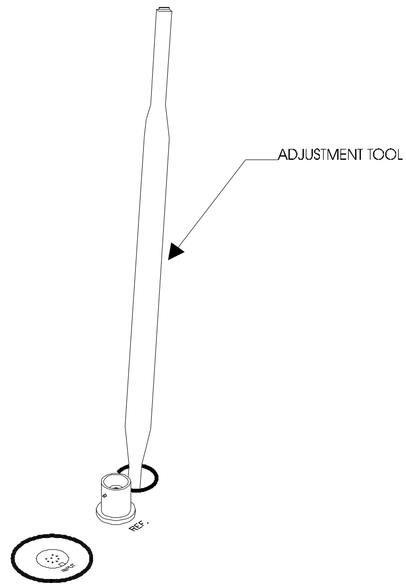



**FIG. 4-2 ADJUSTING THE REFERENCE OUTPUT (R113)**

Step 71. Calibration of the TTS is complete.

| Built-in-Test (BIT) Checks | |
|---|---|
| B+ | Plus Battery Voltage |
| B- | Negative Battery Voltage |
| BIT ON | Internal Signal Level with Signal On |
| BIT-OFF | Internal Signal Level with Signal Off |
| TG30 | Test Channel with AGC Gain at 30 |
| RG30 | Reference Channel with AGC Gain at 30 |
| TG10 | Test Channel with AGC Gain at 10 |
| RG10 | Reference Channel with AGC Gain at 10 |
| TG03 | Test Channel with AGC Gain at 3 |
| RG03 | Reference Channel with AGC Gain at 3 |
| TG01 | Test Channel with AGC Gain at 1 |
| RG01 | Reference Channel with AGC Gain at 1 |
| TC00 | Test Channel Bias Current Check Bias = 0 mA |
| TC01 | Test Channel Bias Current Check Bias = 0.5 mA |
| TC02 | Test Channel Bias Current Check Bias = 2.0 mA |
| TC03 | Test Channel Bias Current Check Bias = 4.0 mA |
| TC04 | Test Channel Bias Current Check Bias = 6.5 mA |
| TV1 | Test Channel DC Reference Voltage Check Gain =1 |
| TV5 | Test Channel DC Reference Voltage Check Gain = 1/5 |
| INTG-B | Reference channel Integrator Reference Point (65 Hz) |
| INTG00 | Reference No Integrator 65 Hz |
| INTG01 | Reference 1 Integrator 65 Hz |
| INTG02 | Reference 2 Integrator 65 Hz |
| INTG10 | Reference No Integrator 100 Hz |
| INTG11 | Reference 1 Integrator 100 Hz |
| INTG12 | Reference 2 Integrator 100 Hz |
| INTG20 | Reference No Integrator 120 Hz |
| INTG21 | Reference 1 Integrator 120 Hz |
| INTG22 | Reference 2 Integrator 120 Hz |
| External Loopback Checks | |
| AVOLT | A Input Channel Check |
| BVOLT | B Input Channel Check |
| CVOLT | C Input Channel Check |
| CHRG | Charge Channel Check |
| DISP AC | Displacement Channel AC Check |
| DISP DC | Displacement Channel AD Check |

**TABLE 1: BIT TEST CODES AND DESCRIPTIONS**

**NOTE:** *If a failure occurs, verify that the unit has been calibrated. If the unit is calibrated and failure(s) still occur, then repair is needed. Most failures require repair at the factory.*

# CHAPTER 5 - OPERATING PROCEDURES

## A Brief Description of Chapter 5

All information contained in Chapter 5 pertains to the operation of the HI-803 TTS. The Operating Procedures include Modes of Operation, Support Functions, Calibrating a Transducer Under Test and Printing the Results of the Test. Chapter 5 also discusses some Electronic and Mechanical Technology necessary for successful use of this instrument. It is very important that the user be familiar with this chapter before operating the HI-803 TTS.

## Modes of Operation

### Battery Check

This mode displays the voltage state status of the internal TTS batteries. The memory status i.e. how many readings are currently stored in memory, and how many total readings are available.

### Setup Mode

The Setup Mode allows selection of the TUT amplitude units (English or Metric) and the date and time. Setup permits selection of either automatically printing all tests stored in memory (up to 100 tests) or just one test. It also allows selection of standard, RMS or DB units. Additionally, the display backlight and the unit power time-out can be selected in the Setup Mode.

### Monitor Mode

Is used to vibrate or “shake” the Transducer-Under-Test (TUT) for testing and verifying its operation and sensitivity in conjunction with existing machinery vibration monitoring system cables and associated instrumentation.

### Sensitivity Mode

In addition to shaking the TUT, the sensitivity mode is used to automatically calculate the sensitivity of the TUT. It also checks the phase of the signal to be sure that the accelerometer stacking is correct. Test parameters and test results can also be stored in memory for future download via the printer.

The operator manually enters information about the TUT in appropriate data fields or automatically enters data from a library of sensors stored in memory. In either case, the TUT serial number must always be entered.

### Bit Test Mode

The BIT (Built-in-Test) is a diagnostic mode which automatically performs an extensive series of tests on the TTS.

## Support Functions

### Help

Help screens are available during all other modes of operation to assist the operator.

### Print

All test parameters, test results and other data stored in memory can be printed.

### Up/Down Arrows

These symbols appear on many screens in the upper right hand corner to indicate the direction to scroll.

### Power Message

When the power is turned ON, the TTS automatically tests the RAM and ROM, then proceeds to the battery check mode display. If the power has been turned OFF the ON too rapidly, a message appears telling the operator to turn the instrument OFF for 10 seconds before turning the TTS back ON.

## Control and Indicators

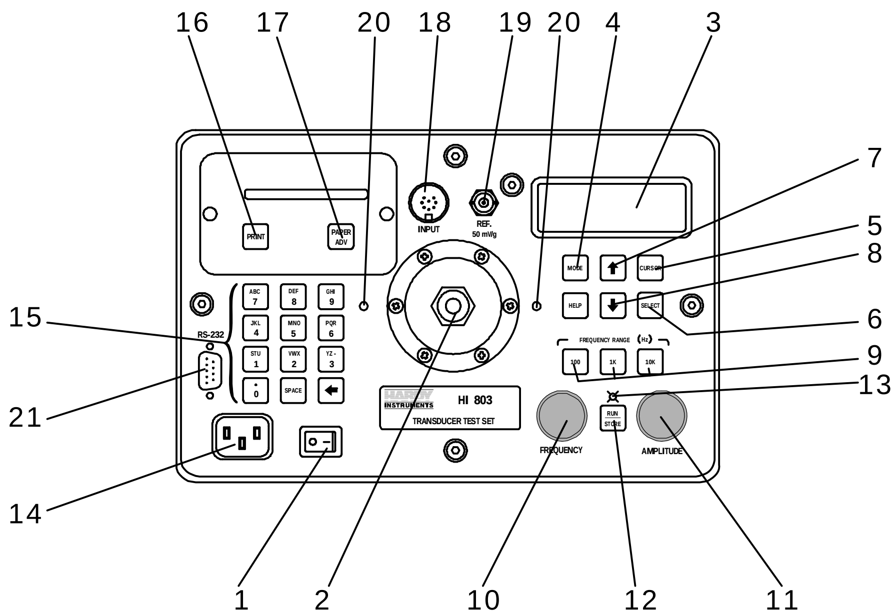



**FIG. 5-1 TTS CONTROLS, INDICATORS AND CONNECTORS**

| ITEM # | Control/Indicator/ Connector | Function |
|---|---|---|
| 1 | Power Switch | Powers TTS ON and OFF |
| 2 | TUT Threaded Connector | Mount for TUT to “shaker” installation. |
| 3 | Display | Primary display for test parameters, test results and other related test data. |
| 4 | MODE Button | Selects the operating modes which include: Battery Check, Monitor, Setup, Sensitivity and BIT |
| 5 | CURSOR Button | Positions the flashing cursor |
| 6 | SELECT Button | Toggles various selections |
| 7 | Up Arrow Button | Used in Sensitivity Mode to select “pages” in descending order |

**TABLE 5-1: TTS CONTROLS, INDICATORS AND CONNECTORS**

| ITEM # | Control/Indicator/ Connector | Function |
|---|---|---|
| 8 | Down Arrow Button | Used in Sensitivity Mode to select “pages” in ascending order |
| 9 | Frequency Range Buttons | Selects 3-100 Hz, 100-1000 Hz and 1000-10,000 Hz frequency ranges |
| 10 | FREQUENCY Control Knob | Provides fine adjustment of test frequency. (10 - Turn) |
| 11 | AMPLITUDE Control Knob | Provides test amplitude adjustment (GIR) (10 - turn) |
| 12 | RUN/STORE Button | Starts and stops shaker in Monitor and Sensitivity Modes. Stores test parameters and results in Sensitivity Mode. Clears help and warning screens. Clears memory in Sensitivity Mode. |
| 13 | Indicator LED | Indicates when the shaker is operating |
| 14 | Power Receptacle | Receptacle for power cord during battery charging |
| 15 | Alpha-numeric Keypads with Left Arrow or Backspace Button | Inputs numbers (press once) or letters (press two, three or fours times. The Left Arrow or Backspace Button erases Alpha-numeric characters |
| 16 | PRINT Button | Prints stored test parameters. |
| 17 | Paper Advance Button | Advances paper in the printer |
| 18 | Input Connector | Used in Sensitivity Mode, to electronically connect TUT to TTS, using correct cable |
| 19 | REF BNC Connector | Provides 50 mV/g, 100 Ohms reference signal output |
| 20 | Mounting Holes | Used to mount proximity probe fixture |
| 21 | 9 Pin Connector | RS-232 communications port for optional data transfer program |

**TABLE 5-1: TTS CONTROLS, INDICATORS AND CONNECTORS**

**CAUTION**

**THE FLEXURE SYSTEMS IN THE VIBRATOR ARE SUSCEPTIBLE TO DAMAGE DUE TO TWISTING FORCES APPLIED TO THE SHAKER HEAD.**

**WARNING**

**DO NOT OVERLOAD THE INSTRUMENT FOR EXTENDED PERIODS OF TIME AT HIGH AMPLITUDES. TO DO SO MAY CAUSE PROPERTY DAMAGE.**

## Displacement Limits

As long as the displacement limits of the vibrator are not exceeded, the full power of the amplifier can be used to drive the shaker. If the TTS is being used to test a large load, the amplitude limit may not be reached. The following limits apply:

- The maximum displacement at 10 Hz is 0.1 inches p-p.
- The maximum velocity at 29.3 Hz is 10 inches/second peak.
- The maximum acceleration at 61.73 Hz is 10 G peak.

## Recommended Maximum Loads to be Placed on the TTS

| Freq. Range | 0-100 grams | 100-250 grams | 250-500 grams | 500-750 grams |
|---|---|---|---|---|
| 10-100 Hz | 10g | 4g | 2g | 1g |
| 100-1000 Hz | 7g | 4g | 2g | 1g |
| 1-2 kHz | 3g | 1.5g | 1g | n/a |
| 1-10 kHz | 3g | 1.5g | n/a | n/a |

**TABLE 5-2: MAXIMUM LOADS TO BE PLACED ON THE TTS**

**NOTE:**

*If testing includes higher frequencies (5 kHz to 10 kHz), special care must be taken when installing the test transducer on the shaker head (Also known as the Reference Accelerometer). Before stud mounting the accelerometer, a coupling fluid (thin coat of Vacuum Grease or Machine Oil) should be applied to the mating surfaces. The coupling fluid optimizes the frequency response by increasing the mechanical coupling stiffness, in addition to providing lubrication. Failure to use the coupling fluid will result in increased variances proportional to increasing frequencies.*

## Stud Torque Values

Use a torque wrench and torque the studs to the following values:

- 1/4-28 Threads 26 inch-pounds nominal
- 10-32 Threads 20 inch-pounds nominal

**CAUTION**

**ALWAYS USE THE SPANNER WRENCH WHEN TORQUING AGAINST THE SHAKER HEAD TO PREVENT DAMAGING THE SUSPENSION SYSTEM THAT SUPPORTS THE MOVING ELEMENT AND THE SHAKER HEAD.**

## Types of Sensors

The three principal vibration sensor or monitor types are:

- **Displacement** - Eddy current Device
- **Velocity** - Spring held magnet moving a coil of wire
- **Accelerometer** - piezoelectric device similar to ultrasonic transducers.

### Displacement Sensor

Displacement sensors are non-contact devices used to measure the gap between the plant equipment and the fixed sensor. The sensor measures vibration as horizontal or vertical motion. Best for measuring low frequencies. The coil in the eddy current device is usually a pancake coil in the end of cylindrical tube, that can be mounted close to the moving part. Excitation is very high frequency, about 240,000 Hz for detection of small gap changes (as low as 1 micrometer [40 milli-inch] at 0.5 Hz.

### Velocity Sensor

Used primarily in handheld probes,providing information for vibration monitoring and balancing of rotating machinery. The basic velocity pickup is a magnet (as a seismic mass) suspended on a spring which moves through a coil of wire.

### Accelerometer

Work well over a very wide range of frequencies (1 to 20,000 Hz) and work best for high frequencies where acceleration is large. Used in applications such the passage of turbine blades, which may be one hundred times the shaft rotation, or the meshing of gears or ball/roller bearings, which may be many times the shaft rotations per minute. Other advantages include their small size, light weight, good temperature stability and moderate price. Accelerometers develop a voltage from a piezoelectric crystal that has a mass mounted upon it. When the mass fixed to the crystal vibrates from the motion ofthe device upon which it is attached, the crystal generates a voltage proportional to the force applied by the mass as it vibrates with the machinery.

### Operating Procedures

Step 1. Make sure that the TTS is OFF.

Step 2. Make sure that the amplitude knob is turned completely counterclockwise.

Step 3. The Transducer Under Test should already be mounted on the Reference Accelerometer. If it is not, go to Chapter 3 for installation instructions.

Step 4. Make sure that you have the TUT Test data handy for reference during the Test Procedures.

Step 5. Turn the Power to ON.

Step 6. The TTS cycles through the self-test.

- The TTS is automatically checking the RAM and ROM.
- The Battery Check Mode screen appears if the tests are successful. (See Fig. 5-1)

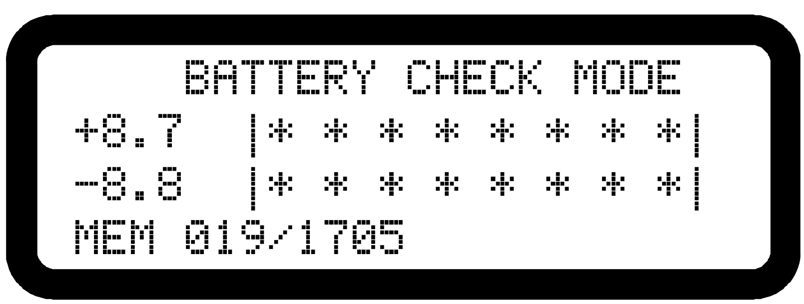



**FIG. 5-2 BATTERY CHECK MODE SCREEN**

**Battery Check Mode**

Step 7. Make sure of the following:

- The + voltage must be greater than the - voltage. This is due to the higher + voltage consumption.
- Both the + voltage and - voltage must be => 8.0. If they are not, plug in a power cord connected to a 110 VAC, single phase, 50/60 Hz outlet. For the DI803-220VAC model plug into a 230 VAC, 50/60 Hz, single phase outlet.
- You can continue to operate the TTS while the batteries are being charged.
- The Memory status is the bottom line beginning with MEM. The first three digits are the number of readings currently stored in memory. The next four digits are the total number of readings that were available. Subtract the first three digits from the next four digits to determine how many readings can still be stored in memory.

**Setup Mode**

Step 8. Press the MODE button to get to the SETUP MODE screen.
Step 9. The SETUP MODE has three (3) displays as follows:


**FIG. 5-3 SETUP MODE SCREEN #1**

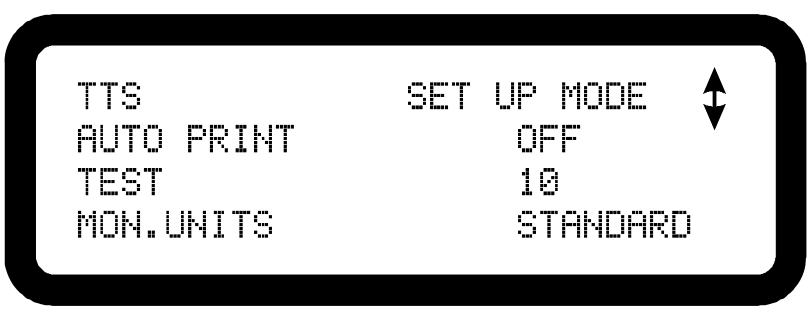



**FIG. 5-4 SETUP MODE SCREEN #2**

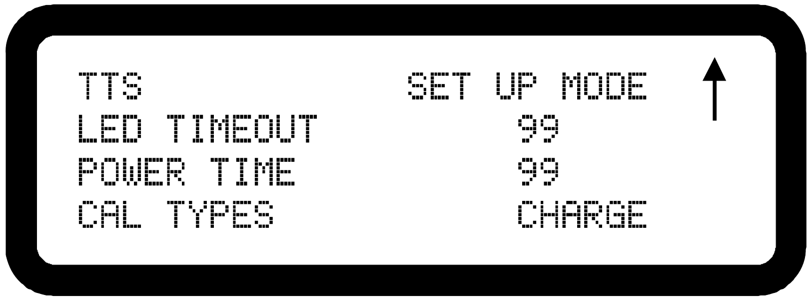



**FIG. 5-5 SETUP MODE SCREEN #3**

**NOTE:** *The arrows in the upper right corner indicate the direction to scroll when using the Up Arrow or the Down Arrow buttons.*

### Setup Screen #1

Step 1. The flashing field, either Units, Date or Time indicates the location of the cursor. To move from one field to the other push the CURSOR button.

Step 2. To set the Amplitude Units, press the CURSOR button until the Units field is flashing. Press the Select button to select:

- ENGLISH
- METRIC

Step 3. Press the CURSOR button until the Date/month/day/year field is flashing. Use the back space or left arrow button to delete the old numbers. Use the keypad and enter the month, press the cursor button and enter the day, press the cursor button and enter the year.

Step 4. Press the CURSOR button until the Time/hour/minutes/seconds field is flashing. Use the back space or left arrow button to delete the old numbers. Use the keypad and enter the hour, press the cursor button and enter the minutes, press the cursor button and enter the seconds. Be sure to use military hour time values. For example 1:00 PM is 13:00, 2:00 PM is 14:00,. 3:00 PM is 15:00, etc.

Step 5. Press the down arrow. Setup Screen #2 appears. (See Fig. 5-4)

### Setup Screen #2

Step 1. Press the CURSOR button until the AUTOPRINT field is flashing. Press the Select button to select:

- ON - Toggles on the automatic printing of up to 100 tests, with up to 25 readings per test stored in memory.
- OFF - Toggles on one printing of only one test at a time.

Step 2. Press the CURSOR button until the MON.UNITS field is flashing. Press the Select button to select one of the Monitor Mode units:

- Standard (Linear)
- RMS
- DB

**NOTE:** *ADB and VDB are valid. If Displacement and DB are selected at the same time, the display defaults to P-P linear units.*

**NOTE:** *The test number is also displayed on this screen, however it should only be changed in the Sensitivity Mode.*

**NOTE:** *The arrow points in both directions. This means you can press the Up arrow to go back to Setup Screen #1 or the Down arrow to go on to Setup Screen #3.*

Step 3. Press the Down arrow. Setup Screen #3 appears. (See Fig. 5-5)

## Setup Screen #3

Step 1. Press the CURSOR button until the LED Time-out field is flashing. Use the back space or left arrow button to delete the old numbers. Use the keypad and enter the LED display time-out in minutes, before the display automatically shuts off. Default display time-out is 1 minute.

Step 2. Press the CURSOR button until the Power Time-out field is flashing. Use the back space or left arrow button to delete the old numbers. Use the keypad and enter the LED display time-out in minutes, before the instrument automatically shuts off. Default display time-out is 5 minutes.

## Monitor Mode

Step 1. Press the Mode button to get to the Monitor Mode screen. (See Fig. 5-6)

Step 2. Press the CURSOR button until the Transducer type is flashing.

Step 3. Press the Select button to select the Transducer Type Under Test. The choices are:

- ACCEL (Accelerometer)
- VELOCITY
- DISPLAEMENT


**FIG. 5-6 MONITOR MODE SCREEN**

Step 4. Press the CURSOR button until the M 0.0 (Mass) is flashing.

Step 5. Use the key pad and enter the weight of the transducer in grams if known. (See Appendix B for Transducer Weight Guide) If you do not enter a weight, 20 grams will automatically be used to correct for the effects of transducer mass loading.

**NOTE:** *When a velocity or accelerometer adapter plate is used, add 103 grams to the transducer mass.*

**NOTE:** *When entering values from the keypad, remember to enter the value and wait a few seconds until the cursor advances to the next position before trying to enter another alphanumeric character. You will also have to press the selected key pad button once for numbers and twice or more for letters.*

### Monitor Mode Testing

Step 1. Press one of the FREQUENCY RANGE buttons (See Fig. 5-1) to select the range you want to use for the test:

- 3-100 Hz
- 100-1000 Hz
- 1000-10000 Hz

Step 2. Unlock the Frequency Knob and adjust to the desired frequency for test.

Step 3. Press the RUN/STORE button to turn on the shaker. Make sure the red LED light is on to indicate that the shaker is operating.

Step 4. Unlock the Amplitude Knob and adjust to the desired Amplitude.

**NOTE:** *It is important to note that the HI-803 has microprocessor controlled monitoring and supervisory limits built into the instrument as follows:*

- *Vibration frequency or amplitude is out of recommended operating range - the display flashes the frequency or amplitude fields. Adjust the shaker to within operating limits. (See Table 5-2)*
- *Vibration amplitude at lower frequencies have exceeded 0.1 inch (2.54mm) PK-PK displacement. The shaker shuts down to prevent damage to the instrument and a message appears:*

***SHAKER DISPLACEMENT***
***OUT OF RANGE!***
***PLEASE TURN***
***AMPLITUDE DOWN***

- *Turn down the amplitude. When the amplitude is within limits, press the RUN/STORE button once.*

Step 5. Press the PRINT button to print the test results.

### Sensitivity Mode

Step 1. Press the Mode button to get to the Sensitivity Mode screen. (See Fig. 5-7)


**FIG. 5-7 SENSITIVITY MODE SCREEN**

**NOTE:** *If you see NO DATA on the screen it refers to a date entry. If test data are in memory, this field shows the test date. The date entered in the SETUP MODE is entered when testing is started. The date can be changed only in the SETUP MODE.*

## Sensitivity Test Setup

Step 2. Press the CURSOR button until the Tst# is flashing.

Step 3. Press the Select button to select a test number from 1 to 70. This test number may coincide with each transducer to be tested. Up to 25 individual readings may be taken for each test. Press the Backspace or left arrow button to descend the test number list.

Step 4. Press the CURSOR button until the MOD field is flashing. An up arrow appears.

Step 5. If you want to clear the form press the up arrow. A message appears as follows:

**PRESS RUN TWICE**
**TO CLEAR ALL FORMS**

Press the RUN/STORE button two times to clear the information in all the forms. You now have a clean form to use for this test.

Step 6. Use the keypad to enter the Transducer Model number. (See Appendix B for Model Number Information) Remember press once for numbers and twice or more for letters and punctuation. To enter the same number twice wait for the cursor to advance forward one position. The instrument will do this automatically.

Step 7. Press the CURSOR button until the S/N field is flashing.

Step 8. Press the Backspace or left arrow button to clear the existing numbers.

Step 9. Use the keypad to enter the Serial Number of the Transducer Under Test. Up to six characters can be entered.

Step 10. Press the CURSOR button until the Mass field is flashing.

Step 11. Use the keypad to enter the weight in grams of the TUT and the test fixture. (See Appendix B for weights)

**NOTE:** *If the Velocity or accelerometer adapter fixture is used, add 103 grams to the transducer mass.*

Step 12. Press the CURSOR button until the TRANSD field is flashing.

Step 13. Use the Select button to select the type of Transducer Under Test. (See Appendix B for Transducer Type Information) The choices are:

- CHARG Charge
- VOLT Voltage (ICP)
- TRIAX Triaxial
- VELOC Velocity
- DISPL Displacement

Step 14. Press the CURSOR button until the Transducer Current (mA) field is flashing. Charge and Displacement do not have a current display.

Step 15. Press the Select button to select the current. The Choices are:

- 0.5 mA
- 2.0 mA
- 2.5 mA
- 4.0 mA
- 4.5 mA
- 6.0 mA

Step 16. The Sensitivity Setup is completed.

### Sensitivity Test Procedures Volt Type Transducer

Step 1. Check to see that the TUT is mounted correctly on the Reference Accelerometer.

Step 2. Check to see that the Amplitude Knob has been turned counterclockwise until it stops.

Step 3. Check to see that the TUT is tightly coupled to the Reference Accelerometer. This ensures that the TUT and reference accelerometer have the exact same motion, which is required for accurate sensitivity measurements.

Step 4. For Sensitivity Mode testing a 100 Hz test frequency is highly recommended. 100 Hz test frequency ensures a high signal to noise ratio for the TUT sensitivity calculation. The following test frequency and amplitude parameters are recommended:

| TUT TYPE | FREQUENCY | | AMPLITUDE | |
|---|---|---|---|---|
| | Low | High | Low | High |
| Triaxial | 70 Hz | 130 Hz | 1 g | 5 g's |
| Velocity | 70 Hz | 130 Hz | 0.2 in/sec | 1.0 in/sec |
| Single Axis Voltage | 30 Hz | 2000 Hz | 1 g | 5 g's |
| Displacement | 70 Hz | 130 Hz | 2 mils | 20 mils |

**TABLE 5-3: TEST FREQUENCY AND AMPLITUDE PARAMETERS**

Step 5. Now that the Sensitivity is set up for the TUT, press the down arrow. Frequency Screen A appears. (See Fig. 5-8)


**FIG. 5-8 SENSITIVITY TEST 1 SCREEN A**

**NOTE:** *The screens A-Y are the 25 tests mentioned before that can be performed per Test Number. Each letter screen (A,B,C,D,ETC.) can be used to do a separate test with separate parameters. For example if you wanted to test a transducer at frequencies from 30 to 130 you can perform the test up to 25 different frequencies.*

Step 6. Press one of the Frequency Range buttons to select a range from 3-100 Hz, 100-1000 Hz, or 1000-10,000 Hz test ranges.
Step 7. Press the Run/Store button to turn on the shaker.
Step 8. Unlock the Frequency Knob and adjust to the frequency you want to test.
Step 9. Unlock the Amplitude Knob and adjust to the amplitude you want to test.
Step 10. Press the Run/Store button once.
Step 11. Press the Print button to print the results.
Step 12. Press the down button to move to screen B.
Step 13. Repeat steps 6-11 for each screen through Y.
Step 14. If you want to clear all the setup information, press the up arrow. A message appears as follows:

**PRESS RUN TWICE**
**TO CLEAR ALL FORMS**

## Sensitivity Mode Testing for Displacement Type Transducer

### Displacement Test Setup

If the TUT is a non-contacting type (e.g. Eddy Current Probes) of displacement transducer, the probe must be mounted in a bridge type fixture (DI 223 [English] or DI 223-1 [Metric] and a special target material must be secured to the shaker head (Reference Accelerometer). Typical Displacement Measurement Systems include:

- Eddy Current Probe
- Extension Cable
- Oscillator/Demodulator.

The TTS allows the displacement measurement systems to be checked dynamically by setting the shaker vibration to a known vibration displacement and frequency measured by the built-in reference accelerometer. The transducer system sensitivity in mV/MIL P-P is read directly on the TTS display. The TTS also has a DC Voltmeter mode which allows for setting initial probe gaps for testing or for checking static linearity.

Step 1. Perform the sensitivity setup procedures outlined above. When selecting the Transducer type (Step 13) select DISPL.
Step 2. Press the down arrow to go to screen A. However, an interim screen appears. (See Fig. 5-9)

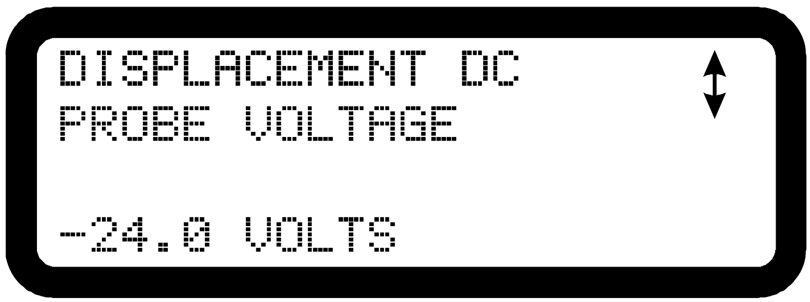



**FIG. 5-9 DISPLACEMENT INTERIM SCREEN**

**NOTE:** *The TTS is now in a DC Voltage measurement mode.*

Step 3. Install the Eddy Current Probe Transducer System (DI-223 or DI-223-1). (See the Eddy Probe Transducer System Manual for Instructions) Contact your local Hardy Representative for purchase information. Hardy Instruments provides two types of Mounting Fixture Kits as options. The type of fixture determines the type of operational checks that can be performed using the TTS.

- Displacement Probe Mounting Fixture - 1 1/4” High (Prt. #0251-0011-01) - Allows measurements to be made at preset probe gaps.

- Displacement Probe Mounting Fixture - 6 “High - Allows for both dynamic sensitivity measurements and static linearity checks.

**NOTE:** *All displacement measurements are made using a 4140 Steel Target Standard that attaches to the reference accelerometer. This target is provided for both kits.*

**NOTE:** *Power for the Oscillator/Demodulator is supplied from an external source, separate from the TTS.*

## Dynamic Sensitivity Test

The test measures the sensitivities of the displacement probe at the various gaps, typically; 30, 40, 50 and 60 mils.

Step 1. Turn on the Power Switch.
Step 2. Install the Target by screwing the target into the reference accelerometer until it is finger tight. Be sure to use the spanner wrench when installing.
Step 3. Install the displacement probe mounting fixture onto the TTS and connect the displacement probe system as shown in Chapter 3, Installation, Displacement Probe, pg 3-5.

**NOTE:** *Make sure the Displacement Probe system is a matched set consisting of a Probe, Oscillator/Demodulator and interconnecting Cable.*

Step 4. Install the Probe in the Mounting Fixture (See Fig. 5-10) and set the Probe Gap (distance from the probe to the target), by reading the DC voltage output listed below. It is important to understand the electrical gap and the mechanical gap are different. The Probe is encapsulated with protective material and epoxy. If a feeler gage is used to set the gap a different output voltage could be read.

- 30 Mils = 6 VDC Based on 200 mV/Mil
- 40 Mils = 8 VDC
- 50 Mils = 10 VDC
- 60 Mils = 12 VDC

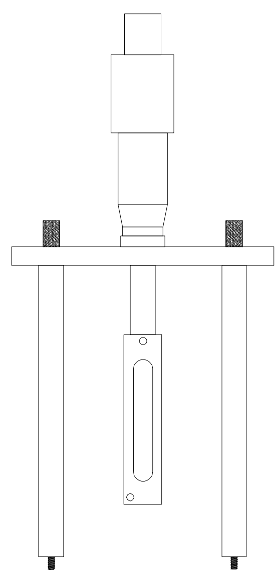


**FIG. 5-10 DISPLACEMENT PROBE MOUNTING FIXTURE WITH DIAL MICROMETER**

Step 5. Turn the TTS Amplitude control knob to the minimum amplitude.
Step 6. Set TTS to operate in the Sensitivity Mode, select Displacement Sensor Type and to read sensitivity in Mils. (Test Page A)
Step 7. Press the 100 Hz Frequency Control button.

Step 8. Press the RUN/STORE button.

Step 9. Set the Amplitude Control to as indicated in the Sample Data Sheet (from 2 to 5 Mils) and verify sensitivity is within the require range. (See Table 5-4)

| Dynamic Sensitivity Test | | | |
|---|---|---|---|
| Gap Mils | Amplitude Mils | SF MV/MIL | Requirement MV/MIL |
| 10 | 2 | | 190-210 |
| 20 | 5 | | 190-210 |
| 30 | 5 | | 190-210 |
| 40 | 5 | | 190-210 |
| 50 | 5 | | 190-210 |
| 60 | 5 | | 190-210 |
| 70 | 5 | | 190-210 |
| 80 | 5 | | 190-210 |

**TABLE 5-4: SAMPLE DATA SHEET**

Step 10. Turn the Amplitude knob counterclockwise until the knob stops. Regap the probe to verify sensitivity over the probes specified calibration range.

Step 11. Repeats steps 9 and 10 until all data points listed in the Sample Data sheet have been verified.

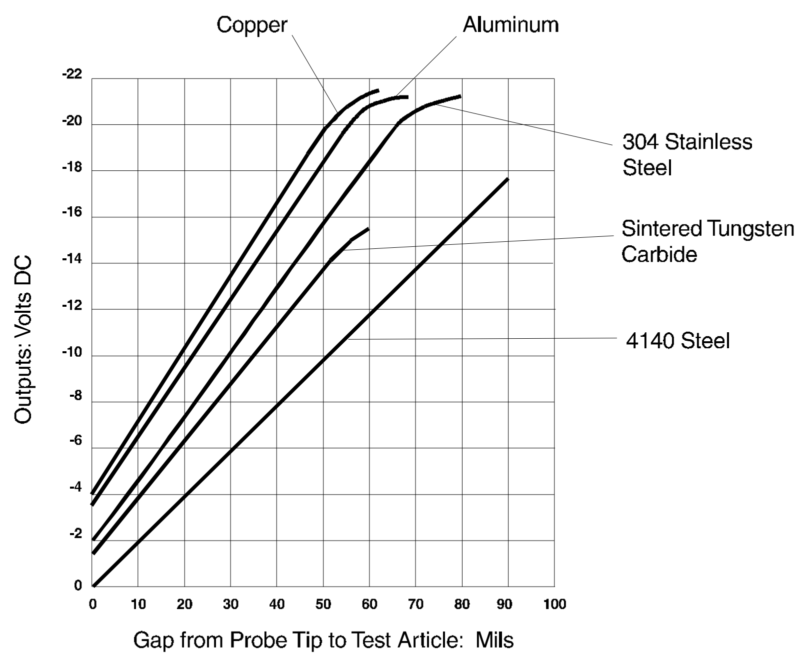


**FIG. 5-11 SENSITIVITY RESPONSE VARIANCES**

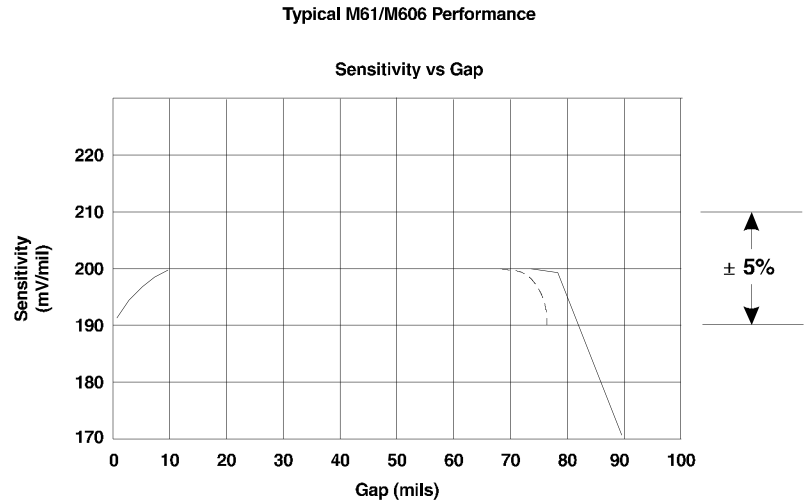



**FIG. 5-12 TYPICAL EDDY CURRENT PROBE PERFORMANCE**

## Static Linearity Test

This procedure is for checking the displacement probe output over its total measurement range, from minimum gap to maximum gap. The Dial Micrometer Attachment and Mounting Fixture is required for this test.

Step 1. Install the Mounting Fixture and Target.
Step 2. Install the Dial Micrometer if it not already attached to the Mounting Fixture.
Step 3. Set the gap to approximately 40 Mils.
Step 4. Install the Probe "Holder Tube" part of the Kit by attaching it to the Dial Micrometer end.
Step 5. Select the holder tube based on the diameter of the Probe being tested. Use the set screw to lock it in place.
Step 6. Set The Dial Micrometer to exactly 40 Mils.
Step 7. Raise the probe in the holder while watching for a gap voltage of -8 VDC (based on 200 mV/Mil.
Step 8. Lock the probe in place using the set screw being sure to maintain the -8 VDC reading.
Step 9. Use the TTS in the DC voltmeter mode to get this reading.
Step 10. Set the Dial Micrometer to 5 Mils on the dial but do not contact the target.
Step 11. Read and record the voltmeter reading.

**NOTE:** *When moving to a new reading on the Dial Micrometer, be very careful not to go past the new reading. It is desirable to take all readings in one direction without backing up. There is a slight hysteresis that occurs when changing directions.*

Step 12. Set the Dial Micrometer to 10 Mils on the dial.
Step 13. Read and record the voltmeter reading.
Step 14. Continue reading and recording data through the entire range as listed on the Sample Data Sheet.

| Displacement Probe Linearity Test | | | |
|---|---|---|---|
| Gap | Volts | Gap | Volts |
| 5 Mils | _____ | 55 Mils | _____ |
| 10 Mils | _____ | 60 Mils | _____ |
| 15 Mils | _____ | 65 Mils | _____ |
| 20 Mils | _____ | 70 Mils | _____ |
| 25 Mils | _____ | 75 Mils | _____ |
| 30 Mils | _____ | 80 Mils | _____ |
| 35 Mils | _____ | 85 Mils | _____ |
| 40 Mils | _____ | 90 Mils | _____ |
| 45 Mils | _____ | 95 Mils | _____ |
| 50 Mils | _____ | 100 Mils | _____ |
| Probe S/N_______________ | Date:_____________ | By:_______ | |

**TABLE 5-5: SAMPLE DATA SHEET**

### Sensitivity Mode Phase Check

During the sensitivity testing of an accelerometer, the phase relationship can be compared to the internal reference accelerometer.

The HI-803 automatically does a phase check when the test frequency is set below 60 Hz. A small arrow appears in the lower right corner of the display. The arrow points up when the TUT is in phase with the internal reference and points down when the TUT is out of phase with the internal reference.

The Phase Check should be the starting point when troubleshooting the TTS for erratic readings, readings that don't settle down when the shaker is running.

Step 1. With the shaker running turn the Frequency Knob counterclockwise until the reading is below 60 Hz.
Step 2. Check to see the position of the arrow in the lower right hand corner of the display.
Step 3. If the arrow is pointing up the phase is correct.
Step 4. If the arrow is pointing down the phase is incorrect.

## Operating Hints

The information contained in this section is for reference only and is provided as useful information when operating the HI-803 TTS.

### General Vibration Information

#### Relationship in the Characteristics of Vibration Signals for Sine Waves

There is a specific relationship in the characteristics of vibration signals that hold true for sine waves.

rms value = 0.707 x peak value
rms value = 1.11 x average value

| | | |
|---|---|---|
| peak value | = | 1.414 x rms value |
| peak value | = | 1.57 x average value |
| average value | = | 0.637 x peak value |
| peak-to-peak | = | 2.0 x peak value |

**Relationships of Sinusoidal Velocity, Acceleration and Displacement**

English Units:

| | |
|---|---|
| V = 3.14 fD | D = meters pk-to-pk |
| V = 61.44 g/f | V = meters per second |
| $g = 0.0511\ f^2\ D$ | f = Hertz |
| g = 0.0162 Vf | $g = 386.1\ in/sec^2$ |
| D = 0.3183 V/F | |
| $D = 19.57\ g/f^2$ | |

Metric Units:

| | |
|---|---|
| V = 3.14 fD | D = meters pk-to-pk |
| V = 1.56 g/f | V = meters per second |
| $g = 2.013\ f^2\ D$ | f = Hertz |
| g = 0.641 Vf | $g = 9.80665\ m/sec^2$ |
| D = 0.3183 V/F | |
| $D = 0.4968\ g/f^2$ | |

**Crossover Frequencies for the TTS**

At the crossover frequencies indicated in the samples below, like numbers are displayed by the TTS. This characteristic makes these frequencies a good choice to make quick operational reference checks.

| | |
|---|---|
| 29.3 Hz | D x 0.01 = v<br>(0.05 inches pk-to-pk = 5 ips) |
| 44.3 Hz | D x 0.01 = A<br>(0.05 inches pk-to-pk = 5 g's) |
| 61.44 Hz | V = g<br>(1 ips = 1 g) |

**Standard Checks for Transducers**

There are two standard checks that can be very easily made with the TTS:

- Linearity Check
- Frequency Response Check

Linearity - The closeness of a calibration curve to a specified straight line, preferably passing through zero. Commonly specified as a % of full scale.

Frequency Response - The portion of the frequency spectrum over which a device can be used, within specified limits of amplitude error.

Linearity Check - is a check to determine that the output sensitivity (mV/Unit of vibration, i.e., mV/g), or actual reading, is maintained from a minimum operation level to a higher operating level while not changing the test frequency. This check is usually made at 100 Hz. The transducer manufacturer usually specifies this frequency on the transducers original calibration certificate. If in doubt, use 100 Hz.

Frequency Response Check - is a check to determine that the output sensitivity (mV/Unit of vibration), or actual reading, is maintained over a normal operating frequency range. Thereference input vibration level is held at a constant level for the frequency response test.

Below are some typical Transducer Checkout sample data sheets that outline typical test frequencies and vibration levels for checking accelerometers and velocity transducers. These parameters should meet most general purpose requirements for verifying the functionality of transducers and measuring systems.

Step 1. Follow the operating procedure in Monitor Mode or Sensitivity Mode except substitute the frequencies and levels provided in the sample data sheets.

Step 2. Turn the down the Amplitude control knob before switching the Frequency Range to avoid jolting the shaker if operating in the Monitor Mode.

**Accelerometer**

| Reference Level | 0.25 g | 0.5 g | 1.0 g | 2.0 g | 3.0 g |
|---|---|---|---|---|---|
| Test Number | A | B | C | D | E |
| Actual Level | | | | | |

**TABLE 5-6: LINEARITY CHECK - FREQUENCY 100 HZ**

| Frequency (Hz) | 100 | 200 | 500 | 1 k | 2 k | 4 k |
|---|---|---|---|---|---|---|
| Test Number | A | B | C | D | E | F |
| Actual Level | | | | | | |

**TABLE 5-7: FREQUENCY RESPONSE CHECK - REF. LEVEL 1 G**

**Velocity Pickup**

| Reference Level | 0.2 ips | 0.4 ips | 0.6 ips | 0.8 ips | 1.0 ips |
|---|---|---|---|---|---|
| Test Number | A | B | C | D | E |
| Actual Level | | | | | |

TABLE 5-8: LINEARITY CHECK - FREQUENCY 100 HZ

| Frequency (Hz) | 30 | 50 | 70 | 100 | 200 | 400 |
|---|---|---|---|---|---|---|
| Test Number | A | B | C | D | E | F |
| Actual Level | | | | | | |

TABLE 5-9: FREQUENCY RESPONSE CHECK - REF. LEVEL 0.2 IPS

## Cable and Connector Checks

Following any vibration performance checks made for transducers and their measurement systems, it is always a good idea to check for cable and connector integrity by running the TTS at a high frequency and at a moderate-to-high vibration level while checking for possible signal interruptions that would occur if looseness was present. Looseness may not be detected at low frequencies but can become very detectable at higher frequencies.

## Quick Check Procedure

The TTS can be used to functionally check for measurement accuracy by comparing readings on the display for Acceleration, Velocity and Displacement at crossover frequencies. These three readings are derived from the reference accelerometer signal output and must be compared with an instrument that is also calibrated to read similar engineering units.

| Crossover Frequency | Readings to Compare | | |
|---|---|---|---|
| 61.44 Hz | 1 g | = | 1 ips |
| 44.3 Hz | 5 g | = | 50 Mils pk-to-pk |
| 29.3 Hz | 5 ips | = | 50 Mils pk-to-pk |

An alternate quick check can be made by setting the TTS to 1 g at 100 Hz and reading the reference accelerometer output. An rms voltmeter should indicate 35.35 mV rms or an oscilloscope should indicate 50 mV peak (100 mV pk-to-pk).

## Built-In-Test (BIT) Test Mode

Step 1. Press the MODE button until the BIT MODE screen appears.

**NOTE:** *The arrow in the upper right corner is for factory installed options and has not function under normal operation.*

Step 2. Press the RUN/STORE button to start the BIT test. While running the test the TTS will simultaneously display and print the results.

Step 3. If a BIT test fails, an asterisk (*) appears in the left hand margin.

## TTS Blink Range Summary

The following table shows boundaries for operation where the display does not blink the display blinking feature has been incorporated to warn the operator that the unit is being operated beyond frequency limits for the type of measurement or there may be some deterioration of specified parameters, such as amplitude accuracy and signal distortion.

| Parameter | Blink Region |
|---|---|
| SENSITIVITY FREQUENCY | |
| Charge & Voltage | hz < 10 or<br>hz > 10000 |
| TRIAX Blink | hz < 10 or<br>hz > 601 |
| Velocity Blink | hz < 8 or<br>Hz > 2001 |
| Displacement Blink | hz < 8 or<br>hz > 200 |
| SENSITIVITY AMPLITUDE | |
| Accelerometer Blink Limit | gs < 0.22 or<br>gs > 11.0 |
| Velocity Blink Limit | ips < 0.2 or<br>ips > 11.0 |
| Displacement Blink Limit | mils < 2 or<br>mils > 110 |
| MONITOR MODE | |
| Monitor Mode Accel. Blink | NONE |
| Monitor Mode Velocity Blink | hz < 8 or<br>hz > 2001 |
| Monitor Mode Disp Blink | hz < 8 or<br>hz > 255 |

**TABLE 5-10: TTS VLINK RANGE AND RESOLUTION SUMMARY**

**NOTE:** *The unit will turn off the shaker when the displacement exceeds .5 inches peak-peak and display a message to inform the operator.*

# TTS CALIBRATION PROCEDURE CHECK-OFF SHEET

TTS S/N ________________________________________ DATE ___________________

TECHNICIAN _____________________________________________________________

List all of the test equipment and their "TE" numbers used during this procedure:

Synthesizer _______________________________ TE# ________________________

DMM ____________________________________ TE# ________________________

After each test is completed successfully, record the appropriate correction factor as shown on the TTS display.

**Step**

8 ____________________

12 ____________________

17 ____________________

21 ____________________

26 ____________________

27 ____________________

28 ____________________

29 ____________________

30 ____________________

33 ____________________

35____________________

37____________________

39____________________

41____________________

43____________________

45____________________

**Step**

47 _______________________

49 _______________________

51 _______________________

Attach the TTS BIT MODE print-out to CHECK-OFF Sheet.

# Test Transducer and Mounting Fixture Weight Guide

| TRANSDUCER MODEL | WEIGHT | FIX WGHT | CHG/VOLT |
|---|---|---|---|
| CEC Instruments | | | |
| 4-102-0001 Velocity | 396.2 | 65 | Self/120k ohm |
| 4-106-0001 Velocity | 226.4 | 65 | Self/120k ohm |
| 4-106-0002 Velocity | 226.4 | 65 | Self/120k ohm |
| 4-123-0001 Velocity | 121 | 65 | Self/120k ohm |
| 4-125-0001 Velocity | 226.4 | 65 | Self/120k ohm |
| 4-125-0112 Velocity | 226.4 | 65 | Self/120k ohm |
| 4-128-0006 Velocity | 56.6 | 65 | Self/120k ohm |
| 4-128-0130 Velocity | 56.6 | 65 | Self/120k ohm |
| Chadwick-Helmuth | | | |
| 4177B Accel | 48 | n/a | V/External |
| 7310 Velocimeter | 48 | n/a | V/External |
| Dynamic Instruments | | | |
| DI-103 Triax Accel | 90 | 0/105* | V/2 mA |
| DI-108 Accel | 90 | 105 | V/2 mA |
| 7993 Accel | 112 | n/a | V/2 mA |
| 7993SM Accel | 150 | n/a | V/2 mA |
| 7983 Accel | 32 | n/a | V/2 mA |
| 7986 Accel | 90 | n/a | V/2 mA |
| Dytran | | | |
| 3100A Accel | 50 | n/a | V/2 mA |
| 3101A Accel | 5 | n/a | V/2 mA |
| 3101B Accel | 5 | n/a | V/2 mA |
| 3184A Accel | 106 | n/a | V/2 mA |
| Endevco | | | |
| 2217E Accel | 32 | n/a | C |
| 2233E Accel | 32 | n/a | C |
| 2258-10 Triax Accel | 15 | 65/105* | V/2 mA |
| 2258-100 Triax Accel | 15 | 65/105* | V/2 mA |
| 2272 Accel | 27 | n/a | C |
| 6222M20 Accel | 96 | 65 | C |
| 6233 Accel | 100 | 65 | C |
| 7251-10 Accel | 11 | n/a | V/2 mA |
| 7251-100 Accel | 11 | n/a | V/2 mA |
| 7254-10 Accel | 20 | n/a | V/2 mA |
| 7254-100 Accel | 20 | n/a | V/2 mA |
| 7250A Accel | 2.3 | 2.5 | V/2 mA |
| Vibrametetrics | | | |
| 6021C Accel | 40 | n/a | V/2 mA |
| 8000 Accel | 56 | n/a | V/2 mA |
| Wilcoxon | | | |
| 786A Accel | 90 | n/a | V/2 mA |
| 793 Accel | 112 | n/a | V/2 mA |
| 797 Accel | 135 | n/a | V/2 mA |
| 993 Triax Accel | 90 | 0/105* | V/2 mA |

* Axis dependent value, enter manually