MODEL 28959F
PORTABLE ACCELEROMETER CALIBRATOR (PAC)

INSTRUCTION
MANUAL

ENDEVCO

San Juan Capistrano, California, U.S.A.

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ENDEVCO MODEL 28959F
INSTRUCTION MANUAL

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SECTION 1
GENERAL INFORMATION

KEEP THE ORIGINAL SHIPPING BOX AND PACKING MATERIAL IN A SAFE PLACE. SHIPPING THIS PRODUCT WITHOUT THE SPECIFICALLY DESIGNED PACKING MATERIAL AND BOX MAY RESULT IN PERMANENT DAMAGE. ALWAYS FOAM-PACK THE PORTABLE ACCELEROMETER CALIBRATOR (PAC).

CHARGE UNIT 24 HOURS PRIOR TO USE.

Caution: Complete discharge of battery can cause battery failure. Always keep battery charged when not in use.

1. INTRODUCTION

    The Endevco Model 28959F Portable Accelerometer Calibrator (PAC) is a powerful, battery powered and totally self-contained accelerometer tester. Used in the field or laboratory, the PAC tests and verifies the performance of most accelerometers including high and low output impedance piezoelectric, piezoresistive, and variable capacitance accelerometers. It is also used to troubleshoot vibration monitoring systems or vibration analyzers, including cabling and associated system alarms and other instrumentation. Although the Model 28959F is capable of testing certain velocity transducers and displacement transducers, these capabilities are not supported in this version.

2. FUNCTIONAL DESCRIPTION

    The Endevco Model 28959F Portable Accelerometer Calibrator (PAC) performs the following primary functions:

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

    2. Automatically Calculates and Displays Accelerometer Sensitivities - Internal electronics provide the necessary signal conditioning and drive current for most accelerometers. By measuring the output signal of the AUT as it is vibrated, and comparing it with an internal reference signal, the sensitivity (signal out per unit of acceleration) of the transducer is automatically calculated. This calculated sensitivity can then be used to determine whether the AUT is within the transducer manufacturer's specifications. A thermal printer is built in to the PAC to provide hard copy printout of the test parameters and test results.

3. PRIMARY FEATURES

The Endevco Model 28959F Portable Accelerometer Calibrator provides the following primary features:

1. <u>Amplitude Units</u> - Vibration amplitude units are selectable and displayed in acceleration, velocity or displacement. They are also selectable in either English or metric. In this version, the velocity and displacement functions are not supported.

2. <u>Frequency Units</u> - Vibration frequency is displayed in hertz (Hz). Ranges are selectable in 3-100 Hz, 100-1000 Hz, and 1000-10,000 Hz, with front panel selections for 100, 1 k and 10 k.

3. <u>Automatic Calculation</u> - Sensitivity calculations (mV/engineering unit or pC/engineering unit) are automatically performed using an internal microcomputer.

4. <u>Phase</u> - During sensitivity calculation when accelerometer is selected, the unit displays the phase of the "accelerometer under test" relative to the internal reference accelerometer.

5. <u>Automatic Mass Load Correction</u> - A special algorithm is used to automatically adjust measurements and calculations to compensate for the mass load of the transducer under test.

6. <u>Help Screens</u> - Help screens are provided during operation to assist the operator.

7. <u>Large Memory</u> - Test parameters, test results and other test data can be stored in memory for printout via the printer, or download to a PC-compatible via the RS232 connector. Information will be retained even though the PAC is turned off.

8. <u>RS232</u> - Serial interface allows transfer of collected field data to a host computer. A DOS based data download software (p/n 31207) is available as an option which lets the user download the data and create reports with other third party software.

9. <u>Printer</u> - The PAC features a built-in thermal printer, which is used to hard copy data stored in memory.

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

11. <u>Battery Powered</u> - Power is provided using two gel cell type batteries. They are charged using two built-in charging systems that utilize 110 VAC 50/60 Hz source. The PAC is operable while charging. 220 VAC is optional.

12.   Charge Accelerometer - A charge amplifier is provided when measuring a high output impedance piezoelectric accelerometer.

13.   ISOTRON$^®$ or ICP type Accelerometers - Selectable current sources (.5 mA, 2 mA, 2.5 mA, 4 mA, 4.5 mA, 6 mA) are provided to power ISOTRON$^®$ or ICP type accelerometers.

14.   Piezoresistive and Variable Capacitance Accelerometers - An optional Bridge Conditioner Module (p/n 35922) can be used directly with the PAC to calibrate piezoresistive and variable capacitance accelerometers.

15.   End-to-End System Calibration - At the 0.0 mA constant current setting, the PAC can be used to calibrate the AUT with external signal conditioning, a very powerful feature for checking system accuracy.

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

17.   Automatic Power Management - A power management and supervisory system is used to optimize power consumption, increasing the time between required charging. The unit 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.

18.   Automatic Monitoring and Supervisory Limits -

   a.   Warning - When test amplitude and/or frequency are out of acceptable ranges, operator is warned of condition with flashing displays.

   b.   Shutdown - To prevent damage to the shaker, the PAC is automatically shut down when maximum acceptable displacement limits are exceeded (approximately .125 inch P-P displacement).

4.   SPECIFICATIONS

Table 1-1.
Endevco Model 28959F Portable Accelerometer Calibrator Specifications

DISPLAY:
· High contrast, wide viewing angle
· Displays 5 x 7 dots plus cursor
· 20 characters x 4 lines
· Backlighted

CALIBRATION:
Traceable to NIST standard at 2 g's from 20 Hz to 10 kHz

MEASUREMENT UNCERTAINTY:
· Acceleration: 10 Hz to   2 kHz ± .3 dB
                   2 kHz to 10 kHz ± 1.0 dB

FREQUENCY READOUT ACCURACY:
· 3 Hz to 10 kHz: .001% ± 1 count

AMPLITUDE RANGE:
· Max. acceleration 10 g (98.1 m/sec^2), pk
· Generates the peak accelerations at the frequency ranges and loads as follows:

Maximum Load

[Weight] [Frequency]	≤100 gm	≤250 gm	≤500 gm	≤750 gm
10-100 Hz	10g	4g	2g	1g
100-1000 Hz	7g	5g	2g	1g
1-10 kHz	3g	2g	n/a	n/a

NOTE:

(1)   Limited at lower frequencies to 0.1 inch (2.54mm) pk-pk displacement.
(2)   Care should be taken when mounting the test accelerometer and its fixture to reduce possibility of resonance and decoupling (anti-resonance).
(3)   For maximum output, batteries should be fully charged. Preferably, PAC should be powered by AC source.

ACCELEROMETER SENSITIVITY RANGE:
· ISOTRON®, (ICP), Piezoresistive and Variable Capacitance:
    1 mV/g - 200 mV/g
· High impedance Piezoelectric
    1 pC/g - 200 pC/g

REFERENCE ACCELEROMETER OUTPUT:
· Sensitivity = 50 mV/g ± .15 db @ 100 Hz
· Output Impedance = 100Ω nominal

POWER: *(Built-in Charger)*
· Battery powered
· 115 Vac, 50/60 Hz Charger (operable while charging)
· Optional 28959FV features 220 VAC, 50 Hz charging capability

PRINTER:
· Fast, rugged thermal type printer
· Character Format: 5 x 7 dot matrix
· Printing Speed (Line/Sec): 0.9
· Paper Width: 2.3"

PHYSICAL:
· Size: 11" long x 7" wide x 10" high
· Weight: 22.7 lbs

ENVIRONMENTAL: 10-120°F @ 95% RH

5.   MODES OF OPERATION AND SUPPORT FUNCTIONS

1.   Modes of Operation - The following information presents a brief description of the PAC modes of operation:

a.   Battery Check - This mode displays the voltage state status of the internal PAC batteries. It also provides the memory status; that is, how many readings are currently stored in memory, and how many total readings were available.

b.   Setup Mode - The setup mode allows selection of AUT amplitude units (English or metric) and the date and time. It 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.

c.   Monitor Mode - The monitor mode is used to vibrate or "shake" the Accelerometer-Under-Test (AUT) for testing and verifying its operation and sensitivity in conjunction with existing machinery vibration monitoring system cables and associated instrumentation.

d.   Sensitivity Mode - In addition to shaking the AUT, the sensitivity mode is used to automatically calculate the sensitivity of the AUT. It also checks the phase of the signal to ensure 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 AUT in appropriate data fields or automatically enters data from a library of sensors stored in memory. In either case, the AUT serial number must always be entered.

e.   BIT Test Mode - The BIT (Built-In-Test) is a diagnostic mode which automatically performs an extensive series of tests on the PAC.

2. <u>Support Functions</u> - The following information provides a brief description of the PAC support functions:

   a. <u>Help</u> - Help screens are available during all other modes of operation to assist the operator.

   b. <u>Print</u> - All test parameters, test results and other data stored in memory can be hard copied during the printing operation.

   NOTE: When power is turned "ON", the PAC automatically tests the RAM and ROM, then proceeds to the battery check mode display. Additionally, if the power has been turned "OFF" then "ON" rapidly, a message will appear requesting operator turn "OFF" power for 10 seconds minimum, before turning the PAC "ON".

6. <u>CONTROLS AND INDICATORS</u>

   The Model 28959F controls, indicators and connectors are illustrated in Figure 1-1 and described in Table 1-2.
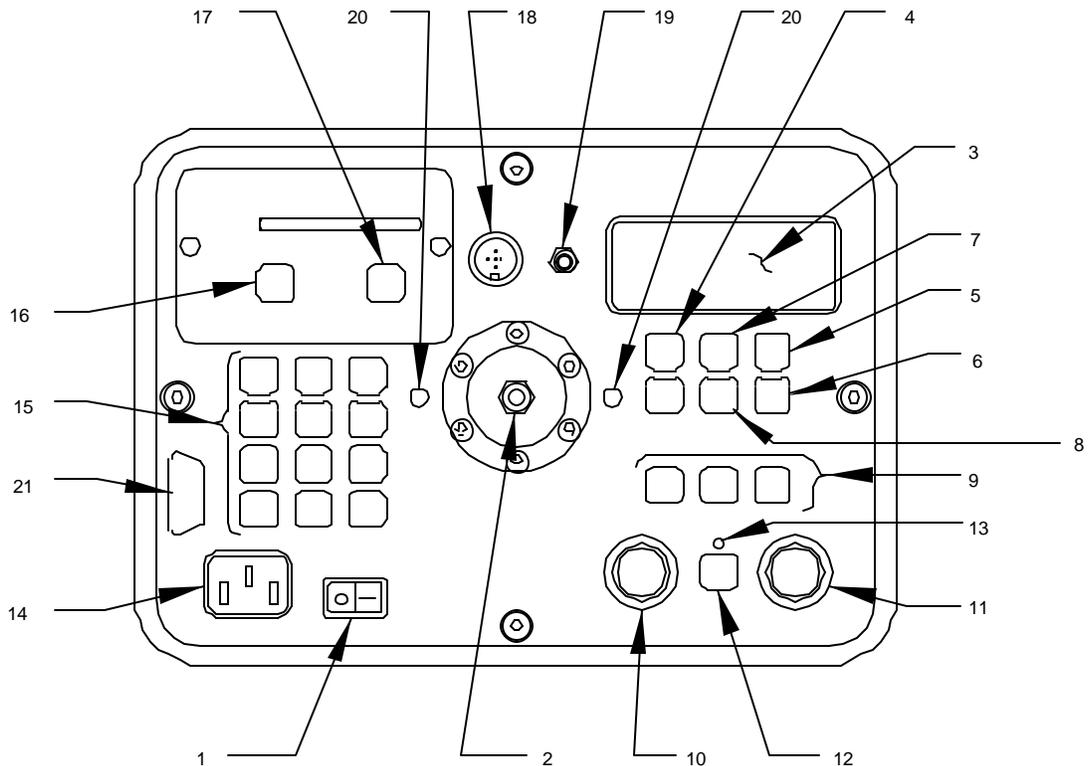
FIGURE 1-1. PAC CONTROLS, INDICATORS, CONNECTOR

TABLE 1-2. PAC CONTROLS, INDICATORS AND CONNECTORS

Item # (Fig. 1-1)	Control/Indicator/Connector	Function
1	Power Switch	Powers PAC ON and OFF
2	AUT Threaded Connector	Mount for AUC to "shaker" installation
3	Display	Primary display for test parameters, test results and other related test data.
4	Mode Key	Used to select operating modes: Battery check, Monitor, Setup, Sens. BIT
5	Cursor Key	Positions flashing cursor.
6	Select Key	Toggles for various selections.
7	⇑ Key	Used in sensitivity mode to select "pages" in reverse order.
8	⇓ Key	Used in sensitivity mode to select "pages" in ascending order.
9	Frequency Range Selector Key	Selects 100, 1K and 10K frequency ranges.
10	Frequency Control	Provides fine adjustment of test frequency. (10 - Turn)
11	Amplitude Control	Provides test amplitude adjustment. (10 - Turn)

Item # (Fig. 1-1)	Control/Indicator/Connector	Function
12	Run/Store Key	Starts and stops shaker in Monitor and Sens. modes. Stores test parameters and results in Sens. mode. Clears help and warning screens. Also used to clear memory in Sens. mode of operation.
13	Indicator LED	Indicates when shaker is operating.
14	Power Receptacle	Receptacle for power cord during battery charging.
15	Alpha/Numeric Keys and $\Leftarrow$ Key	Inputs numbers (press once) or letters (press two, three or four times). $\leftarrow$ key backspaces left.
16	Print Key	Prints after test parameters and results have been stored.
17	Paper Adv Key	Advances printer paper.
18	Input Connector	Used in Sens. mode, to electronically connect AUT to PAC, using appropriate cable.
19	REF BNC Connector	Provides 50 mV/g, 100 Hz reference signal output.
20	Mounting Hole	Not used in this model.
21	RS 232 Connector	Output stored data to PC-compatible.

7. CALIBRATION AND REPAIR OF PAC

Due to the complexity of the calibration equipment required to calibrate this Portable Accelerometer Calibrator, it is recommended to send the unit back to ENDEVCO for calibration and repair. Typically, a one-year calibration cycle is recommended. If the unit sees heavy use, a 6-month cycle is recommended. Special CS830 System Calibration is available at ENDEVCO to calibrate the PAC with NIST traceability.

SECTION 2
GETTING STARTED/QUICK GUIDE

By following a calibration example in this Getting Started section, you will become familiar with the Model 28959F Portable Accelerometer Calibrator (PAC) without spending excessive time reading the whole manual. This short guide will discuss the Monitor and Sensitivity modes of the 28959F with a step-by-step approach. Please see Fig.1-1 or the figure below to familiarize yourself with the physical layout of the 28959F front panel. The numbers identified on these figures refer to front panel controls which are defined on Table 1-2. These same figure numbers are referenced in the write up below with parentheses.
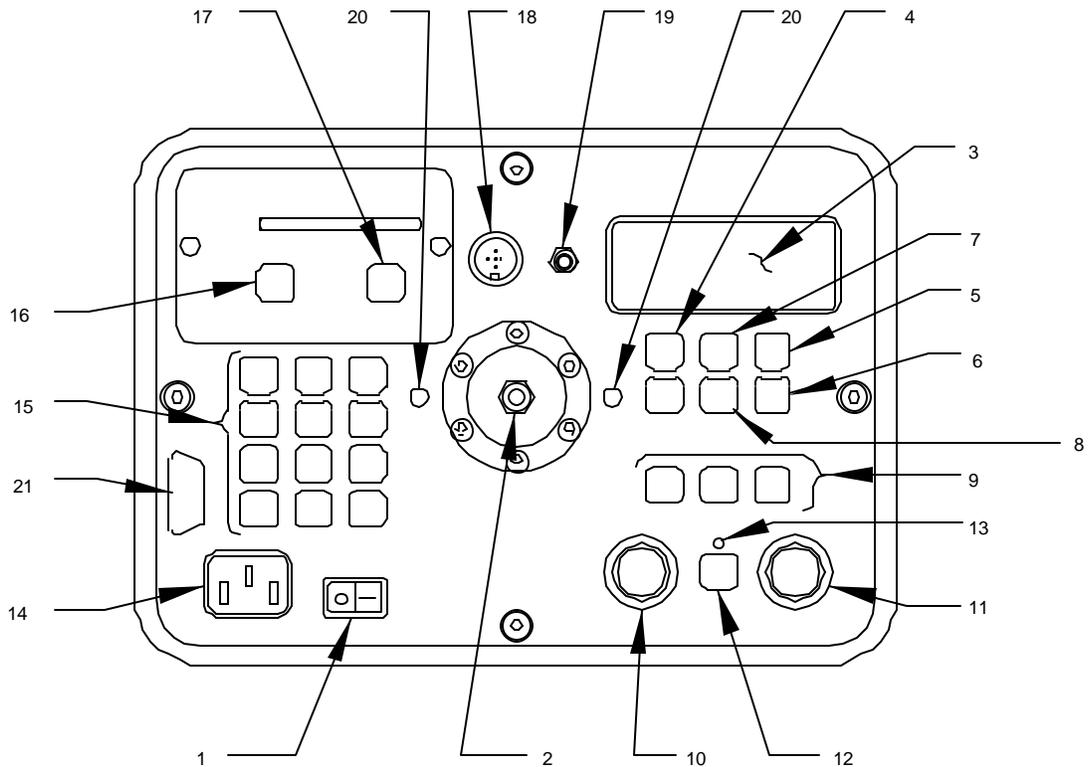
Lets Start!

Step 1.   Push Power On switch (1) - display shows logo and battery check.

Step 2.   Push MODE button (4) 2 times - now you are in the Monitor Mode! You have 3 selections to make:

<div align="center">

TYPE, FREQ., AMP
</div>

TYPE
Push CURSOR button (5) until TYPE selection blinks. Push SELECT button (6) to choose **accel**., **vel**., or **displ.** Select accel. for this example.

FREQ.
Select the frequency range you want with FREQ. range buttons (9). Choices are coarse ranges of 100Hz, 1kHz, or 10kHz.

AMP
Push RUN/STORE button (12), then unlock the Amplitude (11) and Frequency (10) fine tune adjustment knobs to set levels you want. Push RUN/STORE button (12) again to stop.

Step 3. Push MODE button (4) 1 time - you are now in the Sensitivity Mode. Push CURSOR button (5) until Tst# **blinks** in display.
Push SELECT button (6) to go to new (blank) Tst#.
Push CURSOR button (5) 1 time, now you will be entering the accelerometer model number. Use the KEYPAD (15) on the left hand side to enter the number.

> **NOTE: There is a sequential step process for each button on the keyboard. For example, the 3 button also does the Y, Z and - functions. Also, wait for each space on the LCD display to be highlighted before entering digit or letter!**

Step 4. Push CURSOR button (5) 1 time again to enter accelerometer serial number. Push CURSOR button (5) to enter mass of accelerometer in grams. Push CURSOR button (5) 1 time again to enter the type of input (charge, volt, triax, vel., or displ.).

If you have an ISOTRON/ICP type piezoelectric accelerometer, select volt and 4.0 mA current level as follows:

When transducer line is flashing, push SELECT button (6) for input choices per above description. Once you have chosen volt, push CURSOR button (5) 1 time, this will move you to the right of the display. Now you can choose the constant current value you want from 0.0 to 6.0mA. Do this by pushing the SELECT button (6).

If you have a high impedance piezoelectric accelerometer, select charge and go on to the next step.

Step 5. Push CURSOR button (5) 1 time to go back to " Tst# ". Push button (8) 1 time. You are now ready to read the Amplitude and Sensitivity of the unit or system under test.

Step 6. Push RUN/STORE button (12) 1 time again, then push PRINT button (16) 1 time. Wait for printer to stop. Push PAPER ADV button (17) 3 times and tear off print out for review!! **Tear the paper from right to left to avoid occasional jamming of paper at the printer head.**

SECTION 3
OPERATING INSTRUCTIONS

1.   Verify that the Transducer Test Set (PAC) is "OFF".

2.   Ensure that the amplitude control is adjusted to minimum (counterclockwise).

3.   Mount the AUT and adapter, if required, to the hexagon shaker head.

   CAUTION: **When installing or removing the AUT or adapter, always use the spanner wrench (provided in the lid) to hold the hexagon shaker head in place. In most cases, when testing at low frequencies, the AUT and adapter mounting bolts require only a "finger tight" torque.**

   WARNING: **Failure to follow this CAUTION may twist off the reference accelerometer, causing severe damage to the PAC.**

4.   Turn POWER switch "ON" by pressing right side of POWER switch ("-" = ON, "0" = OFF).

5.   Observe display as the PAC cycles through self-test.

   1.   The PAC is automatically checking the RAM and ROM.

   2.   The Battery Check Mode screen will appear if the tests are successful. Select Battery Check Mode.

6.   Select PAC mode of operation by pressing MODE key. There are five modes that are sequentially selected.

   1.   Battery Check
   2.   Setup Mode
   3.   Monitor Mode
   4.   Sens. (Sensitivity) Mode
   5.   BIT (Built-In-Test) Mode

   The operational characteristics of each mode are described in the following sections.

7. <u>BATTERY CHECK MODE</u>:   <u>Observe display</u>

> BATTERY CHECK
> + voltage _XXXXXXXXX_
> - voltage   _XXXXXXXXX_
> MEM   000/1725

1. Check voltage level of batteries. (+Voltage will always be lower than -voltage because +voltage consumption is higher.) Time between charging depends on operating use; however, the PAC will automatically turn off when voltage level is less than approximately 7 volts.

2. Charge batteries if required: plug power cord into the PAC power receptacle and 110 Volts, (28959FV is charged with 230 Volts) 50/60 Hz outlet.

3. Charging can be performed either when the PAC is off, or when it is on and operating. Under heavy operating loads the batteries will take a longer time to fully charge.

4. Memory status is displayed under the battery status. The first three digits indicate the number of readings currently stored in memory. The next four digits indicate the total number of readings that are available. Subtract the first three digits from the next four to determine how many readings can still be stored in memory.

5. A complete battery charge will indicate 8.3Vdc. Minimum battery charge with nominal load is 7.0Vdc.

8. <u>SETUP MODE</u>:   <u>Observe either of the following displays</u>

> <u>Screen "a"</u>   PAC   SETUP MODE
>   UNITS   ----
>   DATE   ----
>   TIME   ----

> <u>Screen "b"</u>   PAC   SETUP MODE
>   AUTO PRINT ----
>   TEST   ----
>   MON.UNITS   ----

> <u>Screen "c"</u>   PAC   SETUP MODE
>   LED TIMEOUT   ----
>   POWER TIME   ----

NOTE: The arrow in the right upper corner indicates the ability to scroll and in which direction.

1. Screen "a" Setup

   a. To select units, date or time, proceed as follows:

      (1) Observe flashing UNITS, DATE or TIME. This indicates current position of cursor.
      (2) Select setup field by pressing CURSOR key. This positions flashing cursor on desired selection.
      (3) Amplitude Units: Press SELECT key to select units.

         (a) English
         (b) Metric

      (4) Date and Time: Press alpha/numeric keys to change date or time. Use ⇐ key to position cursor left within the two digit fields.

   b. Once Screen "a" is setup, continue Setup Mode by pressing ⇓ key for Screen "b" selection.

2. Screen "b" Setup

   a. Select setup field by pressing CURSOR key.

   b. AUTOPRINT: Press SELECT key to select print mode.

      (1) ON - permits automatic printing of up to 100 tests, with up to 25 readings per tests stored in memory
      (2) OFF - permits printing of only one test at a time.

   c. MON.UNITS: Press SELECT key to select Monitor Mode units.

      (1) Standard (Linear)
      (2) RMS
      (3) 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, but it should only be changed in the Sensitivity Mode.

   d. Once Screen "b" is setup, complete Setup Mode by pressing ⇓ key for Screen "c" selection.

3. <u>Screen "c" Setup</u>

    a.   Select setup field by pressing CURSOR key.

    b.   <u>LED Timeout</u>: Press alpha/numeric keys to change LED (display) time before automatic shutoff.   Use $\Leftarrow$ key to position left within the five position field. Use number keys to enter timeout in minutes. The default timeout is one minute.

    c.   <u>Power Time</u>: Press alpha/numeric keys to change the PAC "non-use" power time before automatic shutoff. Use $\Leftarrow$ key to position left within the five position field. Use number keys to enter time in minutes. The default timeout is five minutes.

9.   <u>MONITOR MODE</u>: <u>Observe display</u>

                  MONITOR MODE
      TYPE   ---
      FREQUENCY   ---   M 0.0
      AMP.   0.00

1.   <u>Monitor Mode Setup</u>

    a.   Press CURSOR key to select accelerometer type and accelerometer mass.

    b.   When accelerometer type is flashing, press SELECT key.

          (1)   ACCEL (accelerometer)
          (2)   VELOCITY
          (3)   DISPLACEMENT

NOTE: VELOCITY and DISPLACEMENT are not supported in this product.

    c.   When the mass (M 0.0) is flashing, enter in the weight of the accelerometer in grams, if known. Otherwise, 20 grams will automatically be used to correct for the effects of accelerometer mass loading.

NOTE: If a adapter plate is used, add the weight of the adapter to the accelerometer mass.

        Press alpha/numeric keys to enter mass in grams.
        (1)   Use $\Leftarrow$ to position left within the five digit field.
        (2)   Press key once to enter numbers.
        (3)   To enter a decimal point, press "0" key twice and wait for dark square to flash in the next square. Then proceed entering numbers.

2.   Monitor Mode Testing

NOTE: Prior to testing in Monitor Mode, recheck that the AUT has been installed properly in accordance with the appendices. Also, ensure that CAUTIONS have been followed:

CAUTION: Ensure that the amplitude control is adjusted to minimum (counterclockwise).

CAUTION: When installing or removing the AUT or adapter, always use the spanner wrench (provided in the lid) to hold the hexagon shaker head in place. In most cases, when testing at low frequencies, the AUT and adapter mounting bolts require only a "finger tight" torque.

a.   Press FREQUENCY RANGE keys to select either 100 Hz, 1 K, or 10 K test ranges.

b.   Select desired test frequency by unlocking FREQUENCY knob (counterclockwise turn) and adjust knob. Observe frequency display.

c.   Press RUN/STORE key to turn on shaker. Observe red led is on, indicating that shaker is operating.

d.   Select desired test amplitude by unlocking AMPLITUDE knob (counterclockwise turn) and slowly adjust knob. Observe display.

NOTE: Because the Model 28959F is microprocessor controlled, several important monitoring and supervisory limits automatically engage when:

(1)   Vibration frequency and amplitude is out of recommended operating range (see Table 1-1 PAC Specifications) - The display flashes frequency and amplitude. Adjust shaker within limits.

(2)   Vibration amplitude at lower frequencies have exceeded 0.1 inch (2.54mm) pk-pk displacement. The shaker shuts down to prevent damage and message appears:

                SHAKER DISPLACEMENT
                OUT OF RANGE!
                PLEASE TURN
                AMPLITUDE DOWN

After amplitude has been turned down, press RUN/STORE key once to remove message and again to rerun test.

e.   Once vibration test frequency and amplitude have been established, press RUN/STORE key once. To print test results, press PRINT key.

10.   SENS. (SENSITIVITY) MODE: Observe display

          SENS.   NO DATA   Tst1_
          MOD
          S/N   MASS 0.0
          TRANSD   .CHARGE

NOTE: The arrow in the right upper corner indicates the ability to scroll
        and in which direction.

NO DATA refers to a date entry. If test data are in memory, this field shows the
test date. The date entered in the Setup Mode will be entered when testing is
started. The date can be changed only in the Setup Mode.

1.   Sens. Mode Setup

      a.   Press CURSOR key to select one of the following flashing display fields:

             (1)   TST _ _ _   Test Number
             (2)   MOD   Manufacturer and Model No.
             (3)   S/N   Serial Number
             (4)   MASS _ . _   Mass in grams
             (5)   TRANSD.   Transducer Type
             (6)   ma   Current if applicable

      NOTE: Date does not flash. It can only be changed by entering the Setup
              Mode, Screen "a".

      b.   TEST (Tst) NUMBER: Press SELECT key to sequentially select test
             numbers from 1 to 70. This test number may coincide with each
             accelerometer to be tested. Additionally, up to 25 individual readings may
             be taken for each test. To reduce test number by one, press ⇐ key.

      c.   Transducer Model: Press alpha/numeric keys to enter MOD. MOD is the
             model number of the AUT. Up to 15 alpha/numeric positions are available.

             (1)   Use ⇐ key to position left within the 15 position field.

             (2)   Press key once for numbers. Non-equal numbers may be
                    sequentially entered rapidly. To enter same number twice, wait for
                    dark square to flash in the next square.

             (3)   Press key two, three, or four times for letters. After a few
                    seconds, flashing will occur in the next position to the right.

d.   Transducer Serial Number: Press alpha/numeric keys to enter S/N. S/N is the serial number of the AUT. Up to six alpha/numeric positions are available.

   (1)   Use ⇐ key to position left within the six position field.

   (2)   Press key once for numbers. Non-equal numbers may be sequentially entered rapidly. To enter same number twice, wait for dark square to flash in the next square.

   (3)   Press key two, three, or four times for letters. After a few seconds, flashing will occur in the next position to the right.

e.   Mass: To correct calculations and test results for the effects of mass loading of the accelerometer under test (AUT), enter the weight of the AUT and test fixture (if any) in grams. If mass is not entered, a 20 gram weight will be automatically assumed for the calculations.

NOTE: If an accelerometer adapter fixture is used, add the weight of the adapter to the accelerometer mass.

   Press alpha/numeric keys to enter mass in grams.
   (1)   Use ⇐ key to position left within the five digit field.
   (2)   Press key once to enter numbers.
   (3)   To enter a decimal point, press "0" key twice and wait for dark square to flash in the next square. Then proceed entering numbers.

f.   TRANSD (Type): Press SELECT key to select vibration accelerometer type.

   (1)   CHARG   Charge
   (2)   VOLT   Voltage (ISOTRON/ICP)
   (3)   TRIAX   Triaxial
   (4)   VELOC   Velocity
   (5)   DISPL   Displacement

NOTE: VELOCITY and DISPLACEMENT are not supported in this product.

   Press CURSOR key to proceed in Sens. Mode setup.

g.   TRANSD. CURRENT (mA): For ISOTRON/ICP, piezoresistive and variable capacitance accelerometer, press CURSOR key then press SELECT key to select current (mA) required by the accelerometer under test. For piezoresistive and variable capacitance accelerometers, set the current to 0 mA and follow the instructions of 35922 Bridge Conditioner Module. For system calibration, set the current to 0 mA and treat the input as an accelerometer signal.

2.   <u>Sens. Mode Testing</u>

(1)   Prior to testing in Sens. Mode, recheck that the AUT has been installed properly in accordance with the appendices. Ensure that the proper input cable is connected to the AUT. Also, ensure that CAUTIONS have been followed:

CAUTION: Ensure that the amplitude control is adjusted to minimum (counterclockwise).

CAUTION: When installing or removing the AUT or adapter, always use the spanner wrench (provided in the lid) to hold the hexagon shaker head in place. In most cases, when testing at low frequencies, the AUT and adapter mounting bolts require only a "finger tight" torque.

(2)   The AUT must be tightly coupled to the hexagon shaker head (reference accelerometer).   This ensures that the AUT and the reference accelerometer have the exact same motion, which is absolutely required for accurate sensitivity measurements.

(3)   During Sens. Mode testing, a 100 Hz reference test frequency is recommended. Additionally, to ensure a high signal to noise ratio for the AUT sensitivity calculation, levels from 1 g to 5 g are recommended.

<u>Observe Display:</u>

                                          A
            FREQUENCY _ _ _ Hz
            AMP _ _ _ G
            SF _ _ _   mv/eu or pc/eu

a.   Press ⇑ or ⇓ keys to "page" through separate test pages lettered A through Y in the upper right hand corner.

b.   Press FREQUENCY RANGE keys to select either 100 Hz, 1 K, or 10 K test ranges.

c.   Select desired test frequency by unlocking FREQUENCY knob (counterclockwise turn) and slowly adjust knob. Observe frequency display.

d.   Press RUN/STORE key to turn on shaker. Observe red led is on, indicating that shaker is operating.

e.   Select desired test amplitude by unlocking AMPLITUDE knob (counterclockwise turn) and slowly adjust knob. Observe display.

f.   Once vibration test frequency and amplitude have been established, press RUN/STORE key once. To print test results, press PRINT key.

g.   Press ⇓ key to advance to next test page letter if required for testing at another frequency and/or amplitude.

NOTE: To clear all setup information, press ⇑ until message to clear all forms appears, then press RUN twice. Return to Sens. Mode by pressing ⇓ key.

3.   Sens. Mode Phase Check

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

The phase check is done automatically 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 AUT is in phase with the internal reference and points down when the AUT is out of phase with reference.

4.   Printing Example

The display with the arrow can be printed out in the normal manner, but the arrow will print out as an inverted v (^) when pointing up and a normal v when the arrow is pointing down. This can be seen in the example below.

Example Display

SENS. _ _/_ _/_ _ Tst1
MOD _ _ _ _ _ _ _ _ _ _
S/N _ _ _ _ MASS _ _ _ _
TRANSD.VOLT.   2.0ma

                                A
FREQUENCY   56   HZ
AMP 0.94 G
SF 9.73 mv/eu   ^

11.   OPERATING HINTS

The following information is offered for reference use and as helpful hints for the user.

1.   General Vibration Information

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
$g = 0.0511\ f^2D$	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
$g = 2.013\ f^2D$	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 PAC

At these crossover frequencies, like numbers are displayed on the PAC as shown in the examples. This characteristic makes these frequencies as good choice to make quick operational reference checks.

29.3 Hz   -   D x 0.01 = V
(0.05 inches pk-to-pk = 5 ips)

44.3 Hz   -   D x 0.01 = A
(0.05 inches pk-to-pk = 5 g)

61.44 Hz   -   V = g
(1 ips = 1 g)

2.   Standard Checks for Accelerometers

Two standard checks, Amplitude Non-Linearity and Frequency Response, can be made with the PAC very easily.

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

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

The following Typical Transducer Checkout sample data sheet outlines typical test frequencies and vibration levels for checking accelerometers and velocity accelerometers. These should meet most general purpose requirements for verifying the functionality of accelerometers and measuring systems.

Follow the operating procedure in the Monitor Mode or Sensitivity Mode section except substitute the frequencies and levels given in the sample data sheet.

Be certain to turn down the Amplitude control before switching the Frequency Range to avoid jolting the shaker if operating in the Monitor Mode.

TYPICAL TRANSDUCER CHECKOUT SAMPLE DATA SHEET

Linearity Check - Frequency   100 Hz

Reference Level	0.25g	0.5 g	1.0 g	2.0 g	3.0 g
Test No.	A	B	C	D	E
Actual Level					

Frequency Response Check - Ref. Level 1 g

Frequency (Hz)	100	200	500	1k	2k	4k
Test No.	A	B	C	D	E	F
Actual Level						

3.   Cable and Connector Checks for Looseness

Following any vibration performance checks made for accelerometers and their measurement systems, it is always a good idea to check for cable and connector integrity by running the PAC 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.

4.   Quick Check Procedure

The PAC 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	1g	= 1 ips
44.3 Hz	5g	= 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 PAC 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).

12.   BUILT-IN-TEST (BIT) TEST MODE

a.   Observe display when BIT Mode is selected.

> BIT MODE _
> PRESS RUN TO
> START BUILT
> IN TEST

NOTE: The arrow in the right upper corner if for factory installed options and has no function under normal operation.

b.   Pressing the RUN/STORE key will start the BIT test which will simultaneously display and print results.

c.   If a BIT test fails, an asterisk (*) will appear in the left hand margin.

13. PAC 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.

TABLE 2-2. PAC BLINK RANGE AND RESOLUTION SUMMARY

Parameter	Blink Region
SENSITIVITY FREQUENCY	
Charge & Voltage Accel. Blink	hz < 10 or hz > 10000
TRIAX Blink	hz < 10 or hz > 601
Velocity Blink	hz < 8 or hz > 2001
Displacement Blink	hz < 8 or hz > 200
SENSITIVITY AMPLITUDE	
Accel. Blink Limit	gs < 0.2 or gs > 11
Velocity Blink Limit	ips < 0.2 or ips > 11.0
Displacement Blink Limit	mils < 2 or mils > 110
MONITOR MODE	
Monitor Mode Accel. Blink	NONE
Monitor Mode Vel. Blink	hz < 8 or hz > 2001
Monitor Mode Disp Blink	hz < 8 or hz > 255

NOTE: **The unit will turn off the shaker when the displacement exceeds .15 inches peak-peak and display a message to inform the operator.**

SECTION 4
ACCESSORIES

1. STANDARD ACCESSORIES SUPPLIED WITH MODEL 28959F

Description	Part No.
1. Power Cord	6006-0008
2. Connector, Spare	2112-0007
3. Wrench, Special Spanner	0228-0072-01
4. Accelerometer Transducer Mounting Fixture	0228-0071-01
5. Mounting 1/4-28 Stud Adapters:	
1/4-28 Stud	EHM1476
10-32 UNF Stud	EHM1477
2-56 UNC Threaded Hole Bushing	EHM1478
6-32 UNC Threaded Hole Bushing	EHM1479
10-32 UNF Threaded Hole Bushing	EHM1480
6. Cable, 10-32 Micro Dot, Voltage Mode	3090CM50
7. Cable, 10-32 Micro Dot, Charge Mode	3090CM51

2. OPTIONAL ACCESSORIES

| Description	Part No.
1. Bridge Conditioner Module (for Piezoresistive and Variable Capacitance accelerometers)	35922
2. Mounting Fixture for PR and VC accelerometers	30279
3. Mounting Fixture for Adhesive-Mounted accelerometers	31283
4. Serial Interface Software for PC	31207
5. 10-32 to BNC Adapter	EP171
6. 10-32 to 10-32 Adapter	EJ34

SECTION 5
PRINTER PAPER REPLACEMENT
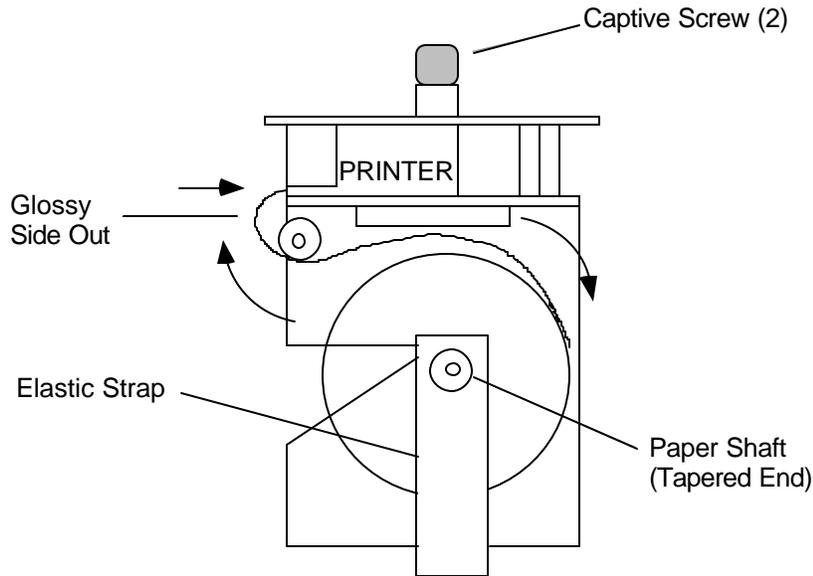
FIGURE 5-1. PRINTER

A.   Paper Source (SEIKO P/N TP201-211-25C)

Available at most office supply stores as calculator paper.

B.   When paper is appearing with red strip on one side, replace roll.

C.   Paper Replacement:

1.   Remove printer from PAC by loosening two captive screws and <u>carefully</u> lifting printer out. Cable remains attached and caution must be used to avoid damage.

2.   Remove old paper roll by pulling elastic strap off tapered end of paper shaft, see Figure 4-1, and remove roll.

3.   Turn PAC ON and press PAPER ADV key to remove paper still in printer.

4.   Prepare new paper roll by cutting leading edge squarely with scissors.

5.   Feed paper edge, with the glossy side out, through the printer, see illustration.

6.   Press PAPER ADV key to advance paper through printer.

7.   Reinstall shaft and replace elastic strap onto tapered end of paper shaft.

8.   Reinstall printer into PAC and tighten captive screws.

NOTE: If paper jams the printer, the PAC automatically turns off. To restart, turn off the PAC, wait several seconds before turning it back on.

APPENDIX A

PAC TO ACCELEROMETER
CABLE CONNECTOR PIN OUT DIAGRAM

CHANNEL A	4
CHANNEL B	5
CHANNEL C	6
CHARGE	1
DISPLACEMENT INPUT	8
GND	2
+9V	3
TEST SIGNAL	7
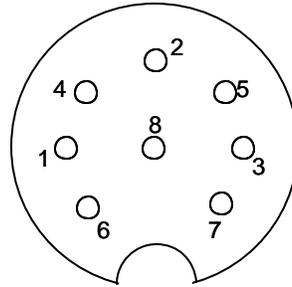
Pin-out of Input Connector
2112-0007 shown from rear

FIGURE A-1. CABLE CONNECTOR PIN OUT DIAGRAM

SEE FIGURES A-2 TO A-4 FOR SPECIFIC
ACCELEROMETER TO CABLE CONNECTOR WIRING DIAGRAM.

Channel A   Input for all transducers that provide voltage outputs. Current can be selected by menu from 0 mA to 6 mA.

Channel B & C   Used only when testing triaxial ISOTRON/ICP accelerometers.

Charge   Used for charge accelerometers with sensitivity between   1 pC/g to 200 pC/g.

Displacement Input For proximity type displacement transducers with voltage output between 0 and 24 volts. Not supported in this model.

GND   PAC signal ground.

+5V   Regulated +9V output at 6 mA max.

Test Signal   Test signal output for use with loop back test cable. Not supported in this model.

Accelerometer
(ISOTRON or ICP types)
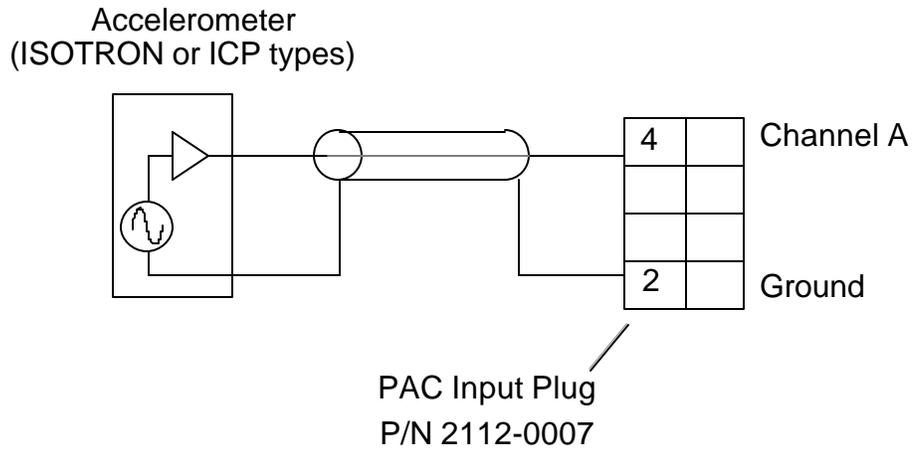
FIGURE A-2. VOLTAGE MODE ACCELEROMETER
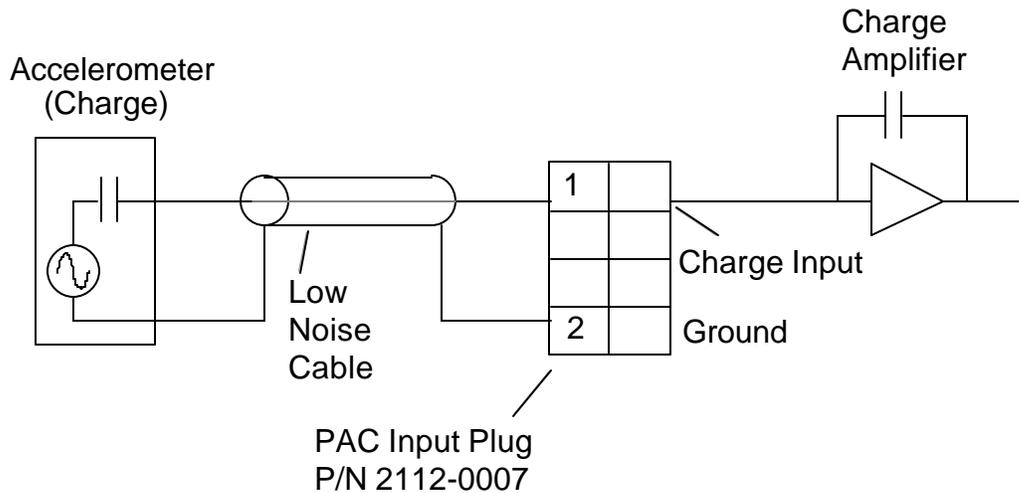
**FIGURE A-3. CHARGE MODE ACCELEROMETER**
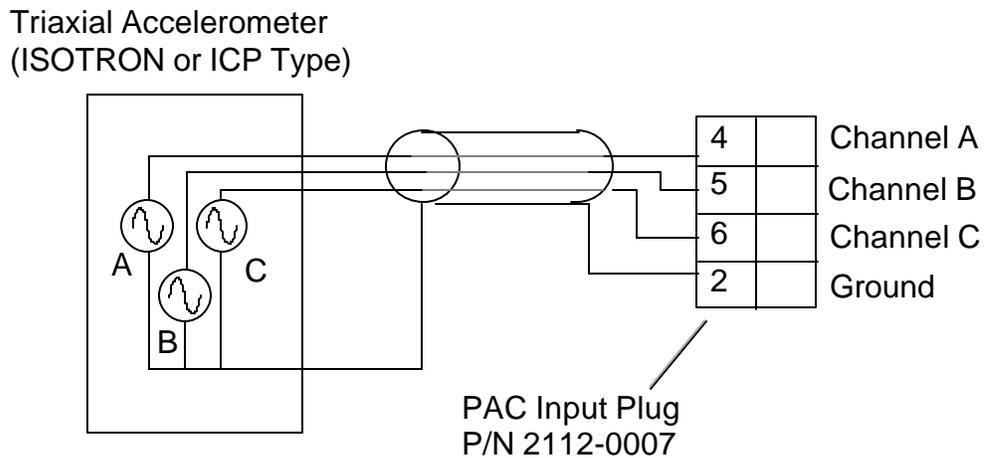
FIGURE A-4. VOLTAGE MODE ACCELEROMETER (TRIAXIAL)