

SENSORS FOR ACCELERATION, SHOCK, AND VIBRATION



**Model 352C22**

**ICP<sup>®</sup> Accelerometer**

**Installation and Operating Manual**

For assistance with the operation of this product, contact the SVS Division of PCB Piezotronics, Inc.

**SVS toll-free 888-684-0013**  
**24-hour SensorLine™ 716-684-0001**  
**Fax 716-685-3886**  
**E-mail [svs@pcb.com](mailto:svs@pcb.com)**



SHOCK AND VIBRATION SENSORS DIVISION

# General OPERATING GUIDE

for use with

## PIEZOELECTRIC ICP® ACCELEROMETERS

### SPECIFICATION SHEET, INSTALLATION DRAWING AND CALIBRATION INFORMATION ENCLOSED

PCB ASSUMES NO RESPONSIBILITY FOR DAMAGE CAUSED TO THIS PRODUCT AS A RESULT OF PROCEDURES THAT ARE INCONSISTENT WITH THIS OPERATING GUIDE.

#### 1.0 INTRODUCTION

Congratulations on the purchase of a quality, ICP® acceleration sensor. In order to ensure the highest level of performance for this product, it is imperative that you properly familiarize yourself with the correct mounting and installation techniques before attempting to operate this device. If, after reading this manual, you have any additional questions concerning this sensor or its application, feel free to call a factory Application Engineer at 716-684-0001 or your nearest PCB sales representative.

#### 2.0 ICP® ACCELEROMETERS

Powered by simple, inexpensive, constant-current signal conditioners, these sensors are easy to operate and interface with signal analysis, data acquisition and recording instruments. The following features further characterize ICP® sensors:

- Fixed voltage sensitivity, regardless of cable type or length.
- Low-impedance output signal, which can be transmitted over long cables in harsh environments with virtually no loss in signal quality.
- Two-wire operation with low cost coaxial cable, two-conductor ribbon wire or twisted-pair cabling.
- Low-noise, voltage-output signal compatible with standard readout, signal analysis, recording, and data acquisition equipment.
- Low cost per-channel - ICP® accelerometers require only an inexpensive, constant-current signal conditioner to operate.

- Intrinsic self-test feature - monitoring the sensor's output bias voltage provides an indication of proper operation, faulty condition, and bad cables.

In the rear of this manual you will find a **Specification Sheet**, which provides the complete performance characteristics of your particular sensor.

#### 3.0 OPTIONAL FEATURES

Many sensors are supplied with standard, optional features. When listed before the model number, the following prefix letters indicate that the sensor is manufactured or supplied with a particular optional feature: "A" option- adhesive mount; "HT" option- extended high temperature range; "J" option- electrically ground isolated; "M" option- metric mounting thread; "Q" option- extended discharge time constant; "T" option- built-in transducer electronic data sheet (TEDS); and "W" option- attached, water-resistant cabling. Other prefix letters, such as "K", "KR", "GK", "GKR", "KL", and "GKL", indicate that the sensor is ordered in kit form, including interconnect cabling and signal conditioner. If you have any questions or concerns regarding optional features, consult the SVS Division's Shock and Vibration Sensor product catalog or contact a PCB factory representative.

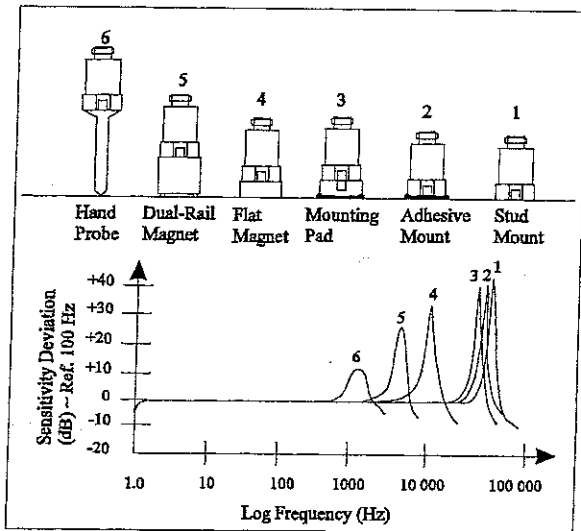
#### 4.0 INSTALLATION OVERVIEW

When choosing a mounting method, consider closely both the advantages and disadvantages of each technique. Characteristics like location, ruggedness, amplitude range, accessibility, temperature, and portability are extremely critical. However, the most important and often overlooked consideration is the effect the mounting technique has on the high-frequency performance of the accelerometer.

® ICP is a registered trademark of PCB Piezotronics, Inc., which uniquely identifies PCB sensors that incorporate built-in microelectronics.

Shown in figure 1 are six possible mounting techniques and their effects on the performance of a typical piezoelectric accelerometer. (Note that not all of the mounting methods may apply to your particular sensor). The mounting configurations and corresponding graph demonstrate how the high-frequency response of the accelerometer may be compromised as mass is added to the system and/or the mounting stiffness is reduced.

**NOTE:** *The low-frequency response is unaffected by the mounting technique. This roll-off behavior is typically fixed by the sensor's built-in electronics. However, when operating AC-coupled signal conditioners with readout devices having an input impedance of less than one megaohm, the low frequency range may be affected. If necessary, contact a factory representative for further assistance.*



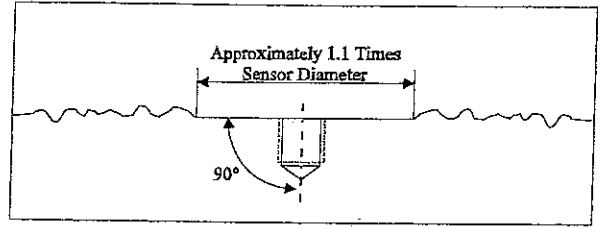
**Figure 1.** Assorted Mounting Configurations and Their Effects on High Frequency

#### 4.1 STUD MOUNT

This mounting technique requires smooth, flat contact surfaces for proper operation and is recommended for permanent and/or secure installations. Stud mounting is also recommended when testing at high frequencies.

**NOTE:** *Do NOT attempt mounting on curved, rough, or uneven surfaces, as the potential for misalignment and limited contact surface may significantly reduce the sensor's upper operating frequency range.*

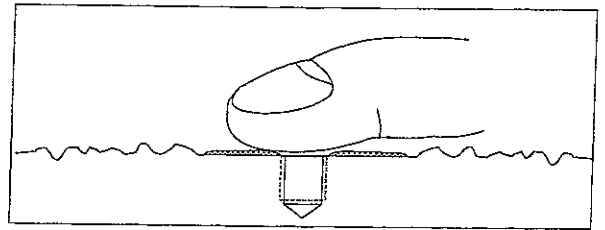
**STEP 1:** First, prepare a smooth, flat mounting surface, then drill and tap a mounting hole in the center of this area as shown in Figure 2 and in accordance with the enclosed **Installation Drawing**.



**Figure 2.** Mounting Surface Preparation

A precision-machined mounting surface with a minimum finish of 63  $\mu\text{in}$  (0.00016 mm) is recommended. (If it is not possible to properly prepare the test structure mounting surface, consider adhesive mounting as a possible alternative). Inspect the area, checking that there are no burrs or other foreign particles interfering with the contact surface.

**STEP 2:** Wipe clean the mounting surface and spread on a light film of grease, oil, or similar coupling fluid prior to installation.



**Figure 3.** Mounting Surface Lubrication

Adding a coupling fluid improves vibration transmissibility by filling small voids in the mounting surface and increasing the mounting stiffness. For semi-permanent mounting, substitute epoxy or another type of adhesive.

**STEP 3:** Screw the mounting stud into the base of accelerometer and hand-tighten (this step is unnecessary for units having an integral mounting stud). Then, screw the sensor into the tapped hole that was prepared in the test object. Tighten the unit in place by applying, with a torque wrench, the recommended mounting torque, as listed on the enclosed **Installation Drawing**.

**NOTE:** *It is important to use a torque wrench during this step. Under-torquing the sensor may not adequately couple the device; over-torquing may result in stud failure.*

#### 4.2 ADHESIVE MOUNT

Adhesive mounting is often used for temporary installation or when the test object surface cannot be adequately prepared for stud mounting. Adhesives like hot glue and wax perform well for temporary installations whereas two-part epoxies and quick-bonding gels (super glue) provide a more permanent installation. Two

techniques are used for adhesive mounting; they are via an adhesive mounting base (method 1 below) or direct adhesive mounting (method 2 below).

**NOTE:** *Adhesively mounted sensors often exhibit a reduction in high-frequency range. Generally, smooth surfaces and stiff adhesives provide the best high frequency response.*

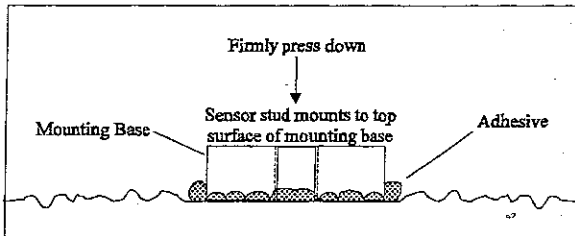
**METHOD 1 - Adhesive Mounting Base**

This method involves attaching a base to the test structure, then securing the sensor to the base. This allows for easy removal of the accelerometer. Also, since many bases are manufactured of "hard-coated" aluminum, they provide electrical isolation to eliminate ground loops and reduce electrical interference that may propagate from the surface of the test object.

**STEP 1:** Prepare a smooth, flat mounting surface. A minimum surface finish of 63  $\mu\text{m}$  (0.00016 mm) generally works best.

**STEP 2:** Stud-mount the sensor to the flat side of the appropriate adhesive mounting base according to the guidelines set forth in STEPS 2 and 3 of the Stud Mount Procedure presented above.

**STEP 3:** Place a small portion of adhesive on the underside of the mounting base (the underside is discernable by the concentric grooves which are designed to accept the adhesive). Firmly press down on the assembly to displace any extra adhesive remaining under the base.



**Figure 4.** Mounting Base: Adhesive Installation

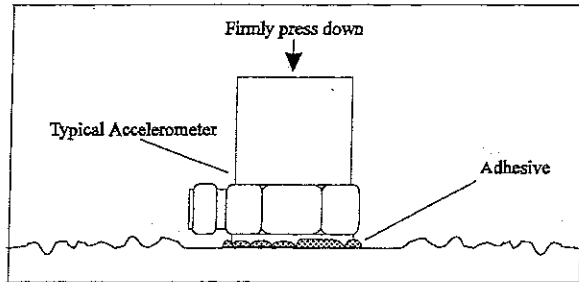
**METHOD 2 - Direct Adhesive Mount**

For restrictions of space or for convenience, most sensors can be adhesive-mounted directly to the test structure (an exception being units having integral mounting studs).

**STEP 1:** Prepare a smooth, flat mounting surface. A minimum surface finish of 63  $\mu\text{m}$  (0.00016 mm) generally works best.

**STEP 2:** Place a small portion of adhesive on the underside of the sensor. Firmly press down on the top of the assembly to displace any adhesive. Be aware that

excessive amounts of adhesive can make sensor removal difficult. Also, adhesive that may invade the tapped mounting hole in the base of the sensor will compromise future ability to stud mount the unit.



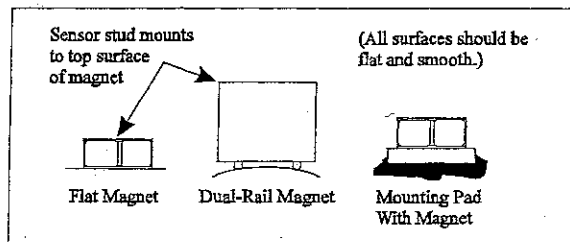
**Figure 5.** Direct Adhesive Mounting

**4.3 MAGNETIC MOUNT**

Magnetic mounting provides a convenient means for making quick, portable measurements and is commonly used for machinery condition monitoring, predictive maintenance, spot checks, and vibration trending applications.

**NOTE:** *The correct magnet choice and an adequately prepared mounting surface are critical for obtaining reliable measurements, especially at high frequencies. Poor installations can cause as much as a 50% drop in the sensor frequency range.*

Not every magnet is suitable for all applications. For example, rare earth magnets are commonly used because of their high strength. Flat magnets work well on smooth, flat surfaces, while dual-rail magnets are required for curved surfaces such as motor housings and pipes. In the case of non-magnetic or rough surfaces, it is recommended that the user first weld, epoxy, or otherwise adhere a steel mounting pad to the test surface. This provides a smooth location for mounting and a target to insure that subsequent measurements for trending purposes are taken at the same location.



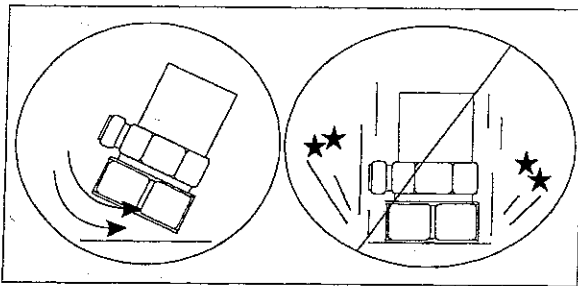
**Figure 6.** Magnet Types

**STEP 1:** Prepare a smooth, flat mounting surface. A minimum surface finish of 63  $\mu\text{m}$  (0.00016 mm) generally works best. After cleaning the surface and checking for burrs, apply a light film of silicone grease, machine oil, or similar-type coupling fluid.

**STEP 2:** After choosing the correct magnet type, inspect the magnet, verifying that its mounting surfaces are flat and smooth.

**STEP 3:** Stud-mount the accelerometer to the appropriate magnet according to the guidelines set forth in **STEP 3** of the above Stud Mount Procedure.

**STEP 4:** To avoid damage to the sensor, install the magnet/sensor assembly to the prepared test surface by gently "rocking" or "sliding" it into place.



**Figure 7. Magnet Mounting**

**CAUTION:** *Magnetically mounting of an accelerometer has the potential to generate very high (and very damaging) acceleration (g) levels. To prevent such damage, exercise caution and install the assembly gently by rocking it into place. If shock is expected to be a particular concern, use a sensor with built-in shock protection. For further assistance, contact a factory representative.*

#### 4.4 HANDHELD OR PROBE TIP MOUNT

This method is NOT recommended for most applications. Both the accuracy and repeatability at low (<5 Hz) and high frequency (>1 kHz) ranges are questionable. It is generally used only for machinery condition monitoring, when installation space is restricted, or other portable trending applications. The technique, however, can be useful for initially determining locations of greatest vibration to establish a permanent sensor installation point.

#### 5.0 CABLING

Care and attention to cable installation and cable condition is essential as the reliability and accuracy of any measurement system is no better than that of its weakest link. Do to the nature of vibration measurements, all sensor cables will ultimately fatigue and fail. Good installation practice will extend the life of a cable, however, it is highly recommended to keep spare cables on hand to enable continuation of the test in the event of a cable failure.

**STEP 1:** Ascertain that you have the correct cable type.

One cable type cannot satisfy all applications. ICP<sup>®</sup> sensors can be operated with any ordinary two-wire or coaxial cable. Special, low-noise cables that are typically recommended for use with high-impedance, charge-output sensors can also be used. For applications requiring conformity to **CE**, low noise cables are essential. Industrial applications often require shielded, twisted-pair cables to reduce the effects of EMI and RFI that is present near electrical motors and machinery. Teflon-jacketed cabling may be necessary to withstand corrosive environments and higher temperatures. Consult the SVS Division Shock and Vibration Product catalog for more information about cables or feel free to contact a factory representative for a specific recommendation on cables that are best suited for your application.

**STEP 2:** Connect the cable to the accelerometer.

A small amount of thread-locking compound placed on the connector threads prior to attachment helps secure the cable during testing. In wet, oily, or dirty environments, the connection can be sealed with silicone rubber sealant, O-rings, and flexible, heat-shrink tubing.

**Coaxial Cables:** Make connection by inserting the cable's connector pin into the sensor's mating socket. Then thread the connector into place by turning the cable connector's outer shell onto the accelerometer's electrical connector.

**NOTE:** *Do not spin the accelerometer while holding the cable connector stationary, as this will cause undue friction on the center pin of the cable connector and lead to premature fatigue.*

**Multi-pin connectors:** Make connection by inserting the sensor's mating pins onto the cable connector's mating sockets. Then thread the connector into place by turning the cable connector's outer shell onto the accelerometer's electrical connector.

**Pigtail Connections:** Certain miniature accelerometers and shock sensors are provided with lightweight cables attached to "Pigtail" connections. This type of connection reduces overall weight and incidence of connection intermittency under shock conditions. In the event of a cable or connection failure, the cables may be repaired in the field simply by re-soldering the stripped leads to the exposed pins on the sensor. (Check the **Sensor Outline Drawing** to determine signal and ground pins). In many cases, it is also helpful to protect the solder joint with heat-shrink tubing or epoxy.

**NOTE:** *If you do not have the experience or resources to attach pigtail leads, consult PCB to discuss factory attachment. Damage to internal electronics may be*

caused by excessive heat during soldering and such failure is not covered by warranty.

**STEP 3:** Route the cable to the signal conditioner, making certain to relieve stress on the sensor/cable connection. Also, minimize cable motion by securing it with tape, clamps or ties at regular intervals.

Common sense should be used to avoid physical damage and minimize electrical noise. For instance, avoid routing cables near high-voltage wires. Do not route cables along floors or walkways where they may be stepped on or become contaminated. To avoid ground loops, shielded cables should have the shield grounded at one end only, typically at the signal conditioner.

**STEP 4:** Finally, connect the remaining cable end to the signal conditioner. It is good practice to dissipate any electrical charge that may have accumulated in the cable by shorting the signal pin to the ground pin or shell prior to attachment.

## 6.0 POWERING

All ICP<sup>®</sup> sensors require constant current excitation for proper operation. For this reason, use only PCB constant-current signal conditioners or other approved constant-current sources. A typical system schematic is shown in Figure 8.

**NOTE:** Damage to the built-in electronics resulting from the application of incorrect power, or the use of an unapproved power source, is NOT covered by warranty.

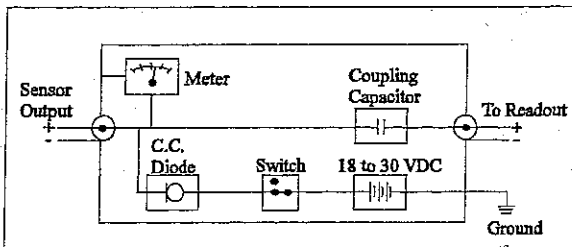


Figure 8. Typical System Schematic

The power supply consists of a current-regulated, 18 to 30 VDC source. This power is regulated by a current-limiting circuit, which provides the constant-current excitation required for proper operation of ICP<sup>®</sup> sensors.

In general, battery-powered devices offer versatility for portable, low-noise measurements, whereas line-powered units provide the capability for continuous monitoring. Consult the SVS Division Shock and Vibration Product catalog for more information about signal conditioners.

**NOTE:** Under no circumstances should a voltage be supplied to an ICP<sup>®</sup> accelerometer without a current-regulating diode or equivalent electrical circuit. This

may include ohmmeters, multi-meters and continuity testers.

Meters or LEDs are used on PCB signal conditioners to monitor the bias voltage on the sensor output signal, to check sensor operation, and detect cable faults. Normally, a "yellow" reading indicates an open circuit; "green" indicates normal operation; and "red" indicates either a short or overload condition. Finally, a capacitor at the output stage of the device removes the sensor output bias voltage from the measurement signal. This provides a zero-based, AC-coupled output signal that is compatible with most standard readout devices.

**NOTE:** Units having a low bias voltage may be in the "red," when actually they are working properly. If suspect, the bias voltage can be checked with a voltmeter attached to a "T" connector installed on the input connector to the signal conditioner.

**Note:** For readout devices having an input impedance near one gigaohm (as encountered with some A to D converters), it may be necessary to place a one megaohm resistor in parallel to the readout input to eliminate slow turn-on and signal drift.

Today, many FFT analyzers, data acquisition modules, and data collectors have the proper constant-current excitation built-in for direct use with ICP<sup>®</sup> sensors. Before using this feature, however, check that the supply voltage and constant current are within acceptable limits for use with your particular sensor. (Check enclosed **Specification Sheet**). Please contact the respective signal conditioner manufacturer or check the product manual for more information.

## 7.0 OPERATING

After completing the system setup, switch on the signal conditioner and allow 1 to 2 minutes for the system to stabilize. The meter (or LED) on the signal conditioner should be reading "green." This indicates proper operation and you may begin taking measurements. If a faulty condition is indicated (red or yellow reading), first check all system connections, then check the functionality of the cable and signal conditioner. If the system still does not operate properly, consult a PCB factory representative.

**NOTE:** Always operate the accelerometer within the limitations listed on the enclosed **Specification Sheet**. Operating the device outside these parameters can cause temporary or permanent damage to the sensor.

## 8.0 ACCELEROMETER CALIBRATION

Accelerometer calibration provides, with a definable degree of accuracy, the necessary link between the

physical quantity being measured and the electrical signal generated by the sensor. In addition, other useful information concerning operational limits, physical parameters, electrical characteristics, or environmental influences may also be determined. Without this link, analyzing data becomes a nearly impossible task. Fortunately, most sensor manufacturers provide a calibration record that documents the exact characteristics of each sensor. (The type and amount of data varies depending on the manufacturer, sensor type, contractual regulations, and other special requirements).

Under normal conditions, piezoelectric sensors are extremely stable, and their calibrated performance characteristics do not change over time. However, the sensor may be temporarily or permanently affected by harsh environments influences or other unusual conditions that may cause the sensor to experience dynamic phenomena outside of its specified operating range. This change manifests itself in a variety of ways, including: a shift of the sensor resonance due to a cracked crystal; a temporary loss of low-frequency measuring capability due to a drop in insulation resistance; or total failure of the built-in microelectronic circuit due to a high mechanical shock.

For these reasons, it is recommended that a recalibration cycle be established for each accelerometer. This schedule is unique and is based on a variety of factors, such as: extent of use, environmental conditions, accuracy requirements, trend information obtained from previous calibration records, contractual regulations, frequency of "cross-checking" against other equipment, manufacturer recommendation, and any risk associated with incorrect readings. International standards, such as ISO 10012-1, provide insight and suggest methods for determining recalibration intervals for most measuring equipment. With the above information in mind and under "normal" circumstances, PCB conservatively suggests a 12- to 24-month recalibration cycle for most piezoelectric accelerometers.

**NOTE:** It is good measurement practice to verify the performance of each accelerometer with a Handheld Shaker or other calibration device before and after each measurement. The PCB Handheld Shaker operates at a fixed frequency and known amplitude (1.0 g) to provide a quick check of sensor sensitivity.

### 8.1 RECALIBRATION SERVICE

PCB offers recalibration services for our piezoelectric accelerometers, as well as units produced by other manufacturers. Our internal metrology laboratory is certified to ISO 9001, complies with ISO 10012-1 (and former MIL-STD-45662A), and uses equipment directly traceable to NIST. Our investment in equipment, traceability and conformance to industry standards ensures

accurate calibration against relevant specifications, in a timely fashion.

### 8.2 BACK-TO-BACK CALIBRATION THEORY

Many companies choose to purchase the equipment necessary to perform the recalibration procedure in house. While this may result in both a savings of time and money, it has also been attributed to incorrect readings and costly errors. Therefore, in an effort to prevent the common mistakes associated with customer-performed calibration, this document includes a broad overview of the Back-to-Back Calibration technique. This technique provides a quick and easy method for determining the sensitivity of a test accelerometer over a wide frequency range.

Back-to-Back Calibration is perhaps the most common method for determining the sensitivity of piezoelectric accelerometers. This method relies on a simple comparison to a previously calibrated accelerometer, typically referred to as a reference standard.

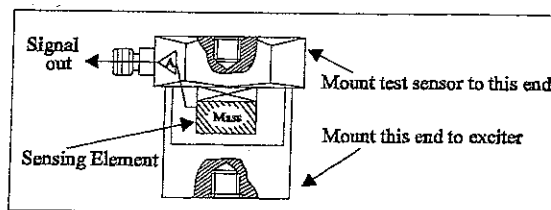


Figure 9. Reference Standard Accelerometer

These high-accuracy devices, which are directly traceable to a recognized standards laboratory, are designed for stability, as well as configured to accept a test accelerometer. By mounting a test accelerometer to the reference standard and then connecting this combination to a suitable vibration source, it is possible to vibrate both devices and compare the data as shown in Figure 10. (Test set-ups may be automated and vary, depending on the type and number of accelerometers being calibrated).

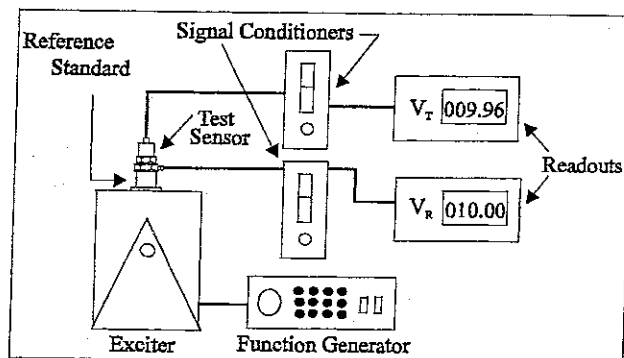


Figure 10. Typical Back-to-Back Calibration System

Because the acceleration is the same on both sensors, the ratio of their outputs ( $V_T/V_R$ ) must also be the ratio of their sensitivities. With the sensitivity of the reference

standard ( $S_R$ ) known, the exact sensitivity of the test sensor ( $S_T$ ) is easily calculated by using the following equation:

$$S_T = S_R (V_T/V_R)$$

By varying the frequency of the vibration, the sensor may be calibrated over its entire operating frequency range. The typical response of an unfiltered accelerometer is shown in Figure 11.

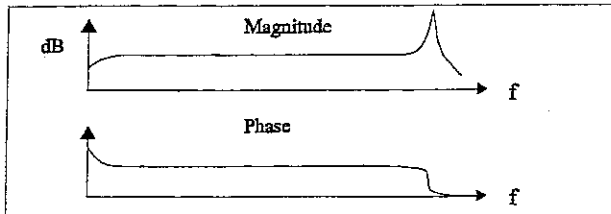


Figure 11. Typical Test Accelerometer Response

### 8.3 PCB CALIBRATION PROCEDURE

Numerous precautions are taken at PCB to insure accurate and repeatable results. This section provides a brief overview of the primary areas of concern.

Since the Back-to-Back Calibration technique relies on each sensor experiencing an identical acceleration level, proper mounting of the test sensor to the reference standard is imperative. Sensors with mounting holes are attached directly to the reference standard with a stud tightened to the recommended mounting torque. A shouldered mounting stud is typically used to prevent the stud from "bottoming out" in the hole. Both mounting surfaces are precision-machined and lapped to provide a smooth, flat interface according to the manufacturer's specification. A thin layer of silicone grease is placed between the mating surfaces to fill any imperfections and increase the mounting stiffness. The cables are stress-relieved by first routing them to the shaker head, then to a nearby stationary location. This reduces cable motion, which is especially important when testing charge output sensors, and helps to prevent extraneous motion or stresses from being imparted into the system. A typical set-up is shown in Figure 12.

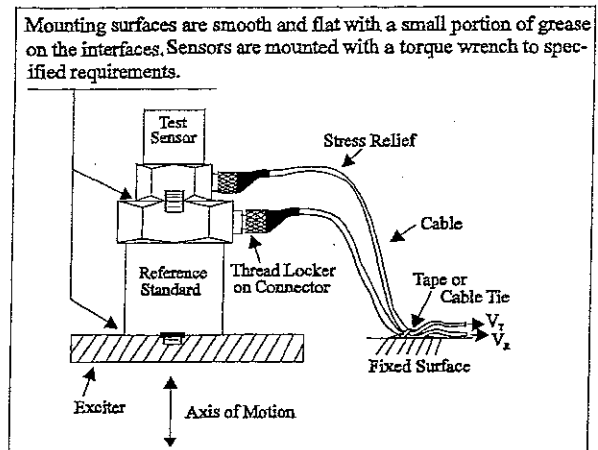


Figure 12. Typical Calibration Set-Up

Adhesively mounted sensors use similar practices. However, in this case, a small portion of quick-bonding gel, or similar temporary adhesive, is used to attach the test sensor to a reference standard designed with a smooth, flat mounting surface.

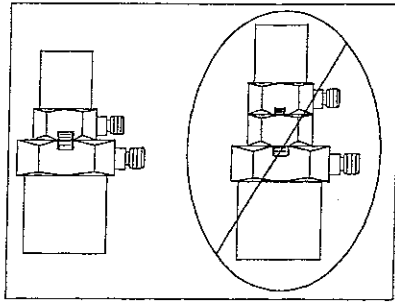
In addition to mounting, the selection of the proper equipment is critical. Some of the more important considerations include: 1) the reference standard must be specified and previously calibrated over the frequency and/or amplitude range of interest; 2) the shaker should be selected to provide minimal transverse (lateral) motion and minimal distortion; and 3) the quality of the meters, signal generator, and other devices should be selected so as to operate within the limits of permissible error.

### 8.4 COMMON MISTAKES

Most calibration errors are caused by simply overlooking some of the fundamental principals of dynamics. This section attempts to address some of the more common concerns.

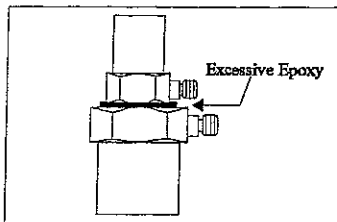
For stud-mount sensors, always mount the accelerometer directly to the reference standard. Ensure that the mounting surfaces are smooth, flat, and free of any burrs. Always use a coupling fluid, such as silicone grease, in the mounting interface to maintain a high mounting stiffness. Mount the sensor according to the manufacturer's recommended mounting torque. **DO NOT** use any intermediate mounting adaptors, as the mounted resonant frequency may be reduced, and thereby compromise the high-frequency performance. If necessary, use adaptor studs.





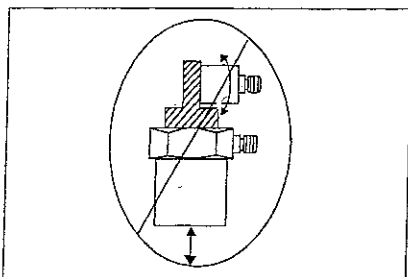
**Figure 13. Stud Mounting**

For adhesive mount sensors, use a thin, stiff layer of temporary adhesive such as quick-bonding gel or superglue. **DO NOT** use excessive amounts of glue or epoxy, as the mounting stiffness may be reduced and compromise high-frequency performance. It may also damage the sensor during removal.



**Figure 14. Incorrect Adhesive Mounting**

Triaxial accelerometers should always be mounted directly to the reference standard. Unless absolutely required, **DO NOT** use adaptors to re-orient the sensor along the axis of motion, as the mounting stiffness may be altered. The vibration at the test sensor's sensing element may differ from the vibration at the reference standard due to a "cantilever" effect, seen in Figure 15.



**Figure 15. Mounting Triaxial Sensors (Incorrect)**

Understand Back-to-Back Calibration limitations. Do not expect the uncertainty of calibration to be any better than  $\pm 2\%$ . (In fact, the uncertainty may be as high as  $\pm 3\%$  or  $\pm 4\%$  for frequencies  $< 10$  Hz or  $> 2$  kHz.) Since large sensors may affect high-frequency accuracy, verify that the test sensor does not mass load the reference standard. Validate your calibration system with another accelerometer prior to each calibration session. Check with the manufacturer for exact system specifications.

## 8.5 CONCLUSIONS

Without an adequate understanding of dynamics, determining what, when, and how to test a sensor is a difficult task. Therefore, each user must weigh the cost, time, and risk associated with self-calibration versus utilizing the services of an accredited laboratory.

## 9.0 REPAIR/SERVICE

Because of the nature of most PCB instrumentation, field repair is typically **NOT** recommended and may void any warranty. If factory service is required, return the instrument according to the **RETURN PROCEDURE** (Section 10.0). A quotation will be provided prior to servicing if requested.

## 10.0 RETURN PROCEDURE

To expedite the repair process, contact a PCB factory representative for a **RETURN MATERIAL AUTHORIZATION (RMA)** number prior to sending any equipment to the factory. Please have information available, such as model number, serial number, and purchase order number. Also, to insure efficient service, be sure to include a written description of the symptoms and problems associated with the equipment. An included purchase order with authority to proceed with repairs will greatly expedite return.

Customers outside the U.S. should consult their local PCB distributor for information on returning equipment. For exceptions, please contact the International Sales department at PCB to request shipping instructions and an RMA. For assistance, please call (716) 684-0001, or fax us at (716) 684-0987. You may also receive assistance via e-mail at [sales@pcb.com](mailto:sales@pcb.com) or visit our web site at [www.pcb.com](http://www.pcb.com).

## 11.0 CUSTOMER SERVICE / WARRANTY

The employees of PCB strive to provide superior, unmatched customer service. Should you at any time find yourself dissatisfied with any PCB product for any reason, consult a PCB Application Engineer or local representative/distributor to discuss repair, refund, or exchange procedures.

PCB instrumentation is warranted against defective material and workmanship for one year unless otherwise expressly specified. Damage to instruments caused by incorrect power or misapplication is not covered by warranty. If there are any questions regarding power, intended application, or general usage, please consult with a factory representative, your local sales contact, or distributor. Batteries and other expendable hardware items are not covered by warranty.

When unexpected measurement problems arise, call our 24-hour SensorLine to discuss your immediate dynamic

instrumentation needs with a factory representative. Dial 716-684-0001.



***SHOCK AND VIBRATION SENSORS DIVISION***

3425 Walden Avenue, Depew, NY 14043-2495 USA **SVS toll-free** 888-684-0013 **24-hour SensorLine™** 716-684-0001  
**FAX** 716-685-3886 **E-mail** [svs@pcb.com](mailto:svs@pcb.com) **Website** [www.pcb.com](http://www.pcb.com)

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**DYNAMIC PERFORMANCE**

Voltage Sensitivity  
Measurement Range (for ±5V output)  
Frequency Range:  
(±5%)  
(±10%)  
(±3 dB)  
Mounted Resonant Frequency  
Broadband Resolution (1 Hz to 10 kHz)  
Amplitude Linearity  
Transverse Sensitivity

10 [1,0] (±15%)  
500 [4 900]  
1.0 to 10,000  
0.7 to 13,000  
0.3 to 20,000  
≥60  
0.002 [0,02] [2]  
≤±1 [1]  
≤5

**ENVIRONMENTAL**

Shock Limit - All Axes (maximum)  
Operating Temperature Range  
Temperature Response

±g pk [±ms<sup>-2</sup> pk]  
°F [°C]  
%/°F [%/°C] [2]  
See Graph

**ELECTRICAL**

Excitation Voltage/Constant Current  
Output Impedance  
Output Bias  
Discharge Time Constant  
Warm Up Time (within 10% of output bias)  
Spectral Noise:

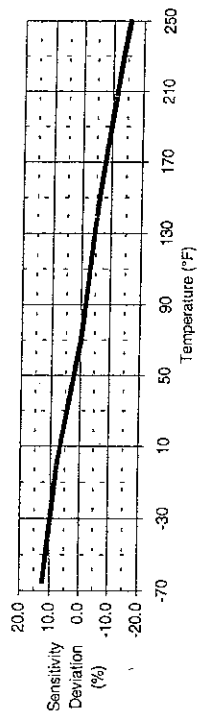
VDC/mA  
ohms  
VDC  
sec  
sec  
μg/√Hz [(μms<sup>-2</sup>)/√Hz] [2]  
18 to 30/2 to 20  
≤300  
7 to 11  
1.0 to 3.5  
<3  
800 [7 840]  
250 [2 450]  
45 [440]  
20 [196]  
10 [98]  
≥10<sup>8</sup>

Ground Isolation

**MECHANICAL**

Sensing Element  
Housing  
Size (Height x Width x Length)  
Weight  
Electrical Connector  
Mounting

material/geometry  
material/sealing  
in [mm]  
oz [gm]  
type/location  
type  
Ceramic/Shear  
Aluminum/Epoxy  
0.14 x 0.25 x 0.45 [3,6 x 6,4 x 9,2] [4]  
0.017 [0,5] [2]  
3-56 Coaxial Jack/Side  
Adhesive [3]



All specifications are at room temperature unless otherwise specified.  
In the interest of constant product improvement, we reserve the right to change specifications without notice.  
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DD032 Rev. G 2/16/99

**OPTIONAL VERSIONS**

Optional versions have identical specifications and accessories as listed for the standard model except where noted by the letter prefixes below. More than one option may be used.

-None-

**NOTES:**

- [1] Zero-based, least-squares, straight line method.
- [2] Typical.
- [3] Supplied with Model 030A10 Cable (3-56 coaxial plug to 10-32 coaxial plug) 10 feet long, attached to side exit connector.
- [4] Aluminum housing with insulating anodized finish.
- [5] See PCB Declaration of Conformance PS023 for details.

**SUPPLIED ACCESSORIES:**

- Model 039B04 Removal Tool (1)
- Model 080A109 Petro Wax Sample (1)
- Model 030 A10 Cable (Attached)
- NIST Traceable Calibration Certificate



Phone (888) 684-0013  
Fax (716) 685-3886  
E-Mail: svssales@pcb.com

3425 Walder Avenue, Depew, New York 14043

Drawn: <i>[Signature]</i>	Eng: <i>[Signature]</i>	Sales: <i>[Signature]</i>	App: <i>[Signature]</i>	Spec Number:
Date: <i>[Signature]</i>	Date: 10/27/99	Date: 10/27/99	Date: 10/27/99	10668

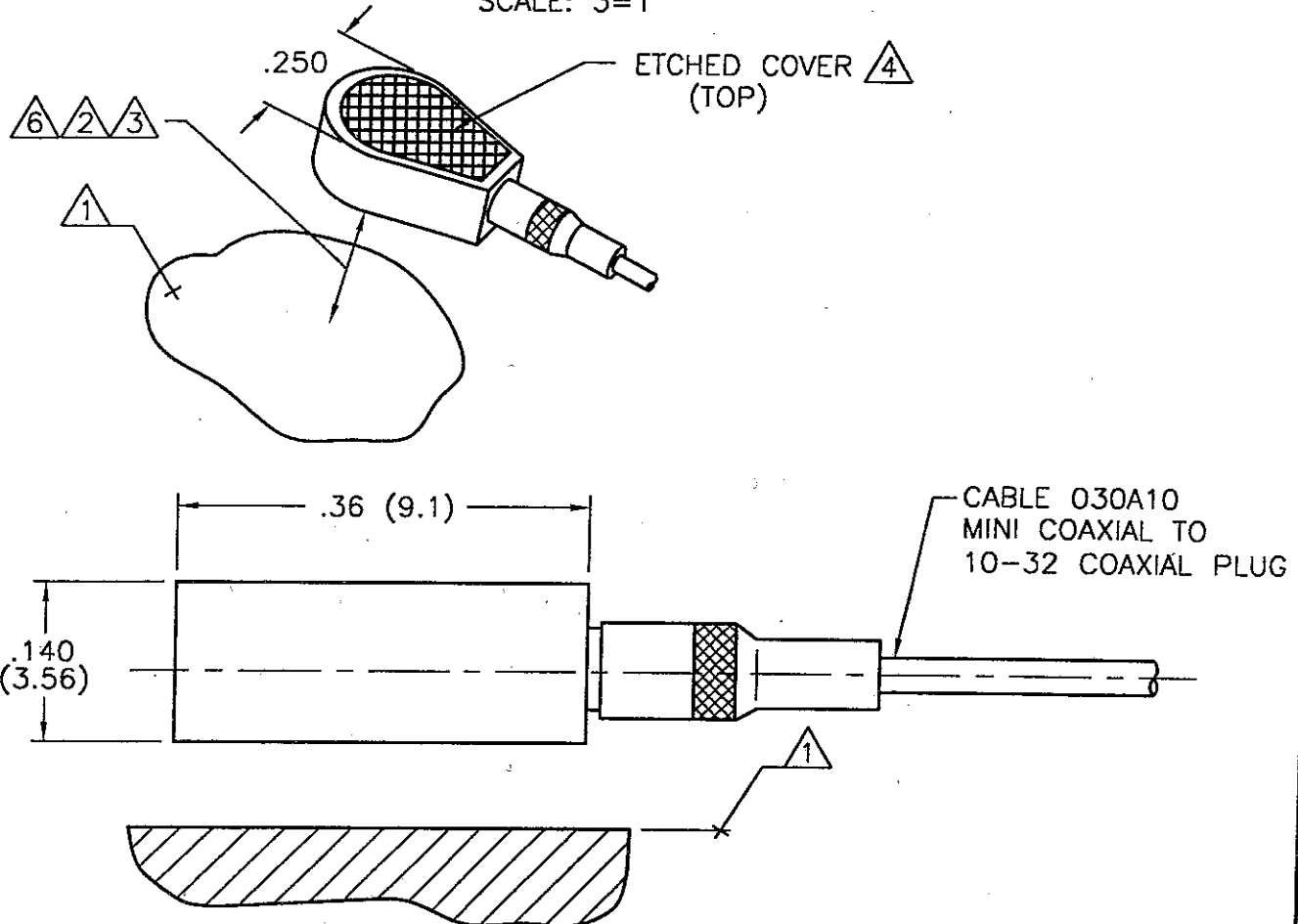
10600

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APPLICATION		
NEXT ASS'Y	USED ON	VAR

REVISIONS				
REV	DESCRIPTION	ECN	DATE	APP'D

3D VIEW  
SCALE: 3=1



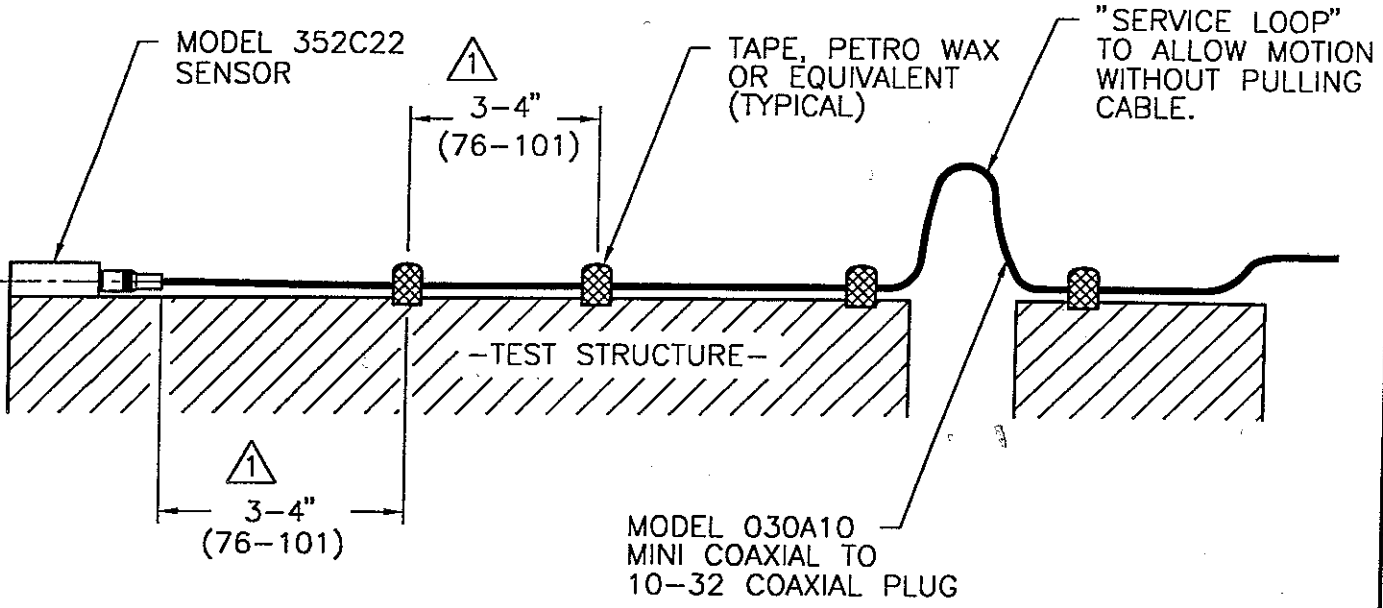
- ⚠ BE CAREFUL TO NOT APPLY "QUICK BONDING GEL" TO CONNECTOR THREADS, IMPROPER CONNECTOR MATING WILL RESULT.
- 5.) SEE SHEET 2 OF 2 FOR CABLE STRAIN RELIEF AND REMOVAL INFORMATION.
- ⚠ DO NOT MOUNT ON THIS SURFACE.
- ⚠ FOR SEMI-PERMANENT MOUNTING USE MODEL 080A90 "QUICK BONDING GEL" OR EQUIVALENT.
- ⚠ FOR TEMPORARY MOUNTING APPLICATIONS, USE PETRO WAX (MODEL 080A24). APPLY APPROXIMATELY 5 POUNDS(22 NEWTONS) OF FORCE TO TOP OF ACCELEROMETER CREATING A THIN BUT HOMOGENEOUS LAYER OF WAX.
- ⚠ RECOMMENDED MOUNTING SURFACE SHOULD BE FLAT TO WITHIN .003(.08) TIR OVER  $\phi .375(\phi 9.52)$  WITH A  $32\sqrt{(0.8\sqrt{)}}$  FINISH FOR BEST RESULTS.

UNLESS SPECIFIED TOLERANCES		DRAWN	<i>SRM</i>	<i>3/10/99</i>	MFG	<i>AL</i>	<i>3/10/99</i>	 3425 WALDEN AVE. DEPEW, NY 14043 (716) 684-0001 EMAIL: SALES@PCB.COM
DIMENSIONS IN INCHES	DIMENSIONS IN MILLIMETERS (IN PARENTHESIS)	CHK'D	<i>DM</i>	<i>3/10/99</i>	ENGR	<i>YJM</i>	<i>3/10/99</i>	
DECIMALS XX ±.01 XXX ±.005	DECIMALS XX ±0.3 XXX ±0.13	APP'D	<i>SRM</i>	<i>3/10/99</i>	SALES	<i>CSA</i>	<i>3/10/99</i>	
ANGLES ±2 DEGREES	ANGLES ±2 DEGREES	TITLE		INSTALLATION DRAWING MODEL 352C22 ACCELEROMETER		CODE IDENT. NO.	DWG. NO.	
FILLET AND RADII .003 - .005	FILLET AND RADII (0.07 - 0.13)	D0011 REV. B 03/13/98		SCALE: 6 X		SHEET 1 OF 2		

10600

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APPLICATION			REVISIONS				
NEXT ASS'Y	USED ON	VAR	REV	DESCRIPTION	ECN	DATE	APP'D
				-SEE SHEET ONE-			



2.) TO AVOID UNNECESSARY DAMAGE TO THE SENSOR AND/OR CABLE, USE THE SUPPLIED REMOVAL TOOL (MODEL 039B04). A QUICK TWISTING MOTION WILL FREE THE SENSOR FROM THE TEST STRUCTURE.

FASTEN CABLE TO TEST STRUCTURE TYPICALLY WITHIN 3-4" (76-101) OF SENSOR. THEN FASTEN AGAIN WITHIN 3-4" (76-101) OF PREVIOUS ATTACHMENT. BETWEEN THE TEST STRUCTURE AND A FIXED STRUCTURE, ALLOW A SERVICE LOOP LARGE ENOUGH TO PREVENT PULLING OF THE CABLE WHEN SHAKING. MORE ATTACHMENT POINTS WILL PROVIDE LESS NOISE IN THE RESULTING DATA. LOOSE CABLES OR PARTS ELSEWHERE ON THE TEST STRUCTURE CAN ALSO GENERATE "NOISE" ON THE SIGNAL RECEIVED FROM THE MODEL 352C22.

UNLESS SPECIFIED TOLERANCES		DRAWN	DM	3/10/99	MFG	AL	3/10/99	 3425 WALDEN AVE. DEPEW, NY 14043 (716) 684-0001 EMAIL: SALES@PCB.COM
DIMENSIONS IN INCHES	DIMENSIONS IN MILLIMETERS (IN PARENTHESIS)	CHK'D	DM	3/10/99	ENGR	JM	3/10/99	
DECIMALS XX ± .01 XXX ± .005	DECIMALS XX ± 0.3 XXX ± 0.13	APP'D	DM	3/10/99	SALES	CSA	3/10/99	
ANGLES ± 2 DEGREES	ANGLES ± 2 DEGREES	TITLE						CODE
FILLET AND RADII .003 - .005	FILLET AND RADII (0.07 - 0.13)	INSTALLATION DRAWING MODEL 352C22 ACCELEROMETER						DWG. NO.
DD011 REV. B 03/13/98								52681
							10600	SCALE: 1.25 X   SHEET 2 OF 2