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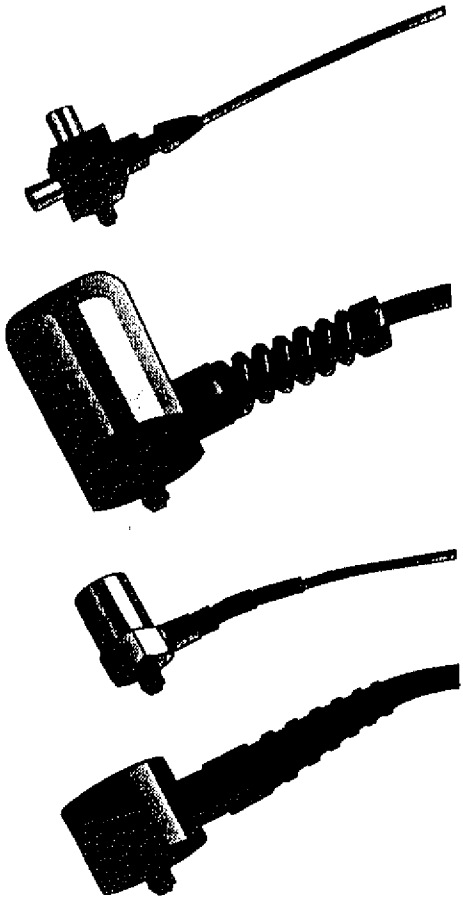
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User's Guide



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ACC 101, ACC 102, ACC 103, ACC 301
Accelerometers

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It is the policy of OMEGA Engineering, Inc. to comply with all worldwide safety and EMC/EMI regulations that apply. OMEGA is constantly pursuing certification of its products to the European New Approach Directives. OMEGA will add the CE mark to every appropriate device upon certification.

The information contained in this document is believed to be correct, but OMEGA accepts no liability for any errors it contains, and reserves the right to alter specifications without notice.
WARNING: These products are not designed for use in, and should not be used for, human applications.

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ACC 101, 102, 103, 301 ACCELEROMETERS
OPERATOR'S MANUAL TABLE OF CONTENTS

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SECTION 1 - INTRODUCTION

Thank you for selecting our accelerometer for your application. You have made an outstanding choice by selecting this OMEGA Engineering product and we are glad to provide you with the best accelerometer that modern technology can offer. This equipment has set the world standard for excellence and should provide you with years of faithful service.

Before you use your accelerometer, please read this manual to insure the maximum performance of your unit. If you should have any problem with this equipment, please call our Customer Service Department at 1-(800) 622-2378. There are customer service people available to help you between 8:30 AM and 5:00 PM (EST) Monday through Friday.

SECTION 2 - UNPACKING YOUR ACCELEROMETER

Remove the packing list and verify that all equipment has been received. If there are any questions about the shipment, please call OMEGA Customer Service Department at 1-(800) 622-2378 or (203) 359-1660.

Upon receipt of the shipment, inspect the container and equipment for any signs of damage. Take particular note of any evidence of rough handling in transit. Immediately report any damage to the shipping agent.

NOTE:

The carrier will not honor any claims unless all shipping material is saved for their examination. After examining and removing contents, save the packing material and carton in the event reshipment is necessary.

The accelerometer comes packaged in its own protective case which may also contain a cable (integral or separate). Each accelerometer is equipped with an insulating thermal boot. The boot may already be fitted over the accelerometer and may or may not be removable depending upon the model. The package may also contain an isolating mounting stud, spacing washers, a magnet assembly, or other special part. Care should be taken not to loose any part including the case which can continue to be used to accommodate the accelerometer, accessories, and calibration data sheet.

Notice that the serial number and sensitivity of the unit is indicated on the calibration data sheet. The data sheet also includes performance specifications that are endorsed for the particular unit.

SECTION 3 - UNDERSTANDING YOUR ACCELEROMETER

WHAT IS AN ACCELEROMETER?

An accelerometer is a device for measuring shock and vibration. An accelerometer transduces the acceleration of an object into a proportional analog signal. The analog signal indicates the real-time, instantaneous acceleration of the object on which the accelerometer is mounted.

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HOW DOES IT WORK?

Piezoelectric Accelerometers

Mounted within the accelerometer housing is a piezoelectric crystal affixed to a small mass. This mass is coupled to the supporting accelerometer base through the piezoelectric crystal. When the accelerometer is subjected to an acceleration, the mass exerts a force on the crystal. This force results in a charge output of the crystal that is directly proportional to the input acceleration.

There are many piezoelectric crystal materials that are useful in accelerometer construction. The most common materials used are ceramic Lead Metaniobate, Lead Zirconate, Lead Titanate, and natural quartz crystal. There are also many different mechanical configurations of the masses and crystals within the accelerometer case.

The materials and physical construction used in an accelerometer design are selected to furnish the particular performance characteristics desired. For more information about the construction of your accelerometer refer to the appropriate sales bulletin or contact OMEGA Engineering, Inc.

HIGH IMPEDANCE OR LOW IMPEDANCE?

There are two distinctly different types of accelerometers that are manufactured. These are "high impedance" and "low impedance" types. Essentially, if the output sensitivity is specified in mV/g (millivolts per g) such as 10mV/g or 100mV/g, then you are working with a low impedance sensor. If the output sensitivity is specified in units of pC/g (pico coulombs charge per g) then you are working with a high impedance sensor. OMEGA's accelerometers are the low impedance type of accelerometer (see Figure 3-1).

A low impedance accelerometer is one in which the electronics required to detect the charge generated by the piezoelectric crystal are built right into the case of the sensor. In this way, "high" to "low" impedance transformation is done at the point of measurement and only low impedance signals are transmitted from the sensor. The low impedance output is desirable for driving long cables and it provides a proper impedance match to virtually all conventional data acquisition systems.

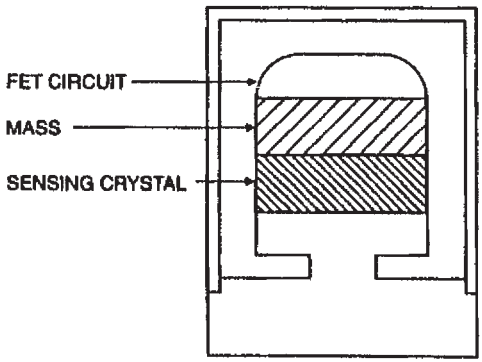


Figure 3-1. Low Impedance Accelerometer

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LOW IMPEDANCE MICRO CIRCUIT

OMEGA has a broad line of micro circuits which yield excellent low impedance output characteristics. These hybrid circuits often include special filtering capabilities and protection schemes. The specific micro chip properties are engineered to create the output characteristics desired. They are extremely rugged and capable of withstanding extremely high shock without damage or degradation of performance. Additional circuit protection schemes include:

- ESD protection
- cross wire protection
- over voltage protection

When used properly within specified limits, OMEGA's accelerometers will provide years of reliable, trouble-free service.

NOISE IN ACCELEROMETERS

Electrical Grounding

An accelerometer may be designed with the output signal ground either connected to the case of the accelerometer or isolated from the case of the accelerometer.

Case Grounded Accelerometers

Case grounded accelerometers (see Figure 3-2) are connected electrically to any conductive surface on which they are mounted. When these units are used, care must be exercised to avoid errors due to ground noise. These case grounded accelerometer cases should not be allowed to conduct to any outside potential or noise source.

The case ground type accelerometer should not be selected for applications where ground loops might be problem, such as machinery monitoring. OMEGA Model ACC 103 is a case grounded accelerometer.

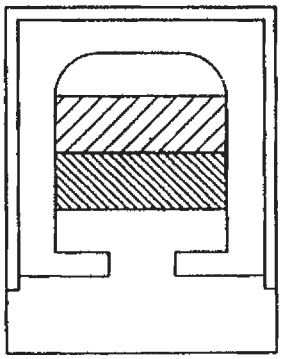


Figure 3-2 Case Grounded Accelerometer

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Case Isolated Accelerometers

Case isolated accelerometers (see Figure 3-3) are isolated electrically from any conductive surface on which they are mounted. Isolated accelerometers from OMEGA are built in a variety of configurations and they eliminate any possibility of ground noise interiection. OMEGA Models ACC 101, ACC 102, and ACC 301 are case isolated accelerometers.

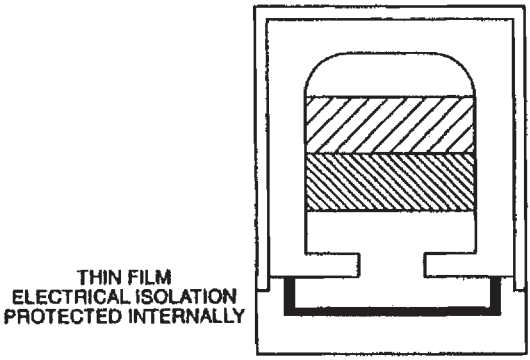


Figure 3-3. Case Isolated Accelerometer

GENERAL CHARACTERISTICS

Axis of Sensitivity

Most accelerometers are built to be sensitive to motion in one major axis. Normally, the accelerometer will transduce shock and vibration that is input normal to the accelerometer's mounting base. It should be noted that the accelerometer will have some sensitivity to motion in the other two orthogonal axes. This transverse or cross axis sensitivity is minor and usually amounts to less than 5% of the major axis sensitivity.

Triaxial Accelerometers

The triaxial units essentially have three single axis accelerometers integrated into a single package. Triaxial units have three independent output signals. In triaxial units the three sensors share the same ground conductor requiring only a 4-wire connector. Note that most single axis accelerometers are two wire systems and most triaxial accelerometers are 4-wire systems.

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SECTION 4 - POWER REQUIREMENTS

The low impedance type of accelerometer must be powered by a constant current power source. Modern data acquisition systems (oscilloscopes, FFT analyzers, data collectors, etc.) often have this constant current power supply built in.

The power required to drive the accelerometer is typically 2-4 mA at either 15 or 24 volts. Please refer to the specifications describing your particular model for clarification on its power requirements. Further note that all OMEGA accelerometers will not be damaged even if the power supply provides constant current as high as 10 mA or voltage as high as 30 volts. Incorrect powering may impede some of the operating characteristics such as dynamic range, temperature range, and noise level.

You should take care not to exceed the 10 mA current limit. If a custom power supply is used, it must incorporate a 2 mA constant current diode in series with the output to insure that the accelerometer is not over-powered.

POWER SUPPLIES

If the data acquisition system being used does not incorporate its own power supply then a separate power supply must be used. OMEGA manufactures single channel and multiple channel accelerometer power supplies.

Low impedance accelerometers do not require much power and it is preferable that a very low noise regulated power supply be used. For this reason, it is often appropriate to use a battery powered unit for powering the accelerometer. The battery-powered unit offers the cleanest (low noise) characteristics and can be offered in either NiCad rechargeable or disposable battery pack versions. Regulated line power supplies are also available for these applications where power must stay on for extended periods of time. Please refer to the appropriate sales bulletins and operating manuals provided for each OMEGA power supply. Figure 4-1 illustrates how a low impedance accelerometer should be connected to a constant current power supply. This schematic diagram shows the basic components within the accelerometer and power supply.

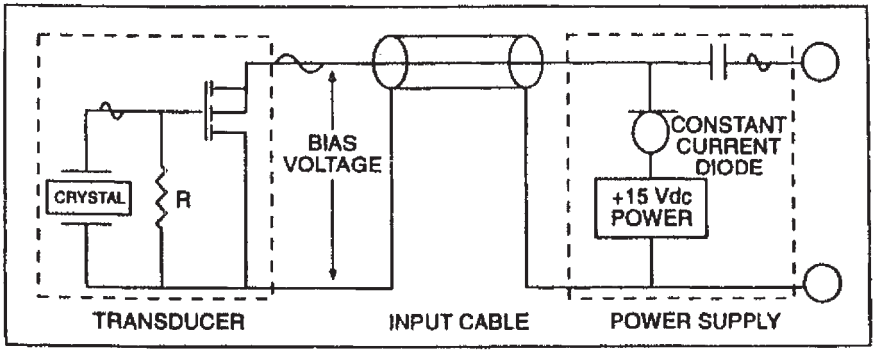


Figure 4-1. Low Impedance Accelerometer Interconnection

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Some data acquisition systems incorporate the power supply portion of the schematic diagram. In these instances, the accelerometer is simply fed into the data acquisition system's input connector which may be labeled "Accelerometer In" or Integrated Circuit Power" (see Figure 4-2).

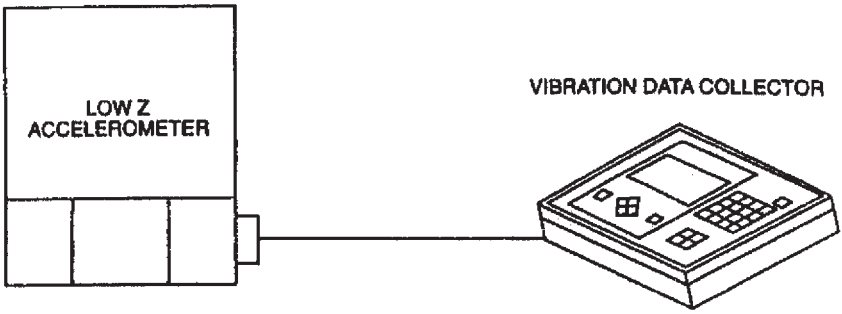


Figure 4-2. Low Impedance Wiring Directly to Instrumentation

For those applications where the data acquisition system does not supply the constant current power, an external power supply must be used. Essentially, the accelerometer should be connected to the power supply connector labeled "Acceleration In." The power supply connector labeled "Output" should be connected to the input of the data acquisition system being used (see Figure 4-3).

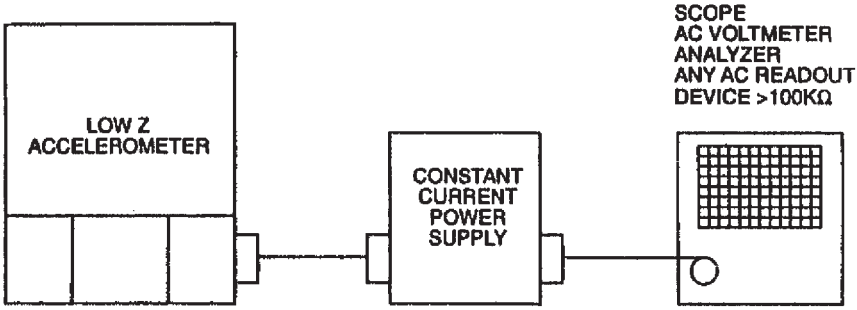


Figure 4-3. Low Impedance Wiring to Power Supply and Instrumentation

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SECTION 5 - CONNECTOR WIRING

COAXIAL CONNECTORS

Most single axis sensors use a coaxial cable terminating in a coaxial connector. In these cases the center conductor is used for sending power to the accelerometer. The center conductor is also used to transmit the dynamic acceleration signal from the accelerometer. The shield of the coaxial cable is used as ground for the power supply and acceleration signal. Figure 5-1 shows the coaxial connection.

TWO PIN CONNECTORS

Some single axis accelerometers use a two pin connector in place of the typical coaxial type. The two pins are connected within the accelerometer in the same way that coaxial connectors are wired. The result is that the two pins correspond to the center conductor and shield of a coaxial accelerometer. The two pin configuration lends itself to be wired with either coaxial cable or with shielded twisted pair wire. Figures 5-1 and 5-2 depict these two conventional wiring schemes.

FOUR PIN CONNECTORS

Triaxial accelerometers use four pin connectors. In these cases, three of the pins are used for powering the three individual accelerometers. The three independent acceleration signals are also present on these same three lines. The fourth pin is the ground conductor and is shared among all three integral sensors. Please refer to the individual specifications for your triaxial unit to determine the particular pinout configuration.

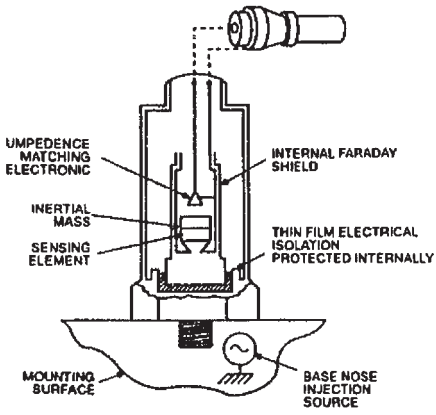


Figure 5-1. Coaxial Cable Connection

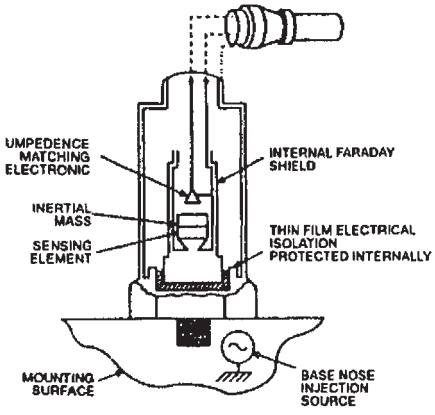


Figure 5-2. Two-Pin (Twisted Pair) Cable Connection

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SECTION 6 - CABLING TECHNIQUES

As stated, no special "noise treated" cables are required when operating with low impedance accelerometers. Signals may be run over any conventional instrumentation grade two wire twisted pair shielded or coaxial cable.

SECURING CABLES

Figure 6-1 shows the recommended method of securing cables. These conventions minimize cable or connector fatigue failures and consequent loss of data. Typically, low impedance devices are not affected by sharp cable bends or cable motion.

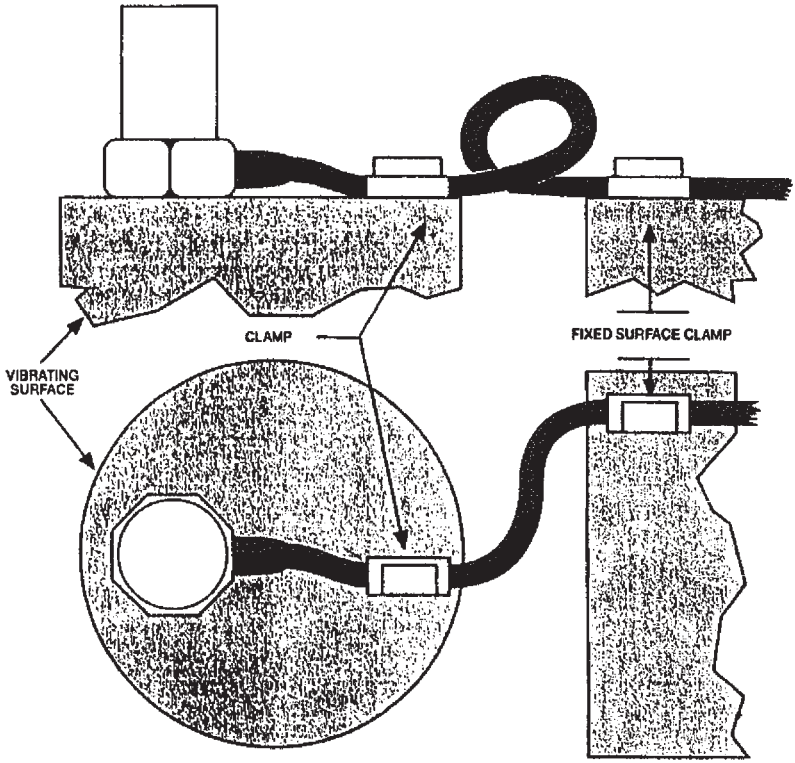


Figure 6-1. Cable Routing and Securing

SPLICING & EXTENDING CABLES

Common sense and care should be used when splicing and extending cables. Of course, it is always a good idea to turn off all power and, if possible, disconnect the accelerometer and power supply when performing this work.

When extending a coaxial cable, it is advisable to use coaxial connectors. Male and female cable connectors are readily available for this purpose (i.e., BNC to BNC, TNC to TNC, 10-32 to 10-32, etc.). These adapters and extension cables are available from OMEGA.

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NOTE

The outside shell of these splicing connectors is the accelerometer signal ground. The splice connector shell should not be allowed to touch ground or conduct to any outside potential or noise source. Letting a connector (which is signal common) touch ground can cause ground loop noise interjection.

When working with permanently routed cable systems it is recommended that the splices be sealed with heat shrink (see Figure 6-2). Some heat shrink products contain heat activated two-part epoxy which provides a watertight seal over the splice.

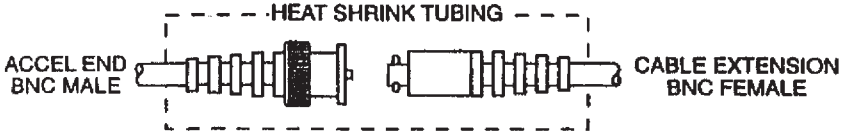


Figure 6-2. Cable Splice with Heat Shrink

SECTION 7 - MOUNTING THE ACCELEROMETER

For reliable vibration data, particularly at high frequencies, it is important that your accelerometer be mounted correctly. Different mounting techniques provide for different frequency response characteristics from the accelerometer. Figure 7-1 is a frequency response plot describing the relative merits of seven common mounting techniques.

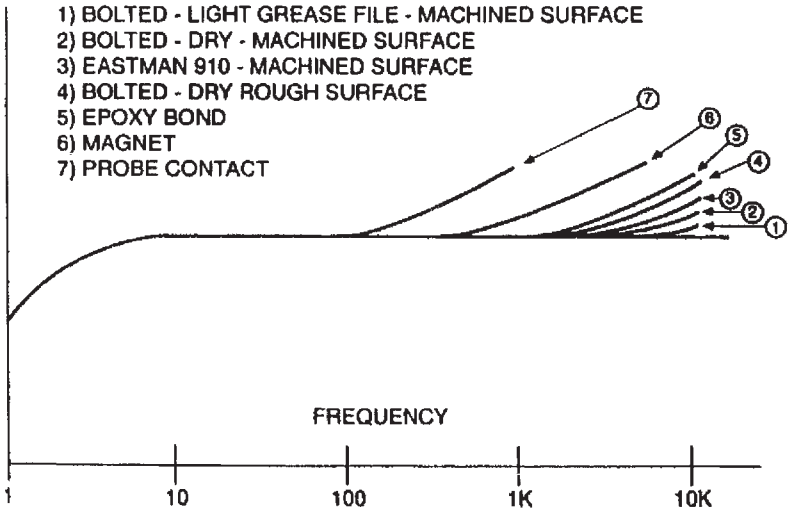


Figure 7-1. Frequency Response of Different Mounting Techniques

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STUD MOUNTING

Most OMEGA accelerometers have a mounting stud protruding from the bottom of the unit. This stud may or may not be removable, depending upon the model. When attaching the accelerometer with the mounting stud, you should make certain that the mating hole is clean of debris and that it is deep enough to accommodate the mounting stud. The surface should be flat, clean, and dry. Refer to Tables I and II below for the recommended flatness, perpendicularity, and bolt seating torque.

For those applications requiring a flat bandwidth above 4KHz, a light film of grease may be applied between the accelerometer and the mounting surface. The grease film provides enhanced dynamic transmission at the higher frequencies.

Table I **Mounting**	**Table II** **Adhesives**
Surface Flatness: .0004 TIR	Armstrong A36
Surface Roughness: 32 Microinch rms	Belzona Super Metal
Hole Perpendicularity: 1 degree causes 0.015% error	Ciba-Geigy 8504 Eastman 910
Tap Class: 2	Hysol 309
Mounting Torque: 6-32 10 in-lb 10-32 20 in-lb 1/4-28 35 in-lb	Tridox F88 Ultra Bond 522 Cyanoacrylate Type Cements

ADHESIVE MOUNTING

Practically all accelerometers lend themselves to be adhesively bonded to an object. Temporary bonds can be achieved with many different tacky adhesives, beeswax, or cyanoacrylate type cements (such as Krazy Glue). These types of bonds are easily peeled off or broken off in shear. More permanent bonds can be achieved with two part epoxy adhesives. Refer to Table II above for a list of recommended adhesives. Notice that there are many other good, permanent, two part adhesives which may be used for accelerometer bonding. Further note that the durability of the adhesive is quite often better for slow curing adhesives that it is for fast curing types.

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ADHESIVE MOUNTING BUSHINGS

An adhesive mounting bushing may be bonded to an object so that the accelerometer may be screwed into the bushing rather than into the object being measured. This is appropriate for those applications where it is not practical to drill into an object for stud mounting. It is also appropriate for applications where it is anticipated that the accelerometer will need to be removed periodically.

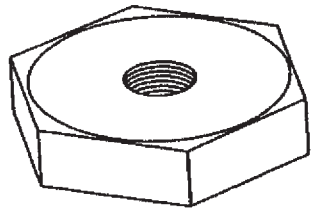


Figure 7-2. Adhesive Mounting Bushing

The bushings may be welded or adhesively bonded in place. Care should be taken when bonding the bushings to make certain no adhesive is allowed to seep into the bushing's mounting hole. This can be avoided by threading the accelerometer or a dummy bolt into the bushing before bonding it to the surface. Additional care should be taken to prevent uncured adhesive from being drawn up through the hole when the accelerometer or bolt is removed.

MAGNETIC MOUNTING

Magnets are not generally recommended for measurements above 5KHz. They are quite adequate for lower frequency measurements and can be helpful when a single accelerometer is used to measure a great number of points. The obvious requirement is that the measurement point must be ferro-magnetic so that the magnet can stick to it.

A flat magnet with smooth machined surfaces and perpendicular mounting hole is recommended. This allows the magnet to bond efficiently to the mounting surface providing good dynamic transmissibility. For those points where the magnet does not seat well, it may be necessary to bond a sizeable ferro-magnetic bushing. Note that most adhesive mounting bushings are made of Series 300 stainless steel which will not rust and is not ferro-magnetic.

As with other mounting techniques, a thin film of grease can be used to enhance the dynamic transmissibility when using a magnet.

Using horse-shoe (or U-shaped) magnets on curved surfaces, although popular, should be restricted to measurements below 1 KHz. See figure 7-3 for an example of magnetic mounting.

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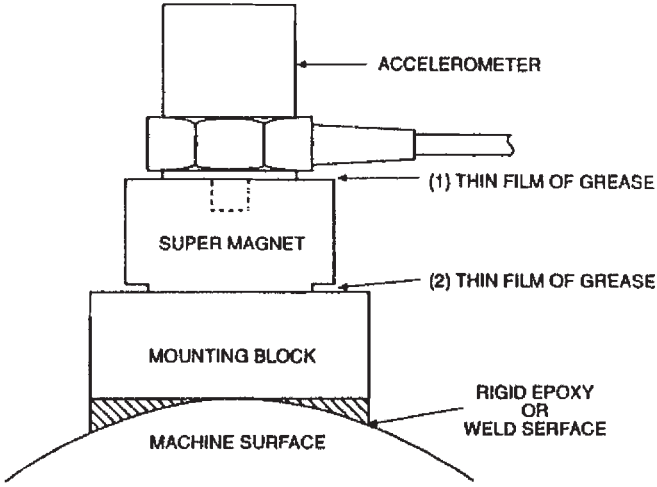


Figure 7-3. Magnetic Mounting

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SECTION 8 - SPECIFICATIONS

The performance specifications for OMEGA accelerometers are very well defined and listed in this section. Refer to the appropriate sales bulletin and the calibration certificate which is supplied with each accelerometer product for more information.

BASIC SENSITIVITY

OMEGA's low impedance accelerometers are standardized into two major output sensitivity groups: 10mV/g and 100mV/g. The basic sensitivity specification represents the output of the accelerometer as measured at 100Hz. Of course, the basic sensitivity varies from one unit to the next within fixed limits.

This limit is usually specified at ±5%.

A ±5% specification on this basic sensitivity means that a particular 100mV/g unit may be manufactured with a sensitivity which is actually between 95mV/g and 105mV/g. The actual sensitivity for each unit is verified at 100 Hz and recorded on the accelerometer's calibration certificate.

BASIC FREQUENCY RESPONSE

The frequency response specification for an accelerometer indicates how much the actual sensitivity may vary over the useable frequency range. Typically this frequency response specification is stated to be ±5% over a specified frequency range. Figure 8-1 depicts a typical wide band frequency response for an accelerometer. The useable frequency range within a ±5% frequency response specification is indicated by the frequencies between points A and B.

This frequency response specification should not be confused with the basic sensitivity specification.

Example: If a unit has an actual sensitivity of 95mV/g at 100 Hz and a frequency response specification of ±5%. The actual sensitivity at a frequency within the operating frequency range may be as high as 100mV/g or as low as 90mV/g.

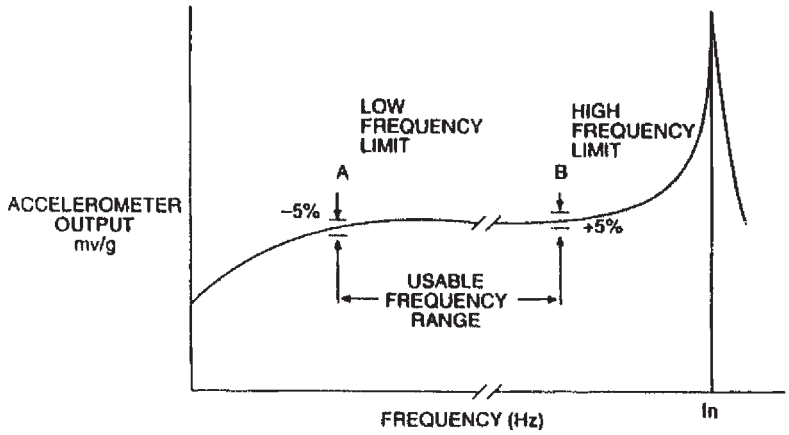


Figure 8-1. Typical Frequency Response Plot

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ACC 101 SPECIFICATIONS

Excitation:	2mA nominal @ 20 to 30 Vdc, constant current
Rated Output:	100 mV/g nominal @ 100 Hz
Frequency Range:	3 Hz to 5 KHz (up to ± 10% rated output shift)
Amplitude Range:	± 80 g peak
Amplitude Linearity:	± 1% up to 65 g peak
Temperature Range:	0 to 180°F (-18 to 80°C)
Temperature Sensitivity Effect:	-65 to 100°F = less than 5% FS 100 to 250°F = less than 8% FS
Thermal Shock:	1.2 g/°C
Transverse Sensitivity:	5% of axial maximum
Maximum g Without Damage:	5,000 g peak
Maximum g Without Clipping:	± 80 g peak
Mounted Resonance Frequency:	>18 KHz
Output Impedance:	50 ohms nominal
Bias Voltage:	10 V nominal
Base Strain:	0.002 g/microstrain maximum
Noise Floor (wideband):	0.00025 g (rms)
Weight:	50 grams nominal (without cable)
Material:	aluminum, hard-anodized thermal insulating boot included
Dimensions:	0.50" height x 1.0 hex base
Connector:	10 ft. integral coaxial cable to BNC side exit
Mounting:	1/4-28 removable stud
Mounting Torque max:	20 in-lb (22 cm-kg)

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ACC 102 SPECIFICATIONS

Excitation:	2mA @ 24 to 30 Vdc, constant current
Rated Output:	100 mV/g nominal @ 100 Hz
Frequency Range:	3 Hz to 8 KHz (up to ± 5% rated output shift)
Amplitude Range:	± 75 g peak
Amplitude Linearity:	± 1% up to 65 g peak
Temperature Range:	-40 to 180°F (-40 to 80°C)
Temperature Sensitivity Effect:	-65 to 100°F = less than 5% FS 100 to 250°F = less than 8% FS
Thermal Shock:	1.2 g/°C
Transverse Sensitivity:	7% of axial maximum
Maximum g Without Damage:	5,000 g peak
Maximum g Without Clipping:	± 75 g peak
Mounted Resonance Frequency:	>23 KHz nominal
Output Impedance:	200 ohms nominal
Bias Voltage:	13 V nominal
Base Strain:	0.04 g/microstrain maximum
Noise Floor (wideband):	0.0003 g (rms)
Weight:	50 grams nominal (without cable)
Material:	Inner Housing: 303 stainless steel Outer Jacket: non-conductive composite polymer
Dimensions:	0.75" height x 1.00" diameter
Connector:	10 ft. integral coaxial cable to BNC side exit
Mounting:	10 - 32 removable stud
Mounting Torque max:	20 in-lb (22 cm-kg)

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ACC 103 SPECIFICATIONS

Excitation:	2mA nominal @ 15 to 30 Vdc, constant current
Rated Output:	10 mV/g nominal @ 100 Hz
Frequency Range:	3 Hz to 10 KHz (up to ± 5% rated output shift)
Amplitude Range:	± 500 g peak
Amplitude Linearity:	± 2% up to 400 g peak
Temperature Range:	-65 to 250°F (-55 to 120°C)
Temperature Sensitivity Effect:	-65 to 100°F = less than 5% FS 100 to 250°F = less than 8% FS
Thermal Shock:	3 g/°C
Transverse Sensitivity:	5% of axial maximum
Maximum g Without Damage:	10,000 g peak
Maximum g Without Clipping:	± 500 g peak
Mounted Resonance Frequency:	>60 KHz
Output Impedance:	1000 ohms nominal
Bias Voltage:	7 V nominal
Base Strain:	0.003 g/microstrain maximum
Noise Floor (wideband):	0.0012 g (rms)
Weight:	15 grams nominal (without cable)
Material:	303 stainless steel thermal insulating boot included
Dimensions:	0.75" height x .5" hex base
Connector:	10 - 32 side coaxial 6 ft cable included (10 - 32 to BNC)
Mounting:	10 - 32 removable stud
Mounting Torque max:	20 in-lb (22 cm-kg)

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ACC 301 SPECIFICATIONS

Excitation:	2mA nominal @ 15 to 30 Vdc, constant current
Rated Output:	10 mV/g nominal @ 100 Hz per axis
Frequency Range:	3 Hz to 10 KHz (up to ± 5% rated output shift)
Amplitude Range:	± 500 g peak
Amplitude Linearity:	± 2% up to 400 g peak
Temperature Range:	-65 to 250°F (-55 to 120°C)
Temperature Sensitivity Effect:	-65 to 100°F = less than 5% FS 100 to 250°F = less than 8% FS
Thermal Shock:	3 g/°C
Transverse Sensitivity:	5% of axial maximum
Maximum g Without Damage:	5,000 g peak
Maximum g Without Clipping:	± 500 g peak
Mounted Resonance Frequency:	>50 KHz
Output Impedance:	1000 ohms nominal
Bias Voltage:	7 V nominal
Base Strain:	0.005 g/microstrain maximum
Noise Floor (wideband):	0.0015 g (rms)
Weight:	10 grams nominal (without cable)
Material:	titanium
Dimensions:	0.75" height x 0.5" square
Connector:	side 4 pin, 1/4 - 28 thread 6 ft cable included (1/4 - 28 to 3 BNCs)
Mounting:	10 - 32 removable stud
Mounting Torque max:	20 in-lb (22 cm-kg)

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WARRANTY/DISCLAIMER

OMEGA ENGINEERING, INC. warrants this unit to be free of defects in materials and workmanship for a period of **13 months** from date of purchase. OMEGA's WARRANTY adds an additional one (1) month grace period to the normal **one (1) year product warranty** to cover handling and shipping time. This ensures that OMEGA's customers receive maximum coverage on each product.

If the unit malfunctions, it must be returned to the factory for evaluation. OMEGA's Customer Service Department will issue an Authorized Return (AR) number immediately upon phone or written request. Upon examination by OMEGA, if the unit is found to be defective, it will be repaired or replaced at no charge. OMEGA's WARRANTY does not apply to defects resulting from any action of the purchaser, including but not limited to mishandling, improper interfacing, operation outside of design limits, improper repair, or unauthorized modification. This WARRANTY is VOID if the unit shows evidence of having been tampered with or shows evidence of having been damaged as a result of excessive corrosion; or current, heat, moisture or vibration; improper specification; misapplication; misuse or other operating conditions outside of OMEGA's control. Components in which wear is not warranted, include but are not limited to contact points, fuses, and triacs.

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The purchaser is responsible for shipping charges, freight, insurance and proper packaging to prevent breakage in transit.

FOR **WARRANTY** RETURNS, please have the following information available BEFORE contacting OMEGA:

1. Purchase Order number under which the product was PURCHASED,
2. Model and serial number of the product under warranty, and
3. Repair instructions and/or specific problems relative to the product.

FOR **NON-WARRANTY** REPAIRS, consult OMEGA for current repair charges. Have the following information available BEFORE contacting OMEGA:

1. Purchase Order number to cover the COST of the repair,
2. Model and serial number of theproduct, and
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OMEGA's policy is to make running changes, not model changes, whenever an improvement is possible. This affords our customers the latest in technology and engineering.

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