



Dynamic Transducers and Systems

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OPERATING GUIDE

MODELS 3145A2 & 3145A2G

ULTRA-MINIATURE HIGH FREQUENCY

MINIATURE LIVM™ ACCELEROMETERS,

HERMETICALLY SEALED

NOTE:

Models 3145A2 and 3145A2G feature very low mass and hermetically sealed construction. Hermeticity is obtained by all-welded construction and glass-to-metal sealed connectors. Electrical connections are via a top mounted 5-44 coaxial connector. The nominal sensitivity of these models is 5.0 mV/G. Model 3145A2 features a 5-40 integral mounting stud while Model 3145A2G is designed for adhesive mounting. All other specifications are similar.

This guide contains:

- 1) Operating instructions, Models 3145A2 & A2G.
- 2) Outline/installation drawing, 127-3145A2 & A2G
- 3) Specifications, Model 3145A2 & A2G
- 4) Paper, "Low Impedance Voltage Mode (LIVM) Theory and Operation.

NOTE: LIVM™ is Dytran's trademark for its line of Low Impedance Voltage Mode sensors with built-in amplifiers operating from constant current sources over two wires. LIVM instruments are compatible with all comparable systems designated IEPE.

OPERATING INSTRUCTIONS MODELS 3145A2 & 3145A2G MINIATURE LIVM ACCELEROMETERS

INTRODUCTION

The Dytran Model 3145A2/3145A2G accelerometers feature **Low Impedance Voltage Mode (LIVM)** operation and small size, weighing only 2.5 grams. LIVM operation means that these instruments function via a single coaxial cable, signal and input power sharing the same cable.

The self-generating planar shear mode seismic element, utilizing piezoceramic crystalline materials, converts input acceleration (vibration and shock) to an analogous charge signal. This very high impedance signal is fed to the gate of a tiny on-board IC MOSFET charge amplifier which drops the output impedance level ten orders of magnitude allowing this instrument to drive long cables without appreciable effect on sensitivity and frequency response.

Simple constant current type LIVM power units supply power to operate the integral IC and separate the signal from the DC bias of the internal amplifier. Coaxial cables or even twisted pair wire may be used to connect accelerometer to power units.

Models 3145A2/A2G also feature hermetic sealed construction for normal operation in moist and dirty environments. The nominal sensitivity of Series 3145A2 is 5.0 mV/G

DESCRIPTION

Figure 1, below, is a representative cross section of Model 3145A2.

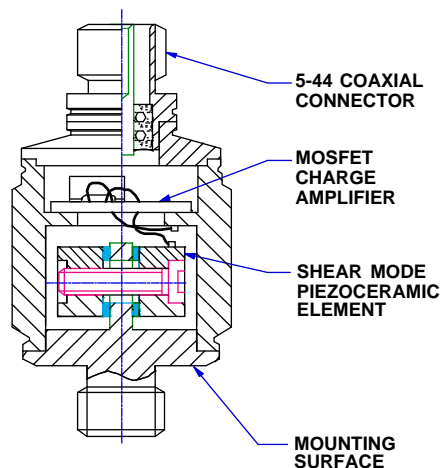


Figure 1-Cross section, Model 3145A2

The seismic masses, made from a very dense tungsten alloy, are tightly preloaded against the piezoceramic crystals by means of a special preload screw under very high compressive force. This is so there is absolutely no relative motion between mass, crystals and base keeping the non-linearity low and the natural frequency high.

The force from acceleration (vibration or shock) acting upon the mounting base, is transferred to the seismic mass through the crystals, stressing the crystals in shear mode and producing an electrostatic charge exactly analogous to the input acceleration. This dynamic charge is impressed across the gate of the MOSFET IC charge amplifier.

The IC amplifier is a miniature charge amplifier operating over 2 conductors and it converts the electrostatic charge generated by the shear mode element into a low impedance voltage which is able to drive long cables directly. (See Figure 2 below)

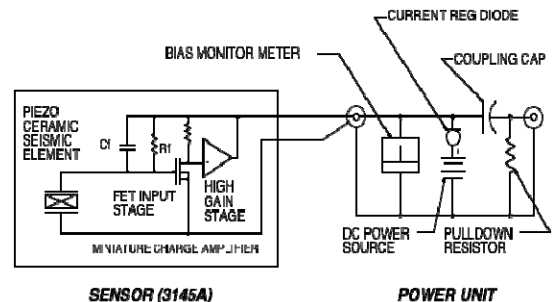


Figure 2-Electro-mechanical schematic, accelerometer and power unit system.

When constant current from the LIVM power unit is applied to the accelerometer amplifier input terminal, the amplifier "turns on" (self biases) at approx. +9 Volts DC quiescent bias level. When the accelerometer senses acceleration, the resultant dynamic signal is superimposed upon this bias voltage. In the power unit, in its simplest form, a capacitor blocks the DC bias and allows the dynamic signal voltage to be separated and brought out to an "output" jack on the power unit. At this point the signal may be connected directly to almost any type of readout instrument such as DVM's, oscilloscopes, data

collectors, spectrum analyzers, etc. The approximate 100 Ohm output impedance of the signal allows the driving of long cables without adverse effects on sensitivity or frequency response.

Referring to figure 2, the feedback resistor R_f serves to bias the gate of the IC to its proper operating point and it also, in conjunction with feedback capacitance C_f , forms a first order high-pass filter which sets the low frequency response of the accelerometer in accordance with the following equation:

$$f_{-3db} = \frac{.16}{RC} \quad (\text{eq.1})$$

where:

f_{-3db} = lower -3db frequency (Hz)

R = resistance value R_f (Ohms)

C = total shunt capacitance C_f (Farads)

RC = discharge time constant TC (Seconds)

Equation 1 above, defines the low frequency at which the accelerometer sensitivity will be 3db down when compared to the reference sensitivity measured at 100 Hz.

The discharge time constant for Model 3145A2/A2G is 0.5 Sec. yielding a lower -3db frequency of 0.32 Hz, from equation 1.

As rule of thumb, the lower -5% frequency is three times the -3db frequency or $3 \times .32 = 0.96$ Hz.

INSTALLATION, 3145A2

(Refer to Outline/Installation drawing 127-3145A2). To install Model 3145A2, is necessary to prepare (or find) a flat mounting area of at least 1/4 inch diameter ($\varnothing.250$). Ideally, the mounting surface should be flat to .001 in. TIR. The flat mounting surface ensures intimate contact between accelerometer base and mounting surface for best high frequency transmissibility, thus accuracy.

At the center of the mounting area, drill and tap a 5-40 mounting port in accordance with instructions on drawing 127-3145A2. Clean the area to remove all traces of machining chips, burrs, etc.

Next, thread the integral mounting stud of model 3145A2 into the tapped hole. The stud should enter easily and thread in up to the point where the mounting surface of the accelerometer meets the test

mounting surface. Check to see that the mating surfaces are meeting properly, i.e., that they are meeting flush and that there is not an angle formed between the two surfaces indicating that they are not co-planar. If this condition is observed, torquing the accelerometer down will strain the base possibly causing poor frequency response and even erroneous reference sensitivity. Inspect the perpendicularity of the tapped hole.

After ensuring that the surfaces meet squarely, back the accelerometer out and spread a light coating of silicone grease, or other lubricant, on either of the mating surfaces and thread the accelerometer back into the tapped hole by hand, then torque the 3145A2 to the mating surface with 8 to 10 lb-inches of torque, preferably measuring the torque with a torque wrench torquing on the hex surface only.

Proper torque will ensure the best high frequency performance from the instrument as well as repeatability of sensitivity when mounting and remounting.

Remember, the 5-40 integral stud is very small and overtightening can break it.

Connect the cable (typically Models 6014AXX, 6024AXX or 6040AXX) to the accelerometer snugging up the threaded cable lock ring tightly by hand.

NOTE: Do not use a pliers or vise grips on the knurled lock ring. This could damage the connector of the 3145A2 and/or the cable connector.

To avoid stressing the cables which could lead to early failure, especially under larger excursions of the test object, it is good practice to tie the cable down to a fixed surface near the mounting area at a point approximately one inch from the accelerometer.

If there is excessive motion between the accelerometer and the nearest tie point, allow a strain loop of cable to let relative motion occur without stressing the cable.

Connect the other end of the cable to the "Sensor" jack of the Dytran power unit (Models 4102, 4103, 4110, 4114, etc.) and switch the power on.

Observe the monitor voltmeter located at the front panel of each of the power units. If the meter reads in the mid-scale region, (labeled "Normal"), this tells you that the cables, accelerometer and power unit are functioning normally and you should be able to proceed with the measurement.

Check for shorts in the cables and connectors if the meter reads in the "Short" region. Check for open cables or connections if the meter reads in the "Open" area. In this manner, the meter becomes a trouble shooting tool for the measurement system.

Consult the guide "Low Impedance Voltage Mode (LIVM) Theory and Operation", included with this manual, for a more complete guide to using the fault monitor meter as a trouble-shooting tool.

INSTALLATION, MODEL 3145A2G

To install model 3145A2G, it is necessary to prepare a flat, clean surface of at least 1/4 in. diameter. It is important that there is intimate contact between mounting surfaces for best high frequency response and for maximum adhesive joint strength. The recommended adhesive is the "Instant" cyanoacrylate adhesive. Use it sparingly and according to the manufacturers recommendation.

To remove the accelerometer, twist gently on the hex body until the adhesive fails in shear. Do not strike or pry to remove. This type of trauma may damage the accelerometer.

HIGH FREQUENCY RESPONSE

All piezoelectric accelerometers are basically rigid spring mass systems, i.e., second order mechanical systems with essentially zero damping. As a result, these instruments will exhibit a rising characteristic as the resonant frequency is approached. A filter incorporated into Model 3035A2 compensates for this rise to extend the useable frequency range of this unit.

The upper frequency at which the sensitivity may increase or decrease by 5%, is approximately 10,000 Hz, the frequency to which the 3145A2 is calibrated. The accelerometer is usable above this frequency but to use it above 10,000 Hz, it must be calibrated at the specific frequencies of intended use because sensitivity deviations will increase drastically as you greatly exceed this high frequency calibration limit. Consult the factory for special calibrations required above 10,000 Hz.

CAUTIONS

1) Do not store or use the 3145A2 above 300 degrees F. To do so can damage the IC amplifier.

2) Do not allow cables to vibrate unrestrained. This will eventually destroy the cable and could lead to system inaccuracies.

3) If the 3145A2 is to be used in rapidly changing thermal environments, call the factory to ask about our thermal insulating boots.

4) Avoid dropping or striking the accelerometer, especially against rigid materials such as concrete and metals. While Model 3145A2 is protected against shock induced overloads, the very high overloads induced by dropping can do permanent damage to the MOSFET amplifier or to the mechanical structure of the accelerometer. This type of damage is not covered by the warranty.

MAINTENANCE AND REPAIR

The welded construction of the Model 3145A2 precludes field repair.

Should the mounting surface become distorted, nicked and otherwise distressed, so as to make operation suspect, return the instrument to the factory for repair. We can take very fine machine cuts off the mounting surface to restore the flatness to original specifications.

Should the electrical connector become contaminated with moisture, oil, grease, etc., the entire instrument may be immersed in degreasing solvents to remove the contaminants. After degreasing, place the instrument in a 200 to 300 degree F oven for one hour to remove all traces of the solvent.

Should a problem be encountered with the operation of the instrument, contact the factory for trouble shooting advice. Often our service engineers may point out something which may have been overlooked and which may save the expense and time of returning the 3145A2 to the factory.

If the instrument must be returned, the service department will issue you a **Returned Materials Authorization (RMA)** number to aid in tracking the repair through the system. Do not send the instrument back without first obtaining an RMA number. At this time you will be advised of the preferred shipping method.