



Dynamic Transducers and Systems

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OPERATING GUIDE

MODEL 3089A QUARTZ SHEAR MODE

MINIATURE IEPE ACCELEROMETER



NOTE:

Model 3089A is a lightweight miniature piezoelectric accelerometer. The accelerometer is adhesively mounted and incorporates integral wires.

This guide contains:

- 1) Operating instructions, Model 3089A.
- 2) Outline/installation drawing, Model 3089A
- 3) Specifications, Model 3089A
- 4) Paper, "Low Impedance Voltage Mode (LIVM) Theory and Operation

NOTE: IEPE is an acronym for Integrated Electronics Piezoelectric types of low impedance voltage mode sensors with built-in amplifiers operating from constant current sources over two wires. **IEPE** instruments are compatible with most other manufacturers' comparable systems.



**SPECIFICATIONS
MODEL 3089A IEPE ACCELEROMETER**

SPECIFICATION	VALUE	UNITS
PHYSICAL		
WEIGHT	0.6	grams
SIZE, DIA x HEIGHT	0.19 x 0.25	inch
MOUNTING	adhesive	
OUTPUT WIRES	integral	
WIRE LENGTH	variable	
HOUSING MATERIAL	300 Series	Stainless Steel
PERFORMANCE		
SENSITIVITY, $\pm 5\%$ [1]	10.0	mV/g
RANGE F.S. FOR ± 5 VOLTS OUTPUT	± 500	g
FREQUENCY RANGE, $\pm 10\%$	1 to 10000	Hz
RESONANT FREQUENCY	>50	kHz
EQUIVALENT ELECTRICAL NOISE FLOOR	.0014	g rms
LINEARITY [2]	$\pm 1\%$	% F.S.
TRANSVERSE SENSITIVITY, MAX.	5	%
STRAIN SENSITIVITY (@250 $\mu\epsilon$)	.012	g/ $\mu\epsilon$
ENVIRONMENTAL		
MAXIMUM VIBRATION/SHOCK	$\pm 600/\pm 3000$	g PEAK
TEMPERATURE RANGE	-60 to +250	$^{\circ}\text{F}$
SEAL, HERMETIC	welded/gtm header	
COEFFICIENT OF THERMAL SENSITIVITY	.03	%/ $^{\circ}\text{F}$
ELECTRICAL		
SUPPLY CURRENT [3]	2 to 20	mA
COMPLIANCE VOLTAGE RANGE	+18 to +30	V
OUTPUT IMPEDANCE, TYP.	100	Ω
BIAS VOLTAGE	+7 to +9	VDC
DISCHARGE TIME CONSTANT, NOM.	0.3 to 0.6	Sec
POLARITY (SEE OUTLINE DWG)	positive	
ELECTRICAL ISOLATION	case grounded	

[1] Measured at 100 Hz, 1 grms per ISA RP 37.2.

[2] Measured using zero-based best straight-line method, % of F.S. or any lesser range.

[3] Do not apply power to this device without current limiting, 20 mA MAX. To do so will destroy the integral IC amplifier.



OPERATING INSTRUCTIONS MODEL 3089A IEPE ACCELEROMETER

INTRODUCTION

The Dytran Model 3089A accelerometer features **IEPE** operation. The self-generating seismic element, utilizing pure synthetic Alpha quartz, converts acceleration to an analogous voltage signal. This very high impedance signal is fed to the gate of a tiny on-board IC MOSFET 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 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. Power and signal are conducted over the same two-wire cable.

Model 3089A is a miniature accelerometer designed to be adhesive mounted. The accelerometer features an integral cable.

The sensitivity of Model 3089A is 10 mV/g.

DESCRIPTION

The 3089A incorporates a GTM header for hermetic seal.

The seismic masses, made from a very dense tungsten alloy, are tightly preloaded through the quartz crystals to the element base in shear mode. 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 a voltage exactly analogous to the input acceleration. This voltage is impressed across the gate of the MOSFET IC.

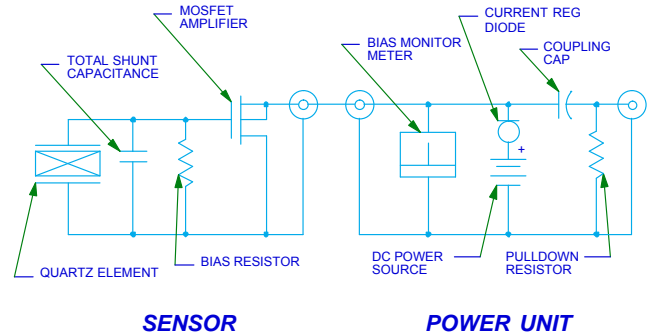


Figure 1-Electro-mechanical schematic, accelerometer and power unit system.

When constant current from the IEPE power unit is applied to the accelerometer amplifier source terminal, the amplifier "turns on" at approx. +10 Volts DC quiescent bias level. When the accelerometer senses acceleration, the resultant 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 gate resistor R serves to bias the gate of the IC to its proper operating point and it also, in conjunction with shunt capacitance C, 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:

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



R = resistance value R (Ohms)

C = total shunt capacitance C (Farads)

RC = discharge time constant TC (Seconds)

Equation 1 above, defines the 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 Series 3089A is 0.3 TO 0.6 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 $3 \times .16 = 0.64$ Hz.

INSTALLATION

(Refer to Outline/Installation drawing 127-3089A) To install Model 3089A, is necessary to prepare (or find) a flat mounting area of approximately 1/8 inch diameter. 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.

Connect the integral cable to the power unit in accordance with drawing 127-3089A..

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 to two inches 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.

If the installation is made with a Dytran IEPE power unit, 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.

HIGH FREQUENCY RESPONSE

All piezoelectric accelerometers are basically rigid spring mass systems, i.e., second order systems with essentially zero damping. As a result, these instruments will exhibit a rising characteristic as the resonance is approached. A filter incorporated into Model 3089A compensates for this rise.

The frequency at which the sensitivity may increase or decrease by 10% is approximately 10000 Hz, the frequency to which the 3089A is calibrated.

CAUTIONS

1) Do not store or use the 3089A above 250°F. To do so can damage the IC amplifier.

2) Do not allow wires to vibrate unrestrained. This may eventually destroy the wires and could lead to system inaccuracies.

3) Avoid dropping or striking the accelerometer, especially against rigid materials such as concrete and metals. While Model 3089A 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 3089A precludes field repair.

Should the mounting surface become distorted, nicked and otherwise distressed, it can be redressed by **CAREFULLY** wiping on a new sheet of 400 grit emery paper on top of a clean surface plate. We stress "carefully" because if not done properly, this procedure can do more harm than good. Press the surface firmly against the paper and draw directly



toward you in several short precise strokes making sure that the surface remains in full contact with the paper and does not "rock". Rotate the accelerometer 90 degrees and repeat the procedure. When you observe the bottom surface it should appear perfectly flat with straight marks across it. If you cannot achieve flatness with several attempts, return the instrument to the factory for repair.

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 3089A 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.

A short note describing the problem, included with the returned instrument, will aid in trouble shooting at the factory and will be appreciated.

We will not proceed with a non-warranty repair without first calling to notify you of the expected charges. There is no charge for evaluation of the unit.