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OG3225M24
REV A, ECN 5014
REV B, ECN 6517, 01/21/10
REV C, ECN 8765, 06/20/12

OPERATING GUIDE

MODEL 3225M24

MINIATURE HIGH SENSITIVITY PLANAR SHEAR MODE

LIVM™ ACCELEROMETER WITH REMOVABLE CABLE

This manual contains:
1) Specifications, model 3225M24
2) Outline/Installation drawing 127-3225M24
3) Paper "Low Impedance Voltage Mode 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**.

SPECIFICATIONS

MODEL 3225M24 MINIATURE LIVM ACCELEROMETER

SPECIFICATION	VALUE	UNITS
PHYSICAL		
WEIGHT	1	gram
SIZE (DIA x LENGTH HEX x HEIGHT)	0.25 x 0.43 x .215	inch
MOUNTING PROVISION	Flat mounting surface for adhesive mount	
CONNECTOR, RADIALLY MOUNTED [1]	3-56	
CASE MATERIAL	Titanium	
SENSING ELEMENT TYPE	Piezoceramic, planar shear	
PERFORMANCE		
SENSITIVITY, ±10% [2] [3]	100	mV/g
RANGE F.S. FOR ± 5 VOLTS OUT	±50	g
FREQUENCY RESPONSE, ± 10% [3]	2 to 10,000	Hz
MOUNTED RESONANT FREQUENCY, NOM.	40	kHz
EQUIVALENT ELECTRICAL NOISE FLOOR	.0007	grms
AMPLITUDE NON-LINEARITY, (ZERO BASED BEST-FIT ST.LINE METHOD)	2	% F.S., MAX.
TRANSVERSE SENSITIVITY, MAX.	5	%
STRAIN SENSITIVITY @ 250με	.05	g/με
ENVIRONMENTAL		
MAXIMUM VIBRATION	400	grms
MAXIMUM SHOCK	5000	gpk
TEMPERATURE RANGE	-60 TO +220	°F
THERMAL COEFFICIENT OF SENSITIVITY	.15	%/°F
ENVIRONMENTAL SEAL	Hermetic, TIG welded & glass-to-metal seal connector	
ELECTRICAL		
SUPPLY CURRENT [4]	2 to 20	mA
COMPLIANCE VOLTAGE RANGE	+18 to +30	Volts
OUTPUT IMPEDANCE, TYP.	70	Ω
BIAS VOLTAGE	+11 to +13	Vdc
DISCHARGE TIME CONSTANT	0.2 to 1.0	sec
OUTPUT SIGNAL POLARITY FOR ACCELERATION TOWARD TOP	Positive	

SUPPLIED ACCESSORIES:

(1) MODEL 6591A INSTALLATION REMOVAL WRENCH
(2) 6298 SMALL PETRO WAX

NOTES:
[1] CONNECTOR MATES ONLY WITH DYTRAN CABLE MODEL 6003AXX (XX IS LENGTH IN FEET)
[2] MEASURED AT 100 Hz, 1 grms PER ISA RP37.2.
[3] ACTUAL SENSITIVITY IS GIVEN ON A CALIBRATION CERTIFICATE TRACEABLE TO NIST, SUPPLIED WITH EACH INSTRUMENT.
[4] 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 3225M24 MINIATURE LIVM ACCELEROMETER

INTRODUCTION

Model 3225M24 is a miniature, low profile, voltage mode LIVM piezoelectric accelerometer designed to mount in spaces inaccessible to other types of accelerometers.

Featuring a titanium housing and weighing only 1 gram, this instrument is ideal for the measurement of shock and vibration of very small, lightweight specimens such as printed circuit boards and board-mounted components.

Designed for adhesive mount, Model 3225M24 may be mounted in very narrow spaces only slightly greater than .25 inch (6.4 mm) wide. The height is .215 inch (5.5 mm).

Model 3225M24 features a special 3-56 coaxial connector which mates with a replaceable coaxial cable, with a 10-32 coaxial jack at the end. This cable is model 6003A03. (XX is the cable length in feet)

A built-in impedance converting electronics package converts the high impedance voltage output from the piezoelectric shear mode seismic element to a low impedance voltage able to drive long cables without attenuation.

DESCRIPTION

Refer to outline/installation drawing 127-3225M24

Model 3225M24 is constructed in "teardrop" form with the a miniature coaxial connector exiting at the end of the teardrop.

Model 3225M24 generates an electrostatic voltage mode signal by stressing a "planar shear" type self-generating piezoelectric crystal element in response to input acceleration. The planar piezoelectric crystals are supported by a flat post and the seismic masses are fastened together by a preload screw.

When the unit is accelerated along the main axis, the quartz crystals are stressed in shear mode generating a voltage analogous to this acceleration.

This very high impedance voltage is fed to the JFET input stage of a miniature on-board IC amplifier which drops the impedance level 10 orders of magnitude and adds voltage gain. This allows the 3225M24 to have fixed voltage sensitivity (100 mV/g nominal) and to have the ability to drive long cables with little or no attenuation.

Because of its very low mass and high crystal stiffness, this instrument has a resonant frequency of about 40 kHz. This means that it may be used to measure high frequency vibrations with very little error.

THE REMOVABLE CABLE FEATURE

The cable designed for Model 3225M24 is one of the smallest in the industry. Use care when attaching and removing the 6003A03 cable. The knurled cable nut is very small, of necessity, and must be engaged and disengaged carefully and only by hand. Do not, under any circumstances, use a pliers to tighten and loosed this cable nut. Damage would most likely occur to the cable nut and/or to the connector. With reasonable care, the cable and connector should give no problems under normal use.

INSTALLATION

IMPORTANT: Only mount the Model 3225M24 on its mounting surface. DO NOT MOUNT TO THE TOP SURFACE. Not only will the signal polarity be reversed and the sensitivity and frequency response be adversely affected but also there is danger of damaging the top cap of the accelerometer when removing it, if mounted in the inverted position. This type of damage is considered abuse and is not covered by the manufacturer's warranty.

To install Model 3225M24, it is necessary to select (or prepare) a flat surface to accept the .25 diameter mounting surface of the instrument. As a rule of thumb, the flatter the mounting surface, the better the high frequency response will be. A surface flat to .001 TIR will give excellent results when a thin glue line is used during mounting. Clean the mounting surfaces with solvents such as alcohol or Freon, etc., to remove debris, oils and greases before mounting.

The recommended adhesives are the "instant" setting cyanoacrylate cements such as Eastman 910 and "Crazy Glue". Apply a very small drop to either mating surface, and simply press the 3225M24 to the mating surface with the finger and hold for 30 seconds. If the adhesive does not set, check the expiration date on the container. It is our experience that when the glue gets old, the first indication is that it will not set up properly. Replace if necessary.

Other types of adhesive may be used but consider them carefully. Dental cement is not recommended for this instrument because if its tenacity. Removal when this adhesive is used may harm the instrument.

In some cases, mounting waxes such as "Petro" wax may be used to mount the 3225M24 but this method is not suitable for measurements at high temperature and high frequency.

Irrespective of which adhesive is used, keep the glue line thin, i.e., don't use too much adhesive. Too much adhesive places a "spring" between the specimen and the instrument. This can create another second order spring mass system (the mass being the weight of the accelerometer) and can cause serious measurement errors at high frequencies.

OPERATION

To operate Model 3225M24, it is necessary to connect it to a source of constant current in the range of 2 to 20 mA with a compliance voltage of +18 to +30 VDC. Dytran offers a variety of LIVM power units suitable for powering the 3225M24. The output from these power units is a low impedance voltage mode signal which may then be fed directly to the readout instrument(s).

The replaceable cable used with Model 3225M24 (model 6003A03) is terminated in a jack type (male thread) 10-32 coaxial connector. Dytran manufactures a series of cables suitable as extension cables for this instrument that will mate with this cable. The Model 6010A03 has a 10-32 plug at the end and would be used with power units which have a 10-32 "Sensor" jack. The Model 6011A03 cable has a BNC plug at the end and would be used when the power unit has a BNC "Sensor" jack.

The polarity convention of Model 3225M24 is positive for acceleration toward the top of the unit.

UNMOUNTING THE ACCELEROMETER

In order to "unmount" the Model 3225M24, use the Model 6591A tool. The larger slotted end of the tool is used for this purpose. Slip the tool over the accelerometer body from the rounded end (as opposed to the connector end) and gently rotate the tool in either direction until the adhesive shears and the instrument is released.

Do not use pliers, wrenches and other tools to remove the instrument as these are certain to mar or otherwise damage the unit.

After unmounting, inspect the mounting surface for traces of residual adhesive and remove completely to be ready for the next installation.

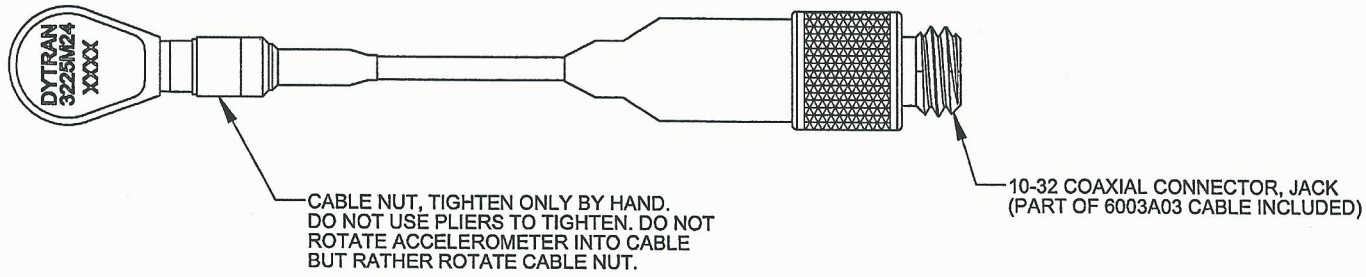
MAINTENANCE AND REPAIR AND RECALIBRATION

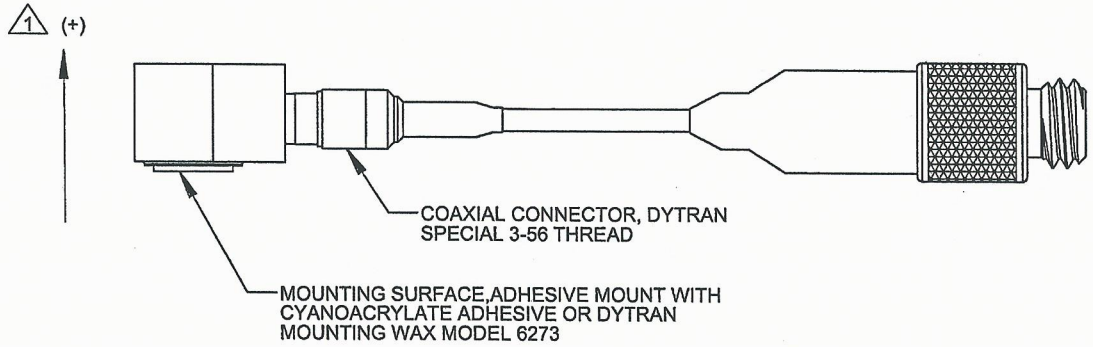
The only maintenance necessary is to keep the miniature coaxial connector and other cable connections clean and free from moisture and other contaminants.

Should a problem arise with the accelerometer or should it require routine recalibration, contact the factory for assistance in trouble shooting or returning the instrument for evaluation and/or repair. Do not send the instrument back without first calling the factory to obtain a Returned Material Authorization (RMA) number. This will help us track the repair/recalibration

DWG NO 127-3225M24 SH 1 REV C

REVISIONS					
REV.	ECN	DESCRIPTION	BY/DATE	CHK	APPR
B	5081	REDRAWN IN SOLIDWORKS	JS 02/28/08	RA	PML
C	9494	UPDATED VIEW OF CONNECTOR	AB 05/03/13		





3. CASE AND CONNECTOR MATERIAL: TITANIUM.

2. WEIGHT LESS CABLE: 0.85 GRAMS.

1 ARROW INDICATES SENSE AND DIRECTION OF INPUT ACCELERATION FOR POSITIVE GOING OUTPUT SIGNAL.

NOTES: UNLESS OTHERWISE SPECIFIED

DRILL HOLE SIZE	TOLERENCE
.0135 THRU .125	+.004 / -.001
.1260 THRU .250	+.005 / -.001
.2510 THRU .500	+.008 / -.001
.5010 THRU .750	+.008 / -.001
.7510 THRU 1.000	+.010 / -.001
1.001 THRU 2.000	+.012 / -.001

THIRD ANGLE PROJECTION USA

UNLESS OTHERWISE SPECIFIED:
INTERPRET DIM & TOL PER ASME Y14.5M - 1994.
REMOVE BURRS.
COUNTERSINK INTERNAL THDS 90° TO MAJOR DIA.
CHAM EXT THDS 45° TO MINOR DIA.
THD LENGTHS AND DEPTHS ARE FOR MIN FULL THDS.
THDS PER MIL-S-7742.
DIMENSIONS APPLY AFTER FINISHING
63
ALL MACHINED SURFACES.
TOTAL RUNOUT WITHIN .005.
BREAK SHARP EDGES .005 TO .010.
MACHINED FILLET RADII .005 TO .015.
WELDING SYMBOLS PER AWS A2.4.
ABBREVIATIONS PER MIL-STD-12.

UNLESS OTHERWISE SPECIFIED:
DIMENSIONS ARE IN INCHES.
TOLERANCES ARE:
DECIMALS .XX ± .010 .XXX±.005
ANGLES ±1°

MATERIAL:

FINISH:

DO NOT SCALE DRAWING

CONTRACT NO.

APPROVALS		DATE
ORIG	JS	02/01/08
CHK	CES	02/13/08
APP	DV	02/14/08
APP	DV	5/8/13

DYTRAN INSTRUMENTS, INC. Chatsworth, CA

TITLE: OUTLINE/INSTALLATION DRAWING 3225M24

SIZE	CAGE CODE	DWG NO	REV
B	2W033	127-3225M24	C

SCALE: NONE | SOLIDWORKS | SHEET 1 of 1

172-0072, REV A

DYTRAN INSTRUMENTS, INC.

LOW IMPEDANCE VOLTAGE MODE (LIVM) THEORY AND OPERATION

LIVM: WHAT IS IT?

LIVM is Dytran's trademark for our version of Low Impedance Voltage Mode piezoelectric instruments, i.e., piezo instruments with integral-impedance-converting amplifiers operating from constant current supplies over two wires. **LIVM** instruments are fully compatible with the new **IEPE** designated instruments.

LIVM instruments produced at Dytran include force, pressure and acceleration sensors. Each class of sensors is produced in many varieties for a wide range of applications.

Also falling under the class of LIVM instruments are in-line charge amplifiers that utilize the same two-wire constant current operating mode as the LIVM sensors.

Operating principles for all LIVM sensors and in-line amplifiers are similar in that they all utilize the same two-wire constant current operating mode. The amplifiers built into the sensors are either MOSFET input unity gain voltage amplifiers or MOSFET or JFET input charge amplifiers.

All types of LIVM amplifiers serve to convert the very high impedance of the piezoelectric crystals to a much lower impedance voltage signal that has the capability of driving long cables with little or no signal degradation.

THEORY OF OPERATION

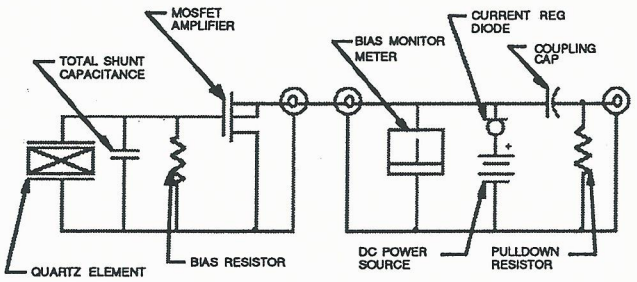


FIGURE 1: TYPICAL LIVM VOLTAGE MODE SYSTEM

Figure 1 is a simplified schematic of a basic LIVM system including the sensor with integral electronics, the cable and the power unit. The sensor amplifier in this case is the unity gain voltage follower. This is the type of amplifier used in most LIVM sensors and almost exclusively used with quartz element sensors.

The sensing element (force, pressure or acceleration), usually made with quartz crystals, is connected directly to the gate of a MOSFET input integrated circuit (IC) amplifier. This amplifier is operated as a source follower and, as such, has unity voltage gain.

The source terminal of the IC is supplied with constant current over the range of 2 to 20 mA at a compliance (supply) voltage of +18 to +30 volts DC. The power unit may take the form of many different configurations from simple battery powered 2 mA units with constant current diode to line-powered adjustable current power units able to supply 2 to 20 mA of constant current from adjustable level constant current circuits.

In either case, the constant current device (current diode or constant current circuit), acts as the source impedance for the unity gain IC built into the sensor or for the in-line charge amplifier.

Under quiescent conditions, most Dytran sensor amplifiers will bias themselves at approximately +11 volts DC at the input (source) terminal of the sensor. This sensor bias voltage is monitored and displayed, on most Dytran power units, and this feature serves as a handy trouble-shooting tool, serving as an indicator for normal or abnormal operation. (More on this topic in a following section, "The fault monitoring monitor as a trouble-shooting tool").

The sensor signal, produced by the measurand acting upon the piezo element, is superimposed upon the sensor bias voltage and appears at the "Sensor" jack of the power unit. At this point, the DC bias portion of the signal is blocked by a coupling capacitor and the AC (signal) portion is coupled directly to the "Output" jack of the power unit.

This jack may be connected directly to the input of readout instruments (oscilloscopes, spectrum analyzers, AC meters, frequency counters, etc.). The very low output impedance of the LIVM sensor (about 150 Ohms) makes the effect of most readout instruments on the signal, negligible.

Be aware that the coupling capacitor in the power unit (usually 10 µF), and the impedance of the readout load, constitute a high-pass filter which may set the low frequency response of the system below the LF response built into the sensor. In most accelerometer applications, the 10 µF capacitor provides ample time constant to allow vibration measurements down to fractions of a Hz.

Dytran also manufactures several DC-coupled power units for LIVM sensors that utilizes an active variable voltage level amplifier circuit to "buck out" the DC bias voltage of the sensor. One of these units, model 4115B, supplies constant current to the sensor and direct-couples the sensor to the output jack eliminating the coupling capacitor. This feature allows the user to take full advantage of the long time constant built into the sensor and precludes the effect of readout instrument load on the low frequency response of the system, The 4115B is especially useful for very long-term (quasi-static) measurements especially with force and pressure sensors.

OPERATION, GENERAL

Special note: LIVM sensors depend on the power unit to supply a fixed amount of current to the sensor IC. These IC circuits will absorb any amount of current supplied until they exceed their power rating and burn up. For this reason, never apply power to an LIVM sensor without this current limiting protection. This precludes the connection of LIVM sensors directly to batteries, DC power units and many types of resistance measuring devices. Never measure the continuity of an LIVM sensor with any type of Ohmmeter. This type of measurement is redundant and may lead to destruction of the sensor. To determine if the IC is intact,

use the monitor meter on the front panel of your Dytran power unit. This topic is covered in the following section, "The fault monitoring meter as a trouble-shooting tool".

After installing the sensor in accordance with instructions in the operating guide (manual) supplied with each sensor. connect the sensor to the power unit's "Sensor" jack . This jack, in most cases, is a BNC coaxial connector. You should have been supplied with the proper cable to connect the sensor to the power unit you have selected. If you were not, contact the factory for help.

It is important to carefully support the cable, especially in situations where there is movement between the sensor and its surroundings. This practice will prolong cable life and will diminish or preclude the effects of triboelectric (cable generated) noise on the signal.

THE FAULT MONITOR METER AS A TROUBLE - SHOOTING TOOL

Most Dytran power units incorporate a dc voltmeter on the front panel that measures the DC bias voltage at the sensor terminal. Measuring this voltage supplies information about the "health" of the measurement system. The three conditions it can identify are 1) normal operation, 2) shorted cable or sensor or faulty power unit and 3) open sensor or cable connection. We will examine each possibility here.

NOTE: The fault monitor meter may be the LED style shown on the left, Fig. 2, or the D'Arsonval panel meter style shown on the right, Fig. 2.

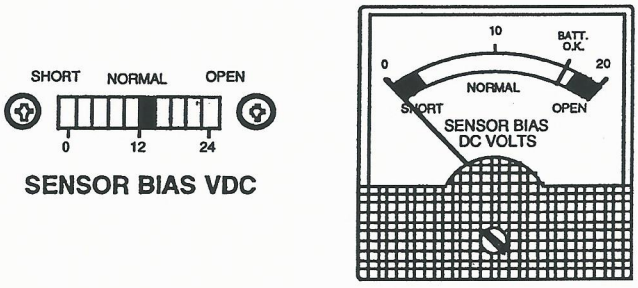


FIGURE 2 TYPICAL FAULT MONITOR METERS

NORMAL OPERATION

Under normal operating conditions, the monitor meter will indicate approx. mid-scale (+10 to +13 volts DC) when the sensor is connected. Many of the meter faces have a "Normal" area delineated to indicate that the sensor is functioning and the cable from sensor to power unit is neither open or shorted. It is possible that certain failure modes of the sensor can produce "Normal" indications but these modes are very rare. In most cases, if the meter reads in the "Normal" area, the system is viable.

As a further quick check on normal operation, with some sensors such as pressure and force sensors, pressing on the diaphragm or force sensitive surface with a finger can cause the monitor meter pointer to deflect showing that the sensor is "alive". With some higher sensitivity accelerometers, shaking them by hand can deflect the monitor meter enough to show the sensor is functioning.

OPEN SENSOR OR CABLE (FULL SCALE METER READING)

If the sensor amplifier is burned out or the cable connecting sensor to power unit is open, the monitor meter will read in the "Open" area of the scale since the current source in the power unit has no load. To check if the problem is in the sensor, disconnect the sensor from its cable (leaving the other end connected to the power unit), and short across the open end of the cable with a metallic object while observing the meter. If the meter does not indicate zero ("short") while the sensor end of the cable is shorted, the cable is open. Replace the cable and try the sensor again, looking for the "Normal" indication.

If the meter reads zero when the short is applied, the cable is OK but the sensor is open. If another sensor is available, try it to verify the finding.

SHORTED SENSOR OR CABLE ("SHORT" METER READING)

If the fault monitor meter reads in the "Short" area after connecting the sensor, this means that there is a short in the cable or sensor.

This condition cannot hurt the power unit since the maximum current is limited by the constant current circuit or diode in the power unit. Sometimes, shards of metal can scrape off of the cable connector of the 10-32 cables and these may short across the sensor connection. Check for this. Cleaning with a stiff-bristled brush will dislodge such metal shards.

If a short is still indicated, then the problem is with the cable or the power unit. Disconnect the cable from the power unit and observe the meter reading. If the meter reads full scale, the power unit is OK and the problem is a shorted cable or sensor. Replace the cable to verify.

MAINTENANCE AND REPAIR

Because of their small size and sealed construction, field maintenance of LIVM sensors is limited to cleaning of connectors and maintenance of mounting surfaces.

Clean connectors with a cloth or paper wipe dipped in solvents such as alcohol, Freon, etc. For hermetically sealed units, acetone may be used also. Acetone is not recommended for non-hermetic units.

Clean epoxy from the mounting surfaces of accelerometers, if necessary, with acetone or other solvents that will dissolve and remove epoxies.

If the problem you are having is poor low frequency response and the sensor is not hermetically sealed, baking in a 250° oven for one hour will often get rid of moisture that may have shorted across the crystals and shortened the discharge time constant.

If you cannot solve the problem, call the factory for assistance in trouble shooting the system or for instructions for returning the instrument for evaluation and/or possible repair.

If the instrument is to be returned, you will be issued a Returned Material Authorization (RMA) number by the service department which helps speed the instrument through the evaluation process. Do not return an instrument without first contacting the factory.