P96.61.1/2

DYTRAN INSTRUMENTS, INC.

Dynamic Transducers and Systems

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OPERATING GUIDE

SERIES 3055B

LIVM tm ACCELEROMETERS, 10, 50, 100 & 500 mV/G

HERMETICALLY SEALED AND CASE ISOLATED

NOTE:
Series 3055B features hermetically sealed construction and electrically isolated case for "off-ground" performance. Hermeticity is obtained by all-welded construction and glass-to-metal sealed connector. Case material is titanium. Case ground isolation is by an electrically isolated threaded insert located in the base of the instrument. Signal ground return is electrically isolated from the mounting surface.

This guide contains:
1) Operating instructions, Series 3055B.
2) Outline/installation drawing, Series 3055B
3) Specifications, Series 3055B
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 most other manufacturers' comparable systems.

SPECIFICATIONS
MODEL SERIES 3055B LIVM ACCELEROMETERS

SPECIFICATION	VALUE	UNITS
PHYSICAL		
WEIGHT	10	Grams
SIZE, HEX x HEIGHT	.50 x 0.62	Inches
MOUNTING PROVISION	10-32 X .150 DEEP TAPPED HOLE	
CONNECTOR, RADIALLY MOUNTED	10-32	Coaxial
MATERIAL, BASE, CAP & CONNECTOR	TITANIUM	
SEISMIC ELEMENT TYPE	CERAMIC, PLANAR SHEAR	

PERFORMANCE

	MODELS				
	3055B1	**3055B2**	**3055B3**	**3055B4**	
SENSITIVITY, ± 5% [1]	10	100	500	50	mV/g
RANGE F.S. FOR ± 5 VOLTS OUTPUT	± 500	±50	±10	±100	g's
FREQUENCY RANGE, ± 5% (all models)		1 to 10,000			Hz
RESONANT FREQUENCY, NOM. (all models)		35			kHz
EQUIVALENT ELECTRICAL NOISE	.007	.0007	.00014	.0014	g's RMS
LINEARITY [2] (all models)		±2			% F.S.
TRANSVERSE SENSITIVITY, MAX. (all models)		±2			%

ENVIRONMENTAL

	3055B1	**3055B2**	**3055B3**	**3055B4**	
MAXIMUM VIBRATION/SHOCK	600/3000	400/2000	200/1000	500/2000	± g's/g's PK
TEMPERATURE RANGE (all models)		-60 to +250			°F
SEAL, HERMETIC		Glass-to-metal/welded			
COEFFICIENT OF THERMAL SENSITIVITY		.06			%/°F

ELECTRICAL

SUPPLY CURRENT/COMPLIANCE VOLTAGE RANGE [3]	2 to 20/+18 to +30	mA/Volts
OUTPUT IMPEDANCE, TYP.	100	Ohms
BIAS VOLTAGE, +10.5 VOLTS NOM.	+9 to +12	VDC
DISCHARGE TIME CONSTANT, NOM.	0.5	Sec
OUTPUT SIGNAL POLARITY FOR ACCELERATION TOWARD TOP		Positive
ELECTRICAL ISOLATION, CASE GROUND TO MOUNTING SURFACE		10 Meg Ω, min.

Accessories supplied: (1) Model 6200 mounting stud.

[1] Measured at 100 Hz, 1 G RMS 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 SERIES 3055B

LIVM ACCELEROMETERS

INTRODUCTION

The Dytran Model Series 3055B consists of four accelerometers, differing only in sensitivity and range. Model 3055B1 is 10 mV/g, Model 3035B2 is 100 mV/g, Model 3055B3 is 500 mV/g and Model 3055B4 is 50 mV/g.

These accelerometers features Low Impedance Voltage Mode (**LIVM**) operation. The self generating seismic element, utilizing piezoceramic crystals in planar shear mode, convert acceleration to an analogous electrostatic charge mode signal. This very high impedance signal is fed to the input of a miniature on-board IC JFET charge amplifier that drops the output impedance level ten orders of magnitude, allowing this instrument to drive long cables without an appreciable effect on sensitivity and frequency response.

Simple constant current type power units supply power to operate the integral charge amplifier and separate the signal from the DC bias at the output 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 series 3055B also features signal ground isolation from the mounting surface to avoid annoying ground loops and hermetic sealing for normal operation in moist and dirty environments.

DESCRIPTION

Figure 1, below, is a representative cross section of series 3055B.

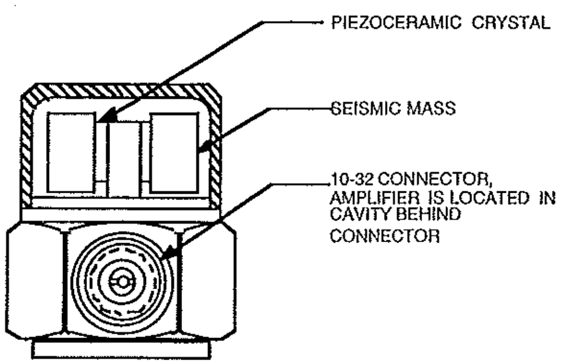


Figure 1-Cross section, series 3055B

The seismic masses, made from a very dense tungsten alloy, are tightly preloaded against the ceramic crystals by means of a special preload screw, under hundreds of pounds of force. This is so there is absolutely no relative motion between mass, crystals and base, thus 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 masses through the crystals, stressing the crystals in shear and producing an electrostatic charge signal analogous to the input acceleration. This charge is impressed across the input of the JFET IC charge amplifier.

Because the IC is a 2-wire LIVM charge amplifier, the dynamic output voltage signal is impressed across the connector of the sensor which is the same point into which the constant current from the power unit is applied. (See Figure 2 below)

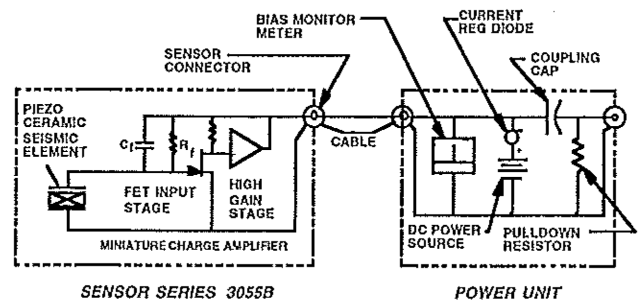


Figure 2-Electro-mechanical schematic, accelerometer and power unit system.

When constant current from the LIVM power unit is applied to the accelerometer amplifier input terminal, the amplifier "turns on" 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 feedback resistor R 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:

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

where:

f_{-3db} = 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 all Models is 0.5 seconds, nom., yielding a lower -3db frequency of 0.3 Hz, from equation 1.

As rule of thumb, the lower -5% frequency is three times the -3db frequency or 1 Hz.

INSTALLATION

(Refer to Outline/Installation drawing 127-3055B) To install Model 3055B, is necessary to prepare (or find) a flat mounting area of approximately 0.5 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.

At the center of the mounting area, drill and tap a 10-32 mounting hole in accordance with instructions on drawing 127-3055B. Clean the area to remove all traces of machining chips, burrs, etc.

Next, thread the Mod. 6200 mounting stud into the base of the 3055B. The stud should enter easily and thread in up to the raised collar of the stud by hand. This collar prevents the stud from bottoming inside the tapped hole in the 3055B where it could possibly cause stresses in the base structure which could, in turn, cause anomalous behavior of the accelerometer at higher frequencies.

After seating the stud, spread a light coating of silicone grease, or other lubricant, on either of the mating surfaces and thread the accelerometer/stud combination into the tapped hole by hand, until the accelerometer base seats against the 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 causing possible poor frequency response and even erroneous reference sensitivity. Inspect the perpendicularity of the tapped hole.

If the hand tight meeting between the two surfaces is satisfactory, torque the 3055B to the mating surface with 15 to 20 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. Excessive torque could damage the ground isolation base.

Connect the cable (typically Models 6010AXX or 6011AXX) to the accelerometer snugging up the threaded 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 3055B 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.

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 3055B compensates for this rise.

The frequency at which the sensitivity may increases or decrease by 5% is approximately 10,000 Hz, the frequency to which the 3055B series 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 10kHz.

CAUTIONS

1) Do not store or use the 3055B above 250 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) Avoid dropping or striking the accelerometer, especially against rigid materials such as concrete and metals. While Model 3055B is protected against shock induced overloads, the very high overloads induced by dropping can do permanent damage to the IC 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 series 3055B 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 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°F to 250°F oven for one hour to remove all traces of the solvent.

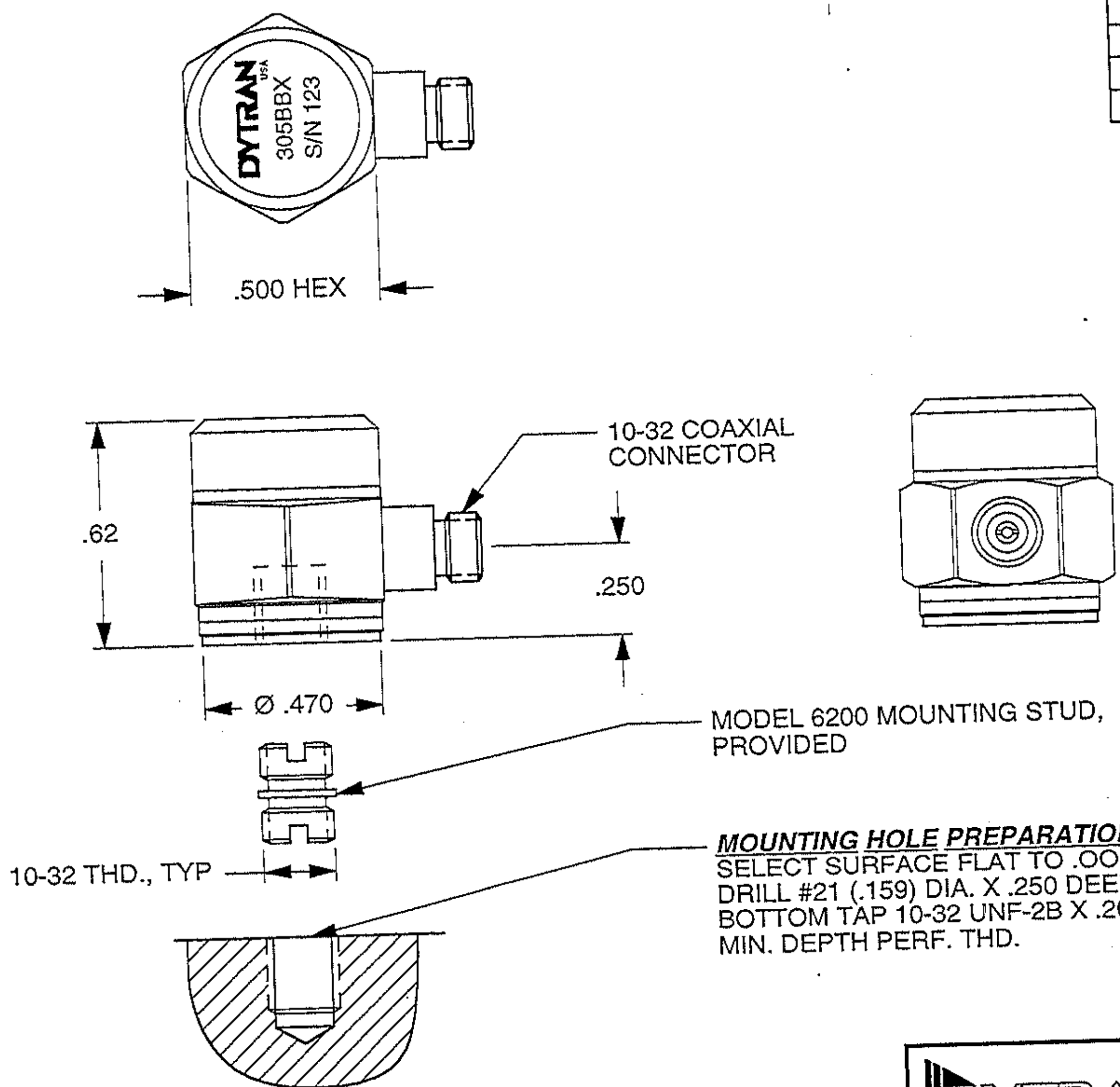
Should a problem be encountered with the operation of the instrument, contact the factory for trouble shooting advice. Often our service engineers may point out something which may have been overlooked and which may save the expense and time of returning the 3055B to the factory.

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.

MODEL	SENSITIVITY	F.S. RANGE, ±5V
3055B1	10 mV/G	±500 G's
3055B2	100 mV/G	±50 G's
3055B3	500 mV/G	±10 G's
3055B4	50 mV/G	±100 G's



MOUNTING HOLE PREPARATION:
SELECT SURFACE FLAT TO .OO1 TIR
DRILL #21 (.159) DIA. X .250 DEEP
BOTTOM TAP 10-32 UNF-2B X .200
MIN. DEPTH PERF. THD.

DYTRAN INSTRUMENTS, INC. CHATSWORTH, CA.

SCALE 2X	REV -	DATE -	ECN -
DATE 12/22/04	PART NO. SERIES 3055B		
DRAWN N.C. / CHECKED R.A.	MAT'L -		
APPROVED 12-22-04	NEXT ASSEMBLY	USED ON 3055B1, B2, B3 & B4	
TITLE OUTLINE/INSTALLATION DRAWING, MODEL SERIES 3055B		DWG NO. 127-3055B	SHEET 1 OF 1

1. CASE AND CONNECTOR MATERIAL: TITANIUM.

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., piezoelectric instruments with integral impedance-converting amplifiers operating from constant current over two wires.

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

Also falling under the class of LIVM instruments are in-line charge amplifiers utilizing the same two-wire mode of operation as the LIVM sensors.

Operating principles for all LIVM sensors and in-line amplifiers are similar in that all utilize the two wire constant current operating principle. The amplifier built into the sensors is either a MOSFET input unity gain voltage amplifier or an MOS or JFET input charge amplifier.

Both types of amplifier serve to convert the very high impedance of the piezoelectric crystals to a much lower impedance voltage signal which has the capability of driving long cables with little signal degradation.

THEORY OF OPERATION

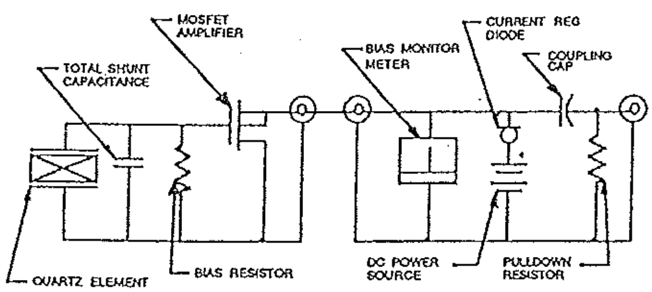


FIGURE I THE VOLTAGE MODE LIVM SYSTEM

Figure I 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 sensors.

The sensing element (force, pressure or acceleration) usually made from quartz, is connected directly to the gate of a MOSFET input integrated circuit (IC) amplifier. The 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 can take many configurations from simple battery powered 2 mA supplies with constant current diode to line powered adjustable current power units able to supply 2 to 20 mA of constant current from a variable magnitude constant current circuit.

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

Under quiescent conditions, the IC will bias itself at approximately +10 volts DC at the input (source) terminal of the sensor. This bias voltage is monitored with most Dytran power units and this feature serves as a handy trouble shooting tool serving as an indicator for normal or abnormal operation of sensor, cable and power unit. (More on this topic in a following section, "The fault monitor as a trouble shooting tool)".

The sensor signal, produced by the measurand acting upon the piezo element, is superimposed upon the +10 Volt DC bias 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 portion containing the sensor information, is coupled to the "Output" jack. This jack is connected directly to the readout instrument(s), (oscilloscope, spectrum analyzer, frequency counter, etc. The very low output impedance of the sensor (about 100 Ohms) makes the effect of most readout instruments negligible.

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

Dytran also manufactures a DC coupled power unit for LIVM sensors which utilizes an active variable voltage amplifier circuit to buck out the bias voltage of the sensor IC. This unit, the Model 4115, supplies constant current to the sensor and direct couples the sensor to the output jack eliminating the coupling capacitor. This allows the user to take full advantage of the long time constant built into the sensor and precludes the effect or readout load on the low frequency response of the system. This unit is especially useful for very long term (quasi-static) measurements 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 circuits will absorb any amount of current supplied until the 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 to batteries, Ac and DC power units and many types of resistance measuring instruments. 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 IC. To determine if the IC is burned out, use the Monitor meter on the front panel of most Dytran LIVM power units. This topic is covered in the following section, "The fault monitor meter as a trouble shooting tool."

After installing the sensor in accordance with instructions in the Operating Guide (manual) supplied with each instrument, connect the sensor to the power unit "Sensor" jack. This jack is, in most power units, a BNC coaxial connector. You should have been supplied with the proper cable to connect the sensor to the power unit.

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

THE FAULT MONITOR METER AS A TROUBLE SHOOTING TOOL

Most Dytran LIVM power units incorporate a DC voltmeter on the front panel which measures the DC bias voltage at the sensor terminal. Measuring this voltage supplies information about the health of the sensor, cable and power unit which can be very useful in searching for problems in the measurement system. The three conditions it can identify are: 1) normal operation, 2) shorted cable or power unit or non operating power unit and 3) open sensor, or cable. We will examine each condition here.

NOTE: The fault monitor meter may be the led style (shown on left in Fig 2) or the D'Arsonval panel meter style, shown on the right, Fig 2, depending on the power unit model.

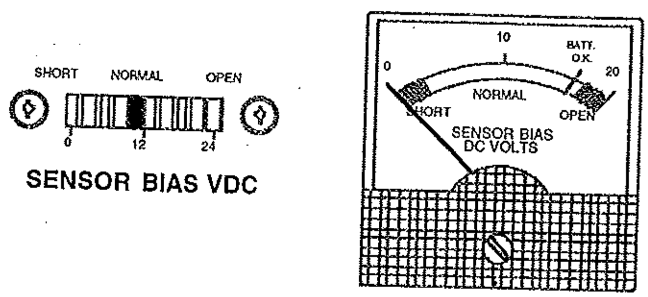


FIGURE 2 TYPICAL FAULT MONITOR METERS

NORMAL OPERATION

Under normal operating conditions, the Monitor meter will indicate mid scale or approximately +10 volts DC when the sensor is connected. Many of the meter faces have a "Normal" area delineated to indicate that the sensor IC is functioning and the cable from sensor to power unit is not open or shorted. It is still possible that certain failure modes of the sensors can provide "Normal" indications but these modes are very rare. In most cases, if the meter reads in the normal area, the system is ready to receive data

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 the hand can cause the monitor meter pointer to deflect showing that the sensor is "alive". With some higher sensitivity accelerometers, shaking them back and forth in the sensitive axis can deflect the monitor meter enough to show that the sensor is functioning.

OPEN SENSOR OR CABLE (FULL SCALE METER READING)

If the sensor amplifier is blown or the cable connecting sensor to power unit is open, the monitor meter will read full scale (in the "Open" area) since the current source in the power unit has no load. To see if the problem is in the sensor, disconnect the sensor from its cable, (leaving the other end of the cable attached to the power unit), and short across the cable end with a metallic object while observing the meter. If the meter does not go to zero ("Short" indication) while the cable end is shorted, the cable is bad (open) replace the cable and try again for the "normal" indication.

If it 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" (zero volts) region after connecting the sensor, this means that a short has brought the voltage output of the constant current circuit to zero volts.

This condition cannot destroy the power unit since the current will be limited to from 2 to 20 mA, depending upon the specific power unit. Sometimes, shards of metal will scrape off the cable connector threads (with the 10-32 connectors) and will short across the cable contacts. To remove these shards, tap the ends of the cable connectors gently against a rigid surface to dislodge them. Cleaning the connector end with a stiff bristled brush may also dislodge any metal shavings.

If the short is still indicated, then the problem is with the cable or the power unit itself. Disconnecting the cable from the power unit and getting a full scale reading means that the power unit is OK and the problem is a shorted cable. Replace the cable.

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-sealed units.

Clean epoxy from the mounting surfaces of accelerometers with acetone or such other solvent which will dissolve epoxies.

If the problem you are having is poor low frequency response and the sensor is not hermetically sealed, baking in a 250 degree F oven for an hour will often get rid of moisture which may have shortened the discharge time constant.

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

If the instruments 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.

Dytran Instruments, Inc.
21592 Marilla St. Chatsworth, CA 91311 Ph: 818-700-7818 Fax: 818-700-7880
www.dytran.com email: info@dytran.com

WARRANTY

Dytran Instruments, Inc. warrants its products against defects in materials and workmanship for a period of one year after delivery. During the warranty period, Dytran, at its option, will either repair or replace products that prove to be defective.

WARRANTY LIMITS

1. Improper or inadequate maintenance by the buyer.
2. Unauthorized modification or misuse.
3. Improper installation by the buyer.

EXCLUSIVE REMEDIES

The remedies provided herein are the buyer's sole and exclusive remedies. Dytran shall not be liable for any direct, indirect, special incidental or consequential tort or any other legal theory. Dytran warrants only the free recalibration of any sensor which deviates beyond its calibrated value within the warranty period.

Contact the factory for return instructions before sending any material for repair.

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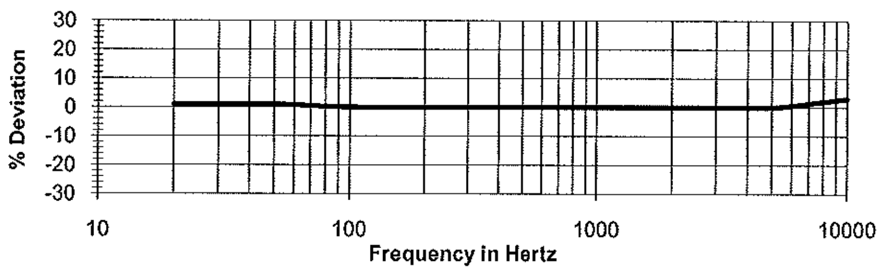
CALIBRATION CERTIFICATE
VOLTAGE MODE ACCELEROMETER

CUSTOMER:	ALLIANTECH SAS			TEST REPORT #:	9122
PURCHASE ORDER #:	293-252	SALES ORDER #:	139040	PROCEDURE:	TP3002
MODEL:	3055B1	SERIAL #:	9122	RANGE, F.S. (g's):	+/- 500
NEW UNIT	X	RE-CALIBRATION [1]		AS RECEIVED CODE	AS RETURNED CODE
REF. SENSITIVITY (mV/g) [2]:	9.90	TEMP (°C):	23	HUMIDITY (%):	42

FREQUENCY RESPONSE [3]

FREQUENCY (Hz)	SENSITIVITY (mV/g)	FREQUENCY (Hz)	SENSITIVITY (mV/g)
20	10.00	500	9.90
30	10.00	1000	9.90
50	10.00	3000	9.90
100	9.90	5000	9.90
300	9.90	8000	10.10
TRANSVERSE SENSITIVITY (%):	1.0	10000	10.20
DISCHARGE TIME CONSTANT (sec):	0.70	BIAS VOLTAGE (VDC):	12.3

Amplitude Response



REMARKS:

TEST EQUIPMENT LIST - CALIBRATION STATION # 9

DII #	MANUFACTURER	MODEL	SERIAL #	DESCRIPTION	CAL DATE	DUE DATE
540	BERAN INSTRUMENTS	475	182448	VIBRATION CALIBRATOR	06/06/09	06/06/10
541	BERAN INSTRUMENTS	801A	A004	DUAL AMPLIFIER UNIT	06/06/09	06/06/10
692	FLUKE	45	6976018	MULTIMETER	12/24/08	12/24/09
1063	NICOLET	3091	85D02021	DIGITAL OSCILLOSCOPE	01/30/09	01/30/10
686	DYTRAN INST.	3010M14	1684	ACCELEROMETER	10/08/09	10/08/10

[1] AS RECEIVED / AS RETURNED CODES:

1 = IN TOLERANCE, NO ADJUSTMENTS
2 = IN TOLERANCE, BUT ADJUSTED
3 = OUT OF TOLERANCE < 5%
4 = OUT OF TOLERANCE > 5%
5 = REPAIR REQUIRED
6 = REPAIRED AND CALIBRATED
7 = UNIT NON-REPAIRABLE, RECOMMEND REPLACEMENT
8 = UNIT SERVICEABLE WITH CURRENT CALIBRATION DATA

[2] THE REFERENCE SENSITIVITY IS MEASURED AT 100 Hz, 1G RMS.

[3] THIS CALIBRATION WAS PERFORMED IN ACCORDANCE WITH ANSI/NCSL Z540-1-1994, ISO 10012-1, ISO/IEC17025 USING THE BACK-TO-BACK COMPARISON METHOD PER ISA RP37.2 AND IS TRACEABLE TO THE NIST THROUGH TEST REPORT # 12495-120H DUE 10-08-10

ESTIMATED UNCERTAINTY OF CALIBRATION: 2% FROM 20-100 Hz, 1.5% FROM 100-2500 Hz, 2.8% FROM 2.5KHZ-10 kHz. APPLIES TO FREQUENCY RESPONSE ONLY.

CALIBRATION TECHNICIAN: PHUOC TRAN (6 CAL)

TEST DATE : 10/23/09

RECOMMENDED RECALL DATE : 10/23/10