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OG5313A
5-05-03

OPERATING GUIDE

MODEL 5313A

LOW PROFILE TRIAXIAL LIVM

SEAT ACCELEROMETER, PER ISO 8041

INCLUDED WITH THIS MANUAL:

1) Specification Model 5313A
2) Outline/Installation Drawing 127-5313A
3) Paper, "LIVM (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 most other manufacturers' comparable systems.

SPECIFICATIONS
MODEL 5313A TRIAXIAL LIVM SEAT ACCELEROMETER

SPECIFICATION	VALUE	UNITS
PHYSICAL		
WEIGHT	0.47 (227)	Lb. (Grams)
SIZE, DIA. X THICKNESS	Ø9.16 (232) X Ø.47 (12.0)	Inches (mm)
CONNECTORS, AT END OF RADIAL 10 FT. CABLE (3)	BNC PLUGS	
MATERIAL, PAD	RUBBER	
CENTRAL HOUSING	ANODIZED ALUMINUM	
PERFORMANCE		
CONFORMS TO ISO 8041		
EACH AXIS		
SENSITIVITY, EACH AXIS, ± 5% [1]	100	mV/G
RANGE F.S. FOR +/- 5 VOLTS OUTPUT	± 50	G's
FREQUENCY RANGE, ± 5%	0.5 to 3000	Hz
RESONANT FREQUENCY, NOM.	25	kHz
EQUIVALENT ELECTRICAL NOISE FLOOR	.0007	G's RMS
LINEARITY [2]	± 1%	% F.S.
TRANSVERSE SENSITIVITY, MAX.	5	%
STRAIN SENSITIVITY	.012	G's/μσ @ 250 μσ
ENVIRONMENTAL		
MAXIMUM VIBRATION/SHOCK	400/1500	± G's/G's PEAK
TEMPERATURE RANGE, OPERATING	-60 to +160	°F
TEMPERATURE RANGE, SURVIVAL	-100 TO +275	°F
SEAL, ACCELEROMETER	HERMETIC	
COEFFICIENT OF THERMAL SENSITIVITY	.03	%/°F
ELECTRICAL		
SUPPLY CURRENT/COMPLIANCE VOLTAGE RANGE [3]	2 to 20/+18 to +30	mA/Volts
OUTPUT IMPEDANCE, TYP.	100	Ohms
BIAS VOLTAGE RANGE	+9 to +12	VDC
DISCHARGE TIME CONSTANT RANGE	0.8 to 1.2	Sec
OUTPUT SIGNAL POLARITY FOR ACCELERATION TOWARD TOP		Positive
OUTPUT POLARITY FOR ACCELERATION IN DIRECTION OF ARROWS		positive
ELECTRICAL ISOLATION, CASE GROUND TO MOUNTING SURFACE		10 Megohms, min.
CABLE, TERMINATES IN 3-BNC's FOR CONNECTION TO 3 POWER UNITS		6FT 8" LONG

[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 5313A TRIAXIAL SEAT ACCELEROMETER FOR WHOLE BODY MOTION

INTRODUCTION

Model 5313A is a low profile three-axis seat pad accelerometer using the latest in piezoceramic shear technology coupled with 2-wire internal LIVM electronics. This instrument is designed to measure whole body motion per ISO 8041 vehicle testing. The person or test dummy sits upon the instrument which is actually a thin rubber cushion or seat pad The instrument measures the motion imparted to the body in three orthogonal axes. The sensitivity of each axis is 100 mV/g, nominally. The actual sensitivity of each axis is supplied with each instrument.

Model 3134M1 triaxial accelerometer, mounted within the 5313A, contains three miniature piezoceramic laminar shear mode accelerometer elements within a titanium housing. The three elements are mounted orthogonally to each other so that they can measure the complete 3-axis motion of a body.

The Model 3143M1, is mounted to the bottom plate of the central housing of the 5313A. This central housing is in turn contained within a rubber pad which is 9.16 inches (232 mm) in diameter by .500 (12.7mm) thick.

LIVM (Low Impedance Voltage Mode) design means that miniature low-noise IC charge amplifiers are built into each of the three elements, to lower the impedance of the piezo elements by many orders of magnitude. This technique allows the driving of long cables without affecting sensitivity and the use of very simple constant current type power units. (Compatible with ICP systems.)

All accelerometer elements are internally isolated from the outer case and are enclosed by a Faraday shield for superior noise immunity.

DESCRIPTION

Refer to the outline/installation drawing 127-5313A for the dimensions and other details of Model 5313A.

The accelerometer housing, made from aluminum, is mounted at the center of a thin circular rubber pad, approximately 9 inches in diameter by 1/2 inch thick at the center and tapering to approx. 1/8 in. thick at the edges. The pad may be incorporated within the seat of a vehicle or may be simply placed upon the seat. The test person then sits on the pad during the test of 3-axis whole body motion.

The three axes of the accelerometer are brought out radially through a hole and exit the pad with a single 4-wire cable. This cable then splits into three coaxial cables each of which is terminated with a BNC plug. These cable are marked Axis 1, Axis 2 and Axis 3.

INSTALLATION

Refer to Outline/Installation drawing 127-5313A supplied as part of this operating guide. Model 5313A is actually a pad which may be placed directly under the test person or may be incorporated within the design of the seat cushion upon which he or she sits

The three BNC connectors may be connected to the inputs of the constant current LIVM power unit. On Dytran power units, these would be connected to the "Sensor" jack. The acceleration signal is then taken from the "Output" jack. A multi-channel power unit is suggested, however three single channel power units may be used as well.

OPERATION

Several Dytran power units would be suitable for use with the Model 5313A. The line operated Model 4114 has four channels and has BNC sensor and output jacks. The rack mounted 4120 has 6 channel and is also line powered.

Another choice is the battery powered three channel Model 4103C which also features BNC input and output jacks.

Connect the three BNC plugs to the power unit "Sensor" jacks and connect the readout equipment to the "Output" jacks of the power unit

After connecting the accelerometer to the power unit, apply power and allow several seconds for coupling capacitors to fully charge. If you are using one of the multi-channel Dytran power units, rotate the channel selector knob through the first three positions to monitor the bias voltage of each of the three accelerometer element assemblies to check for normal operation. The bias voltage level appears on the front panel mounted voltmeter on the power units

Consult the paper, "Low Impedance Voltage Mode (LIVM) Theory and Operation", included as part of this manual, for instructions in using the bias monitoring voltmeter on the power unit as a check for normal operation and as an effective trouble shooting aid.

Although only one axis of the 5313A may be monitored with the front panel meter on the 4113B 4120 or 4103C, each axis is continuously outputting data at the respective output jack at all times. Selecting a channel for bias monitoring does not affect the signal from that channel.

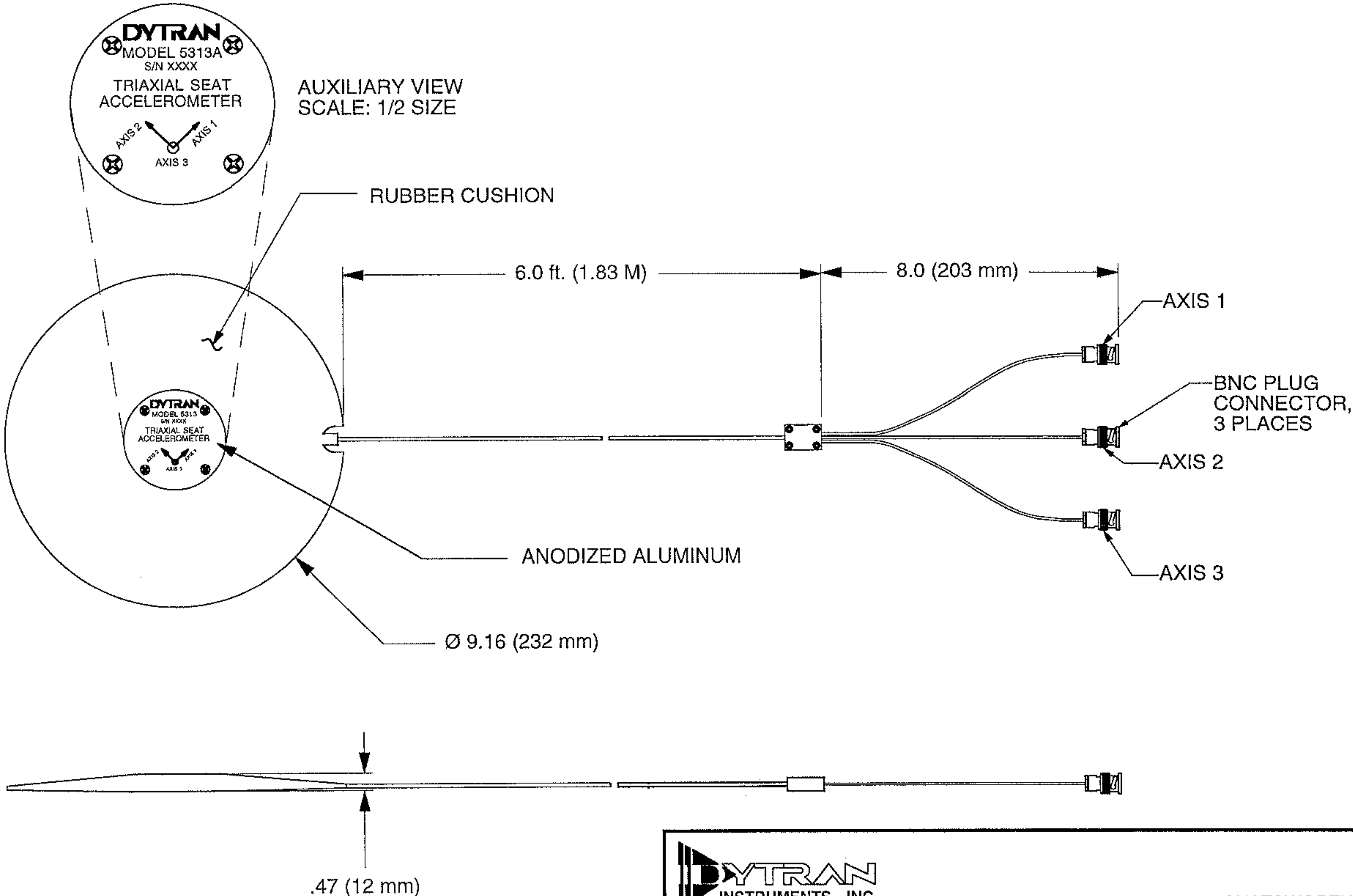
Be sure to check the orientation of each axis with the markings on the instrument upper surface and/or the outline/installation drawing supplied with the Operating Guide.

The output signal polarity of each axis is define with arrows engraved in the top surface of the 5313A and again, on the outline/installation drawing 127-5313A. The arrows indicate the direction and sense of motion of the accelerometer that will produce positive-going output signals. The vertical axis, axis 3, produces positive-going output voltage when the accelerometer is accelerated upward, i.e., away from the mounting surface.

MAINTENANCE AND REPAIR

This instrument is not field repairable. No maintenance is required, or possible. If a problem occurs, contact the factory for help. You will be assigned a Returned Material Authorization (RMA) number should the instrument have to be returned to the factory for evaluation. A short note describing the problem will facilitate the repair procedure.

There is no charge for evaluation of the instrument and we will perform no repair work until you are notified of any charges. It is good practice to return the instrument to the factory for recalibration from time to time with frequency of recalibration dependent on usage intensity and duration.



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CHATSWORTH, CA.

SCALE 1/4	REV B	DATE 3/17/04	ECN -
DATE 1/3/03	PART NO. MODEL 5313A		
DRAWN N.C. / CHECKED R.A.	MAT'L -		
APPROVED 3-19-05	NEXT ASSEMBLY	USED ON MODEL 5313A	
TITLE OUTLINE/INSTALLATION DRAWING MODEL 5313A TRIAXIAL SEAT CUSHION ACCEL		DWG NO. 127-5313A	SHEET 1 OF 1

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

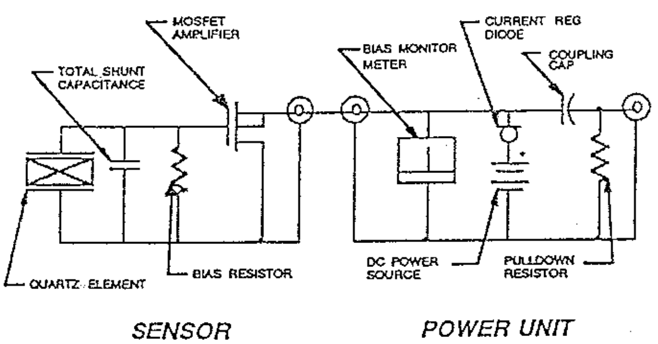

FIGURE I THE VOLTAGE MODE LIVM SYSTEM

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.

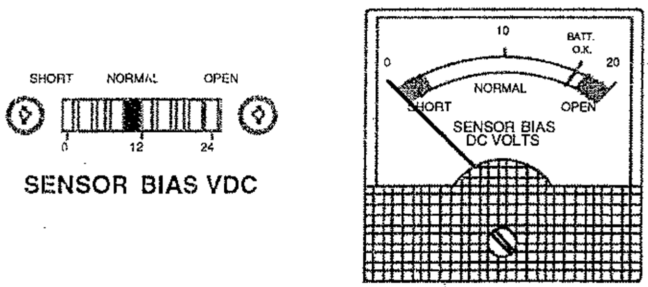

FIGURE 2 TYPICAL FAULT MONITOR METERS

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.

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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 which 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 buyers 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.