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OPERATING GUIDE

MODEL SERIES 1060VX & 1061VX

LIVM FORCE SENSORS

This manual includes:

1) Outline/Installation drawing 127-1060V & 127-1061V
2) Operating Guide Series 1060V/1061V
3) Paper: "Low Impedance Voltage Mode (LIVM) Theory and Operation"

NOTE: LIVM™ is Dytran's trademark for its line of **L**ow **I**mpedance **V**oltage **M**ode 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 SERIES 1060V AND 1061V
LIVM FORCE SENSORS

INTRODUCTION

Series 1060V and 1061V LIVM force sensors are designed primarily to measure dynamic forces up to 25,000 lbs-force. Such dynamic forces include drop shock measurements and other types of impacts, sinusoidal forces, and other slowly and rapidly changing forces.

Series 1060V features a threaded mounting stem extending from the bottom mounting surface of the unit. The electrical connector is mounted at the end of this mounting stem. This configuration is especially useful when there is little space for a connector to protrude radially form the sensor body. This series is mounted by tapping a hole in the mounting surface to receive this threaded stem. The electrical connection must exit through the mounting hole.

Series 1061V has a radially mounted connector and utilizes a separate mounting stud for installation. To mount this series, a tapped hole is required to receive the mounting stud. The connector protrudes radially from the sensor body.

All other features including range, sensitivities, etc. are similar in both series. There are six full scale compression force ranges for each model series ranging from 500 lbs. full scale to 50, 000 lbs. full scale.

In both series, thin, highly preloaded quartz crystals produce electrostatic charge signals exactly analogous to compressive and tensile forces acting on the sensors. These units have a very wide dynamic range, that is, they may be used to measure dynamic forces as low as fractions of a pound up to 50,000 lbs force.

DESCRIPTION

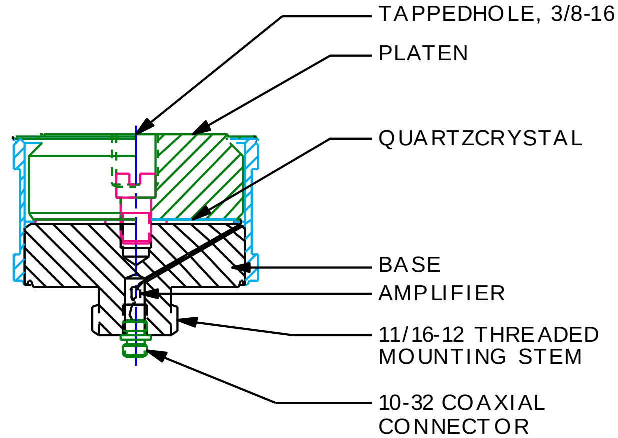


FIGURE 1: CROSS SECTION MODEL 1060V

Built-in electronics make operation very simple (see the enclosed article “Low Impedance Voltage Mode (LIVM) Theory and Operation”) eliminating the need for expensive charge amplifiers.

INSTALLATION

Refer to Outline/Installation drawings 127-1060V and 127-1061V for instructions as to mounting surface and mounting port preparation for both model series.

It is very important that the mounting surface be flat to at least .001 TIR and that the surface be clean and free from particles such as machining burrs, etc. Such inclusions can stress the surfaces of the sensor causing slight discrepancies in calibration and/or frequency response.

Spread a light coat of silicone grease on mating surfaces and torque the sensors in place with 20 to 25 lb-inches of torque. Wrench flats are provided on the body of these sensors for the purpose of tightening these units to their mounting surfaces.

LOADING CONSIDERATIONS, IMPACT

When applying loads to the force sensor, it is important to note that the load must be distributed evenly across the force sensitive face of the force sensor.

For impact measurements, an impact cap accomplishes this adequately in most cases. During impact testing, try to control the impact point so the contact occurs close to the center of the sensor. For more massive objects impacting the sensor, a special thicker cap may need to be employed. Consult the factory for special applications such as this. Never apply impact forces to these force sensors without an impact cap to protect the platen against damage and distribute the force.

Figure 2 (next) is intended to illustrate the right and the wrong way to apply loads to the 1060V and 1061V series. Obviously we cannot address the many different applications but merely want to illustrate, in the most basic sense, the proper and improper ways to apply loads to these instruments for the purpose of heading off measurement problems, which may be incurred by improper use.

In the illustration chosen in Figure 2a, a hydraulic or pneumatic ram is loading the force sensor dynamically. It is important that the force be evenly distributed, centrally, to the force sensor and the right way would be to use a steel ball as shown in 2b, to evenly load the sensor through a special adaptor which has been designed to center the ball over the force sensor.

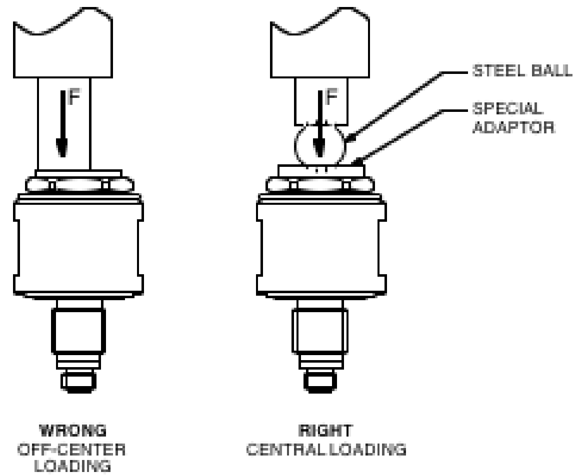


FIGURE 2
ILLUSTRATING OFF-CENTER LOADING

Dytran offers such adaptors as a special order accessory. Our engineering department and our state of the art machine shop are at your disposal for the design and fabrication of such adaptors. Call the factory for assistance with your particular measurement problem.

TENSILE LOADING

Figure 3 illustrates one proper way to load the sensors in tension. Again, the forces must travel through the center of the sensor.

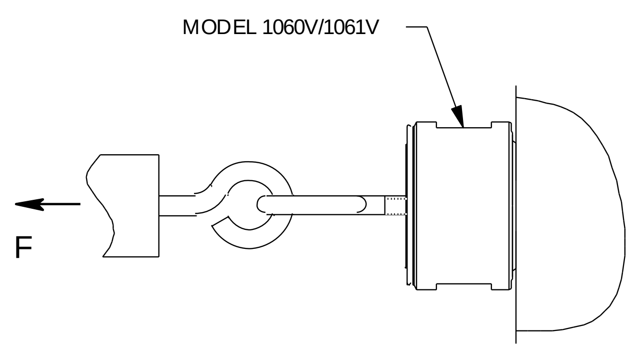


FIGURE 3
PROPER TENSILE LOADING

The arrangement shown in Figure 3 ensures that the load is applied centrally to the sensor without bending moments and transverse loading.

One important point to keep in mind when making tension measurements is that, due to limits in the design of the internal preload structure of these sensors, the **maximum tensile force is limited to 1000 Lbs**. **in this series**. **If this level is exceeded, the sensor may be destroyed and the load could be suddenly released.** This could engender dangerous situations for personnel and equipment if this eventuality is not fully understood.

Remember that the maximum force is the combination of both static and dynamic tensile forces. For example, if the sensor is supporting a static load of 500 Lbs., the maximum dynamic range possible is 500 Lbs, (1000 - 500).

POWERING CONSIDERATIONS

For most dynamic measurement situations, simple AC coupled Dytran power units such as models 4110C and 4114B may be used to power these sensors.

Two situations may occur in the use of these sensors, which may require the use of a particular power unit such as the DC coupled Model 4115 or which may require the application of a “zero clamp”.

These situations are:

1. When measuring quasi-static (near DC) forces and,
2. When measuring repetitive impacts.

1.) QUASI-STATIC MEASUREMENTS

Quasi-static measurements are those measurements which are close to steady state such as when calibrating a sensor with calibration weights. The very long discharge time constant (TC) of these units permits this but AC coupled power units have a much shorter coupling time constant which will not allow such low frequency measurements.

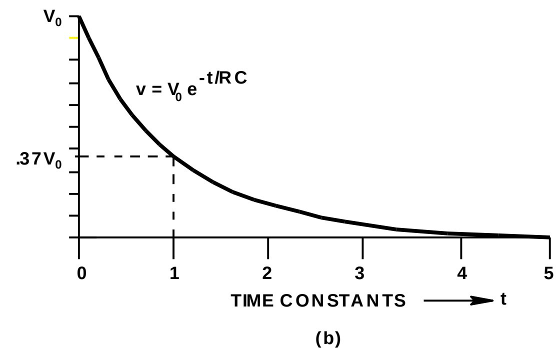


Figure 4: Discharge Time Constant (TC) characteristics.

Figure 4 is a graphic illustration of the response from a dynamic sensor in response to a static input. Immediately upon application of the input force at time $t = t_0$. Although the weight is still present, the output voltage discharges toward the quiescent condition (V = 0) and the discharge curve is governed by the equation:

$$v = V_0\, e^{-t/RC} \qquad \textbf{Eq 1}$$

Where: V_0 = the voltage immediately at t = o (Volts)

e = the base of the natural logarithm

t = any time t after t_0 (Sec)

RC = the discharge time constant, the product of coupling elements R and C. (Sec)

Since equation 1 is approximately linear over the first 10% after t = 0, we may make an observation. This is, for us to be accurate within 1%, we must have a discharge time constant 100 times longer than the event time. Figure 5 below illustrates this graphically.

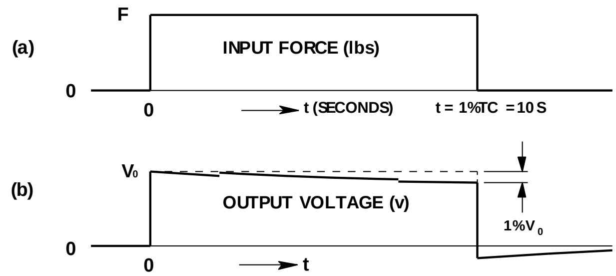


Figure 5: Quasi-static response

Figure 5 illustrates the response of an AC coupled force measurement system to a static input force such as the application of a weight to the sensor.

As an example: if we want to accurately measure a static event with a duration of 5 seconds, our system discharge TC must be at least 100 X 5 or 500 seconds. This is possible with the models 1060V or 1061V V3 to V6 since they all have discharge TC's more than 500 Seconds.

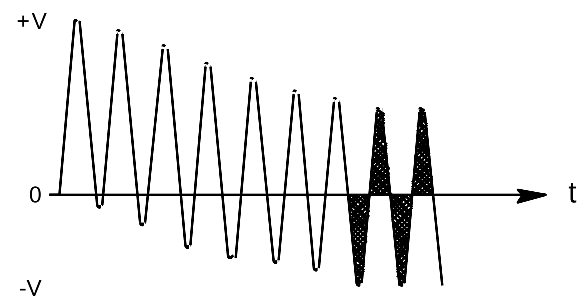
A problem however, is that if we use a Model 4110C AC coupled power unit to couple the force sensor to the readout instrument, the system discharge TC will be a maximum of 10 seconds. This result comes from the multiplication of the coupling capacitor (10 μF) and the pulldown resistor (1 megohm).

The input impedance of the readout unit, since it is in parallel with the pulldown resistor can only exacerbate the problem making the coupling TC even shorter. So it can be seen that even though the sensor has a long enough time constant to do the job, the short coupling TC of the power unit makes the task impossible.

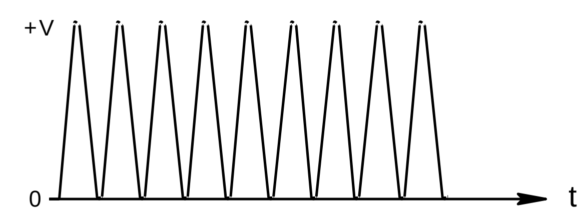
The solution to this dilemma is the Dytran Model 4115 DC coupled power unit. This power unit does not rely on a capacitor to decouple the sensor bias from the dynamic signal. Rather it uses a DC coupled summing circuit which direct couples the dynamic signal from the sensor directly to the readout instrument. Using this power unit, the measurement may now be made with no ill effects. The long discharge TC of the sensor may b now be fully utilized with the use of the Model 4115 DC coupled power unit.

REPETITIVE IMPACTS

When using a typical AC coupled piezoelectric system to measure rapid repetitive force pulses, a slow "drifting" of the average level of the ensuing pulse train will be noticed. (Refer to Figure 6, following)



(a)



(b)

Figure 6: Output waveforms from repetitively pulsed input.

Figure 6a shows graphically what happens to the average level of the waveform. The level will shift until the area enclosed by the waveform below the zero baseline exactly equals the enclosed area above the baseline.

This is acceptable if you are only interested in the peak-to-peak value of the waveform but if you want to display the output on a digital storage oscilloscope for example, this baseline shift may be unacceptable.

The Model 4110C has a feature which will “clamp” the waveform to zero as shown inn Figure 6b. This feature may be switched in or out by means of a rear panel switch and may be “fine tuned” to exactly place the lower extremity of the waveform to zero.

OPERATION

Connect the sensor to the “Sensor” jack of the power unit a using Model 6011AXX cable. (XX is the cable length in feet.) Standard lengths are 3, 5 and 10 feet.

Model 6011AXX has a 10-32 connector on one end and a BNC plug on the other end to mate will most Dytran power units.

Refer to the enclosed paper “Low Impedance Voltage Mode (LIVM) theory and Operation” for tips on using the front panel bias monitoring voltmeter contained in most Dytran power units as a trouble-shooting tool when searching for system problems.

MAINTENANCE AND REPAIR

The sealed construction of these sensors precludes field repair. The electrical connector should be kept clean. Wipe with a cloth dipped in a solvent such as alcohol or Freon TF or similar solvent.

If a degradation of discharge TC is noticed, say after a long period of non-use, bake the unit out in a +250°f oven for at least one hour. In most cases, this will restore the insulation resistance of the crystal element and return the instrument to normal.

If the unit fails to function or behaves erratically, contact the factory for assistance before returning the unit for evaluation. If it is determined that the unit should be returned to the factory, you will be issued a Returned Material Authorization (**RMA**) number which will aid us in giving you the fastest response while moving the instrument through the evaluation system.