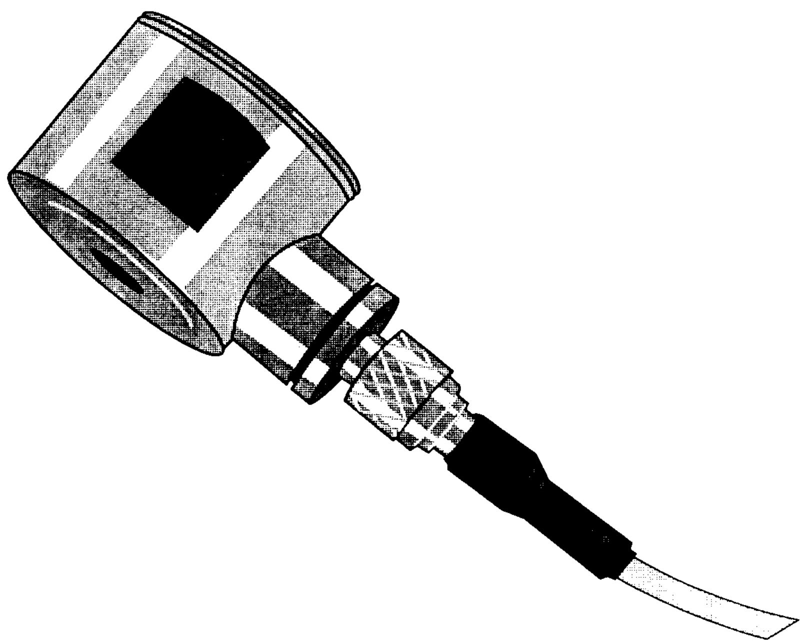
DLC101

Force Sensor



OMEGA®

An OMEGA Technologies Company

Operator's Manual
M1642/0493

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DLC101 TABLE OF CONTENTS

INTRODUCTION

The OMEGA Model DLC101 Series Force Sensors are designed to measure dynamic forces (from 10LbF full scale to 5000 LbF full scale) over a very broad frequency range (quasi-static to 25 kHz).

These sensors are available in six ranges: 10, 50, 100, 500, 1000 and 5000 LbF F.S. for 5 Volts output.

Thin X-cut quartz crystals produce a voltage analagous to dynamic force inputs, positive for compression and negative for tension.

An integral IC amplifier with a MOSFET input stage converts this very high impedance signal to a low impedance output voltage. This type of amplifier is capable of driving long cables and is unaffected by cable length or type, triboelectric noise and most other sources of noise.

The integral IC is powered by a simple current source power supply. Connections from power unit to sensor can be made with coaxial cables, less expensive twisted pair or other types of twin conductor cables.

The DLC101 force sensor has a radially mounted electrical connector and utilizes a separate ¼-28 mounting stud.

UNPACKING THE SENSOR

Remove the packing list and verify that you have received all equipment. If you have questions about the shipment, please call the OMEGA Customer Service Department at (800) 622-2378 or (203) 359-1660.

Upon receipt of shipment, inspect the container and equipment for any signs of damage. Note any evidence of rough handling in transit. Immediately report any damage to the shipping agent.

DESCRIPTION

The Model DLC101 is ideal for driving point force measurements in vibration testing, drop shock testers, impact hammer devices or for instrumenting shafts and pushrods.

The upper platen distributes the input force evenly across the crystals while sealing the sensor from moisture.

The very thin quartz crystals that can be seen in Figure 1, comprise a relatively small part of the overall height of the sensor. This allows for very high stiffness (rigidity), almost the same as a like part made from solid steel.

Refer to the installation drawing included with the manual for a more detailed description of the DLC101.

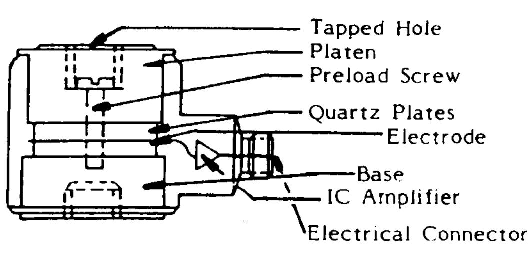

FIGURE 1 - Cross Section - Model DLC101

Figure 1 shows that the DLC101 features a radially-mounted amplifier housing and electrical connector.

THEORY OF OPERATION

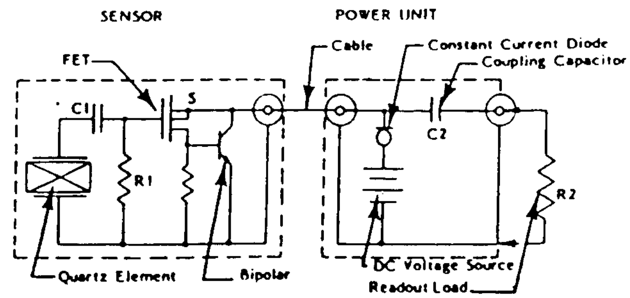

FIGURE 2 - System Schematic

Figure 2 illustrates the sensor/cable/power unit/readout system schematically in its simplest form.

The input force stresses the quartz crystals producing an electrostatic charge Q, which charges total shunt capacity C instantly to voltage V.

Thus: $(V = \frac{Q}{C})$

The MOSFET input IC amplifier operating in unity gain, source follower mode, is supplied with constant current from the power unit via a single coaxial cable.

The voltage signal from the crystal/capacitor combination is connected to the MOSFET gate and results in a like signal at the source, identical in amplitude but superimposed on a +11 Volt bias level. This source terminal is the center contact of the coaxial connector on the sensor.

The +11 VDC level is "removed" or blocked by the $10\mu f$ capacitor in the power unit, thereby returning the output signal to a zero bias condition.

Power can be supplied to this system by an OMEGA accelerometer power supply.

POLARITY OF OUTPUT SIGNAL

Compressive force on these sensors produces positive-going output signals while tensile forces produce negative-going output voltages.

SENSITIVITY

The voltage sensitivity of each sensor is fixed by crystal constants and dimensions and by the value of shunt capacitance C *(Figure 2)* at the time of manufacturing and cannot be changed. The exact sensitivity is shown on a calibration certificate supplied with each sensor. Consult the chart of sensitivities and ranges on the specification sheet for the nominal sensitivity of the various models.

USER PRECAUTIONS

Do not exceed maximum temperature or force ratings.

Do not apply voltage from DC power supply or battery directly to electrical connector. This would immediately destroy the integral electronics.

INSTALLATION

For most applications, the impact cap (supplied) will be used at the load platen.

1. Thread cap into place securely, inspecting for foreign particles between mating surfaces.

   For this section, refer to Figure 3 below.

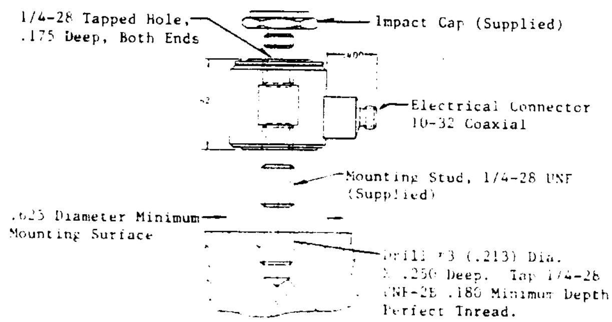

FIGURE 3 - Installation

2. Prepare a flat, smooth area. Drill and tap a ¼-28 hole in the center of this area.
3. Check for burrs and other particles and torque the DLC101 into place using the ¼-28 mounting stud (supplied). It is necessary that the mating surfaces be in intimate contact for proper operation of the sensor.

   A small amount of epoxy may be used on the threads of the stud for a more permanent installation.
4. Connect sensor to power unit as shown in Figure 4, using an ACC-CB2 coaxial cable. Tighten cable locking rings by hand.

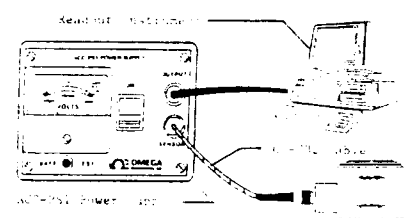

FIGURE 4 - Electrical Interconnections

START-UP

1. Connect the power supply to the readout instrument using an ACC-CB2.
2. Switch power unit on and wait several minutes for coupling capacitors to fully charge and for the system to thermally stabilize.

During this warm-up period, the system output voltage may appear to be unstable, that is, slowly changing in value. This is normal and the system should stabilize within two to three minutes.

LOADING CONSIDERATIONS

When applying loads to the DLC101, it is important to remember that the load must be distributed evenly across the force sensitive surface. Avoid "Point" loading.

The impact cap should be used in all impact and other compressive measurement situations where the load is not fastened directly to the tapped hole in the force sensitive surface.

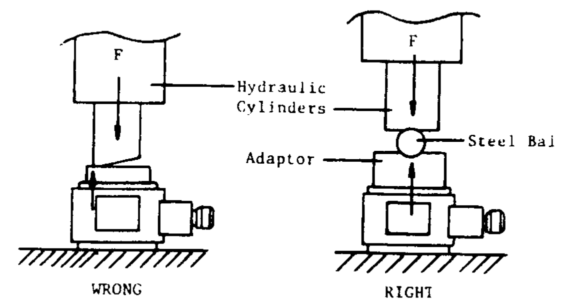

FIGURE 5 - Proper Loading Method

Figure 5 shows the proper way to measure the dynamic force produced by a hydraulic ram. The right way uses a steel ball and adaptor to transmit the force to the load cell, distributing the force evenly across the cell surface.

The wrong way shows the ram contacting the cell at the highest point, off center, with no provision for the proper mating of the two surfaces. An erroneous force reading would most probably result from this set-up.

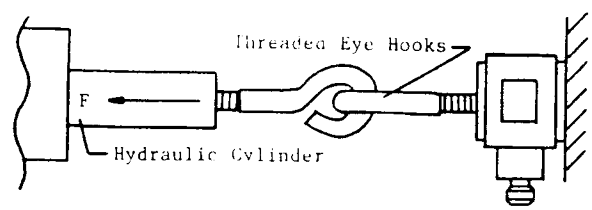

FIGURE 6 - Tension Measurement

Figure 6 shows an acceptable loading method for measuring the tensile force of a ram. The two hook eyes provide the degrees of freedom necessary to ensure that the cell is loaded in pure tension without bending moments being applied to the DLC101. You can also use rod-end bearings.

QUASI-STATIC CONSIDERATIONS

The discharge time constant of some DLC101 models is long enough so that near static force measurements can be made. However, it is important to consider other coupling time constants in the measurement system to obtain the desired results from the sensor.

The integral IC is powered by a single coaxial cable with 2 to 20 mA of constant current *(See Figure 7)*. The voltage produced by force acting upon the sensor is superimposed on a +11 V bias voltage at the sensor connector.

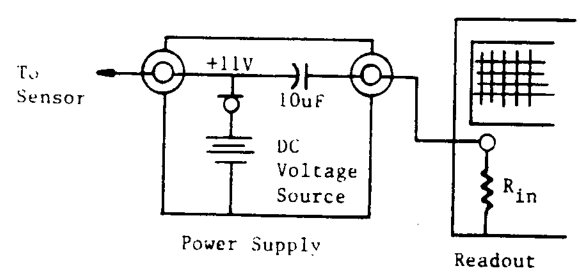

FIGURE 7 - Decoupling Considerations

Most power supplies are AC coupled, which means that they utilize a 10μf tanalytic capacitor to decouple the sensor signal from the sensor. This effectively returns the signal level to zero base and "removes" the +11 VDC bias.

It must be remembered that in most cases, this 10μf capacitor loaded by the input resistance of the readout instrument will limit the quasi-static ability of the sensor system. For Example:

If the input resistance of the readout instrument is 1 megaohm, the discharge time constant for the coupling circuit is:

10μf x 1 meg ohm = 10 seconds

This result says that within .1 second (10 x .01) after application of a static force, disregarding the discharge time constant of the load cell itself, 1% of the signal information will be lost.

A 10 meg ohm readout impedance yields a discharge TC of 100 seconds. Now after one second, 1% of the information is lost — a little better, but still not good enough for a quasi-static reading.

If the +11 Volt offset can be handled by the readout instrument, a simple "T" connection at the readout may be used to direct couple the sensor to the readout.

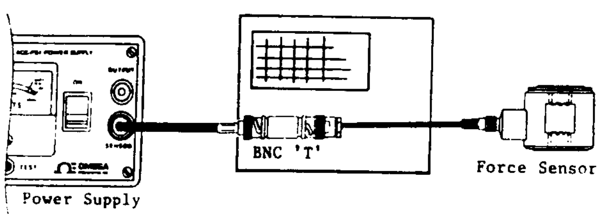

FIGURE 8 - Direct Coupling

Figure 8 shows that using this type of connection allows a standard AC coupled power supply to be utilized. An adjustable "floating" DC power supply can also be used with the set-up shown in Figure 8 to "buck out" the DC bias and return the output level to zero Volts.

CALIBRATION

Since these sensors are dynamic transducers that are designed to measure impacts or rapidly changing forces, it is best to calibrate them dynamically.

The sensors are calibrated at the factory by impacting them with a known, calibrated force hammer.

Another method is to drop a carefully weighed mass/accelerometer assembly onto the force sensor. In view of the fact that force (F) is equal to mass (m) times acceleration (a), the force cell can be calibrated if the exact weight of the accelerometer/mass system and the precise calibration of the accelerometer are known. This is an implementation of Newton's 2nd law: F = mA.

A third method is to apply and remove calibrated weights. This must be done very carefully for repeatable results and cushioning must be used between sensor and weight.

Use some form of storage oscilloscope (preferably a digital model) or a peak meter as a readout instrument for all of these calibration methods.

MAINTENANCE

The sealed construction of these sensors precludes field repair.

Wipe the electrical connector with Freon TF solvent, methylene chloride or alcohol to remove oil, dirt and other contaminants.

Since the output impedance is very low, it is not necessary to maintain super-high impedances at the electrical connector as with high impedance sensors without built-in electronics.

DLC101 SPECIFICATIONS

Excitation*:	2 mA nominal @ 18-30 Vdc, constant current
Rated Output:	5 Vdc nominal FS
Resonant Frequency (@ no load):	75 kHz
High Frequency Range:	25 kHz (approx. 1/3 of resonant frequency)
Low Frequency Range: (-3 dB)	0.08 Hz
Discharge Time Constant:	50 sec (DLC101-10) 100 sec (DLC101-50) 500 sec (DLC 101-100) 2,000 sec (DLC101-500, -1K, -5K)
Maximum Compression:	200 lb (DLC101-10) 1,000 lb (DLC101-50) 2,000 lb (DLC101-100) 10,000 lb (DLC101-500) 15,000 lb (DLC101-1K) 15,000 lb (DLC101-5K)
Maximum Tension:	200 lb (DLC101-10) 500 lb (all ranges except for 10 lb)
Stiffness:	11.4 lb/μIn.
Overload Recovery:	10 uS for 2X range
Maximum Shock/ Vibration: (no load, g)	10,000/±5,000 g's
Amplitude Linearity:	±1% FS (BSFL/0)
Temperature Range:	-100 to 250 deg F (-75 to 120 deg C)
Temperature Sensitivity Effect:	.03% F.S./deg F
Output Impedence:	100 Ohms
Bias Voltage:	10V nominal
Noise Floor (wideband, RMS):	0.00014 lb (DLC101-10) 0.0007 lb (DLC101-50) 0.0014 lb (DLC101-100) 0.007 lb (DLC101-500) 0.014 lb (DLC101-1K) 0.07 lb (DLC101-5K)
Weight:	1.5 oz nominal
Material:	17-4 ph stainless steel housing (Rc 44)
Diameter of Top Force Sensitive Surface:	0.50"
Mounting Holes:	¼-28 x .175 deep tapped hole
Connector:	integral side coaxial, 10-32 male termination (cable not included - order P/N ACC-CB2-10)

*Use ONLY constant current type power supplies. DO NOT supply power from non-current limited power supplies.

MADE IN USA

WARRANTY

OMEGA warrants this unit to be free of defects in materials and workmanship and to give satisfactory service for a period of **13 months** from date of purchase. OMEGA Warranty adds an additional one (1) month grace period to the normal **one (1) year product warranty** to cover handling and shipping time. This ensures that our customers receive maximum coverage on each product. If the unit should malfunction, it must be returned to the factory for evaluation. Our Customer Service Department will issue an Authorized Return (AR) number immediately upon phone or written request. Upon examination by OMEGA, if the unit is found to be defective it will be repaired or replaced at no charge. However, this WARRANTY is VOID if the unit shows evidence of having been tampered with or shows evidence of being damaged as a result of excessive corrosion; or current, heat, moisture or vibration; improper specification; misapplication; misuse or other operating conditions outside of OMEGA's control. Components which wear or which are damaged by misuse are not warranted. These include contact points, fuses, and triacs.

We are glad to offer suggestions on the use of our various products. Nevertheless OMEGA only warrants that the parts manufactured by it will be as specified and free of defects.

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RETURN REQUESTS / INQUIRIES

Direct all warranty and repair requests/inquiries to the OMEGA ENGINEERING Customer Service Department. Call toll free in the USA and Canada: 1-800-622-2378, FAX: 203-359-7811; International: 203-359-1660, FAX: 203-359-7807.

BEFORE RETURNING ANY PRODUCT(S) TO OMEGA, YOU MUST OBTAIN AN AUTHORIZED RETURN (AR) NUMBER FROM OUR CUSTOMER SERVICE DEPARTMENT (IN ORDER TO AVOID PROCESSING DELAYS). The assigned AR number should then be marked on the outside of the return package and on any correspondence.

FOR **WARRANTY** RETURNS, please have the following information available BEFORE contacting OMEGA:

1. P.O. number under which the product was PURCHASED,
2. Model and serial number of the product under warranty, and
3. Repair instructions and/or specific problems you are having with the product.

FOR **NON-WARRANTY** REPAIRS OR **CALIBRATION**, consult OMEGA for current repair/calibration charges. Have the following information available BEFORE contacting OMEGA:

1. Your P.O. number to cover the COST of the of the repair/calibration,
2. Model and serial number of product, and
3. Repair instructions and/or specific problems you are having with the product.

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