INSTRUCTION MANUAL

ELECTRICAL LOAD CELL

Model ANCLO

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E1033-170413

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1 PRODUCT

1.1 DESCRIPTION

ANCLO load cells are used to measure tensile loads in tie-back anchors and rockbolts, or compressive loads in structures. Typical applications include:

• Anchored retaining walls, tieback.
• Anchoring systems for deep excavations
• Tie-down anchors for buoyant structures
• Rockbolts and soil nails monitoring in mines and slope stabilization
• Load monitoring in structures
• To check on the load as determined by hydraulic pressure applied to a jack during proof-testing on tiebacks. Note that in this case because of many parameters, the agreement cannot be guaranteed better than +/-20%.

The load sensing element is a spool of high strength heat-treated steel that withstands rough handling and loading. The ANCLO load cell is built with a hollow cylindrical core onto which four to eight strain gages are bonded in pairs at 90^o intervals around the periphery and connected in a Wheatstone bridge circuit. Load cells less than 152 mm in internal diameter use four bonded strain gages whereas 152 mm or larger internal diameter load cells use eight pairs of bonded strain gages. The gages are wired in a full bridge configuration for temperature compensation, optimum sensitivity and the accurate measurement of non-uniformly distributed loads. A steel housing with o-ring seals covers the spool and protects the strain gauges from mechanical damage and water infiltration. The plain PVC or armor-jacketed electrical cable connects to the cell by

- either a detachable multi-pin electrical connector mounted on the cell
- or permanent factory wiring of the lead cable to the cell. The cable enters the cell through a watertight electrical connector

The load cells are protected against moisture intrusion and are splash proof.

An identification plate on the outside of the cell holds the following information:

- The serial number
- The capacity of the cell in kN

1.2 SPECIFICATIONS

SPECIFICATIONS

Model	Anclo
	Standard Construction
Core:	Heat treated, 4140 zinc plated steel
Housing:	Zinc plated steel
Environmental:	Corrosion resistant, watertight, weatherproof
Cabling:	watertight cable connector (standard) or detachable electrical connector (optional)
Cable model:	IRC-41A (standard) IRC-41AP (optional)
Electrical configuration:	According to cell internal diameter Dia. 152 mm or less: 4 pairs of bonded strain gages, full bridge Greater than 152 mm: 8 pairs of bonded stain gages, full bridge
Impedance:	700 Ω - 4 pairs or 1400 Ω - 8 pairs

Excitation voltage:	1 to 10 volts - 1.5 volts (P-3 readout unit) - 2.0 volts (P-3500 readout unit) - 2.5 volts (SENSLOG data acquisition)
Non-linearity:	≤ 0.5% F.S.
Resolution:	0.1% F.S.
Overload capacity:	2 x rated capacity
Operating temperature range:	-40 °C to +75 °C
Overload capacity:	2 x rated capacity

2 INSTALLATION

The load cell support surface should be smooth and perpendicular to the axis of the anchor or tieback. The use of a load bearing plate of suitable thickness between cell base and the bearing surface, and a load distribution plate between the anchor or tieback head and the load cell is required.

Load distribution on bearing plates that are too thin or improperly dimensioned will result in uneven load distribution causing erroneous results. The inside diameter of the load bearing and distribution plates should be identical to the inside diameter of the load cell.

The load distribution plate can be either a single plate or double spherically seated plates. Use of latter can compensate for misalignment of the bearing surface, load cell and distribution plate. Upon installation, locate the electrical connector downward to minimize the risk of damage.

Connector on load cell	Connection	IRC-41A cable color code
A	P+	RED
B	S+	GREEN
C	S-	WHITE
D	P-	BLACK

TABLE 1: Wiring code for connecting load cell to a "P3" readout unit.

Load cells are accurate instruments and should be treated with care. They should under no circumstances be picked up by the cable. Even if the cells have been designed to be watertight and robust, they can be damaged by misuse, particularly with respect to the cable. Load cells have to be installed with a special care to their installation. From the design arrangements comes the quality of the measurements. The installation design should minimize the eccentric loading and the misalignment of load, whatever the context of measurement (tie-backs, pile test ...). Therefore, cells have to be set between two flat, smooth and stiff plates. The wall where the tie-back applies or the top of the pile during a load test should be plane as well. If necessary, make it so with cement or concrete. If the cells are installed on tie-backs, bushings are often useful to center the hollow cylinder.

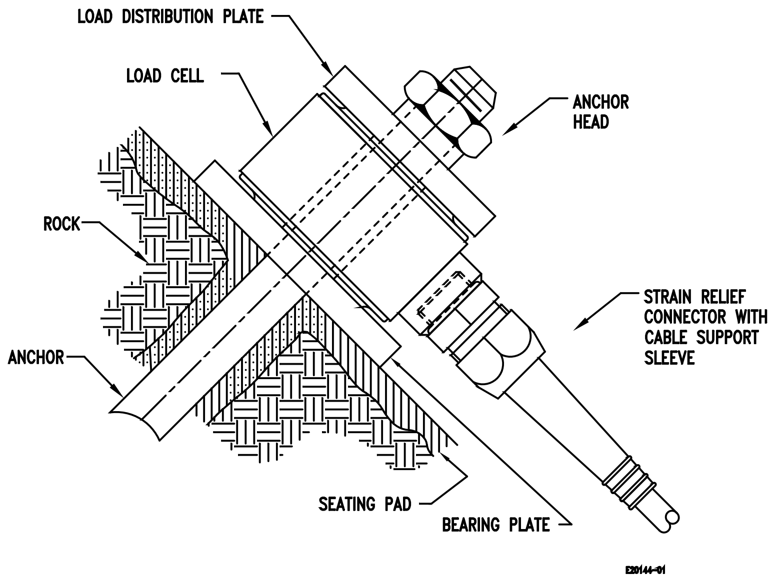


Figure 1: Anclo typical installation on a tie-back

2.1 CABLE INSTALLATION

Cable identification

The electrical signal coming from the sensor is transmitted through an electrical cable. This cable is generally supplied in rolls. Cables are identified with the serial number that is labelled on the sensor housing. The serial number is stamped on a tag that is fastened to the readout end of the cable. In the case where the sensor cable has to be cut or if the cable end is inaccessible, make sure to be able to identify it (by marking its serial number for instance with an indelible marker or using a color code). It is very important to clearly identify the instrument for reading or wiring purposes.

Cable routing

Some of the more important considerations that must be given to cable runs are:

- Avoid traversing transition zones where large differential settlements could create excessive strain in the cable.
- Avoid cable splices. If necessary, refer to the special paragraph below.
- Do not lay cables one on top of the other.
- Use horizontal snaking or vertical snaking of the cable within the trenches. For most materials, a pitch of 2 m with amplitude of 0.4 m is suitable. In very wet clays increase the pitch to 1 m.
- Use a combination of horizontal and vertical snaking at transition zones.

Once a cell is installed, route its cable towards the junction or switching box. Make sure that the cable is protected from cuts or abrasion, potential damage caused by angular material, compacting equipment or stretching due to subsequent deformations during construction or fill placement. If necessary, run the cable through rigid or flexible conduit to the terminal location. To provide protection for cable running over concrete lifts, hand placed concrete is sometimes used, depending on site conditions. Check that the cable does not cross over itself or other cables in the same area. Surface installations require continuous surveillance and protection from the earth moving equipment circulating on the field. During the cable routing, read the instruments at regular intervals to ensure continued proper functioning. Record the cable routing with care and transfer this routing to the drawings.

2.2 ELECTRICAL SPLICES

Generally, cable splices are to be avoided. If necessary, use only the manufacturer's approved standard or high-pressure splice kit. Splicing instructions are included with the splice kit. Should the cable be cut, we recommend the use of our cable splice kits, especially if the splice is located underwater. Furthermore, in special cases on site (large distance between sensors, readout position for example), splices are useful to limit the number of cables to lay. Individual sensor cables can be merged into a multi-conductor cable using a splice or a junction box.

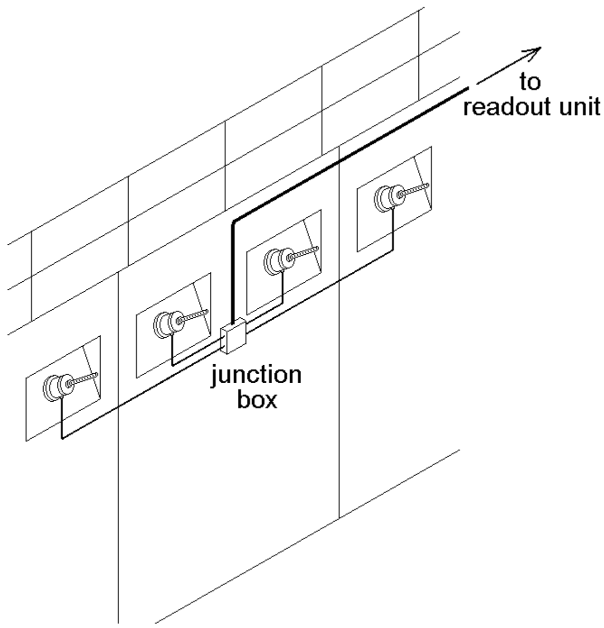


Figure 2: Example of junction box use

Please contact Roctest for additional information about junction boxes and splice kits.

2.3 CABLE WIRING

Before cutting a cable, make sure of its identification. Strip back the conductor insulation by about 1cm. If possible, tin the exposed conductors with a solder.

2.4 LIGHTNING PROTECTION

At all times during the installation, any cable that is exposed to potential damage by lightning must be protected. A large grounded metal cage placed over the cable bundle, combined with direct grounding of all leads and shields is an effective way to prevent lightning damage to the instruments and cables during the installation process. Please contact Roctest for additional information on protecting instruments, junction boxes and data logging systems against power surges, transients and electromagnetic pulses. All junction boxes and data logging systems furnished by Roctest are available with lightning protection.

3 DATA READING AND ANALYSIS

3.1 GENERAL

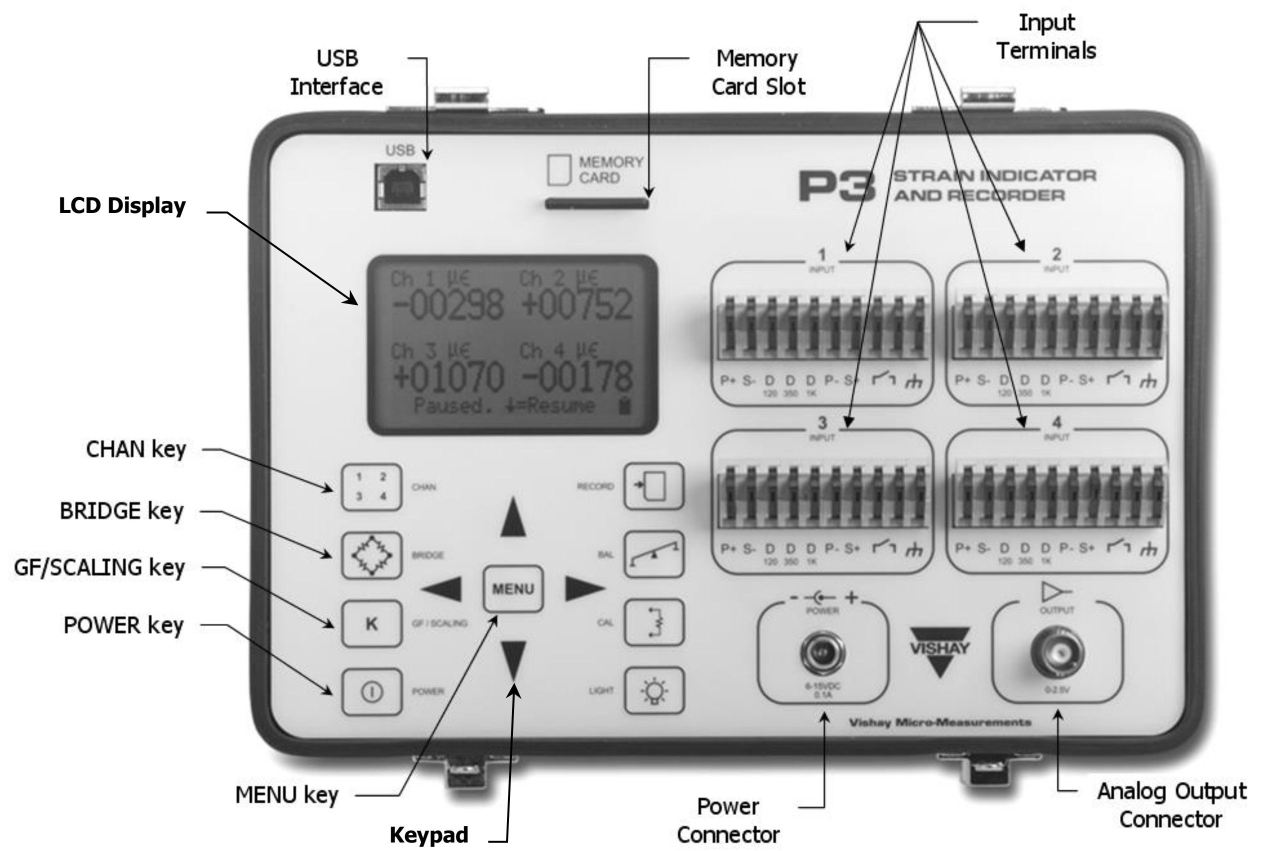
Each load cell comes with a calibration certificate. The certificate lists the sensitivity factor used with a P-3 VISHAY strain indicator or equivalent.

Read each load cell immediately prior to installation. Record each reading under no-load conditions and compare it with the initial value on the calibration data sheet. Readings should agree within +/-0.025mV/V. ANCLO load cells are temperature compensated for a range of -40 °C to +75 °C for equilibrium temperature conditions. It is recommended to protect it from direct sunlight.

If there is a wide discrepancy during storage temperature of the cell and the ambient temperature prior to installation, the cells should be conditioned to the ambient temperature until temperature equilibrium is reached. This ensures that initial reading, made under no-load conditions prior to installation, is a stable value to which subsequent measurements can be referenced. ANCLO load cells can be read with most strain gage indicators. The following procedure applies to the P-3 VISHAY Micro-Measurements indicators.

3.2 READING OUTPUT IN ENGINEERING UNITS

(For more details on other P-3 features, please refer to “P-3 Strain Indicator and Recorder Instruction Manual”)



If you want to see the reading of the load cell directly in engineering units as kN then refer to the following instruction for P-3 configuration. You can connect up to four load cells to a P-3 readout unit as it has four channels available.

1. Press POWER key on the face plate

2. Press CHAN key

"**Chan**" Sub-menu
Use left and right arrows to activate appropriate Channel
Confirm entry by pressing key MENU

3. Press BRIDGE key

"**Bridge**" Sub-menu
Select the appropriate Channel
Use left and right arrows to select appropriate bridge type.
For ANCLO Load Cell, select "Undef FB" for each channel to be used.
Confirm entry by pressing key MENU

4. Press GF/SCALING key

"**Chan**" Sub-menu
Use left and right arrows to select appropriate Channel

"**Units**" Sub-menu
Set appropriate unit among available list

Note that units are provided for convenience only, and have no effect on the calculated values. In order to properly scale the data, it is necessary to supply the full scale value and the mV/V output at the full scale value.

"**Full Scale**" Sub-menu
Set appropriate Full Scale to the full scale value of the load in engineering units as shown on the calibration data sheet.

"**F.S. mV/V**" Sub-menu
Set sensitivity at full scale (in mV/V) according to load cell sensitivity value indicated on the calibration data sheet.

"Dec.Places" Sub-menu
Set the Dec. Places to the correct number in accordance with the units and the full scale reading previously chosen or select Auto for automatic adjustment.

To return to reading display, confirm entry by pressing key MENU

We highly recommend to take note now of the no load zero reading.

5. Press BAL key

Before to use the BAL key you should check if the balance is not in the disable mode. Then go to the main menu and select balance. For each channel be sure to select the mode Auto and press key menu to confirm and come back to reading value.

The balance will do a null reading to see a value near of zero when there is no load on the load cell.

Then press the BAL key on the face plate. Depress the balance button a second time to select auto. This will trigger the auto balance procedure. When completed it will automatically bring up to the Saving Settings menu. Save the settings by depressing the record button on the face plate. The display should now read zero and you are ready to display the load directly in engineering units.

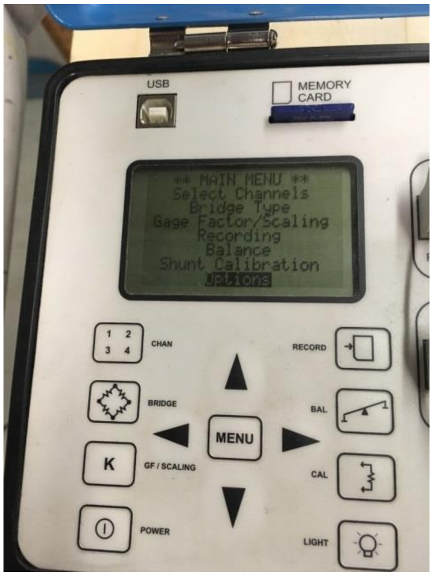
Note that the auto balance only works when the load cell is under zero load. Do not switch from one load cell to another if the load cells are under load.

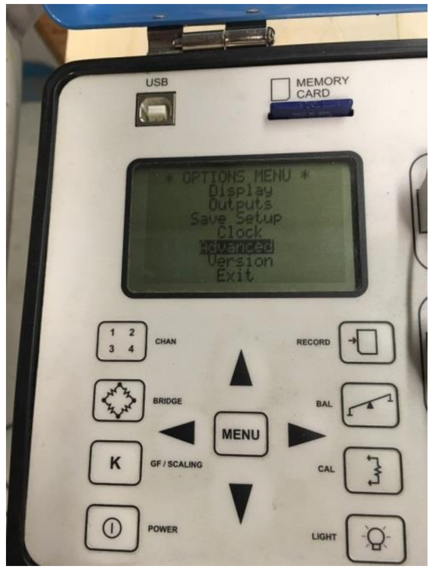
For more details on readings relative to an absolute ZERO, refer to “Manual Balance” topic in “P-3 Strain Indicator and Recorder Instruction Manual”.

3.3 READING OUTPUT IN MV/V

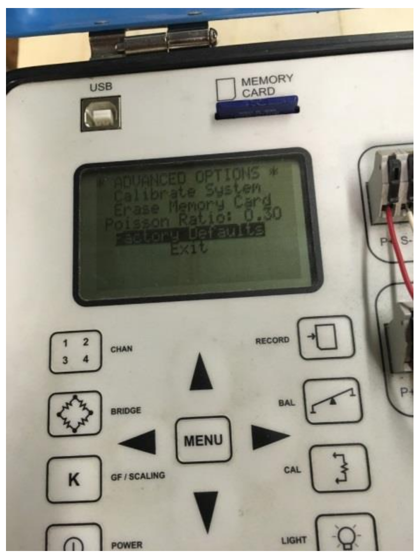
The simplest way to read multiple load cells using the P-3 readout unit is to read the output in mV/V and then use the load cell sensitivity factor in mV/V at full scale to compute the load as shown on the section 3.4.

Before to read in mV/V be sure to erase all previous parameters and settings in the readout unit. To erase the settings go to the Main Menu and select Options as shown on following pictures.

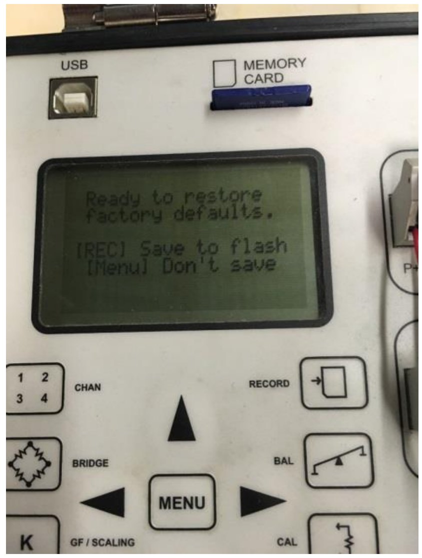




In the menu OPTIONS select Advanced



And select Factory Defaults.



Then press the record button on the front panel to restore factory defaults.

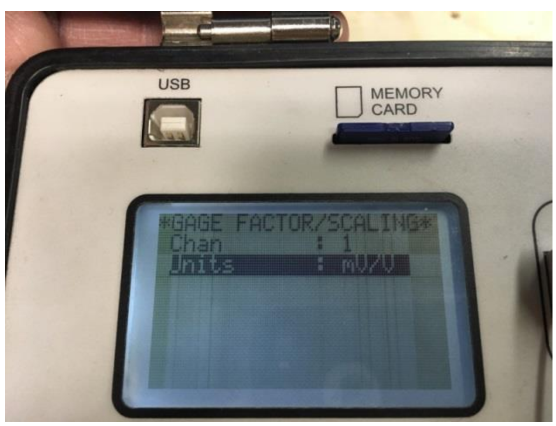
After erasing the settings, set up the P-3 readout unit as follows:

First connect the load cell according to wiring and color code as mentioned on table 1 on channel 1.

Then press CHAN key or from the main menu press "select channel" and activate all channels where you have connected a load cell. Confirm entry by pressing key MENU

Then press "**Bridge**" Sub-menu, select the appropriate Channel and use left and right arrows to select appropriate bridge type. For ANCLO Load Cell, select "Undef FB" for each channel to be used. Confirm entry by pressing key MENU

Then Press GF/SCALING key and in "**Chan**" Sub-menu use left and right arrows to select appropriate channel. In "**Units**" Sub-menu set appropriate unit to mV/V like following picture.



Be sure in the BAL key menu to disable all channels.

Then reading will be displayed in mV/V. See next section for conversion in engineering unit.

3.4 DATA REDUCTION

Reading output in engineering unit

If you display the value in engineering unit on the P-3 readout (section 3.2) then actual load is obtained following this equation:

$$Load = (L - L_o)$$

Where

L = Current reading in P-3 units

L_o = Initial reading in P-3 units

Load = Load in engineering units

Reading output in mV/V

If you display the value in mV/V on the P-3 readout (section 3.3) then actual load is obtained following this equation:

$$Load = \frac{\text{Full scale} \times (L_1 - L_0)}{\text{Load cell sensitivity (S)}}$$

Where

Load= Applied load in engineering unit (kN)

L_1= Current reading in mV/V

L_0= The regression zero no-load reading in mV/V (see calibration data sheet for the value of L_0.

S= is the load cell sensitivity at full scale in mV/V (see the calibration data sheet for the value)

Full Scale= is the full scale capacity of the load cell (see the calibration data sheet for the value)

Here is an example based on the calibration data sheet as defined on section 4.2. For example if the current load cell reading is 1.508mV.

Load = [2000kN x (1.508mV/V – 0.218mV/V)] / 2.1515 mV/V = 1199.16kN

3.5 VERIFICATION OF CELL CIRCUIT

The cell circuit may be checked by reading resistance and comparing it with values below:

- Between P+ and P- wires: 700 ohms (1400 ohms when 8 pairs)
- Between S+ and S- wires: idem
- Other combination between wires: 500 ohms
- Between any wire and ANCLO/structure/shield: >1000 Mega ohms

3.6 POTENTIAL EFFECTS OF INSTALLATION OVER READINGS

Hollow-center load cells are susceptible to varying conditions of end loading. Eccentric loading, warping of the distribution plate and friction between the distribution plate and the load cell can significantly affect readings. Special precautions must be taken to minimize these effects.

Furthermore, cells have to be set between two flat and stiff plates. Thickness of the distribution plate should be at least 25 mm. This thickness should be more important when load range increases and when surfaces of the load cell and the loading element (hydraulic ram) differ. Also, the user may consider asking for doing a calibration using the same distribution and bearing plates he intends to use in the field. Please contact Roctest for more information about distribution plates and calibration.

Finally, different friction conditions between the distribution plate and the cell will also affect readings. We suggest using flat, smooth, non-lubricated, plates in the field as we do during calibration. Friction losses within the hydraulic jack can also affect readings.

4 MISCELLANEOUS

4.1 CONVERSION FACTORS

	To Convert From	To	Multiply By
LENGTH	Microns Millimetres Meters	Inches Inches Feet	3.94E-05 0.0394 3.2808
AREA	Square millimetres Square meters	Square inches Square feet	0.0016 10.7643
VOLUME	Cubic centimetres Cubic meters Litres Litres	Cubic inches Cubic feet U.S. gallon Can–Br gallon	0.06101 35.3357 0.26420 0.21997
MASS	Kilograms Kilograms Kilograms	Pounds Short tons Long tons	2.20459 0.00110 0.00098
FORCE	Newtons Newtons Newtons	Pounds-force Kilograms-force Kips	0.22482 0.10197 0.00023
PRESSURE AND STRESS	Kilopascals Bars Inches head of water* Inches head of Hg Pascal Kilopascals Kilopascals Kilopascals	Psi Psi Psi Psi Newton / square meter Atmospheres Bars Meters head of water*	0.14503 14.4928 0.03606 0.49116 1 0.00987 0.01 0.10199
TEMPERATURE	Temp. in °F = (1.8 x Temp. in °C) + 32 Temp. in °C = (Temp. in °F – 32) / 1.8		

* at 4 °C E6TabConv-990505

TABLE 2: Conversion Factors.

4.2 CALIBRATION DATA SHEET

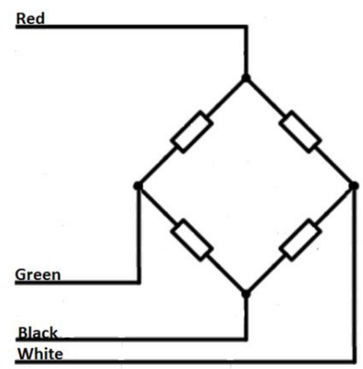
A calibration data sheet is supplied with each load cell. It enables conversion of raw readings into load values. All the sensors are individually calibrated over their working capacity before shipment. The calibration factor coefficient, which is the load cell sensitivity, is obtained using regression techniques through a linear regression formula which may introduce a substantial non-linearity error around the zero reading. See the following page for an example of calibration data sheet.

CALIBRATION DATA SHEET

LOAD CELL

Model: ANCLO-2000
Serial number: 33012030

Capacity: 2000 kN
10.00
Max. excitation: VDC
Temperature: 21 °C
Cable model: IRC-41A
Cable length: 12 m



Color code:

Red: Power P +
Black: Power P -
Green: Signal S +
White: Signal S -

Calibration data:

First pass		Second pass		Average reading		Linear regression	
Load kN	**Output mV/V**	**Load kN**	**Output mV/V**	**Load kN**	**Output mV/V**	**Load kN**	**Error (% F.S.)**
-0.2	0.233	-0.2	0.232	-0.2	0.232	---	---
199.4	0.428	200.6	0.428	200.0	0.428	195.1	-0.24
399.0	0.641	398.7	0.640	398.9	0.641	392.9	-0.30
598.3	0.857	599.2	0.859	598.8	0.858	594.6	-0.21
798.9	1.075	799.7	1.076	799.3	1.075	796.8	-0.13
999.3	1.291	999.3	1.292	999.3	1.292	997.9	-0.07
1199.7	1.509	1199.2	1.508	1199.5	1.508	1199.4	0.00
1399.0	1.724	1399.3	1.725	1399.2	1.725	1400.5	0.07
1599.8	1.941	1599.2	1.940	1599.5	1.941	1601.3	0.09
1800.0	2.157	1799.4	2.156	1799.7	2.157	1802.2	0.12
1999.6	2.369	1999.1	2.369	1999.4	2.369	1999.3	0.00

Load cell sensitivity: **2.1515** **mV/V at full scale**
Regression zero (L_o): **0.2180** **mV/V**

Traceability no: TR-12-07
Certificate no: 033012028-030.xlsx

Calibrated by: Eric Tremblay Date: 2017/04/12

4.3 WIRING DIAGRAM

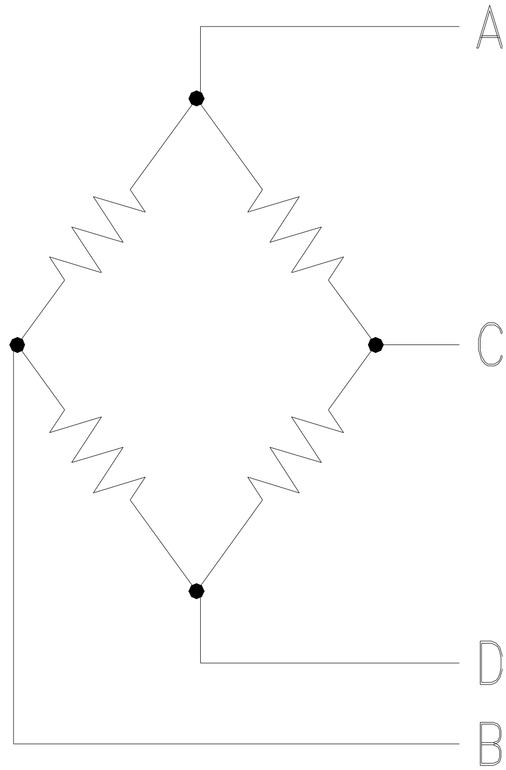


FIGURE 3: ANCLO Load cell wiring diagram (Full Bridge Configuration).