APPENDIX B – STRAIN INDICATOR - PRESSURE CELL

A pressure cell and transducer/strain indicator (see photos B-1 and B-2) is a commercially made unit which accurately measures hydraulic pressure by converting changes in applied pressure into corresponding changes in output voltage. The pressure-sensing element consists of a cell fitted with strain gages. The strain gages are connected to form a balanced Wheatstone Bridge, which responds to pressure changes by proportional changes in resistance. The change in resistance is measured with a transducer/strain indicator. The indicator interprets the change in electrical resistance of the strain gage circuit in relation to the strain developed in the pressure cell.

Since the pressure in the hydraulic system is proportional to the force exerted by the jack, the readout can be calibrated to read directly in kips rather than resistance or strain. Although this system gives accurate measurements of hydraulic pressure, it must be calibrated with a load cell for any given jack and gage combination at least once a year. During calibration, the load cell is placed either behind or in front of the jack (see Figure 7-1) enabling readout of the actual force applied to the prestressing steel. Load cells are calibrated with the "National Bureau of Standards" load cell.

If the Caltrans pressure cell needs to be recalibrated, coordinate with SC HQ Equipment Coordinator. The SCHQ Equipment Coordinator will be in contact with the Structure Representative and METS during this process.

Readings should not be taken while the ram is retracting or in static condition as hysteresis will likely result in erroneous values. The calibration curves and pressure cell readings are only valid when the ram is extending.

Pressure gages are bourden tube-type with rack and pinion gear drive that accounts for part of the poor hysteresis curves. If there is any indication of damage to the gage, the stressing system should be checked with the pressure cell. If there is more than 3% difference between the pressure cell and the calibration chart, the jack and gage should be recalibrated. Usually the stressing contractor has the jacks calibrated with several gages as a backup. Also, if the jack has been overhauled (new packing, machine work, etc.), it must be recalibrated.

Instructions for the Use of the P3500 Pressure Cell: with Meter

1. Place the pressure cell into the hydraulic system near the Contractor's gage.
2. Connect cell to indicator with 4 pin plug.
3. Turn toggle switch on.
4. Set controls (unless otherwise noted for particular jack).

Bridge	350 ohms
Readout switch	E
Sens	turn full clockwise
Polarity	F/B +

5. Close check valve on pressure cell.
6. Open pressure release valve (bleed) on pressure cell.
7. Turn numerical display to zero (0000).
8. Set meter to zero with balance meter.
9. Turn numerical display to a setting for the particular jack being used. (See pressure cell display setting chart).
10. While depressing (PC) switch set meter to zero with gage factor knob.
11. Reset numerical display to zero.
12. Check meter for return to zero. If needle does not return to zero, repeat above procedure of calibration (steps 7-12).
13. After calibration is complete, close pressure release valve.
14. Open check valve.
15. Numerical display indicated load in kips, e.g. 2130 = 213 kips or 213,000 lbs. If set-up requires Ex 10, 213 = 213.
16. Recheck zero after each run until assured zero setting is stable. This requires closing check valve and opening pressure release valve with numerical display set at zero (0000).

Instructions for the Use of the P3500 Pressure Cell: with Digital Display

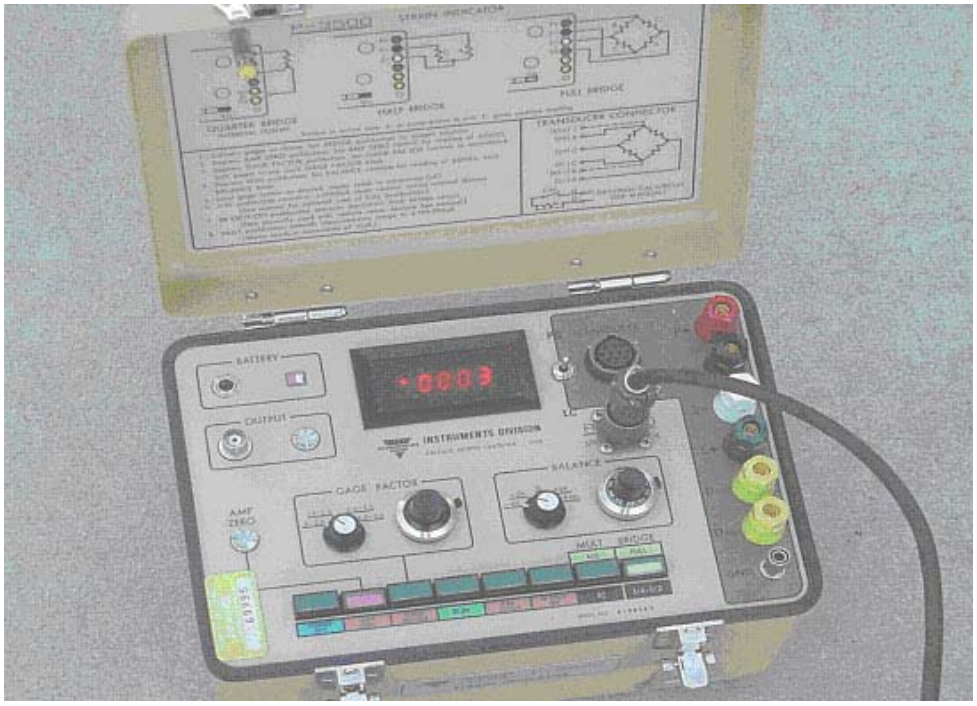


Photo B-1 – Close-up of Model P-3500 Strain.

1. Check pressure cell battery by pressing the "run" button (green on the bottom row) then check the battery indicator to make sure the needle is in the white area. If the needle is in the low white or orange area, it is time to change the battery. There is no charge cable for the pressure cell. Change the battery by closing the pressure cell top down, turn the unit over and unscrew the four screws on the bottom of the unit. Open the lip to the unit, lift the cell portion up from the cell box (the batteries are located on the bottom of the cell unit) change the 4 "D" batteries, put the cell portion back in the box and screw back the 4 screws on the bottom (See Figure B-2).

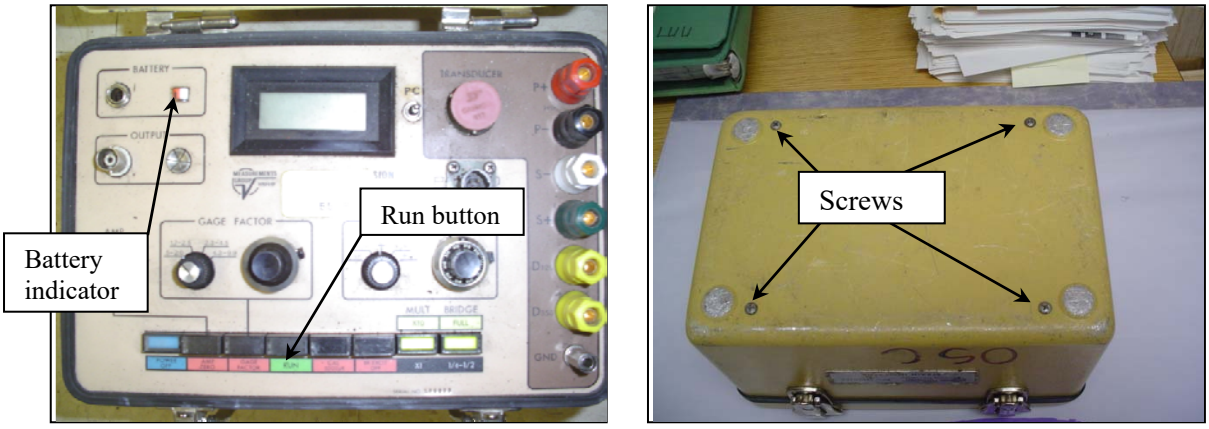


Figure B-2.

2. Turn on unit by pressing the "run" button. Turn off unit once the battery is working properly.
3. Get Jack # and Gauge # (See Figure B-3) from the Contractor, then obtain the gauge factor (GF) and the ND number from HQ's Active Prestress/Post Tensioning Jack Calibration Chart (you can get this from the SC Webpage, under Field Resources, Prestress Calibration Charts).

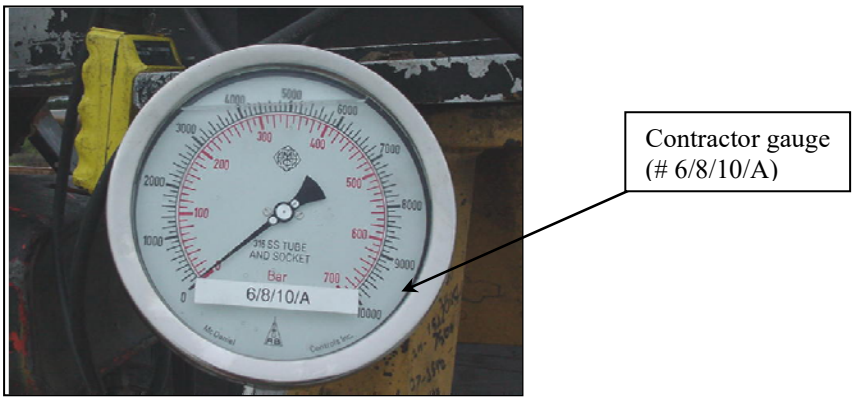


Figure B-3.

4. Plug in cable at both ends (1 to pressure cell, 1 to "T" bar) – (See Figure B-4).

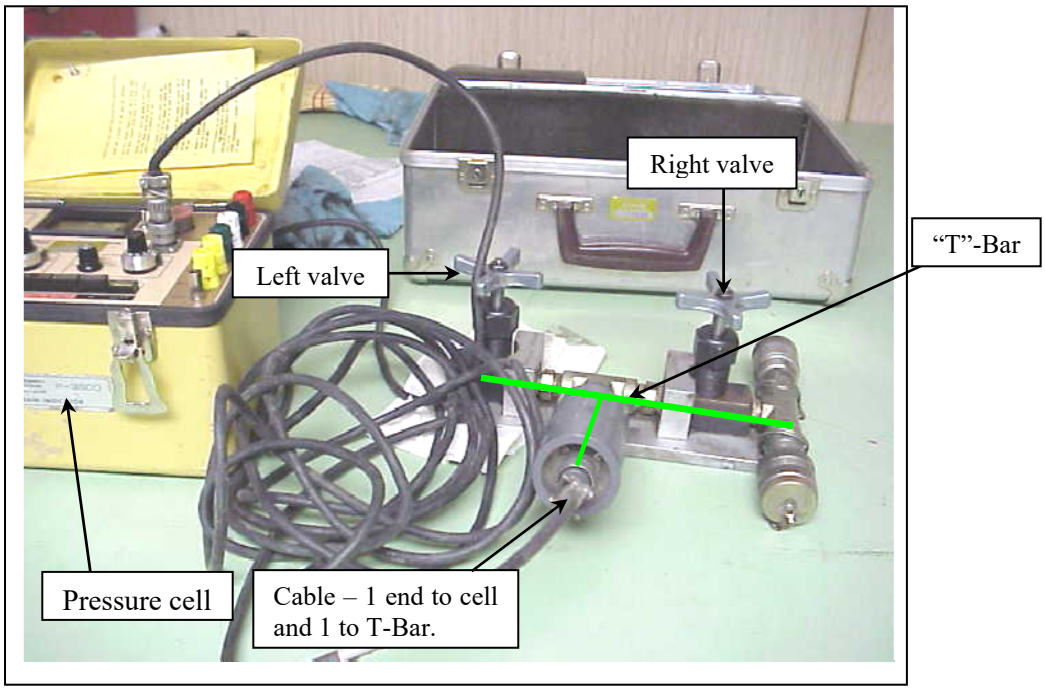


Figure B-4.

5. Close the right valve and open the left valve on the "T" bar (See Figure B-4).

6. Push the "gauge factor" button; check gauge factor knob on the left of the gauge factor square to ensure the gauge factor range is properly set. Use the right knob in the same square to adjust to the correct gauge factor (GF) in the display LCD area. Keep in mind that this button has a locking switch, move switch counter clockwise to unlock before adjusting (Figure B-5).

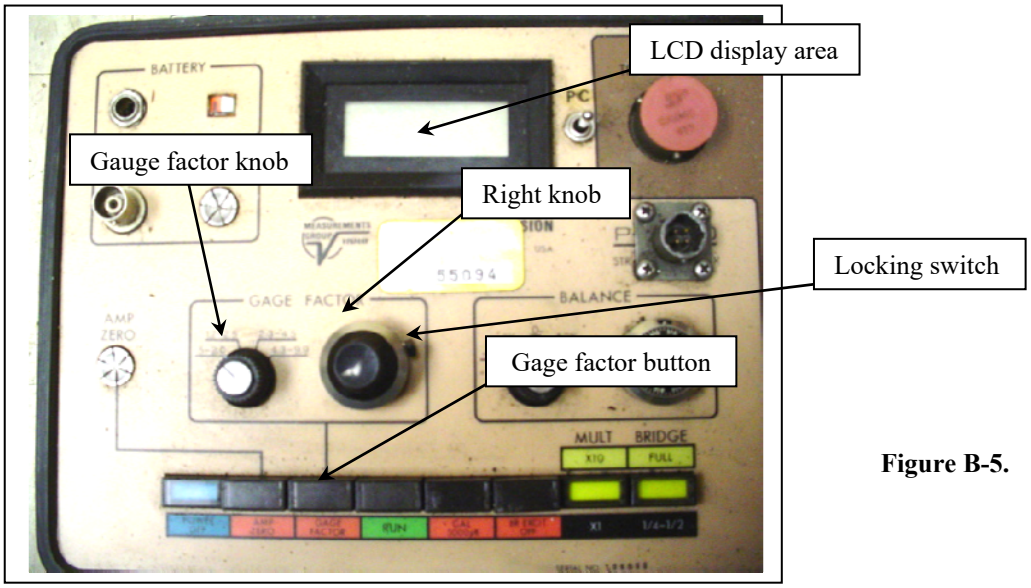


Figure B-5.

7. Push the "run" button, use the knob on the right in the "balance square" to set the number in the LCD display to "0.000+/-" keeping in mind that this button also has a locking switch. Move the switch counter clockwise to unlock. After adjustment, move the switch to the lock position (clockwise) (Figure B-6).

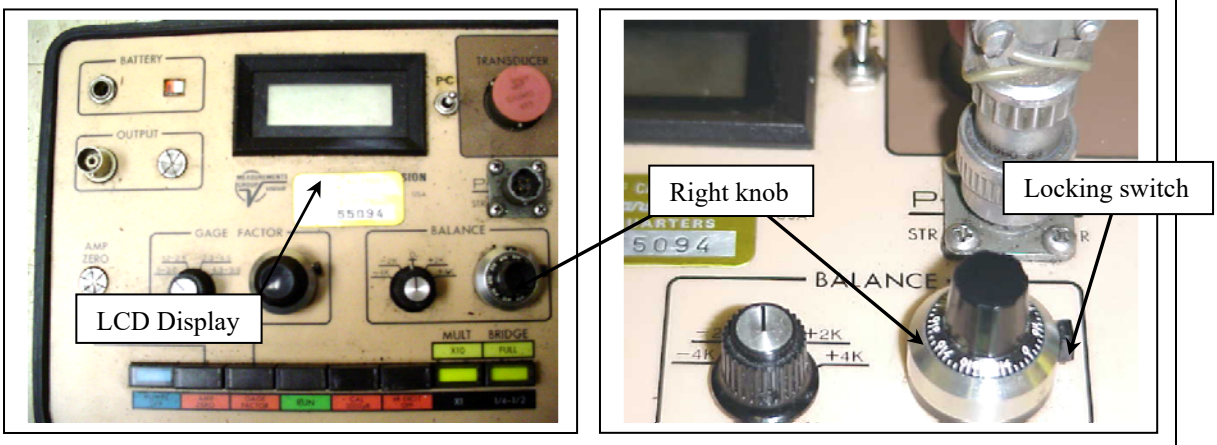


Figure B-6.

8. Push a switch marked “PC” located to the right of the LCD display window upward and hold it in place. Check the display window for the ND # while holding the “PC” switch in place, if the ND # is not the same as the one shown on the calibration chart, then use the right knob in the “gauge factor” square to adjust it to the correct given ND#. Release the “PC” switch, the display should now read +/- 0.000. The unit is now ready.
9. Make sure the stressing contractor closes the left valve and open the right valve once the “T” Bar is connected to the Contractor’s gauge (See Figure B-7).

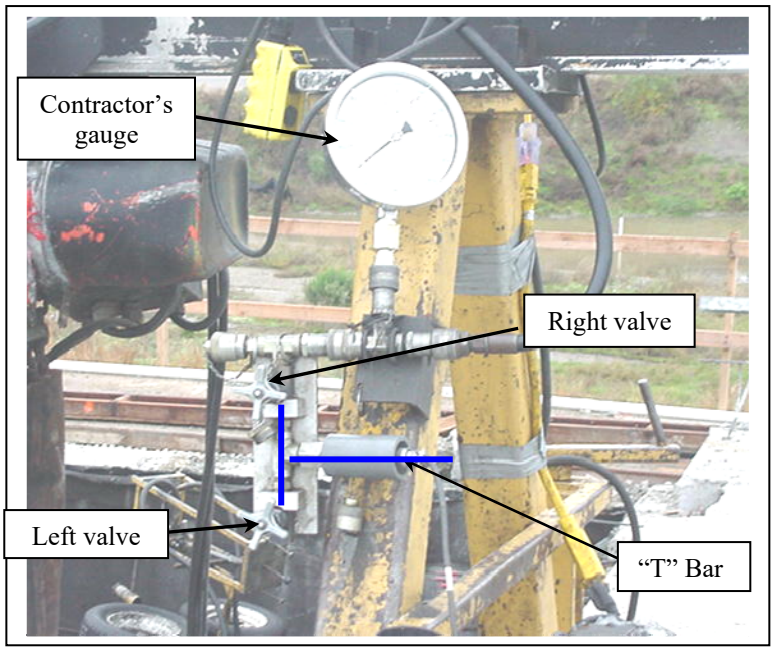


Figure B-7.

Photo B-2 – Model P-3500 Digital Display Strain Indicator.

Instruction for the Vishay P-3 Strain Indicator

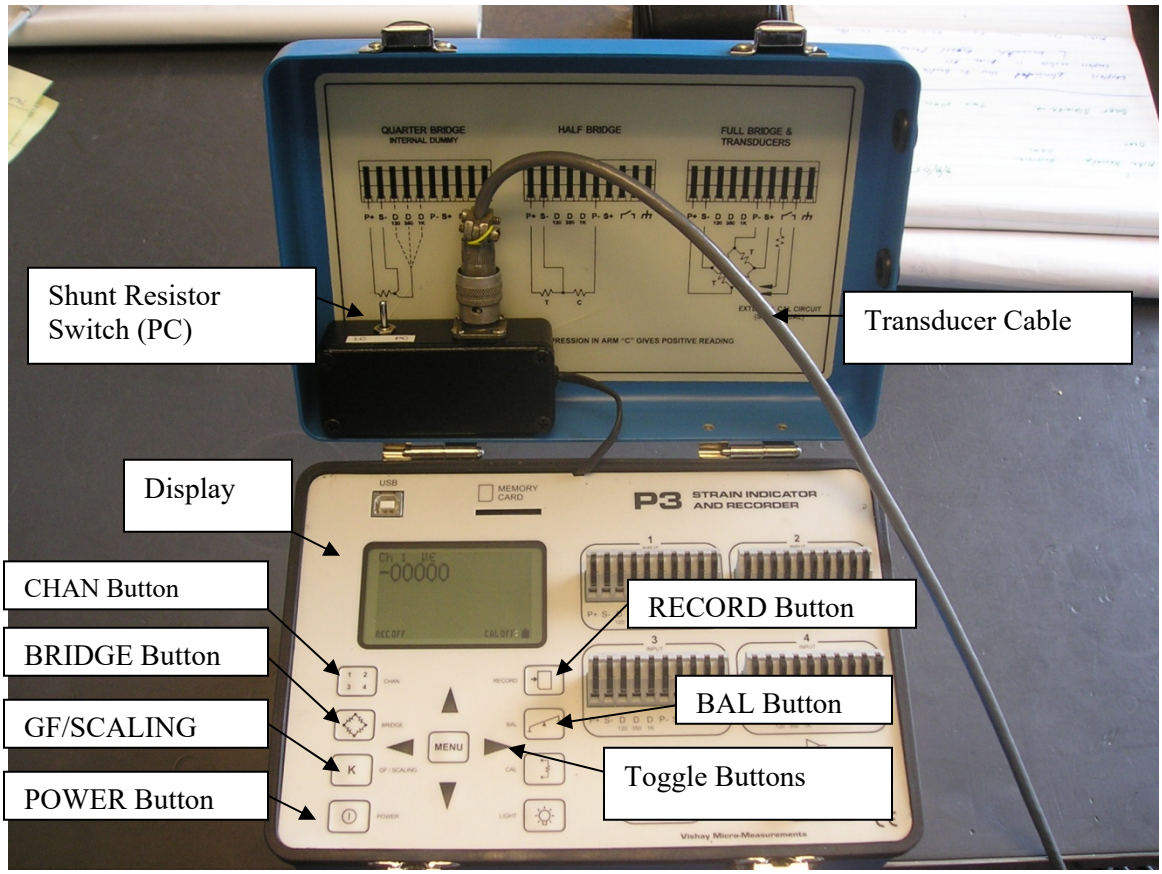
The Vishay P-3 Strain Indicator is a replacement model for the P3500. The P-3 has an all-digital interface, and operates very similarly to the P3500. Compared to the P3500, the P-3 has many more options and features. However, for post tensioning monitoring only the basic of these features are utilized. Below is a quick start guide for the P-3.

Step 1. Pressure Cell Hook-Up.

Have the Contractor hook up the pressure cell into the hydraulic system close to the gage. Install the transducer cable as shown below (small end to the P-3, other end to the pressure transducer).

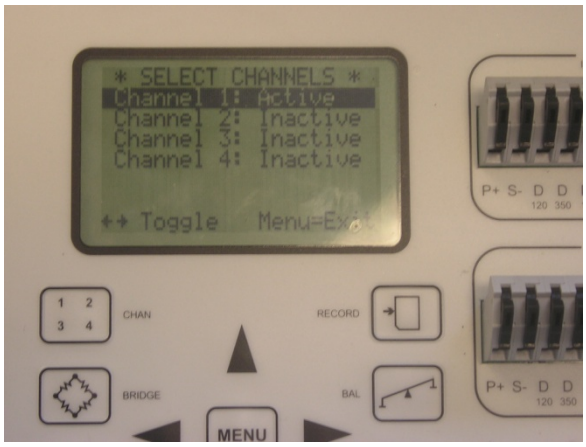
Step 2. Power On

Turn the P-3 unit on by pressing the "Power" button. The unit should beep and briefly display model information. The battery symbol is shown in the lower right corner.

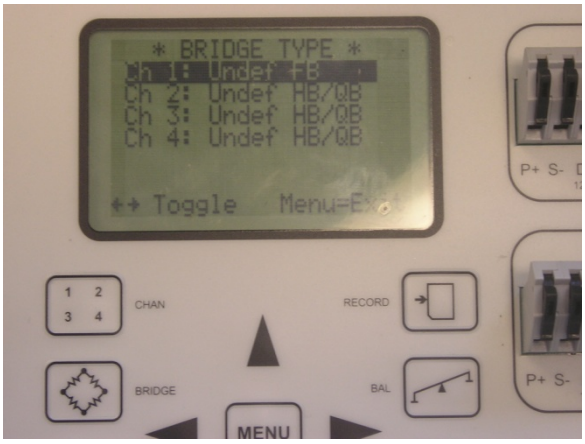


Step 3. Verifying Channel and Bridge Settings

Verify the "Channel" and "Bridge" settings are correct. These settings should not be changed from the values listed below. Press the "CHAN" button. The display should read, "Channel 1: Active". All other channels should read "Inactive". Press the "MENU" button to return to the display. Press the "Bridge" button and verify that Channel 1 is set to “undef FB” (Full Bridge). Press the "MENU" to return to the display. As stated above, these settings should always remain the same and should not be changed. If these settings have been changed, use the toggle buttons to restore them to the correct values. See pictures below.



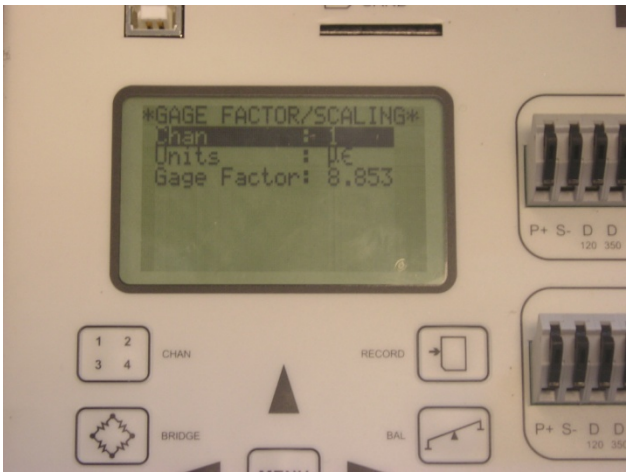
Channel Setting



Bridge Setting

Step 4. Setting Gage Factor

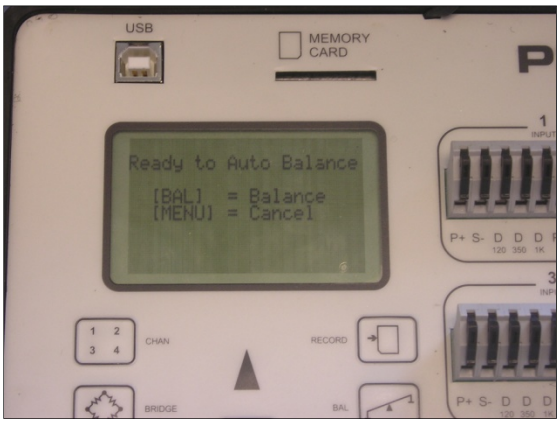
Press the "GF/SCALING" button. Verify that the Channel is set to "1" and the Units are set to με (microstrain). Note these values should never be changed. If these settings have been changed, use the toggle buttons to restore them to the correct values. Set the GF (gage factor) to the value found in the Department’s Prestress Calibration Chart using the toggle buttons. The GF is unique to the stressing jack being used. Once the GF is set, return to the display screen by pressing the "MENU" button.

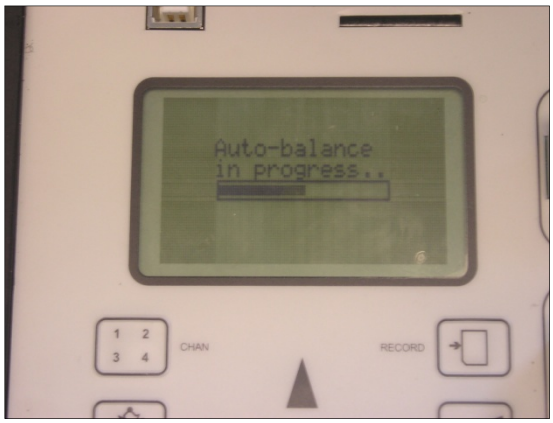


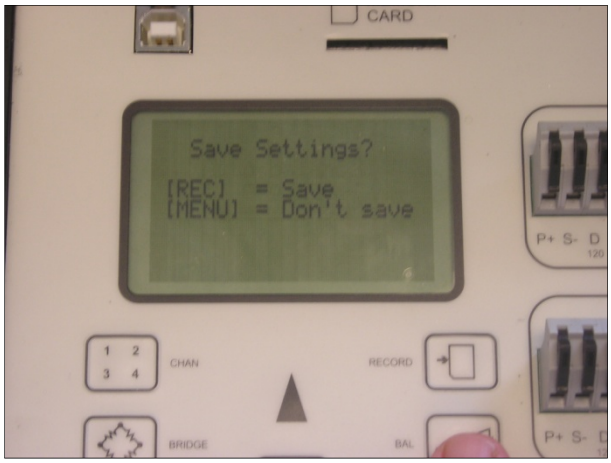
Gage Factor Setting.

Step 5. Balancing

Make sure the Pressure Cell is connected to the Contractor's hydraulic system. Check the cable connections on the P-3 and the pressure transducer. Close the valve closest to the hydraulic hose connection. Open the other valve. (This is done to assure no hydraulic pressure exists at the transducer). Press the "BAL" button on the P-3. Press it again to start the auto-balance. When the auto-balance program is completed you will be prompted to press the "RECORD" button to save the settings. The unit should now read 00000 and is ready for use.







Balancing.

Step 6. Check the Set-Up by Verifying the Numeric Display (N.D.)

To verify if the P-3 is operating correctly, a calibration shunt resistor is applied to the full bridge circuit. The resistor is applied by toggling the switch next to the cable connection to the position marked "PC". After Steps 1 through 5 have been completed, toggle the shunt resistor switch to "PC". The display should read a value close (within 2%) of the Numeric Display (N.D.) listed in the Department's Prestress Calibration Chart for the jack that is being used. If a greater discrepancy is found, check all connections and repeat Steps 1 through 6. If a large discrepancy is still noted, do not use. Arrange for the equipment to be serviced. Contact the SC Equipment Manager at 916-227-7777.

Step 7. Proceed with Stressing Operation and Taking Readings

Similar to the P3500, the P-3 will read in units of kips. No decimal point will be shown. The last digit on the right will be tenths of a kip. For example a display reading of 07586 equals 758.6 kips.

Check List for Malfunctioning Pressure Cell:

1. Cell indicator will not balance. Possible causes:
   a. "Low" battery.
   b. Cell not properly plugged in.
   c. Indicator not turned on.
   d. Loose connections.
   e. Severed or damaged lead wire.
   f. Connections wet and/or muddy.
   g. Cell wet and/or muddy.
   h. Resistor is plugged in (older indicators only).
   i. Broken resistor.
   j. Pressure applied to cell.

2. Gage factor has large change. Possible causes:
   a. Incorrect PC resistor setting.
   b. Poor connection to cell.
   c. Wire or cell damaged.
   d. Cell is wet or damp.
   e. Malfunction of indicator electronics.

3. Needle jumping or erratic. Possible causes:
   a. Tendon friction in structure causing erratic load changes.
   b. Static from motors or pumps – to alleviate, plug in ground wire.
   c. A short or poor connection – connect white terminal to ground.
   d. Hydraulic surge – keep gage connections away from pump.
   e. Local Radio stations.
   f. Contractor's generators.

4. Needle sluggish or will hardly move. Possible causes:
   a. Pressure cell not plugged in.
   b. Low battery.
   c. Water on connections or cell.
   d. Broken or damaged connection cable.

If the malfunction cannot be solved in the field, consider the cell and/or indicator unsatisfactory for use.

Maintenance of the Pressure Cell:

1. Keep all components dry and clean. Do not oil or clean with solvents; wipe with a clean cloth.
2. Keep the battery charged, but do not over-charge. (8 hrs max.)
3. Remember that the pressure cell and readout box are delicate instruments and should be treated as such. Do not transport equipment in bed of truck.