SCALE-TRON
Automation, sensors and weighing systems

SiloWeigh Sensors

Installation Manual
Version 1.7

Models: L-Strain & Silex

February 14, 2024

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Customer Responsibility:
The customer in applying the product described in this document accepts that the product is a programmable electronic system which is inherently complex. In doing so, the customer therefore undertakes the responsibility to ensure that the product is properly installed, commissioned, operated, and maintained by competent and qualified personnel, trained in accordance with any instructions or safety precautions made available, or though proper engineering practices, and to thoroughly verify the use of the product in each particular application.

Errors in documentation:
The product described in this documentation is subject to continuous development and improvement. All information of a technical nature and particulars of the product and its use including the information and particulars contained in this documentation are given in good faith by Scale-Tron Inc.

This manual is intended only to assist the user in the installation, use, and operation of the product, and therefore Scale-Tron Inc. shall not be liable for any loss or damage whatsoever from the use of the information in, or any error in, or omission from this manual.

Please read, follow, and understand the steps in this manual.
Failure to do so can result in a faulty installation, and erroneous readings.

Should you have any difficulty in installation, operation or maintenance of your SiloWeigh system, our staff are available to help you during normal business hours and at any other time by special arrangement.

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1.0 Specification

SiloWeigh is a system for measurement and display of the weight or level, temperature or other parameter of vessels such as silos. The sensors used for these systems are either strain-gauge devices (Silex, L-Strain, load cells) which all connect in exactly the same way as standard load cells.

1.1 L-Strain sensors

Excitation voltage:	15 volts max, 4.6V typical.
Bridge resistance :	350 ohm.
Reading accuracy:	Dependent on sensing method. For strain sensors, 2% to 5% nominal but accuracy depends on weather effects and may be reduced by the vessel support structure.
Compensation method:	Vertical leg measures compression plus expansion of metal with temperature. Horizontal leg gives opposite compensation for temperature.
Wire colors:	+ excitation Red, - excitation Black, + signal Green, - signal White, shield Yellow.
Mounting:	Three parallel mounting pads for use on flat or slightly curved surface. Can be mounted on highly curved or uneven surface by use of spherical washers.
Construction:	Stainless steel with PVC insulated shielded cable.
Limit on vessel capacity:	No limit since structure is normally designed to support the vessel, which usually gives sufficient stress. Practical limitations are with small vessels where structure is overdesigned and stress is too low for good accuracy. Use Stress Calculator on all applications to be sure of successful results.
Temperature:	-30 °C, -25 °F to +60 °C, 140 °F
Water resistance:	IP66, NEMA-4X

1.2 Silex sensors

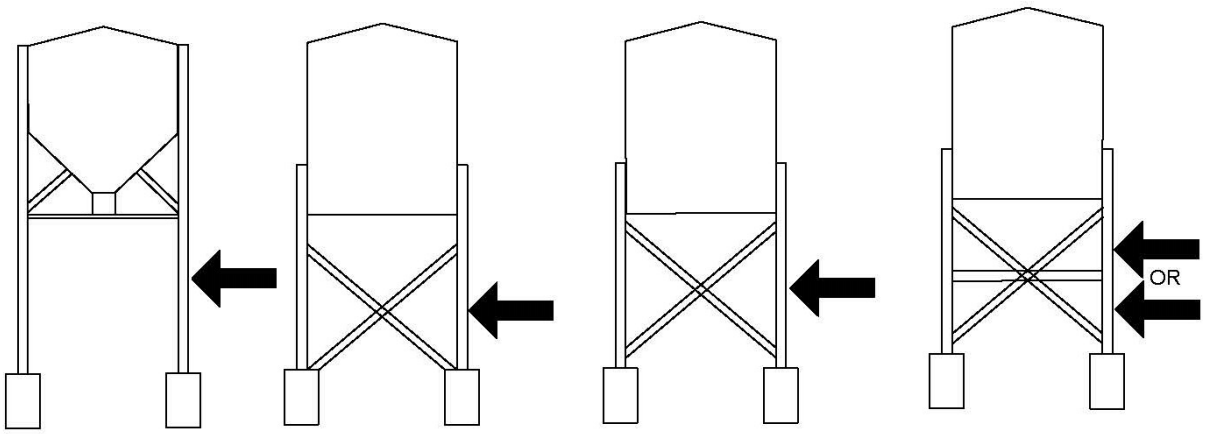
Excitation voltage:	15 volts max, 4.6V typical.
Bridge resistance :	350 ohm.
Reading accuracy:	Dependent on sensing method. For strain sensors, 2% to 5% nominal but accuracy depends on weather effects and may be reduced by the vessel support structure.
Compensation method:	Steel of sensor is not perfectly matched to metal of silo but sensor is oppositely compensated to counteract the effect, for structural steel only.
Wire colors:	+ excitation Red, - excitation Black, + signal Green, - signal White, shield Yellow.
Mounting:	Two parallel mounting pads for use vertical on flat or slightly horizontally curved surface. Can be mounted on highly curved or uneven surface by use of spherical washers.
Limit on vessel capacity:	No limit since structure is normally designed to support the vessel, which usually gives sufficient stress. Practical limitations are with small vessels where structure is overdesigned and stress is too low for good accuracy. Use Stress Calculator on all applications to be sure of successful results.
Construction:	Nickel plated tool steel with PVC insulated shielded cable.
Temperature:	-30 °C, -25 °F to +60 °C, 140 °F
Water resistance:	IP66, NEMA-4

2.0 Installation

2.1 Choosing a position

H-beam, O-beam and Agricultural silo "omega" legs - In general, sensors are best positioned in the center of an unobstructed run of the support beam. Since the sensors will measure the load in the beam at the point of mounting, it is important to first ensure that the point you choose is bearing all the load of the silo and attachments. If the silo empties into a belt or screw conveyor and the conveyor is supported by beams attached to the legs, the sensors must be installed below these beams to measure the entire load. Likewise, if there are load-bearing struts connected to the legs of the silo, the sensors must be installed under these struts. Load bearing struts can be identified by their shape and cross section. If they are similar in cross section (thickness) to the legs, they are load bearing. If they are thin flat bars or light angle, they are cross braces and not load bearing. The sensors can be installed above the bottom ends of these types of struts. See the examples on the next page, and chose the one that best suits your setup. Furthermore, it is better to install the sensors on north, or west facing surface so as to avoid direct exposure to morning sunlight.

Skirted silos - Position sensors at ¾ of the height to the cone attachment ring if possible, away from the door, as shown here. Space them equidistant around the skirt, avoiding the east to south location if possible, stretching this distance if necessary. Locate sensors anywhere on the panels, whether bolted or welded, avoiding the area within 6" (150mm) of the panel seams.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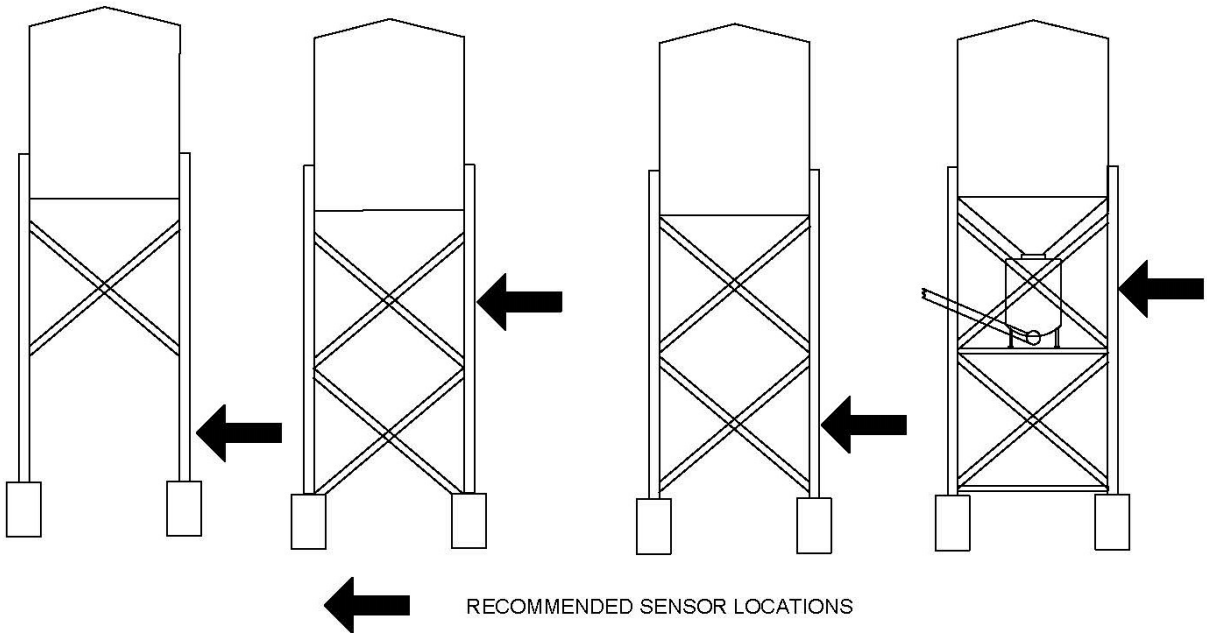

RECOMMENDED SENSOR LOCATIONS

2.2 Bolts, drills and drilling machine

Mounting hardware includes a 10 mm bolt, two Schnorr disk spring washers and a nut for each hole in the sensor. The length of the bolt is adequate for a leg thickness of 0.87" (22 mm).

2.3 Protective coating for nuts/bolts

If your order is shipped by ground or surface transport, we always include a wax or rubber sealant spray coating. In each installation section you will find a reference to this coating. If your order is shipped by air, we cannot include any aerosol spray and it is the customer's responsibility to provide it. Without protection, the spring washers will rust and lose their strength. This in turn makes the sensors prone to slippage and the system will suffer errors as a result.

Spray protectives are readily available in North America at auto stores and hardware stores. Look for "rocker panel spray" or any clear sealant. Clear is preferable to black because the black tends to self-heat by absorbing radiated heat. Do not coat the whole sensor, for this same reason.

3.0 Installation – L-Strain sensor, all mounting kits

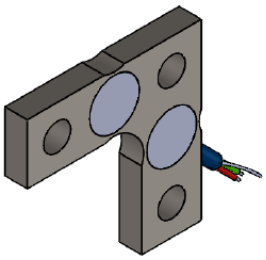
For all types of leg, provisions must be made in order to properly mount the sensors. Different methods are used based on the accessibility of both sides of the mounting surface.

The 'L-Strain' Sensor is a bolt on strain gauge sensor, designed to measure the expansion & compression of the vessel leg.

1. First, identify the legs on the silo to be fitted.

2. Pick a location for the sensors. Refer to section 2.1 for proper placement. Ideally, the sensor should be in the middle of the longest free run of the leg, away from any cross bracing, catwalks, or any other structure. The locations should also be away from direct sunlight, preferably on a north or west facing surface. The sensors are mounted vertically, with the vertical leg centered on the 'Neutral Axis', centerline of the center section as far as possible, to eliminate bending forces, on the flat of the beam. Ensure the desired mounting location is not too close to the corner radius and is free from bumps, burrs, and weld seams. The sensors need to mount on a flat face.

3. Orient all sensors as shown at right with the cable coming from the right hand vertical side. The only exception is if it is difficult to fit in this manner, when it is allowable to turn the sensor through 180º so that the cable is on the left vertical side (as in "L").



4. In the case of excessive paint, the paint under the sensor must be removed. The mounting pads on the back of the sensor must be flush with the bare steel of the leg. Use a sanding disc or scraping tool to clean the mounting pad areas only; do not use a grinder. Ensure there is no interference from paint under the length of the sensor body. Bare metal can be painted over once installed. Clean with a suitable solvent to ensure good adhesion of the Loctite 638.

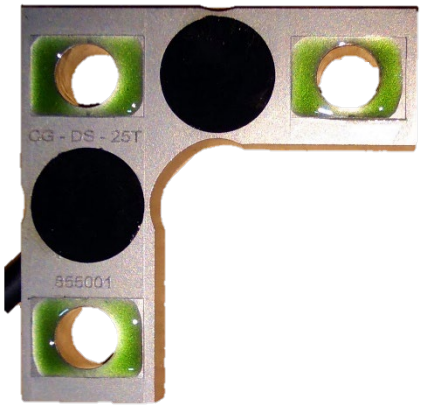
5. Place the drill template on the leg, so that the line & holes in the template align with the line previously drawn on the leg. Tape in place.

6. With the supplied center punch, punch three marks through the three holes in the template. Strike the punch lightly with a hammer, check the position and strike firmly.

7. Ensure the punched center marks are deep enough to hold the drill bit in place. Remove the template and set aside for the next leg.

8. At the punched marks, drill a 3mm pilot hole, and use the step drill supplied or step up to a 8.5mm diameter hole. Finally, enlarge the hole as required by the application kit. Use a cutting lubricant to ease the work and prolong the life of the drill bits.

9. Since large forces can exist between the sensor and the mounting surface, add a bead of Loctite 638 to all three mounting pads on the sensor as shown at right in green prior to assembly. Note that the working time for this is 5 to 10 minutes; ensure that you have completed the next two steps within this time, or start again.



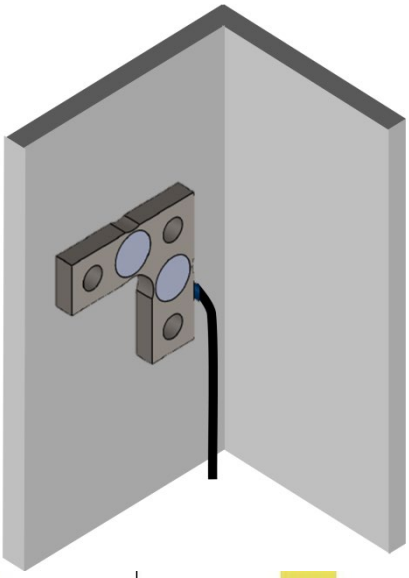
If the drilled holes do not line up with the holes in the sensor and the bolt jams the sensor, it will be damaged!

10. Before tightening the sensors to the final torque, power must be applied to the sensor.

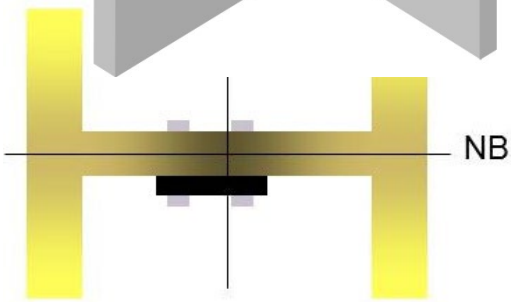
3.1 Installation – Through-Hole installation kit:

For all types of leg, provisions must be made in order to properly mount the sensors. Different methods are used based on the accessibility of both sides of the base metal.

The Through-Hole kit is used for most applications, including "H", "L" and "S" section legs, plus others where both sides of the surface are accessible. Because of the relatively high forces between the sensor and the mounting surface, it is advisable to bond the sensor to the leg surface.

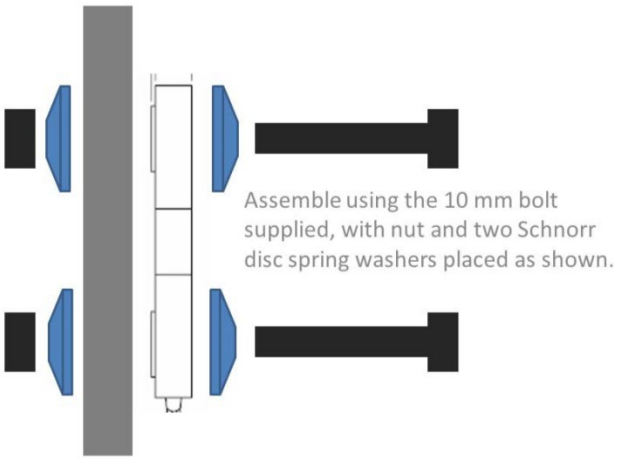


1. Angle (L-section) legs: Install as close to the inside corner as possible, as shown at right. Avoid the inside radius; the position is not critical. Draw a vertical line through the center of the vertical mounting holes at the best position.



2. H-beam and other types of leg with flat surfaces: draw a vertical line in the center of the leg or as close as possible, to fit the sensor, avoiding the inside radius, at the chosen sensor location.

3. Place the drill template on the leg, so that the line & holes in the template align with the line previously drawn on the leg. Tape in place.



4. When assembling, use bolts, Schnorr disc spring washers and nut as shown in the illustration at right. Assemble bolts finger tight and ensure they are centralized without binding, with clearance all around all three bolts, then mark one flat and the metal next to it with a marker pen. Within a few minutes, using a wrench, tighten a further 1/6 turn only. Leave for 10 or more minutes before tightening further; continue with steps 8 and 9 while you are waiting.

5. When assembling on a curved or uneven surface, the same process applies. Since the sensor's mounting surfaces are slightly curved, they can be applied directly to a large diameter curved surface without problems. Proceed as above for the rest of the assembly. For extremely curved surfaces, spherical washers are available.

6. Mount the junction box in a convenient location, above or below the sensor so as not to obstruct the sun shield when you install it, and within the reach of the sensor cable. Position it so that the cables exit through the bottom of the box. Use either the supplied self-drilling / self-tapping screws, or the M6 hardware provided. Drill a 5mm pilot hole for the self-tapping screw, use the 5mm hole to tap the 6mm hole for the M6 bolts or widen the holes to use a nut.

7. Repeat the mounting for the remaining legs, in the same position and orientation as the first sensor.

If the drilled holes do not line up with the holes in the sensor and the bolt jams the sensor, it will be damaged!

8. At this point it is best to complete the wiring to the transmitter, leaving the green and white wires from the sensor free if using more than 4 sensors but connecting the black, red and shield as detailed in section 6.16.0. When wiring is complete, apply power and return with a digital meter to the junction box for each sensor. First, check that the excitation voltage is present by monitoring the red and black wires with the meter. Voltage should be approx. 5 volts DC. Connect the meter to the white and green wires from the sensor and set it to the lowest range, usually 200 mV DC. Reading should be within -5 to +5 mV.

9. The objective is to torque the bolts tight to prevent any possible slippage of the sensor mountings, but not to damage the sensor while doing it. Using either a 17 mm regular wrench or torque wrench, tighten each of the bolt/nut combinations against the washers & sensor from the rear of the leg, holding the bolt head steady, in 2-3 stages to 41Nm (30lb ft) or a total of ¾ turn of the wrench while monitoring the voltage. This voltage should remain between -5 to +5 mV. If it increases above these limits, slacken and check the alignment of the bolts in the holes, then re-tighten as before. When tightened to the full torque the voltage should remain within these limits. If the voltage is allowed to exceed 10 mV, the sensor can be damaged; take care.

10. Spray the welded tabs, bolts and washers with the rubberized spray coating to seal them from possible rust buildup. Wipe off the coating from the sensor body to avoid it being affected from radiated heat.

11. Repeat for all legs, and then connect the green and white wires.

NOTE: **Conduits or bare cables?** We do not supply conduits but they are a worthwhile investment if you want to make the installation permanent, especially where people are working or passing frequently. Whether you use metal or plastic, screw fitting or butt connectors is your choice. One warning: never make the entry into a junction box or DJB from the top. Always enter the box from the bottom where possible; if this is impossible, enter from the side but ensure water tightness. It sounds obvious but the largest issues have been caused by water leakage, which appears as drift in the readings.

3.2 Installation – Tapped Hole installation kit:

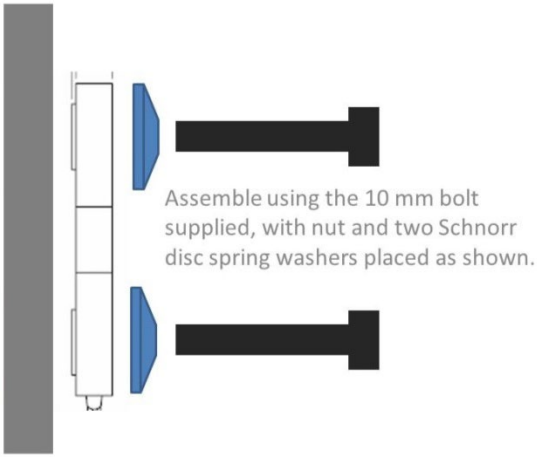
For square or rectangular section legs (or hollow structural steel), provisions must be made in order to properly mount the sensors to the legs. In most cases, the sensor's mounting points need to be tapped into the leg. In soft steel, thin steel, or round legs, weld tabs must be added to the leg. See Weld Tabs, section 4.3. Ideally the leg should have a wall thickness of at least 9mm (0.35").

1. At the punched marks, drill a 3mm pilot hole, and step up to a 8.5mm diameter hole. Use a cutting lubricant to ease the work and prolong the life of the drill bits.

2. Tap each hole with the M10 tap & handle provided. Ensure that the tapping is straight & perpendicular to the sensor when installed.

3. When assembling, use bolts, Schnorr disc spring washers and nut as shown in the illustration at right. Assemble bolts finger tight and ensure they are centralized without binding, with clearance all around all three bolts, then mark one flat and the metal next to it with a marker pen. Within a few minutes, using a wrench, tighten a further 1/6 turn only. Leave for 10 or more minutes before tightening further; continue with steps 14 and 15 while you are waiting.

4. When assembling on a curved or uneven surface, the same process applies. Since the sensor's mounting surfaces are slightly curved, they can be applied directly to a large diameter curved surface without problems. Proceed as above for the rest of the assembly. For extremely curved surfaces, spherical washers are available.



5. Mount the junction box in a convenient location, above or below the sensor so as not to obstruct the sun shield when you install it, and within the reach of the sensor cable. Position it so that the cables exit through the bottom of the box. Use either the supplied self-drilling / self-tapping screws, or the M6 hardware provided. Drill a 5mm pilot hole for the self-tapping screw, use the 5mm hole to tap the 6mm hole for the M6 bolts or widen the holes to use a nut.

6. At this point it is best to complete the wiring to the indicator, leaving the green and white wires from the sensor free but connecting the black, red and shield as detailed in section 6.0. When wiring is complete, apply power and return with a digital meter to the junction box for each sensor. First, check that the excitation voltage is present by monitoring the red and black wires with the meter. Voltage should be approx. 5 volts DC. Alternatively, use a 9 V battery connected to the black and red wires of the sensor. Connect the meter to the white and green wires from the sensor and set it to the lowest range, usually 200 mV DC. Reading should be within -5 to +5 mV.

If the drilled holes do not line up with the holes in the sensor and the bolt jams the sensor, it will be damaged!

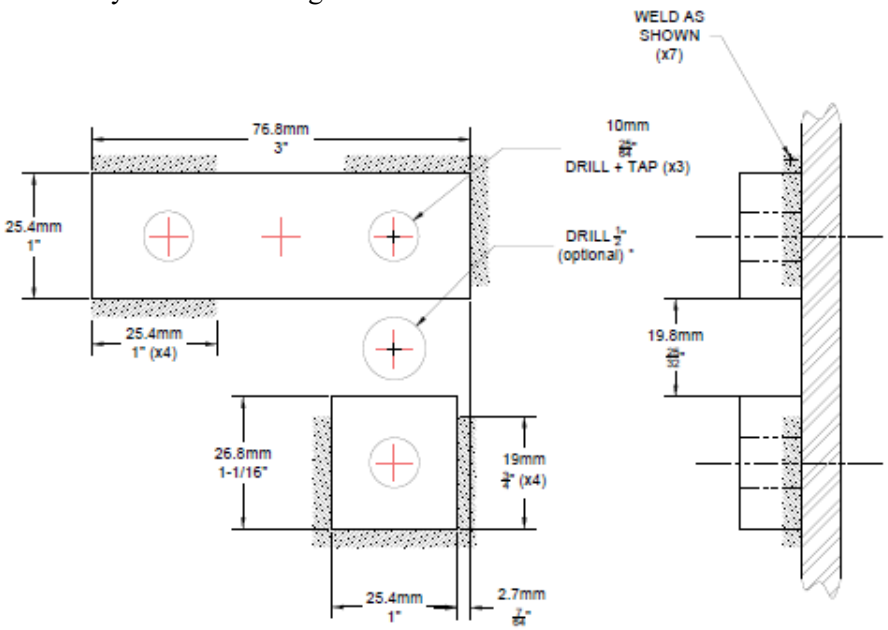
7. The objective is to torque the bolts tight to prevent any possible slippage of the sensor mountings, but not to damage the sensor while doing it. Using either a 17 mm regular wrench or torque wrench, tighten each of the bolt/nut combinations against the washers & sensor from the rear of the leg, holding the bolt head steady, in 2-3 stages to 41Nm (30lb ft) or a total of ¾ turn of the wrench while monitoring the voltage. This voltage should remain between -5 to +5 mV. If it increases above these limits, slacken and check the alignment of the bolts in the holes, then re-tighten as before. When tightened to the full torque the voltage should remain within these limits. If the voltage is allowed to exceed 10 mV, the sensor can be damaged.

8. Spray the welded tabs, bolts and washers with the rubberized spray coating to seal them from possible rust buildup. Wipe off the coating from the sensor body to avoid it being affected from radiated heat.

9. Repeat for all legs, and then connect the green and white wires as detailed in section 6.16.0.

3.3 Installation – Weld Tabs installation kit:

For legs with thin walls or when welding is preferable to tapping, weld tab mounting faces can be installed. (Note L-Strain and Silex sensors use different weld tab mounting kits) It is critical you follow the weld pattern on the drawing included with the kit and shown in the extract below. Use the longer rectangular pad in the horizontal axis and the smaller square pad in the vertical axis. Drilling an optional ½" hole in the leg on the vertical axis will increase sensitivity in low stress legs.



* 1/2" HOLE IN SILO LEG IS OPTIONAL TO INCREASE THE SENSITIVITY OF THE L-STRAIN SENSOR
DO NOT DRILL A HOLE IN THE L-STRAIN SENSOR

1. Remove as much paint as required so that welding can take place.

2. Mark a line parallel to the axis of the leg at the chosen point for installing the sensors.

3. If not already done so, assemble two weld tabs onto one weld tabs alignment jig with the short M10x22mm bolts. (Using the longer mounting bolts when welding can degrade the quality of the bolt.) Thread one of the attachment bolts through the alignment jig into a weld tab and tighten the weld tab finger tight only. Ensure that the bolt does not protrude out of the opposite side of the jig. Repeat for other two weld tabs.

4. Grind the weld tabs to fit the contour of the leg (approximately), without reducing the depth of the threaded hole.

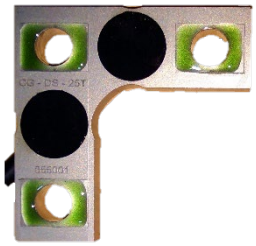
5. Place, and secure in position, the assembled weld tabs & alignment jig. The weld tabs should be centered on the previously drawn marks.

6. First tack weld in place then weld ONLY on the sides as shown in the drawing. Remove the jig; **DO NOT** discard the M10 bolts. Check that the mounting faces of the tabs remain flat, flush, and

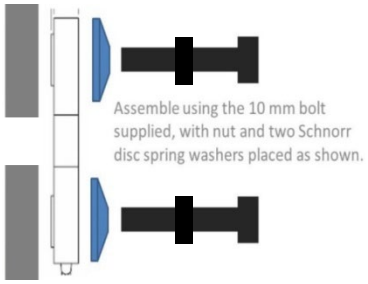
parallel to each other; trim the faces with a hand file if necessary, to ensure that the sensor is not twisted when tightened.

7. Mount the junction box in a convenient location, within the reach of the sensor cable. Position it so that the cables exit through the bottom of the box. Use either the supplied self-drilling / self-tapping screws, or the M6 hardware provided. Drill a 5mm pilot hole for the self-tapping screw. Use the 5mm hole to tap the 6mm hole for the bolts.

8. Clean the tabs with a suitable solvent to ensure good adhesion of the Loctite 638. Since large forces can exist between the sensor and the mounting surface, add a bead of Loctite 638 to all three mounting pads of the sensor as shown at right in green prior to assembly. Note that the working time for this is 10 to 20 minutes; ensure you have completed the next two steps within this time or start again.



9. When assembling, use bolts, Schnorr disc spring washers and nut as shown in the illustration at right. Thread a nut onto the bolt, about 5mm from the bolt head. Place a disk spring washer, convex side out, on the bolt, and insert the bolt & washer into the weld tab until the bolt bottoms. Back it out one full turn and then run the nut onto the washer and sensor until finger tight. Verify that there is freedom of movement on the sensor up & down. This freedom ensures the weld tabs have been welded in place correctly and will not bind the sensor as they are tightened. Mark one flat and the metal next to it with a marker pen. Within a few minutes, using a wrench, tighten a further 1/6 turn only. Leave for 10 or more minutes before tightening further; continue with steps 12 and 13 while you are waiting.



10. Mount the junction box in a convenient location, above or below the sensor so as not to obstruct the sun shield when you install it, and within the reach of the sensor cable. Position it so that the cables exit through the bottom of the box. Use either the supplied self-drilling / self-tapping screws, or the M6 hardware provided. Drill a 5mm pilot hole for the self-tapping screw, use the 5mm hole to tap the 6mm hole for the M6 bolts or widen the holes to use a nut.

If the drilled & tapped holes do not line up with the holes in the sensor and the bolt jams the sensor, it will be damaged!

11. Repeat for the other holes in the sensor, mark one flat on each nut with a marker pen and mark the metal next to it, then tighten each nut an additional 1/6 of a turn.

12. At this point it is best to complete the wiring to the indicator, leaving the green and white wires from the sensor free but connecting the black, red and shield as detailed in section 6.1. When wiring is complete, apply power and return with a digital meter to the junction box for each sensor. First, check that the excitation voltage is present by monitoring the red and black wires with the meter. Voltage should be approx. 5 volts DC. Alternatively, use a 9 V battery connected to the black and red wires of the sensor. Connect the meter to the white and green wires from the sensor and set it to the lowest range, usually 200 mV DC. Reading should be within -5 to +5 mV.

13. The objective is to torque the bolts tight to prevent any possible slippage of the sensor mountings, but not to damage the sensor while doing it. Using either a 17 mm regular wrench or torque wrench, tighten each of the bolt/nut combinations against the washers & sensor from the rear of the leg, holding the bolt head steady, in 2-3 stages to 41Nm (30lb ft) or a total of ¾ turn of the wrench

while monitoring the voltage. This voltage should remain between -5 to +5 mV. If it increases above these limits, slacken and check the alignment of the bolts in the holes, then re-tighten as before. When tightened to the full torque the voltage should remain within these limits. If the voltage is allowed to exceed 10 mV, the sensor can be damaged.

14. Spray the welded tabs, bolts and washers with the rubberized spray coating to seal them from possible rust buildup Wipe off the coating from the sensor body to avoid it being affected from radiated heat.

15. Repeat for all legs, and then connect the green and white wires.

3.4 Installation – Skirted Silo:

Locate the sensors in 4 or more places on the inside walls of the skirt, away from seams in the wall, doorways, windows, etc. The sensors should be evenly distributed around the skirt, except in the area facing southeast where the rising sun is strongest; this will minimize the resulting disturbance. The sensors do not need to be at equal distances apart, but as close to this as possible. If the doorway extends less than halfway to the attachment ring for the discharge cone, install the sensors on a line above the level of the top of the door but at least 3 feet below the cone attachment ring. If wall strengtheners have been used, install directly above these if they do not extend all the way to the cone attachment ring – see picture at right. If the strengtheners do extend to the cone ring, it needs to be determined whether the strengtheners bear most of the load or whether they are only designed to be braces.

Mount the sensors and junction boxes on the inside of the skirt as per the instructions for Through Hole, section 4.1. Attach sun shields as in the picture at right, using extra nuts to secure them, and spray nuts and ends of bolts with the anti-rust compound supplied or bought locally (clear color preferred).

4.0 Installation – Silex sensor, all mounting kits:

For all types of leg, provisions must be made in order to properly mount the sensors. Different methods are used based on the accessibility of both sides of the mounting surface.

The 'Silex' Sensor is a bolt on strain gauge sensor, designed to measure the expansion & compression of the vessel leg.

1. First, identify the legs on the silo to be fitted.

2. Pick a location for the sensors. Refer to section 3.1 for proper placement. Ideally, the sensor should be in the middle of the longest free run of the leg, away from any cross bracing, catwalks, or any other structure. The locations should also be away from direct sunlight, preferably on a north or west facing surface. The sensors are mounted vertically, with the vertical leg centered on the 'Neutral Axis', centerline of the center section as far as possible, to eliminate bending forces, on the flat of the beam. Ensure the desired mounting location is not too close to the corner radius and is free from bumps, burrs, and weld seams. The sensors need to mount on a flat face.

3. Orient all sensors vertically or parallel to the leg if it is angled slightly.

4. In the case of excessive paint, the paint under the sensor must be removed. The mounting pads on the back of the sensor must bite into the metal of the leg. Use a sanding disc or scraping tool to clean the mounting pad areas only; do not use a grinder. Ensure there is no interference from paint under the length of the sensor body. Bare metal can be painted over once installed.

5. Place the drill template on the leg, so that the line & holes in the template align with the line previously drawn on the leg. Tape in place.

6. With the supplied center punch, punch two marks through the holes in the template. Strike the punch lightly with a hammer, check the position and strike firmly.

7. Ensure the punched center marks are deep enough to hold the drill bit in place. Remove the template and set aside for the next leg.

8. At the punched marks, drill a 3mm pilot hole and use the step drill supplied. Or enlarge the hole as required by the application kit. Use a cutting lubricant to ease the work and prolong the life of the drill bits.

If the drilled holes do not line up with the holes in the sensor and the bolt jams the sensor, it will be damaged! Take care!

9. Before tightening the sensors to the final torque, power must be applied to the sensor.

4.1 Installation - Silex sensor using Through-Hole installation kit:

The 'Silex' Sensor is a bolt on strain gauge sensor, designed to measure the expansion & compression of the vessel leg. Refer to the drawing in the appendix.

1. Place a disk spring washer, convex side out, on the back-side of the leg, on the exposed bolt and add the nut. Tighten finger tight.

2. Mount the junction box in a convenient location, close to the installed sensor. Mount the junction box so that the cables exit through the bottom of the box. Use either the supplied self-drilling / self-tapping screws, or the M6 hardware provided. Drill a 5mm pilot hole for the self-tapping screw or use the 5mm hole to tap the 6mm hole for the M6 bolts.

3. Repeat the mounting for the remaining legs, in the same position and orientation as the first sensor.

4. At this point it is best to complete the wiring to the transmitter, leaving the green and white wires from the sensor free but connecting the black, red and shield as detailed in section 6.1. When wiring is complete, apply power and return with a digital meter to the junction box for each sensor. First, check that the excitation voltage is present by monitoring the red and black wires with the meter. Voltage should be approx. 5 volts DC. Connect the meter to the white and green wires from the sensor and set it to the lowest range, usually 200 mV DC. Reading should be within -5 to +5 mV.

5. Using either a regular wrench or torque wrench, tighten each of the bolt/nut combinations against the washers & sensor from the rear of the leg, holding the bolt head steady, in 2-3 stages to 41Nm (30lb ft) or a total of ¾ turn of the wrench while monitoring the voltage. This voltage should remain between -5 to +5 mV. If it increases above these limits, do not tighten further but check the alignment of the bolts in the holes. When fully tightened the voltage should remain within these limits. If the voltage is allowed to exceed 10 mV, the sensor can be damaged.

6. Repeat for all legs, and then connect the green and white wires.

4.2 Installation – Tapped Hole installation kit:

For square section or round legs (or any hollow structural steel), provisions must be made in order to properly affix the sensors to the legs. In most cases, the sensor's mounting points need to be tapped into the leg. In soft steel or thin steel, weld tabs must be added to the leg. Ideally the leg should have a wall thickness of at least 9mm (0.35").

1. Tap each hole with the M10 tap & handle provided. Ensure the tapping is straight & perpendicular to the leg.

2. Mount the junction box in a convenient location, close to the installed sensor. Mount the junction box so that the cables exit through the bottom of the box. Use either the supplied self-drilling / self-tapping screws, or the M6 hardware provided. Drill a 5mm pilot hole for the self-tapping screw. Use the 5mm hole to tap the 6mm hole for the bolts.

3. Spray the holes and any exposed steel with the rubberized spray coating. Spray the bolts, washers and toothed contact areas of the sensors before assembly to seal them from possible rust buildup.

4. Affix the sensor to the leg with the M10 bolts, and Schnorr disk spring washers provided. Put a disk spring washer, convex side out, on the bolt, and insert the bolt & washer into the sensor first, then into the tapped hole in the leg. Verify that, there is freedom of movement on the sensor up & down. This freedom ensures the holes have been drilled correctly and will not bind the sensor as they are tightened.

If the drilled & tapped holes do not line up with the holes in the sensor and the bolt jams the sensor, it will be damaged!

5. Tighten the bolt finger tight. Repeat for the other hole in the sensor.

6. At this point it is best to complete the wiring to the indicator, leaving the green and white wires from the sensor free but connecting the black, red and shield as detailed in section 6.1. When wiring is complete, apply power and return with a digital meter to the junction box for each sensor. First, check that the excitation voltage is present by monitoring the red and black wires with the meter. Voltage should be approx. 5 volts DC. Connect the meter to the white and green wires from the sensor and set it to the lowest range, usually 200 mV DC. Reading should be within -5 to +5 mV. Alternatively, use a 9 volt battery; see section 5.0, item 9.

7. Using either a regular wrench or torque wrench, tighten each of the bolt/nut combinations against the washers & sensor from the rear of the leg, holding the bolt head steady, in 2-3 stages to 41Nm (30lb ft) or a total of ½ turn while monitoring the voltage. This voltage should remain between -5 to +5 mV. If it increases above these limits, do not tighten further but check the alignment of the bolts in the holes. When fully tightened the voltage should remain within these limits. If the voltage is allowed to exceed 10 mV, the sensor can be damaged.

8. Repeat for all legs, and then connect the green and white wires.

4.3 Installation – Weld Tabs installation kit:

For legs with thin walls, or a diameter of 150mm (6”) in diameter or less, mounting faces [weld tabs] must be installed.

1. Mark a line parallel to the axis of the leg at the chosen point for installing the sensors.

2. If not already done so, assemble two weld tabs onto one weld tabs alignment jig with the short M10x22mm bolts. (Using the longer mounting bolts when welding can degrade the quality of the bolt.) Thread one of the attachment bolts through the alignment jig into a weld tab and tighten the weld tab finger tight only. Ensure that the bolt does not protrude out of the opposite side of the jig. Repeat for other weld tab.

3. Place, and secure in position, the assembled weld tabs & alignment jig. The weld tabs should be centered on the previously drawn marks. The weld faces may be mitered to better fit the curvature of the leg if necessary for welding.

4. First tack weld in three or four places, then fully weld the weld tabs to the leg. Ensure the mounting faces of the pair remain flat, flush, and parallel to each other.

5. Once welded, remove the placement jig. **DO NOT** discard the M10 bolts.

6. Mount the junction box in a convenient location, close to the installed sensor. Mount the junction box so that the cables exit through the bottom of the box. Use either the supplied self-drilling / self-tapping screws, or the M6 hardware provided. Drill a 5mm pilot hole for the self-tapping screw. Use the 5mm hole to tap the 6mm hole for the bolts.

7. Spray the welded tabs and any exposed steel with the rubberized spray coating provided. Spray the bolts, washers, and toothed contact areas of the sensors before assembly to seal them from possible rust buildup.

8. Affix the sensors to the legs at the weld tabs with the supplied M10 bolts and nuts. Thread a nut onto the bolt, to about 5mm from the bolt head. Place a disk spring washer, convex side out, on the bolt, and insert the bolt & washer into the weld tab until the bolt bottoms. Back it out one full turn and then run the nut onto the washer and sensor until finger tight. Verify that there is freedom of movement on the sensor up & down. This freedom ensures the weld tabs have been welded in place correctly and will not bind the sensor as they are tightened.

If the holes do not line up with the holes in the sensor and the bolt jams the sensor, it will be damaged!

9. Repeat for the other hole in the sensor.

10. At this point it is best to complete the wiring to the indicator, leaving the green and white wires from the sensor free but connecting the black, red and shield as detailed in section 6.1. When wiring is complete, apply power and return with a digital meter to the junction box for each sensor. First, check that the excitation voltage is present by monitoring the red and black wires with the meter. Voltage should be approx. 5 volts DC. Connect the meter to the white and green wires from the sensor and set it to the lowest range, usually 200 mV DC. Reading should be within -5 to +5 mV. Alternatively, use a 9 volt battery; see section 5.0, item 9.

11. Using either a regular wrench or torque wrench and a long socket fit it over both bolt head and nut, tighten each of the bolt/nut combinations against the washers & sensor from the rear of the leg, holding the bolt head steady, in 2-3 stages to 41Nm (30lb ft) or a total of ½ turn while monitoring the voltage. This voltage should remain between -5 to +5 mV. If it increases above these limits, do not tighten further but check the alignment of the bolts in the holes. When fully tightened the voltage should remain within these limits. If the voltage is allowed to exceed 10 mV, the sensor can be damaged.

12. Repeat for all legs, and then connect the green and white wires.

Installation – Agricultural Silo leg:

Many farm feed & grain silos have a shaped steel leg, that resembles an Omega symbol. The Silex sensor can be attached to legs of this shape, or any other similar shape. The sensor is to be mounted around the minor neutral axis of the leg.

1. From the front edge, measure back about 45 -50 % of the overall width (refer to the appendix). Mark a line parallel to the axis of the leg, at this point for installing the sensors. These will be the mounting centers.

2. Place the drill template on the leg, so that the line & holes in the template align with the line previously drawn on the leg. Tape in place.

3. With the supplied center punch, punch two marks through the two holes in the template. Strike the punch with a hammer.

4. Remove the template and set aside for the next leg. Ensure the punched center marks are on the line and deep enough to hold the drill bit in place.

5. At the punched marks, drill a 3mm pilot hole, and step up to a 8.5mm diameter hole. Finally, enlarge the hole to 13mm. Use a cutting lubricant to ease the work and prolong the life of the drill bits.

6. Spray the holes and any exposed steel with the rubberized spray coating provided. Spray the bolts, washers and toothed contact areas of the sensors before assembly to seal them from possible rust buildup.

NOTE: New regulations prohibit the shipment of pressurized spray cans and this may be missing from your kit. In this case, either purchase a can of rubberized rustproof underbody coating from your local automotive supplier or paint the mounting areas and bolts, washers etc. with any rustproofing paint or coating.

7. Affix the sensor to the leg with the M10 bolts, nuts, and Schnorr disk spring washers provided. Put spring washer, convex side out, on the bolt, and insert the bolt & washer into the sensor first, then through the leg. Verify that, when the bolts are assembled as above, there is freedom of movement on the sensor up & down. This freedom ensures the holes have been drilled correctly and will not bind the sensor as they are tightened.

If the drilled holes do not line up with the holes in the sensor and the bolt jams the sensor, it will be damaged!

8. Place a disk spring washer, convex side out, on the back-side of the leg, on the exposed bolt and add the nut. Tighten finger tight. Repeat for the other hole in the sensor, mark one flat on each nut with a marker pen and mark the metal next to it, then tighten each nut an additional 1/6 of a turn.

9. Mount the junction box in a convenient location, close to the installed sensor. Mount the junction box so that the cables exit through the bottom of the box. Use either the supplied self-drilling / self-tapping screws, or the M6 hardware provided.

10. Repeat the mounting for the remaining legs, in the same position and orientation as the first sensor.

11. At this point it is best to complete the wiring to the indicator, leaving the green and white wires from the sensor free but connecting the black, red and shield as detailed in section 6.1. When wiring is complete, apply power and return with a digital meter to the junction box for each sensor. First, check that the excitation voltage is present by monitoring the red and black wires with the meter. Voltage should be approx. 5 volts DC. Connect the meter to the white and green wires from the sensor and set it to the lowest range, usually 200 mV DC. Reading should be within -5 to +5 mV. Alternatively, use a 9 volt battery; see section 5.0, item 9.

12. Using either a regular wrench or torque wrench, tighten each of the bolt/nut combinations against the washers & sensor from the rear of the leg, holding the bolt head steady, in 2-3 stages to 41Nm (30lb ft) or a total of ¾ turn of the wrench while monitoring the voltage. This voltage should remain between -5 to +5 mV. If it increases above these limits, do not tighten further but check the alignment of the bolts in the holes. When fully tightened the voltage should remain within these limits. If the voltage is allowed to exceed 10 mV, the sensor can be damaged; take care.

13. Repeat for all legs, and then connect the green and white wires

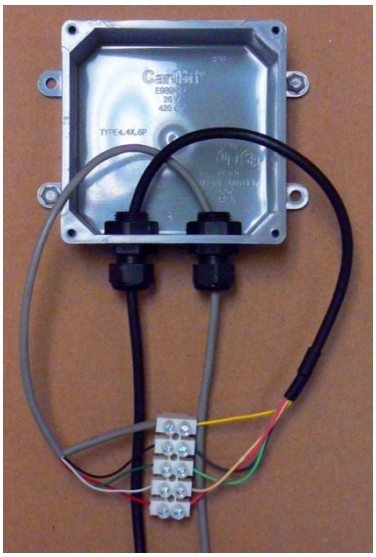
5.0 Wiring sensors to indicator

Each sensor needs to be connected to a junction box. At this point in the installation, all sensors and junction boxes (including the DJB) should already be installed, but not yet connected to one another. This step will connect the sensors to the junction boxes, then connect the junction boxes to the Digital Silo Transmitter (DJB) box, and finally prepare the DJB to be connected to the indicator cabinet, once it has been installed.

NOTE: **Conduits or bare cables?** We do not supply conduits but they are a worthwhile investment if you want to make the installation permanent, especially where people are working or passing frequently. Whether you use metal or plastic, screw fitting or butt connectors is your choice. One warning: never make the entry into a junction box or DJB from the top. Always enter the box from the bottom where possible; if this is impossible, enter from the side but ensure water tightness. It sounds obvious but the largest issues have been caused by water leakage, which appears as drift in the readings.

5.1 Wiring sensors to J-box and DJB

Refer to the connection diagram in your display manual for a 4-leg, 4 sensor vessel, on each leg pass the sensor cable and connecting cable to the DJB up through the strain reliefs in the junction box, and connect the 4 wires plus the shield drain wire to the connector strip. Connect wires of the same color together. This will give four colored wire connections and one more for the shield wire. Insulate the shield wire with some heat shrink tubing or use some of the jacket stripped from the cable to insulate it. For vessels using more than 4 sensors, group the sensors together in pairs so that you have 4 connections to the DJB. For example, for an 8 leg vessel, each 2 adjacent sensors will connect together in a single junction box, to the outgoing cable to the DJB. Connect all wires of the same color together. For 6 legs, either connect as 3 pairs or as 2 pairs and 2 separate sensors. If less than 4 inputs are used, the unused input can be disabled from the Silo Setup menu (System Setup section). Do not forget this – if not disabled, this spare input will create large drifts in readings later.



The sensor cable may be longer than required. Cutting it shorter it is not recommended. Coil in the J-box or coil the extra length and secure it with a cable tie.

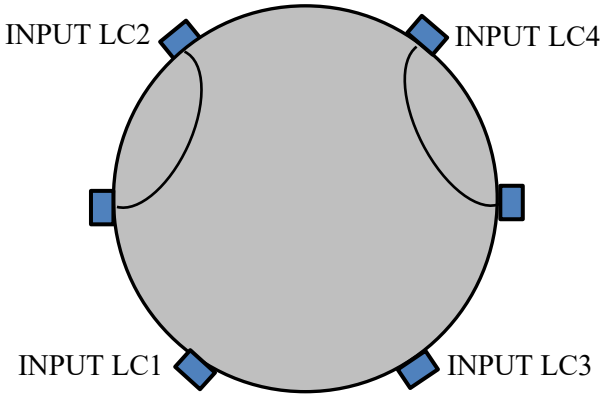
NOTE: **Attaching cables to silo legs and walls:** The metal pads provided should be attached using any good quality cyanoacrylate (instant) glue such as Gorilla Glue or Loctite 430 (non-removable). Clean surfaces with solvent before applying if possible. If leg or wall is wet, remove as much moisture as possible with cloth or paper towel and use instant glue, even on sticky pads. The glue penetrates wet surfaces.

Run a connecting cable between each junction box and the Digital Silo Transmitter (DJB) box which replaces the junction box at the last sensor location. Secure the cable with cable ties. Open the DJB and pass all the sensor wires through strain reliefs. Strip each cable's outer jacket 3" from the end and remove the exposed foil. Do not cut or remove the shield drain wire. Strip 3/16th inch of insulation from each wire.

If any unused strain reliefs remain, plug the holes with plastic plugs provided or use a short piece of sensor cable. Tighten to ensure water tightness.

Sensor wiring: Carefully connect the individual wires from each sensor to the grouped connector strip running the entire length of the DJB. Slide the DJB circuit board and carrier out of the box to provide easier access to the connection points. Each sensor has 4 wires that must connect to the DJB. Each DJB can support up to 8 sensors and if you are using more than 4, connect two sensors in parallel to each input (note that this parallel connection is preferably done in the leg junction box to save cable and use the same number of entry points on the DJB). The actual number of sensors connected to each input will be entered during setup. With the supplied screwdriver, connect the wires per the table on the next page. If using 4 sensors, number them and connect as shown below for best performance.

If using 6 sensors, connect as shown at right and if using 8 sensors, connect all sensors in pairs. and connect each pair to the DJB. These pairings are also printed directly on the circuit board. Note the connector number used for each sensor, e.g. LC1, LC2 etc. which runs left to right on DJB, for entering into the Setup menu.



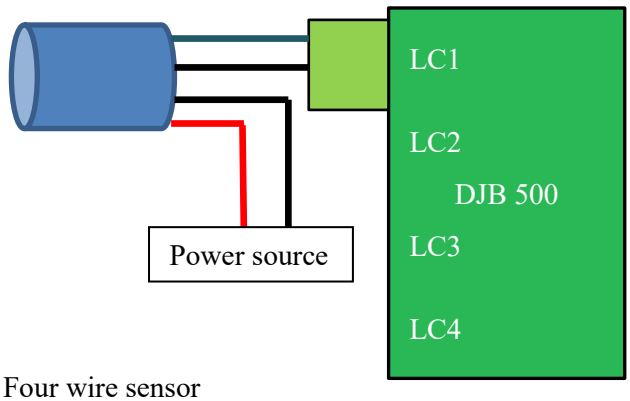
Group the shield drain wires together and braid them into a single wire. Insert this bundle into the hole in the ground stud on the back of the circuit board carrier and tighten gently.

Wire Insulation Color	DJB LC1-4 terminal name
Red	RD/E+
Black	BK/E-
Green	GR/S+
White	WH/S-

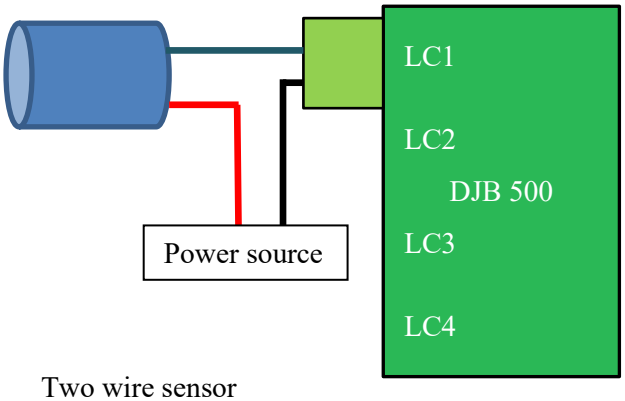
5.2 Four separate inputs on one DJB

5.2.0 With analog 4-20 mA sensors

Pressure sensors, level sensors, temperature and other sensors with analog 4-20 mA outputs can be connected, four to one DJB with the appropriate adapters. Since each DJB has 4 inputs, 4 devices can be connected and set up to read as 4 separate vessels. Connect the adapter board to the four terminals marked E+, E-, S+, S- for each of the inputs LC1 to LC4. Wire the analog input wires from the sensor as shown below.



Four wire sensor

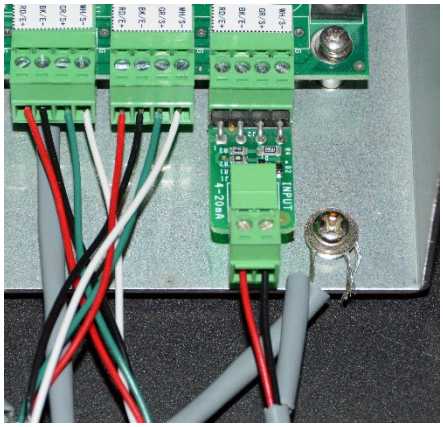


Two wire sensor

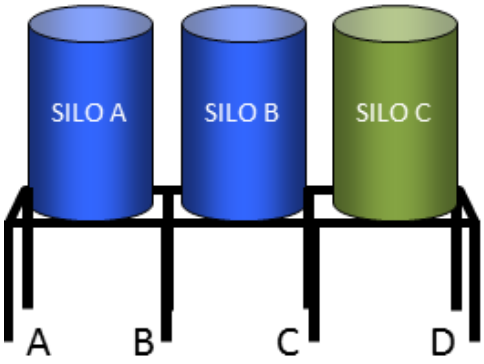
For each vessel, in the DJB Setup menu, enable only one input by putting '1' in the appropriate channel.

5.2.1 Analog 4-20 mA adapter 2420

The adapter, shown in light green above, can be installed inside the DJB enclosure, seen at right. In the picture, only input channel 4 has the adapter installed, to be used with any sensor with 4-20 mA or 0-20 mA output. Configure one vessel to use inputs 1-3 and the other to use only input 4 in the DAQ or indicator menu.

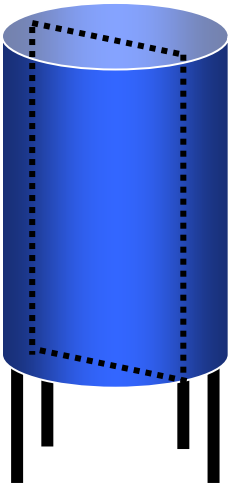


5.3 Wiring Shared Frame silos

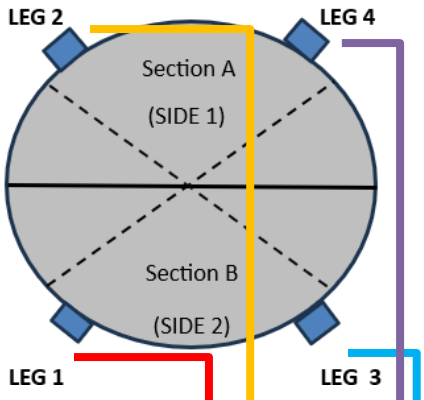


The Shared Frame application is a special case where two or three silos stand on a frame where the legs are shared. When installing on this type of frame, wire the sensors as three or four pairs (for the sets of legs A, B, C and optionally D) with each pair of sensors wired in parallel (all wires of one color connected together, making 2 ingoing and 1 outgoing plus the shields) in one junction box for each pair of legs. Run the outgoing cable from each of these J-boxes to the DJB500 input connector, with J-box A connected to the LC1 input, B to LC2, C to LC3 and D to LC4. The DJB inputs run from right to left on DJB500 and left to right on DJB 2 when the board is oriented with input connector at bottom, with LS1 to LS4 indicating inputs 1 to 4. These connections MUST be in this order for the system to work correctly.

5.4 Wiring a Divided silo



The Divided Silo is a special case where the silo has a division, making two partitions with separate outlets and inlets. The angle of the partition is not important but the legs must be wired correctly in reference to this division and the contents of each partition (see diagram). You should ALWAYS set up section A as the smaller of the 2 partitions if they are not equal.

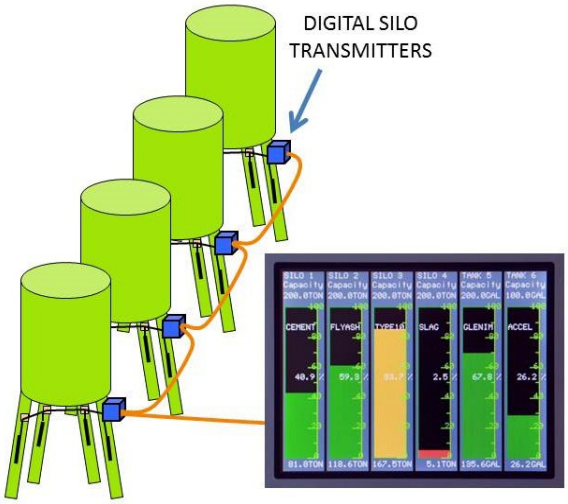


The diagram at left shows the numbering of the legs which is used in connections and programming for the divided silo. Note the arrangement of legs and their relationship to sections A **(Side 1)** and B **(Side 2)** of the vessel. The partition can be at any angle within the dotted lines. Wire the sensor for each leg to the input of the same number on the DJB. The DJB inputs run from right to left when the board is oriented with input connector at bottom left corner with LC1 to LC4 indicating inputs 1 to 4. Be sure to wire them EXACTLY as shown.

5.5 Connecting to DJB's

Connect the cable to run to the indicator or DAQ cabinet as detailed below. Pass the cable into the box through a strain relief. Connect the data cable to the DJB as follows:

Wire Insulation Color	DJB terminal name
Red	J4, V+
Black	J4, 0V
Green	J3, A
White	J3, B
RS485 termination jumper name	JP2 (on both pins = terminated)



If more than one vessel is being connected to the indicator, each vessel's DJB must be daisy chained (multi-dropped) to the next with the data cable (V+, 0V, A and B) as shown above. The first DJB will be connected to the second and the second will be connected to the third, the third will be connected to the fourth and so on, using a single cable. This means that all but the furthest DJB should have two wires in each of these connection terminals. The first DJB in the chain will be connected to the next DJB and to the indicator. On the final DJB only (the one farthest down the chain from the indicator) re-position the jumper:
DJB – move plug on JP2 from one pin only to both pins, (see table above) to terminate the end of the chain and verify that all other DJBs have this jumper in the OFF or one-pin position, unterminated or removed entirely. All cables must enter the DJB enclosure through strain relief fittings.

Insert the shield drain wire into the terminals at the top of the mounting plate of the PCB carrier.

The DJB address number (in hexadecimal notation) is written on both the circuit board carrier and on the front of the enclosure, e.g. 80. It will be needed when setting up the indicator later during the installation.

5.6 Sun Shields

Supplied with your SiloWeigh kit are sheets of aluminum. These are to be used as sun shields.
Without sun shields installed over the sensors, you will notice a drift in the readings over the course of the day. This is normal and is due to a slight warping of the legs caused by direct exposure to sunlight. The significance of the drift depends on the geometry of the legs and the change in temperature experienced by the leg. This effect can be reduced by installing sun shields to insulate the legs of the silo.

Once the sensors have been installed, wired to their respective junction boxes and the system verified for correct operation, the sun shields can be installed. The shields have been sized to fit a 10" H-beam, with a slight overlap. If your legs are smaller than this, the shields can be trimmed to size, or allowed a greater overlap.

1. Wrap and position the aluminum sheet so that the sensor is vertically at the center of the enclosed area and center the overlap on a flat surface of the leg, not in the space between flanges, to avoid wind damage.

2. Secure the sheet in place using the cable ties provided with the kit. Place two cable ties over each sheet, one at the top and one at the bottom.

3. Repeat the above steps for each sun shield that is to be installed.

For large section legs where the regular sun shields will not wrap completely around the leg, we have oversized sun-shields. These are normally supplied when we know about oversized legs but can be shipped separately when required.

NOTE: It is not recommended that the sun shields be painted. If they must be painted, use a light colored paint. This will lessen the amount of sunlight absorbed by the shield.

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