SCALE-TRON
Automation, sensors and weighing systems

SiloWeigh Basic

With ‘L-Strain’ Sensors Installation & Set-up

User’s Manual

Ver. 1.3
March 28, 2023

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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 through 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 Basic system, our staff are available to help you during normal business hours and at any other time by special arrangement.

CALL + 1 514- 940-0337

Website: scaletron.com
Email: service@scaletron.com.

Table of contents

1.0 Introduction

It is essential that you read the parts of this manual that apply to your installation. A check of the table of contents will show which parts these are; you will notice that out of the many variations in applications, you can read only a small part and learn what you need to know in a short time. If you don't read anything else, you MUST read the section on installing the sensors. Without reading this, your installation could easily be a failure!

This manual contains complete instructions for the setup and calibration of the SiloWeigh Basic system. SiloWeigh Basic tells you the weight of the contents of your vessel – not as an empty or full signal, or even a percentage full signal based on a level measurement. SiloWeigh Basic measures the actual weight of the contents inside a silo to give a true picture of the amount on hand – and it costs little more than a level sensor. SiloWeigh Basic can display the weight of practically any material such as cement, sand, aggregates, flour, mineral ores, coal, coke, chemicals, plastics, and grains such as corn, rice, wheat, oats and barley.

Main features:

- Displays one vessel on a 0.6" green LED display.
- Up to 100 m (328 ft) cable connection to each vessel.
- Dustproof NEMA-12 (IP60) plastic wall or horizontal mount cabinet.
- Standard serial RS232 port to connect to computers or printers.
- Monitor amount of each delivery by use of the Tare button prior to filling.

Throughout the manual, warnings, cautions, and special notes are added to indicate a potentially hazardous condition, or to identify a potentially hazardous situation if not corrected.

Describes a condition that may prove to be harmful or fatal to either personnel, equipment or both.

NOTE: Describes a condition which requires special attention.

2.0 Before you start

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

Installation is simple and straightforward, with every step detailed, and presented in order. Anyone with a modicum of mechanical aptitude and manual dexterity can perform the installation. The installation is broken down into several steps, with each step being described in detail in a later section of this manual. The steps, in the order they are to be performed are:

Installing the sensors
Installing the indicator
Setting up the indicator
Operating the system

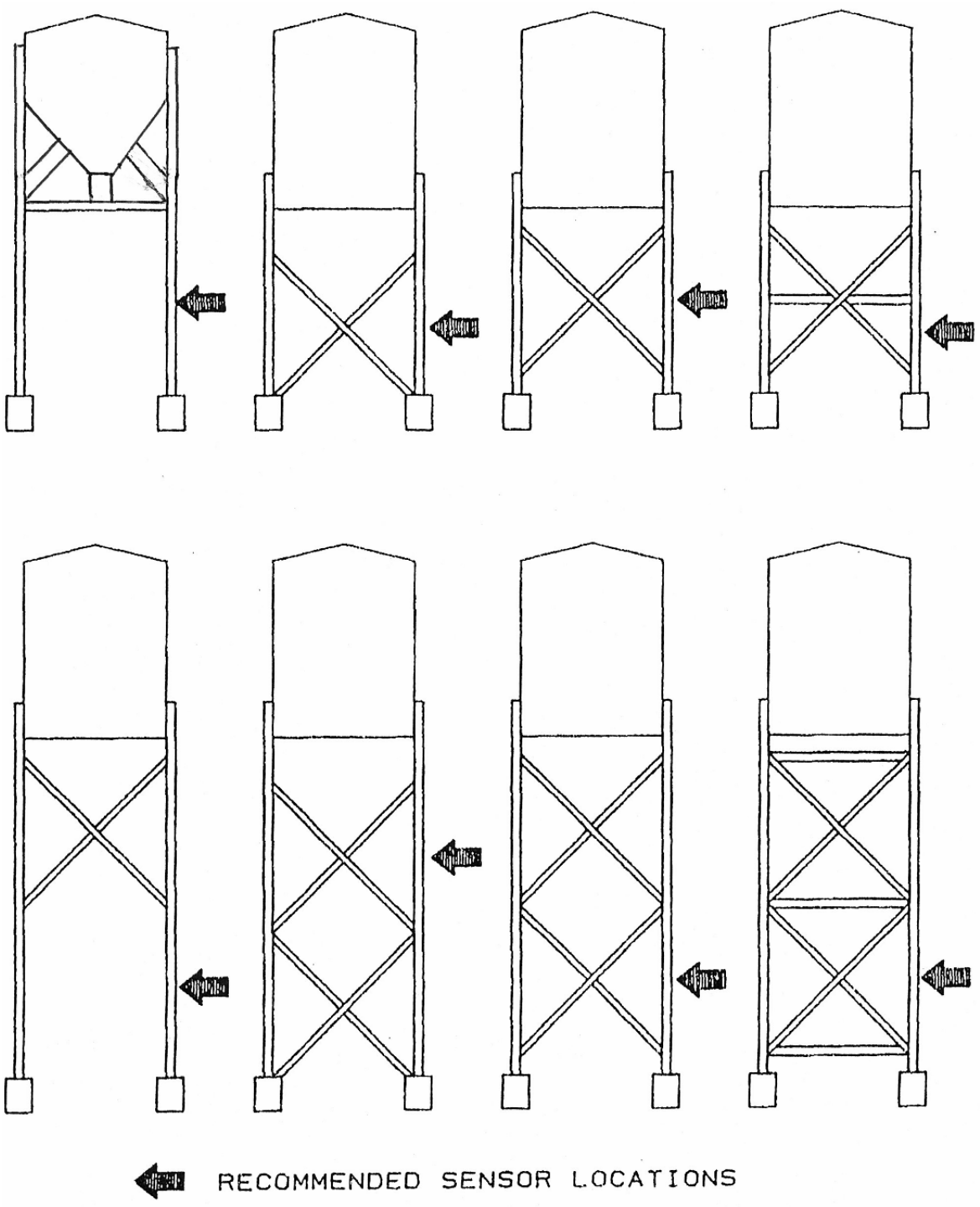
Installation of the SiloWeigh Basic system requires the use of a few basic tools. Ensure the installer understands how to use the tools, and that they are used in a safe manner. The less common tools are provided with the installation kit. Below is a list of the tools needed to perform an installation of the system, although in practice you may choose to use other tools if they make the job easier.

Abrasive paper or sanding disk
Drill
3mm, 5mm, 8.5mm and 13mm drill bits (included)
Center punch (included)
Digital Multimeter (must read millivolts, ohms, and megohms)
10mm & 17mm wrenches for M6 & M10 bolts & nuts
Torque Wrench to fit 17mm nuts & bolts, with long socket if using weld tabs
Small slot blade screwdriver
Wire cutter and stripper (for #22AWG wire)
Knife
Tools for mounting the indicator

3.0 Installation

3.1 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.


RECOMMENDED SENSOR LOCATIONS

3.2 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).

The drills supplied are adequate for installation on a few silos. If installation is to be done on many silos, we recommend the use of a drilling machine with magnetic base fitted with a cutter that drills the correct sized hole in a single pass. The C5000 from Grainger Inc. is shown at right. This cutter has a hollow center through which a spring loaded pilot pin extends. This locates the cutter onto the center punch mark. As the cutter proceeds, it leaves a plug of metal in this hole that locates the cutter as it cuts.

The second picture shows the magnetic based drill and cutter in operation. An assistant is spraying lubricant onto the cutter. This installation was done on a group of 12 skirted silos, each 25 ft in diameter, in southern California. The eight sensors per silo required a total of 192 holes and the rental of the magnetic based drill shaved several days off the job.

3.3 Installation – L-Strain sensor, all mounting kits:

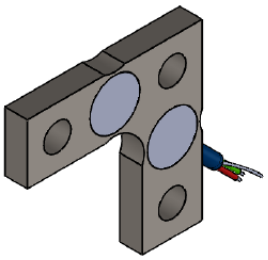
For all types of leg, provisions must be made in order to properly mount the sensors. Different methods are used based on the accessibility of both sides of the mounting surface.

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

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

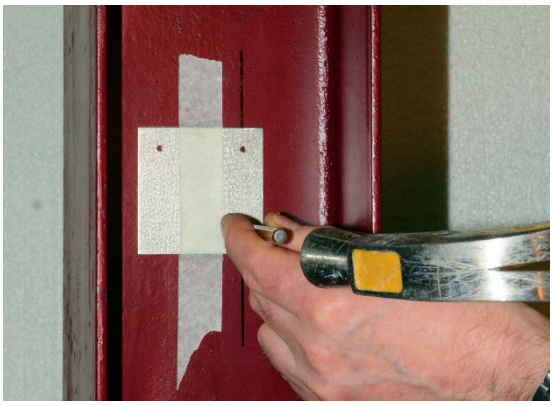
2. Pick a location for the sensors. Refer to section 4.1 for proper placement. Ideally, the sensor should be in the middle of the longest free run of the leg, away from any cross bracing, catwalks, or any other structure. The locations should also be away from direct sunlight, preferably on a north or 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 180 º 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 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. Clean with a suitable solvent to ensure good adhesion of the Loctite 638.

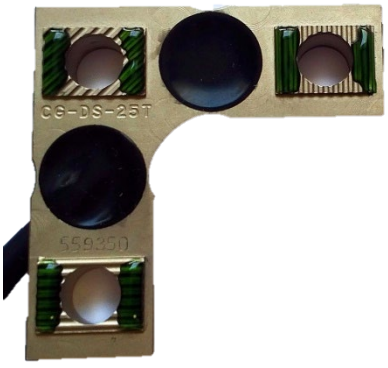
5. Place the drill template on the leg, so that the line & holes in the template align with the line previously drawn on the leg. Tape in place.



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 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 two beads 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.

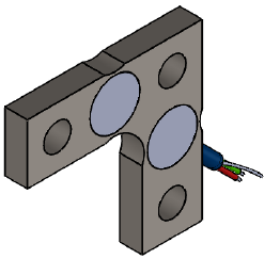
If the drilled holes do not line up with the holes in the sensor and the bolt jams the sensor, it will be damaged! Take care!

3.4 Installation – L-Strain sensor using Through-Hole installation kit:

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.

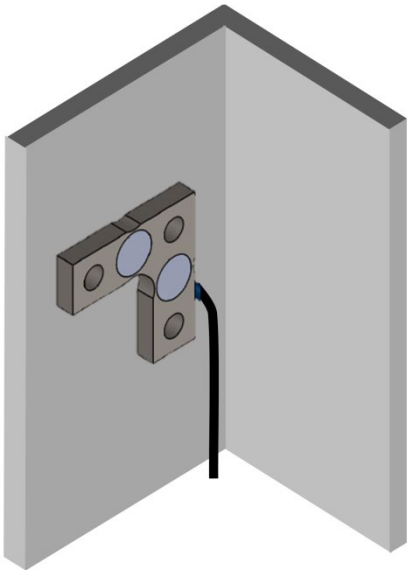
The 'L-Strain' Sensor is a bolt on strain gauge sensor, designed to measure the expansion & compression of the vessel leg. Refer to the drawing in the appendix.

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



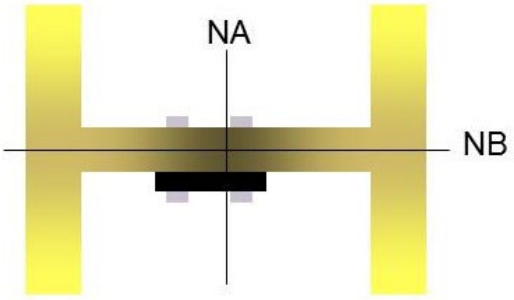
2. Pick a location for the sensors. Refer to section 4.1 for proper placement.

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 180 º 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 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. Clean with a suitable solvent to ensure good adhesion of the Loctite 638.

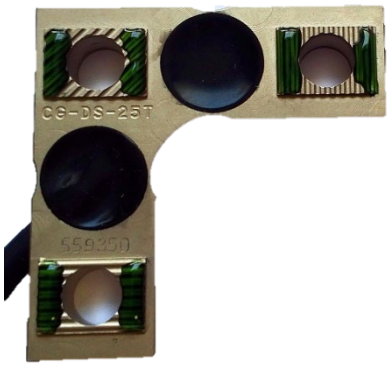
5. Angle (L-section) legs: Install as close to the inside corner as possible, as shown at right. Avoid the inside radius; the position is not critical. Draw a vertical line through the center of the vertical mounting holes at the best position.



6. 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.

7. 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.

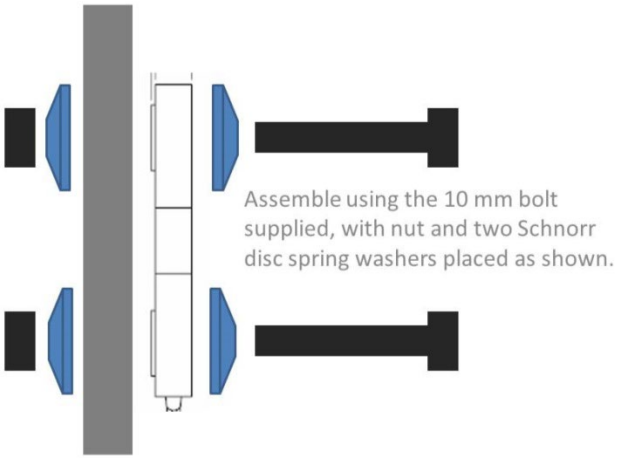
8. With the supplied center punch, punch three marks through the three holes in the template. Strike the punch lightly with a hammer, check the position and strike firmly.



9. 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.

10. 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.

11. Since large forces can exist between the sensor and the mounting surface, add two beads 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 10 to 20 minutes; ensure that you have completed the next steps within this time, or start again.



12. 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 13 and 14 while you are waiting.

13. 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.

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

WARNING CAUTION **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! Take care!**

15. 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 4.9. 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.

16. 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 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.

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

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**.

18. Repeat for all legs, and then connect the green and white wires as detailed in section 4.9.

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.

3.5 Installation – Tapped Hole installation kit:

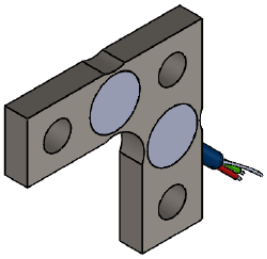
For square or rectangular section legs (or hollow structural steel), provisions must be made in order to properly mount the sensors to the legs. In most cases, the sensor's mounting points need to be tapped into the leg. In soft steel, thin steel, or round legs, weld tabs must be added to the leg. See Weld Tabs, section 4.6. Ideally the leg should have a wall thickness of at least 6mm (¼").

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

2. Pick a location for the sensors. Refer to section 4.1 for proper placement. Ideally, the sensor should be in the middle 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, centered on the leg. Ensure the desired mounting location is free from bumps, burrs and weld seams.

3. Remove as much paint as required so that the mounting pads of the sensor, when mounted, are against bare metal. Use a sanding disc or scraping tool. Do not use a grinder. Ensure there is no interference from paint under the sensor body. Clean with a suitable solvent to ensure good adhesion of the Loctite 638.

4. Draw a vertical line in the center of the leg, at the chosen sensor location.



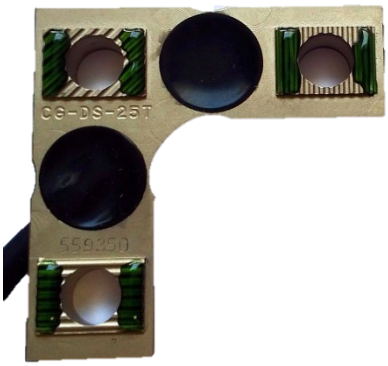
5. Orient all sensors as shown at right with the cable coming from the right hand vertical side. The only exception is if it is difficult to fit in this manner, when it is allowable to turn the sensor through 180 º so that the cable is on the left vertical side (as in "L").

6. 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.

7. 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.

8. 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.

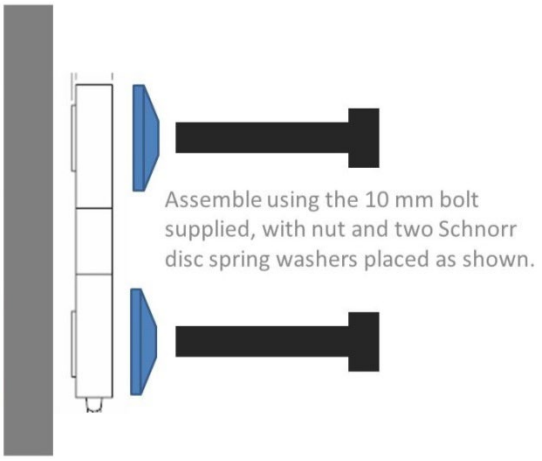
9. At the punched marks, drill a 3mm pilot hole, and step up to a 8.5mm diameter hole. Use a cutting lubricant to ease the work, and prolong the life of the drill bits.



10. Tap each hole with the M10 tap & handle provided. <u>Ensure that the tapping is straight & perpendicular to the sensor when installed</u>.

11. Since large forces can exist between the sensor and the mounting surface, add two beads 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 that you have completed the next two steps within this time, or start again.

12. 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.



13. 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.

14. 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 4.9. 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.

WARNING CAUTION

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! Take care!

15. 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 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.

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

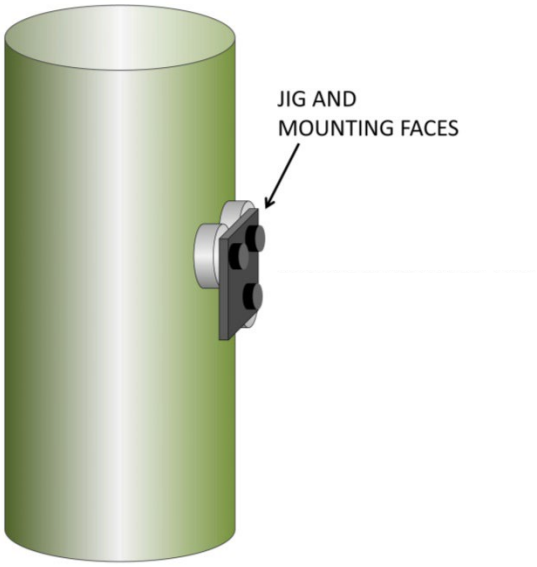
NOTE: **New regulations prohibit the shipment of pressurized spray cans and this may be missing from your kit. In this case, either purchase a can of rubberized rustproof underbody coating from your local automotive supplier or paint the mounting areas and bolts, washers etc. with any rustproofing paint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

17. Repeat for all legs, and then connect the green and white wires as detailed in section 4.9.

3.6 Installation – Weld Tabs installation kit:

For legs with thin walls or when welding is preferable to tapping, mounting faces [weld tabs] must be installed. These weld tabs can be purchased from Scale-Tron. Refer to the drawings in the appendix.

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



2. Pick a location for the sensors. Refer to section 4.1 for proper placement. Ideally, the sensor should be in the middle of the leg, away from any cross bracing, catwalks, or any other structure. The locations should also be away from direct sun light, preferably on a north or west facing surface. The sensors are mounted vertically, centered on the leg. Ensure the desired mounting location is free from bumps, burrs, and weld seams.

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

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

5. If not already done so, assemble three 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.

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

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

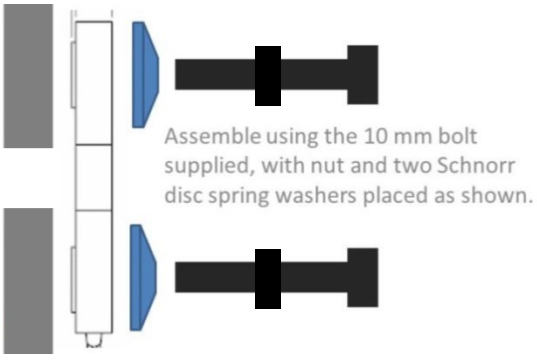
8. First tack weld in three or four places, then fully weld the weld tabs to the leg. Remove the jig; **DO NOT** discard the M10 bolts. Check that the mounting faces of the tabs remain flat, flush, and parallel to each other; trim the faces with a hand file if necessary, to ensure that the sensor is not twisted when tightened.

9. 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.

10. 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 two beads 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.

11. When assembling, use bolts, Schnorr disc spring washers and nut as shown in the illustration at right. 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. 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.



12. 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! Take care!

13. 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.

14. 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 4.9. 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.

15. 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 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.

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

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.**

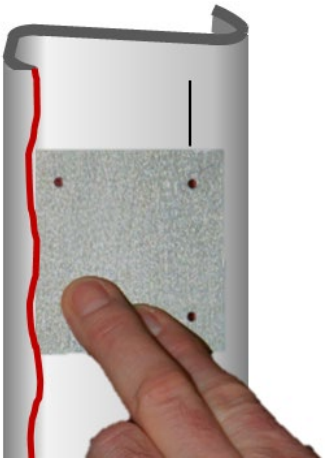
17. Repeat for all legs, and then connect the green and white wires as detailed in section 4.9.

3.7 Installation – "Animal Feed" or "Omega" shaped Silo leg:

Many farm feed & grain silos have a shaped steel leg, that resembles an Omega symbol. The L-Strain 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. First, identify the legs on the silo to be fitted.

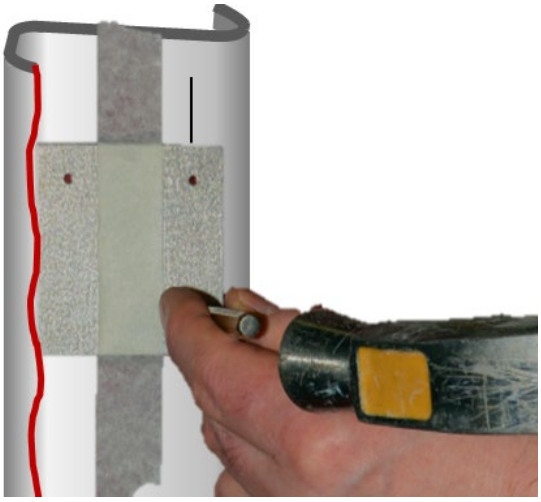
2. Pick a location for the sensors. Refer to section 4.1 for proper placement. Ideally, the sensor should be in the middle of the leg, away from any cross bracing, catwalks, or any other structure. The locations should also be away from direct sunlight, preferably on a north or west facing surface. The sensors are mounted vertically, centered on the flat of the leg. Ensure the desired mounting location is free from bumps, burrs, and weld seams. The sensors need to mount on a flat face.



3. Remove as much paint as required so that the mounting pads of the sensor, when mounted, are against bare or galvanized metal. Use a sanding disc or scraping tool. Do not use a grinder. Ensure there is no interference from paint under the sensor body. Clean with a suitable solvent to ensure good adhesion of the Loctite 638.

4. Draw a vertical line in the center of the leg, at the chosen sensor location.

5. 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 180 º so that the cable is on the left vertical side (as in "L").



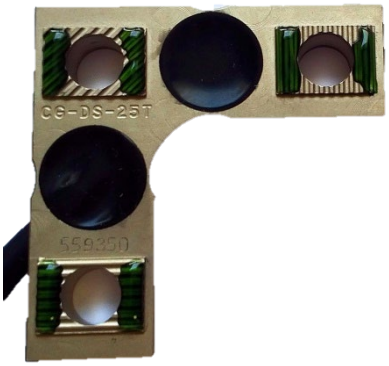
6. Measure the width of the intended mounting face.

7. From the front edge, measure back about 45 - 50 % of the overall width (refer to appendix). Mark a line parallel to the axis of the leg, at this point for positioning the vertical leg of the sensor, if the end of the sensor fits in the space, or as close to this as possible.

8. 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.

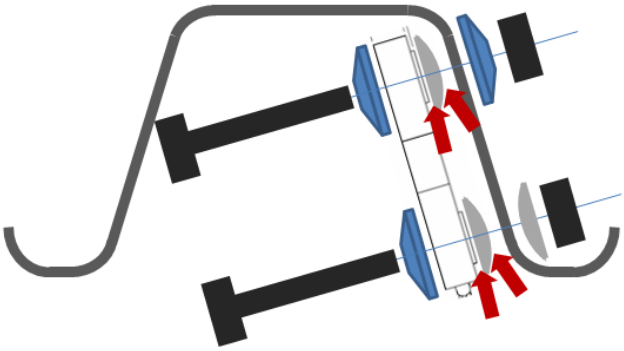
9. With the supplied center punch, punch three marks through the three holes in the template. Strike the punch lightly with a hammer, check the position and strike firmly.

10. 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.



11. 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.

12. Since large forces can exist between the sensor and the mounting surface, add two beads 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 that you have completed the next two steps within this time, or start again.



13. When assembling, use bolts, Schnorr disc spring washers and nut as shown in the illustration at right. Clean inner and outer surfaces and add a thin layer of the Loctite 638 to all surfaces of the three washers, to ensure that they cannot move once installed.
Place a disk spring washer, convex side out, on the back-side of the leg, on the exposed bolt, where possible and add the nut. Where the curvature of the leg does not permit use of the disk spring washer, it can be replaced with a copper/aluminum curved washer plus nut, as shown. Tighten finger tight. 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 only. Leave for 10 or more minutes before tightening further; continue with the following steps while you are waiting.

14. 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.

15. 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! Take care!

16. 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 4.9. 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.

17. 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 regular wrench or torque wrench, tighten each of the bolt/nut combinations against the washers & sensor from either side, holding the other side 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.

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

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**.

19. Repeat for all legs, and then connect the green and white wires as detailed in section 4.9.

3.8 Installation – Skirted Silo:

Sensors installed on skirted silos are done in the same manner as Through-Hole legs (see 4.3), but with a few minor differences.

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. Consult our engineering office and supply pictures or drawings where possible.

Mount the sensors and junction boxes on the inside of the skirt as per the instructions for Through Hole; section 4.3 using the curved copper/aluminum washers.

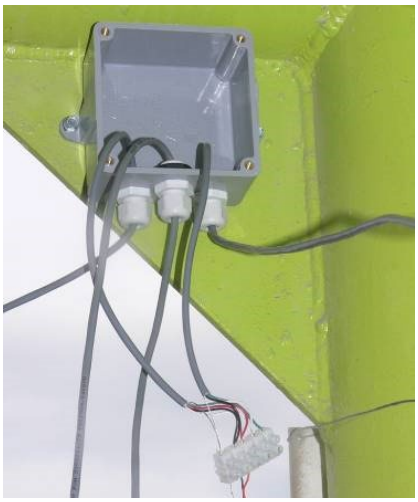
3.9 Wiring Junction Boxes and indicator

The furthest sensor needs to be connected to a junction box and both need to be connected to the summing box and then to the indicator. At this point in the installation, both sensors and junction boxes should already be installed, but not yet connected to one another. This step will connect the furthest sensor to the junction box, then connect both sensors at the summing box, and finally connect the summing box to the indicator.

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 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.

The sensor cable may be longer than required. Cutting it shorter will not interfere with the normal operation of the SiloWeigh Basic system, but it is not recommended. Neatly coil the extra length, and secure it with a cable tie. Should cutting it become necessary, you may, depending on the type of sensor, be faced with 7 wires. The system only uses the red, green, black, white and shield wires. The yellow, blue and brown wires are not required for the system.

For a 4-leg, 4 sensor vessel, on each leg pass the sensor cable and connecting cable to the indicator 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. Connect all sensors in parallel or "daisy-chain" fashion, and then to the indicator. Refer to section 9.1.



The sensor cable may be longer than required. Cutting it shorter will not interfere with the normal operation of the system, but it is not recommended. Neatly coil the extra length, and secure it with a cable tie. Should cutting it become necessary, you may be faced with 7 wires. The system only uses the red, green, black, white and shield wires. The yellow, blue and brown wires are not required for the system.

NOTE: **Attaching cables to silo legs and walls:** We have eliminated the sticky pads used with the cable ties. The pads provided should be attached using any good quality cyanoacrylate glue such as Gorilla Glue or Loctite 430 (non-removable). Clean surfaces with solvent before applying.

Silo cable Insulation Color	Wire name	Indicator cable color
Red	Excitation +	Red
Black	Excitation -	Black
Green	Signal +	Green
White	Signal -	White

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

Mount the indicator in a convenient indoor location; the indicator is not rated for outdoor use. Affix the metal indicator mounting bracket to any convenient wall. You will need a dedicated power outlet within reach of the power adapter. Ensure that the power outlet voltage matches that of the adapter. Note that a waterproof (NEMA-4X) indicator is available (at extra cost) if it is to be mounted outside.

The TI-500E indicator has a 15 ft shielded load cell cable for connection to the silo cable. Plug the cable's 14-pin parallel interface connector into the load cell port on the rear panel of the indicator and wire the bare wires and shield, using a junction box, to the color code shown in the table above.

3.10 Sun Shields

Supplied with your SiloWeigh Basic kit are sheets of aluminum. These are to be used as sun shields; they are necessary only with outdoor installations. 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 lessened by installing sun shields to insulate the legs of the silo from the sun.

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 roughly at the center of the enclosed area.

2. Secure the sheet in place using the tyraps provided with the kit. Place two tyraps 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.

NOTE: It is not recommended that the sun shields be painted. If they must be painted, use a light-coloured paint. This will lessen the amount of sunlight absorbed by the shield. If the edges of the aluminum sheets are considered a safety hazard, wrap these edges with any type of sticky tape.

4.0 Indicator setup

Details of configuration, setup and calibration of the indicator are contained in the indicator manual (TI-500E Plus, on the CD supplied with the system. The following is a guide to the relevant settings for typical installations. Please consult pages 4 – 9 of the 500E Plus manual for details.

TO ACCESS THE CALIBRATION MENUS – Remove one of the two screws on the back of the indicator, slacken the other and rotate the plate to expose the switch underneath. Operate the switch, remove power and reapply. The display should now show F 1. When done, reverse this switch.

NOTE: Many vessels are designed conservatively and if you expect to fill it past the official design capacity, enter a Capacity value that is higher to ensure that your readings do not run off-scale before you stop filling; for example, if your silo is 100 ton, 110 or 120 ton would be a good choice for the capacity value. Likewise, you should decide on the units to use – ton, Metric ton (Mton) or klb (thousands of pounds); If klb or Mton are used, the lb/kg button will convert correctly. Do not attempt to calibrate a large silo or bin in lb or kg; the reading will appear to drift up and down and users will see this as faulty operation. When setting up the F1 value below, try to make it less than 2000 graduations.

Before starting calibration, refer to the indicator manual and determine the number of graduations, based on a display division of 0.1, 0.2 or 1 ton (Mton) or klb (thousands of lb) in order to give between 500 and 2000 graduations. **Example:** if silo capacity is 120 ton, Capacity is 120.0 ton and this divided by the graduation size (0.1 ton) gives 1200. For your convenience, we have tabulated our recommended values below; if your silo is intermediate between values, use the settings for the lower value and calculate F1:

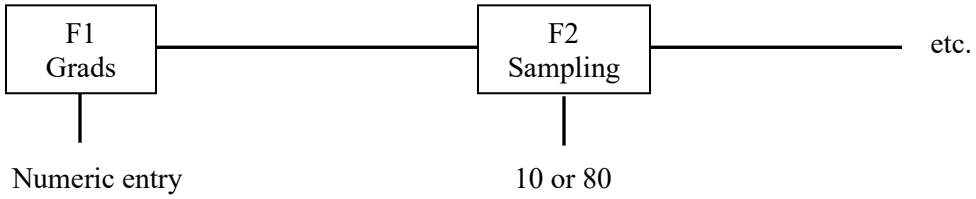
A, Capacity, ton or klb, Metric ton (Mton)	B, Graduation size	F9 value	F1 value (A / B)	F10 value
50.0	0.1	1	500	0.0
100.0	0.1	1	1000	0.0
200.0	0.2	2	1000	0.0
500.0	0.5	5	1000	0.0
1000	1	1	1000	0

After setting the number of graduations (F1), set digital filter to Slow (F6), units to your choice, ton (1), Mton (2) or klb (1) (F8), display divisions (1, 2 or 5) (F9) and decimal point to 0.0 or 0 (F10). Use the following procedure:

TI-500E weight indicator, Menu Structure:

All menus consist of a top level (heading) and a secondary level. The top level contains the code (e.g. F1) for the parameter to be configured. The secondary level contains the selection list or allows access to a programming sequence.

Use the directional keys to move around in the Menu Structure shown below.



1. To move to a new heading, use the TARE (left) or PRINT (right) key to move right or left in the Menu.

2. To move to the selection or programming level, press the ZERO (down) key once. The currently saved selection is shown.

3. To view the available selections for the current heading, use the TARE (left) or PRINT (right) key to move through the selection field.

4. To save a new selection, press the NET/GROSS (Set) key .To exit without saving, press the UNITS (up) key to return to the current heading.

Repeat Steps 2 to 4 until the Menu is programmed.

CODE/NAME	DESCRIPTION	SELECTION LIST
F1, Graduations	The number of full-scale graduations, as above, i.e. capacity / graduation size	Enter value, 100 to 50,000
F6, Digital filter	Reading speed	Set to SLo
F8, Calibration units	Units of measure. 1 = ton (or klb), 2 = Mton (thousands of kg)	1 or 2
F9, Display graduations	Display will read in steps of 1, 2, 5, 10, 20 or 50	Set to 1, 2 or 5
F10, Decimal point	Do not make smaller than necessary. For reading in steps of 10, 20 or 50 (kg or lb) (recommended) set to 00. For steps of 1, 2 or 5 (kg or lb) (Not recommended) set to 0.	0, 0.0, 0.00, 0.000, 0.0000, 00

It is possible to ignore all the other settings, leaving them at their default values. For special applications, see the detailed TI-500E manual.

5.0 Calibration

The calibration process depends on two things: ability to empty the vessel and the amount of the fill. If the fill is from a truck (or trucks) that is weighed before and after, the weight is accurately known. For best accuracy, always perform the Zero calibration immediately before the filling process and record the second value immediately after the filling process, to minimize any error due to temperature change.

NOTE: The calibration can be done in any order at any time. You can enter a zero and exit. The zero value is then stored and you can re-enter the calibration program at a later time and go straight to the High (Full) calibration setting. Likewise, if the vessel is part or completely full and you know the contents accurately you can do the High value calibration first, then empty the vessel and complete the Zero value calibration. If material is used from the silo as it is being filled, note the quantity accurately and deduct this from the total when entering the High value.

5.1 Zero calibration

1. While in the Setup mode, scroll to "F 16", then scroll down once using the ZERO key to enter zero calibration menu. The display will momentarily show "C 0" followed by a value. This value is the internal A/D count and can prove useful when trying to troubleshoot setup problems.
2. After making sure that there is nothing in the silo, press the ZERO key again to zero out the displayed value.
3. Press the NET/GROSS key to save the zero point value. The display will show "EndC0" momentarily, and then revert back up to F16. At this time, proceed to the F17 span calibration to complete indicator calibration.

5.2 High value calibration

Wait until a known quantity of material has been deposited in the vessel. It is critical that the quantity being deposited is known accurately. The larger the quantity of material deposited, the more precise the calibration will be, but filling should always be done over a period of 2 hours or less if possible, to minimize temperature induced errors.

1. While in the Setup mode, scroll to "F 17", then scroll down once using the ZERO key to enter span calibration menu. The display will momentarily show "C 1" for the first span calibration point, followed by a value with one flashing digit. This value will be zero with the Decimal Point parameter as selected in F10.
2. Use the four directional keys to adjust the displayed value to the actual weight value. Increase the flashing digit by pressing the UNITS key. Decrease the flashing digit by pressing the ZERO key. Pressing the PRINT key or the TARE key will change the position of the flashing digit.
3. After entering the value, press the NET/GROSS key to save the value. If the C1 calibration was successful, the display will show "EndC1" momentarily, followed by "C 2" for the second calibration point. Although a second calibration point is possible, for this application it is not necessary; just press the Net/Gross key to exit.

If the calibration was not successful, one of the error messages below will appear. Take the indicated action to correct the problem, and then perform a new calibration.

"Err0" - The calibration test weight or the keyed-in weight is larger than the full capacity of the silo. Change the calibration test weight or check the input data.

"Err1" - The calibration test weight or the keyed-in weight is smaller than 1% of the full capacity of the silo. Change the calibration test weight or check the input data.

"Err2" – There is not enough input signal from the sensors to establish a proper calibration. Most commons causes include incorrect sensor wiring, incorrect bolt torquing or a faulty sensor.

NOTE: Once you have saved the setup and calibration, we recommend keeping a written copy. If you have printed the indicator manual, circle the setup choices, then enter the raw values in the calibration table; otherwise, note your choices in this manual or on a convenient paper. Keep it in a safe place in case your indicator loses this information, or you have to replace it.

6.0 Operation

Once the system has been installed, configured, and calibrated, regular operation can begin. At any time the Gross weight can be read on the display. As the sun rises every morning, the reading may shift upwards and down again over a few hours. This is normal and the best accuracy is always before sunrise or after sunset. Note that the SiloWeigh II Pro and SiloWeigh.Net systems have a proprietary filter to eliminate these effects.

To measure a delivery or a discharge, prior to the operation, press the TARE button. The display will show zero and any deviation is shown as a Net weight, to eliminate the need to remember the tare weight and calculate it. Press the NET/GROSS button to return to the Gross weight display.

If a printer is connected, pressing the PRINT button transfers the reading to the printer or computer.

7.0 Trouble Shooting

Troubleshooting the SiloWeigh Basic system can be narrowed down to troubleshooting the sensors, troubleshooting the SiloWeigh Basic indicator and troubleshooting the hardware (wires and junction boxes), between the sensors and the indicator. Each component has its own issues and solutions.

The sensors respond to weight changes in vessel weight. If the weight remains stable but the readings fluctuate and are erratic then there is probably an issue with one or more sensors. In addition, if the SiloWeigh Basic system is unable to cover the full range of weight then there can be a problem with one or more of the sensors. However, in the second case, the problem can be one of calibration.

The indicator takes the millivolt signal from the sensors and converts it to a digital weight value. If the weight changes are accurate at the low end of the range and give errors that increase as the range increases, then the weight entered during calibration was probably incorrect. In addition, if the SiloWeigh Basic system shows over full scale when the crane is below its full capacity, then the Capacity value used during calibration was not large enough.

The hardware (wires and junction boxes) is responsible for transmitting the weight changes from the sensors to the indicator. If adding weight shows a weight decrease, or the display does not respond, there is probably a connection issue.

7.1 Troubleshooting the Sensors

Take mV readings for each individual sensor. They may not have the same value because installation creates stresses. However, the CHANGE in readings should be similar as the vessel is loaded. A sensor that has a change value significantly different from the other sensors is either faulty or incorrectly installed.

When you bolt a sensor, you can stretch or compress the sensor. You can therefore go beyond the offset capability of the electronics, so you can never calibrate. If the readings for signal voltage (white, - to green, +) on any sensor are outside the range -5 to +10mV, loosen the bolts on the sensor and prise the sensor very carefully to break the glue seal. Remove the sensor and clean the glue from all surfaces. Re-apply the original glue or any type of epoxy (see section **Error! Reference source not found.**); position the sensor so that the bolts are free to move and tighten finger tight, then tighten each bolt a quarter turn at

a time, up to ¾ turn while monitoring the signal voltage. The signal should remain in the ±0 to 5 mV range.

Install the sensors on the right part of the structure. They must be on main load bearing members. Make sure to install the sensors where there is no rust or layers of paint. Ensure that the mounting surface is bare and flat.

If you find that readings jump when the sun rises, or at the same time of the day (for external installations), then you can minimize variations by ensuring the sun shields are properly installed. In addition, mount the sensors on the north or west facing sides of the legs.

It is important to remember that any readjustment of a sensor necessitates a new calibration.

7.2 Troubleshooting the Hardware

Test the wires. An electrician needs to verify that each wire is well connected. Starting from the sensors, test each wire going into each DJB box and going out of each junction box. If there is a problem with the wiring then this approach will help isolate where there is a break or a short circuit. Visually examine the wires and connections. Make sure that there is no moisture or irregularities. Verify the voltage on each sensor connector is as follows:

Connect voltmeter negative (black) to black wire.

Red – 4.5 to 5.2 volts DC

White, Green – exactly half of voltage reading on red, e.g 2.25 to 2.6 volts.

Voltage between white and green must be between -3 and +10 mV maximum.

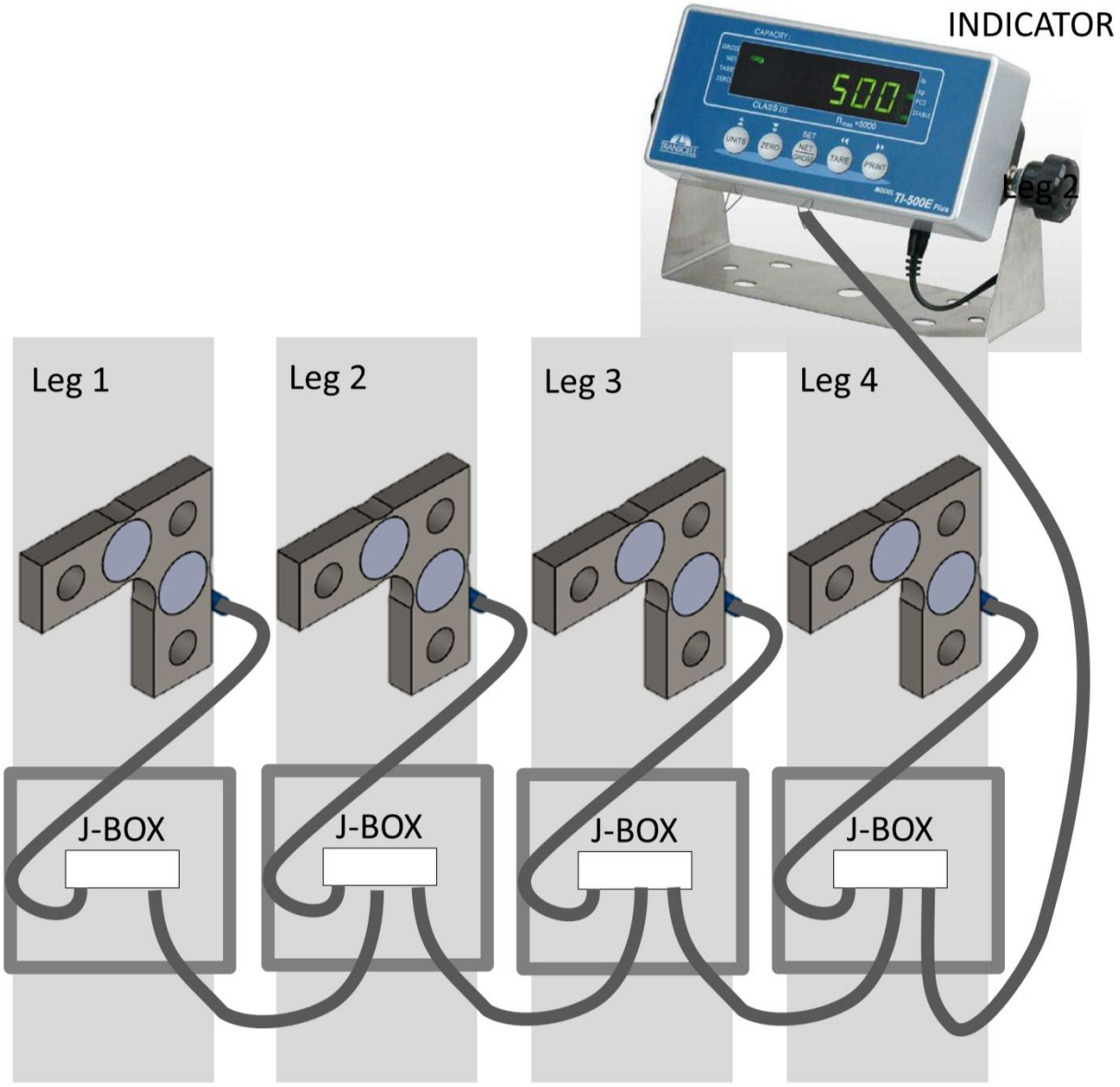
Anything different from the above readings indicates a bad connection or a bad sensor.

7.3 Troubleshooting the system

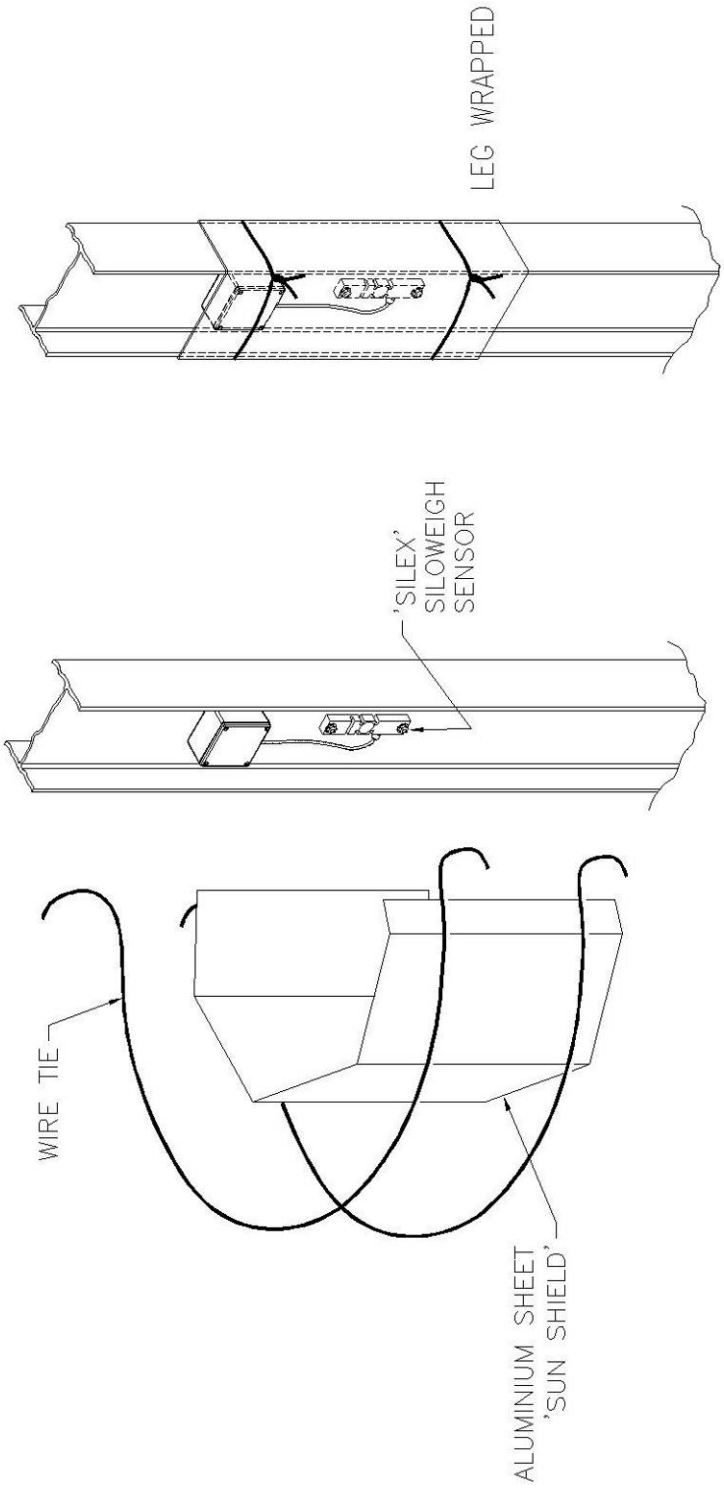
Issue / problem	Probable Cause	Solution
Display not reading	Sensors not connected correctly	Check wire connections to sensors. Check voltages at indicator connector. Volts between blk-red should be 5V. V blk-grn and blk-wht should be 2.5 V. V wht-grn should be 3 to 15 millivolts
	No power	Check power voltage, power adapter and connectors
	Calibration not completed correctly	Practice calibration procedure and re-calibrate
Weight reading decreases or does not change when weight added	Calibration done incorrectly	Check zero weight and test weight settings. Test weight must be greater than zero weight.
	Wires crossed at sensor junction boxes	Check wiring of sensors
	No power at sensors	Check for 5 volts between blk-red, recheck connections at junction boxes
	Shorted signal wires	Disconnect sensor connector at indicator. Resistance between blk-red and between wht-grn should be 350Ω (Ohms) divided by number of sensors (2), i.e. 175 ohm.
Readings erratic and drifting with time	One or more sensors installed incorrectly	Disconnect sensors one at a time until readings stabilize
	Water in sensor or connection box	Remove sensor wires from indicator connector. Check insulation resistance between any sensor wire and ground or silo leg. Must exceed 20 Megohms. Remove covers and check for water
Readings still erratic and drifting with time after checking and eliminating causes above	Sensors installed in wrong part of structure	Must be on main load bearing members – send sketch or picture and get advice
	Structure too sturdy for application	When calculated loading is 1500 psi (per column) or less, these errors increase proportionally. No cure
	Structures interconnected	Check possible impediments and ask for advice
Reads correctly after calibration but jumps suddenly to an incorrect value	Faulty installation of sensor	Remove, check and eliminate paint or rust layers, ensure mounting surface is bare and flat, reinstall with correct torque
	Strong local RF field may cause temporary jumps	Check for walkie-talkie or mobile radios, local radio station etc.
Reading jumps when sun rises	Local heating of sensors if outdoor	Some variation is normal and is minimized by sun shield. Oversized columns make problem worse. Use larger shield for sunlight. Mount sensors on north or west facing sides of columns

8.0 Appendices

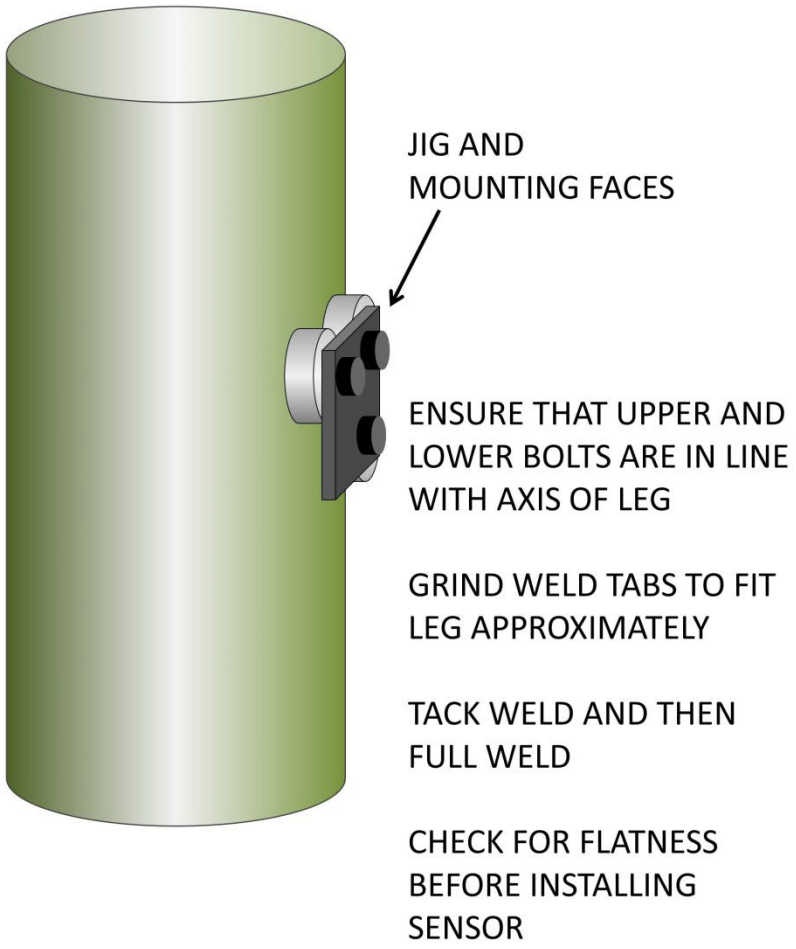
8.1 SiloWeigh Basic Electrical Wiring

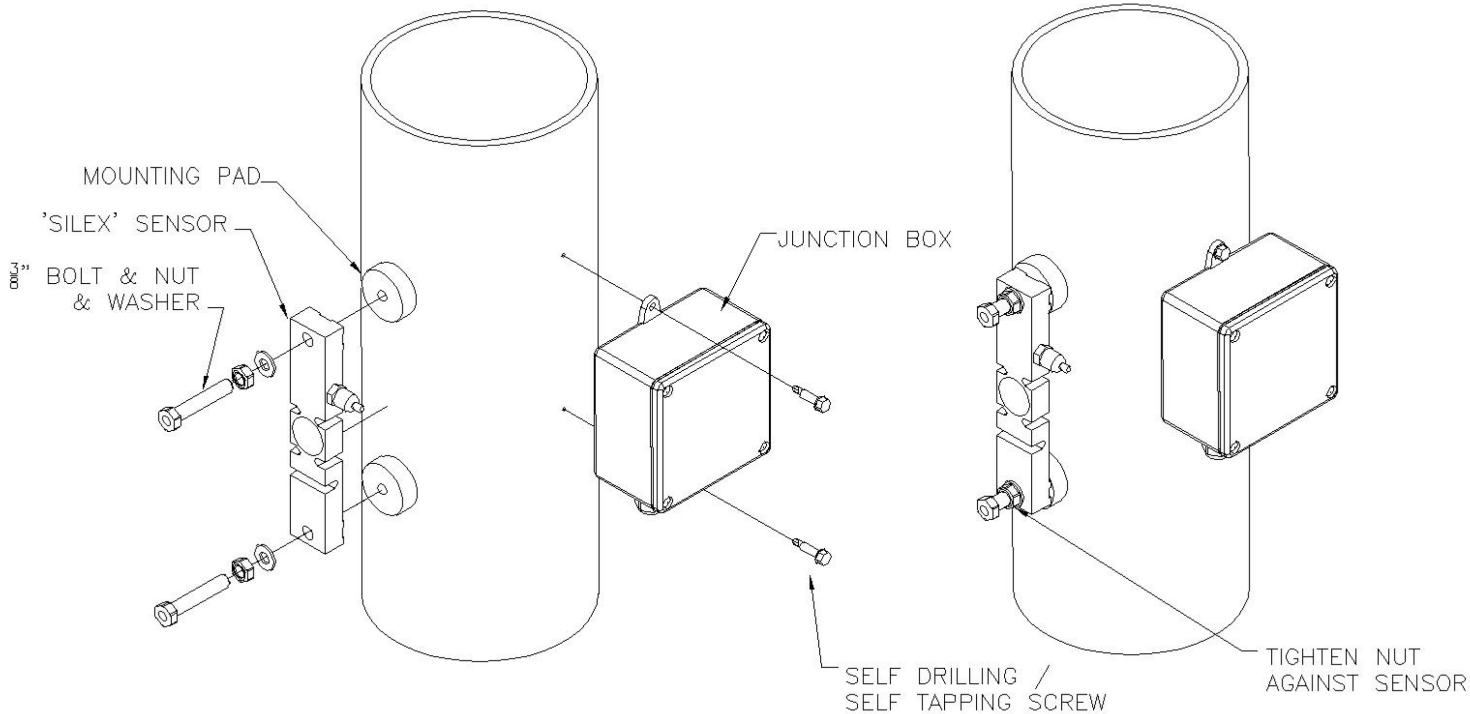


8.2 Sensor Sunshield Installation



8.3 Sensor Installation – 'O' Beam Leg





NOTES:
IN ORDER TO SUCCESSFULLY INSTALL THE 'SILEX' SENSOR ON ROUND LEGS, FLAT & PARALLEL MOUNTING FACES NEED TO BE INSTALLED.

ENSURE THE WELD TABS ARE FLAT & PARALLEL TO EACH OTHER.

MOUNT THE 'SILEX' SENSOR AS SHOWN WITH $\frac{3}{8}$" BOLT & NUT & WASHER AS SHOWN. WHILE HOLDING THE BOLT HEAD WITH ONE WRENCH, TIGHTEN THE NUT AGAINST THE SENSOR WITH THE ANOTHER WRENCH. TIGHTEN TO 45ft/lb.

MOUNT THE SUPPLIED JUNCTION BOX IN A CONVENIENT LOCATION WITH EITHER THE SELF DRILLING / SELF TAPPING SCREWS, OR THE $\frac{1}{4}$" HARDWARE (WILL REQUIRE THE HOLES TAPPED FOR 1/4-20 UNC). ENSURE THE CABLE STRAIN RELIEFS ARE ON THE BOTTOM.

WIRE THE SENSOR AS DETAILED IN THE MANUAL