Contents

OPI-INTEGRIS CABLE AND INTERCONNECT INSTALLATION

INTRODUCTION

Thank you for your purchase, and welcome to the OPI-integris family of products. Here at OPI-integris we are committed to providing you with technology that will grow with your evolving storage management needs. The purpose of this document is to cover the basics necessary for proper installation of the various OPI-Integris cables and interconnects, so please take a few minutes to read these instructions prior to installation. For people with prior experience a general review is highly recommended, however, the final section on “Common Installation Pitfalls” is critical to avoiding common mistakes many installers don’t even realize they are making.

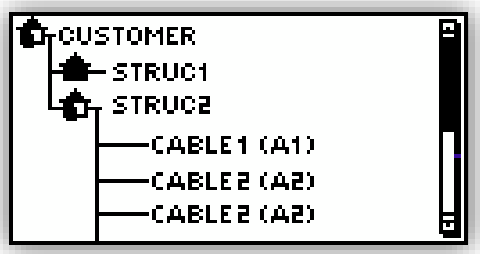
CABLE ADDRESSING AND DISPLAY NAMES

All of the cable types discussed in this document are digitally-based cables, meaning each cable can be addressed with its own unique address. Each sensor within each cable will also have an address, which indicates its position within the cable. These cables may be utilized in either manual monitoring systems using a StorMax handheld monitor or in fully automated Integris systems reporting directly to a PC via Integris software.

In a StorMax monitor-based system, every cable must be programmed with a unique address. Each of these cables must be programmed directly into the StorMax monitor in order to allow proper logging of data. As such, they are often supplied with all cables preprogrammed to the default address “A1”. Cables may be re-programmed multiple times as needed. Alternately, for automated Integris systems, all cables will typically come pre-programmed to the desired address and no further addressing changes should be needed. In the event changes are required it is possible to do so using either a StorMax handheld monitor, or using addressing software via the Integris PC. However it is achieved, a cable’s address enables the system to recognize each individual cable, in order to display and store data in the correct location.

Typically cables are supplied with a label tag on the lead wire near the cable head. On the tag there will be an address number preceded by a capitol “A”. By default this address is “A1” (unless the cable has been pre-programmed to an alternate address prior to shipping.) Whenever a cable is reprogrammed to an address other than the one on its label, it is a good idea to update the address number on the label using a fine tipped indelible ink marker. This may prove useful during future troubleshooting or when making changes.

In both types of systems, cables will also be associated with a “Display Name” (i.e. Bin 26 Cable 3.) In the case of a StorMax system, the cable name will be programmed into the monitor at the same time as the cable address itself is programmed into the cable. The cable name is stored in the monitor only, while the cable address is stored both in the monitor and in the cable. In multi-cable applications, it is common to name the first cable “C1”. C1 would usually be the center cable. Cables are normally mounted with C1 in the center, C2 in the North most position of the next ring, with subsequent cables mounted clockwise from there. If additional rings are called for, the lowest number in each ring mounts due North with the remainder mounted clockwise from that one. If there is no single center cable, C1 should be the north most cable in the inner ring of cables, with the remainder mounted clockwise from there (refer to cable installation diagrams if provided.)



NOTE: For a StorMax system **each cable must be programmed with a unique address and each cable must be programmed individually** (cables cannot be programmed when connected with other cables.) **As such, it is best to either program the cables prior to installation or as they are installed.** Otherwise, it may be difficult to access the cables individually in order to program at a later time. To learn more about programming, refer to the StorMax monitor instruction book.

For cables within an automated Integris system, the cable name will be predefined and set-up in the software ahead of time – changes may be made if needed by OPI-integris personnel.

CABLE TYPES

OPI-integris offers a range of cable types, depending on grain depth and application. Be sure you have selected the appropriate cable for your application:

- Medium Duty Retractable Cable (MDR2)
- Commercial Duty Retractable Cable (CDR2)
- Heavy Duty Retractable Cable (HDR2)
    - All three cables are **StorMax *temperature* monitoring cables**
    - All three have ***retractable*** sensing elements, which make them self-serviceable in-field
- Moisture Cable (MC)
    - **Temperature** *and* **moisture** monitoring cable
        - ✓ Specific crop types are associated with specific moisture curves, which provide a particular moisture content value
        - ✓ Currently, OPI-integris software features moisture curves for the following:
            - Corn
            - Soybean
            - Rice
            - Lentils
            - Peas
            - Sorghum
            - Canary Seed
            - Wheat
            - Canola
            - Barley
            - Oats
            - Popcorn (ASAE)
            - Sunflower Seed
            - VYP212 Rewetting

Note 1 – New curves will be added over time

Note 2 – Custom curves may be developed on a custom cost basis, as required for special applications

Cable Specifications

	UNIT	MDR2	CDR2	HDR2	MC	SE3 ***
Cross Section (Relativistic Sizes)						
Size (L x W)	**inch** **mm**	**0.67 x** **17.0 x 11.2**	**0.81 x** **20.6 x 12.7**	**0.92 x** **23.4 x 14.0**	**0.83x0.83** **21.1x21.1 ***	**0.20 Ø** **5.0 Ø**
Tube ID (min.)	**inch** **mm**	**0.28** **7**	**0.28** **7**	**0.28** **7**	**-**	**-**
Steel Construction	**inch** **mm**	**2 x 1/8** **2 x 3.1**	**2 x 3/16** **2 x 4.8**	**2 x 7/32** **2 x 5.6**	**2 x 1/8** **2 x3.1**	**-**
Tensile Strength	**lb** **kg**	**3400** **1542**	**8400** **3800**	**11200** **5080**	**3400** **1542**	**-**
**Theoretical Load ** **	**lb/ft** **kg/m**	**23.6** **35.1**	**25** **37.2**	**27** **40.2**	**15.1** **22.5**	**-**
Maximum Tie-down	**lb** **kg**	**850** **385**	**2100** **950**	**2800** **1270**	**400** **180**	**-**
Application Range	**feet** **m**	**0-80** **0-24**	**50-130** **15-39**	**100-140** **30-42**	**0-85** **0-25**	**All xDR2 Tubes**

* Widest dimensions of sensor module – the main body of a MC is 0.375” x 0.175” (9.53mm x 4.44mm.)

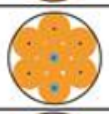
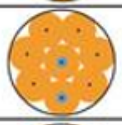
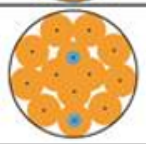
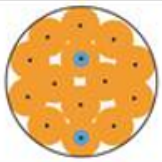
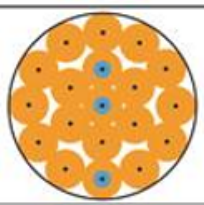
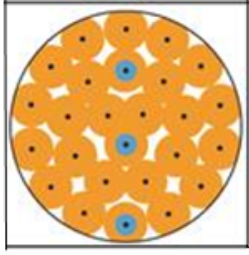
** **NOTE:** Theoretical Load is the typical load per foot/meter of cable, based on dry, clean, “flowable” cereal grain. Loads will increase significantly due to tough, damp, dirty, frozen, bridged or high-density grain, as well as cable location, anchoring mechanism, bin or unloading type and discharge rate. Be certain to read *Instructions for Proper Cable Installation* and consult Bin Manufacturing Company for cable support recommendations. **OPI-integris is in no way liable for damage caused by excessive loading and/or cable failure.**

*** SE3 represents the inner retractable sensor element utilized with the StorMax temperature cables and is not by itself a cable type.

DETERMINING SINGLE-CABLE VERSUS MULTI-CABLE INSTALLATION

For bins with diameters less than 24' (7.3 m), OPI-integris recommends a single center cable. For bins more than 24' in diameter, OPI-integris recommends 3 or more cables/bin. Please refer to the chart below, and to specific site installation instructions, for recommendations on number and placement of multiple cables.

Note – For the cable layout shown below, chart the distance "out" is from the edge of the roof cap, horizontally down the slope line of the roof.

	Bin Diameter	Total # of Cables	Cable Locations
	<24'	1	1 center
	24'	3	3 @ 6'9 (2.11m) out
	36'	4	1 center @ 1' (0.3m), 3 @ 9.2' (2.80m)
	42'	5	1 center @ 1' (0.3m), 4 @ 15' (4.57m)
	48'	6	1 center @ 1' (0.3m), 5 @ 17.3' (5.27m)
	54'	7	1 center @ 1' (0.3m), 6 @ 18.5' (5.63m)
	60'	8	1 center @ 1' (0.3m), 7 @ 20.8 (6.34m)
	72'	13	4 @ 9.2' (2.80m), 9 @ 28.9' (8.80m)
	78'	14	5 @ 9.2' (2.80m), 9 @ 31.2' (9.51m)
	90'	19	1 center @ 1' (0.3m), 6 @ 18.3' (5.57m), 12 @ 39.1' (11.9m)
	105'	26	3 @ 8.1' (2.46m), 9 @ 28.3' (8.62m), 14 @ 48.5' (14.78m)

= moisture cable

ROOF LOADING

Note - MDR2 cables can generate loads exceeding 23.6 lb/ft (35.1 kg/m) of depth. CDR2/HDR2 cables can generate loads exceeding 27 lb/ft (40.2 kg/m) of depth. OPI-integris will not be responsible for roof failure.

Consult your Bin Manufacturing Company to be sure your roof structure is designed to withstand the required design load. Although grain bins are normally designed for peak loads, they cannot withstand any measurable load away from the peak or sidewall. These load estimations are based on normal applications, such as dry, "flowable" small grains. Certain conditions, which may generate even higher cable loads, should be avoided. Examples include:

- **DO NOT** freeze grain, particularly tough grain, as it can "ball-up" on the cable and generate extreme loads, especially during unloading. **If grain temperatures are or at below freezing, be sure to re-warm prior to unloading.**
- Outer radius cables in hopper-bottom bins can generate extreme loads, due to the unloading characteristics of this bin type. It is recommended that outer radius cables **DO NOT** extend into the hopper on larger diameter bins (i.e., below the line where the sloped hopper bottom meets the side wall.) **In cases where the bottom of the cable does extend into the hopper section, it is very important that tie-downs are not secured absolutely tight, as would be done in a flat bottom bin. There must be some slack in the tie-down to allow for some lateral movement in the cable**. Otherwise, the additional load created by grain movement within the hopper can damage the roof structure.
- **Never secure cables with a tie-down material that is more than 25% of the cable breaking strength.** For the various cable types this equates to:

	Unit	MDR2	CDR2	HDR2	MC	VM
Maximum Tie-Down Strength	**lb**	850	2100	2800	400 *	1000
	kg	385	950	1270	180 *	450

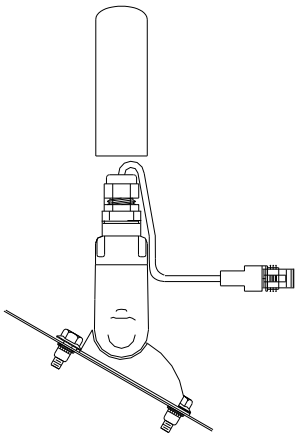
* Design requirements for the MC only allow tie-down strength based on 1 of the 2 internal steel cables.

SUSPENSION TYPE

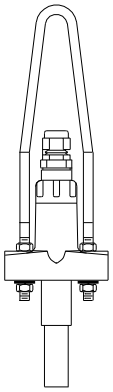
There are 3 primary methods of cable suspension:

- **Angle Bases** are used when mounting the cables externally on the roof top. This is a simple installation done from the outside of the bin. Application examples include center cables drilled in through the roof-cap collar, or outer cables with external cable support brackets.

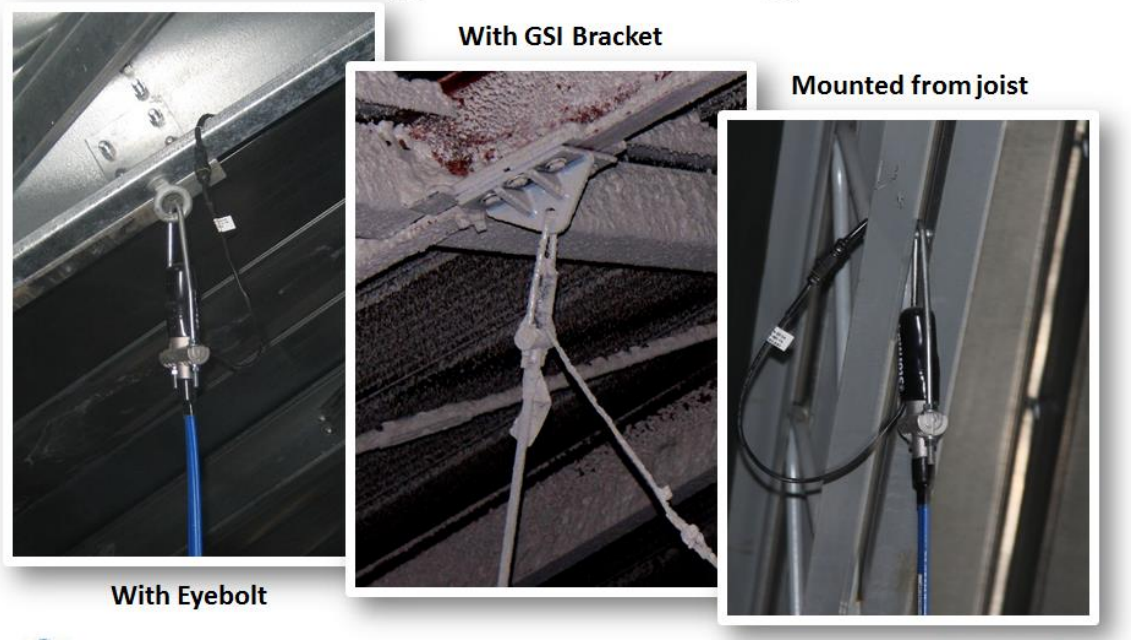
Angle bases “cradle” the suspension head and pivot to the slope of the roof. Older versions allowing for installation of any roof angle from 0-45° while newer versions allow only 2 positions (0, perpendicular or approximately 30 degrees). The cable itself must be mounted vertically, straight up and down, regardless of roof or base angle.



- **“A-bolt”** hanger suspension is used for all cable series, other than VM. Used when hanging cable directly from a suspension structure, typically on the underside of the roof.



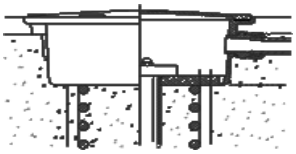
Hanger Mountings



Hanger Mountings

Concrete Roof Mounting Via Preinstalled Support Bar

- **Puck style base** for HDR2 cables, whereby the suspension head rests atop a suspension structure, either inside a CABL-E01 (OPI-integris supplied) cast enclosure, or other suitable suspension surface.



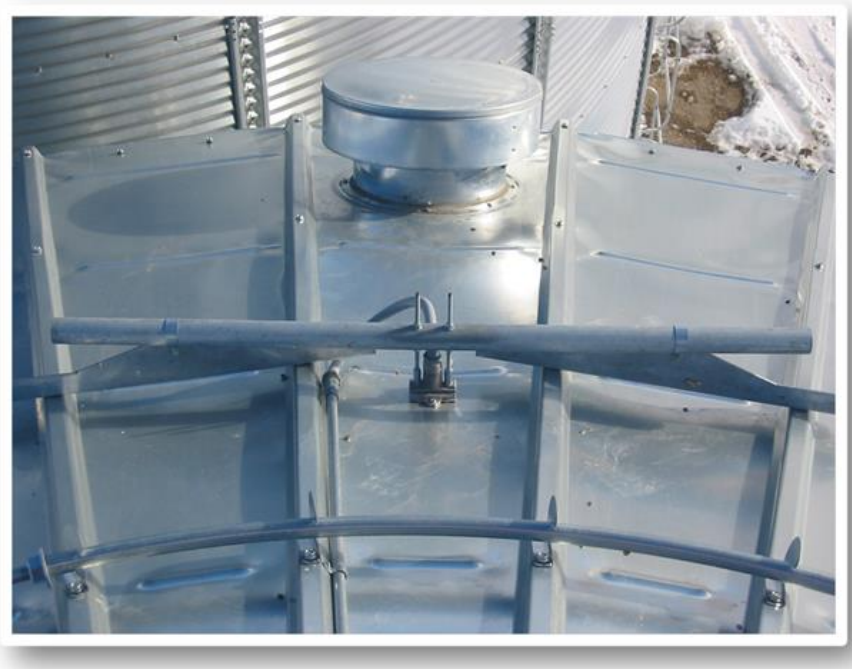
MOUNTING BRACKETS

OPI-integris offers cable support brackets that can be used when externally mounting either MDR2 or MC on top of a steel bin roof. In this case, the cable head assembly remains outside the bin while the main body of the cable extends down inside the bin. This allows easy access to the cable head for troubleshooting and repair purposes. These brackets are used in conjunction with an angle base cable suspension cradle. There are 3 types of brackets available for external roof mounting:

- **CABL-BRK1** four-rib bracket for cables <12’ from center
    - For MDR2 – up to 50’ (15 m) maximum cable length
    - For MC – up to 70’ (21 m) maximum cable length
- **CABL-BRK2** four-rib bracket for cables <12’ from center
    - For MDR2 – up to 50’ (15 m) maximum cable length
    - For MC – up to 70’ (21 m) maximum cable length

BRK 1 & 2

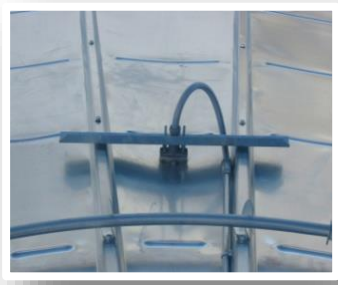
4-Rib Angle Bracket Mounting



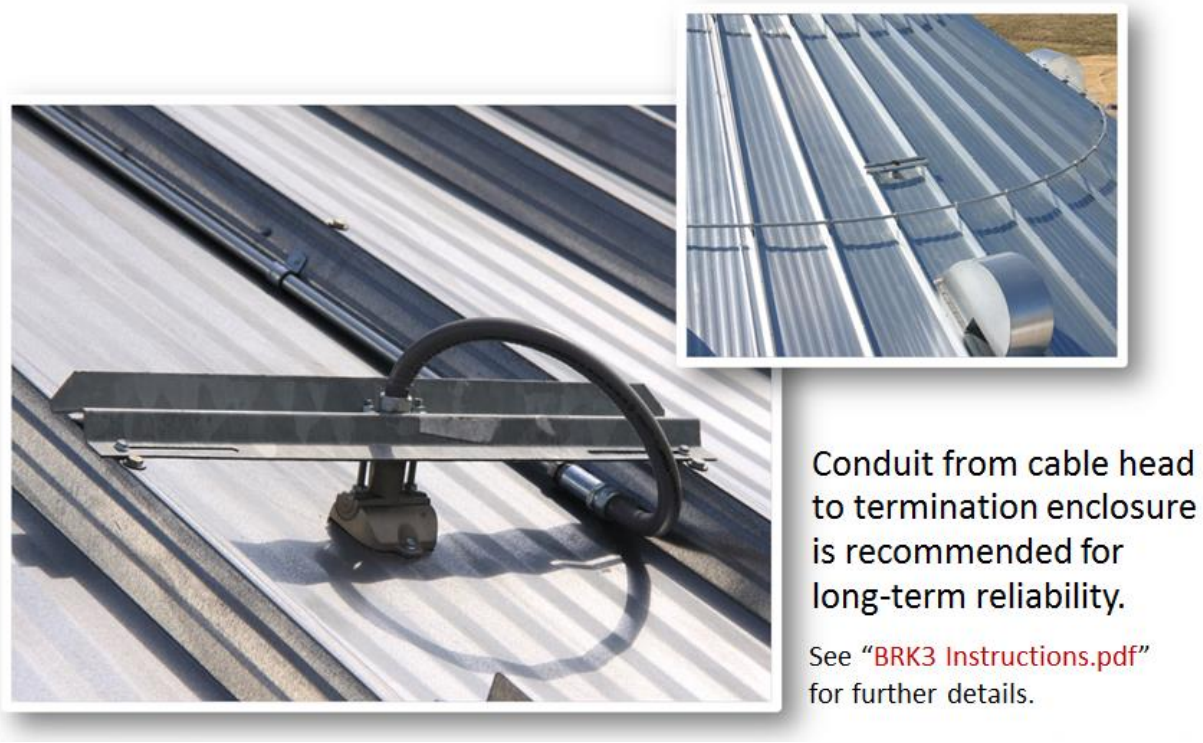
See "Roof Support Installation BRK1 and BRK2.pdf" for further details.

- **CABL-BRK3** two-rib bracket
    - For MDR2 - up to 35' (11 m) maximum cable length
    - For MC - up to 50' (15 m) maximum cable length

BRK 3



2-Rib Angle Bracket Mounting Using BRK3



OPI-integris also offers a similar model of support bracket for use inside a steel bin for a "hanging" style of mount of MDR2 and MC:

- **CABL-BRK6** two-rib bracket
    - For MDR2 - up to 35' (11 m) maximum cable length
    - For MC - up to 50' (15 m) maximum cable length

Certain steel bin manufacturers or cable distributers also supply various mounting brackets of their own design. For those cases, it will be necessary to obtain detailed mounting instructions from the Bin Manufacturing Company or cable distributor.

For most other steel bin "hanging" applications for StorMax temperatures cables and MC, the mounts typically involve some form of plate or bracket, bolted or welded to roof support beams, or simply eye bolts (also mounted to support beams.) In the case of StorMax temperatures cables, or MC, these "hanging" mounts are used in conjunction with the "A-bolt" suspension. In some cases (particularly with eyebolts) the mounts may be purchased via OPI-integris. However, in many cases they will be supplied by the Bin Manufacturing Company.

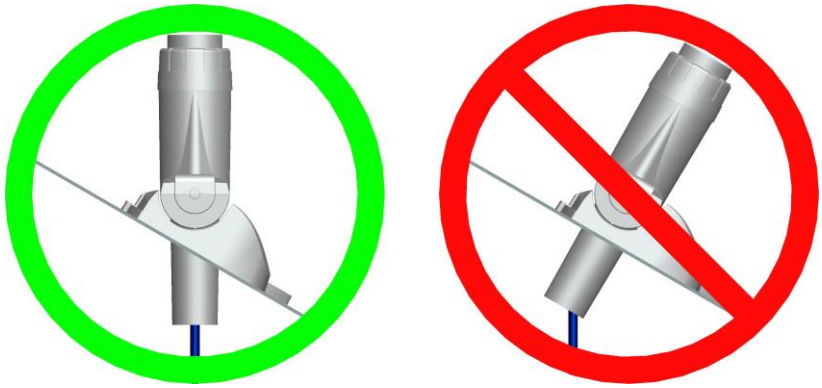
CABLE INSTALLATION

Applies to all cables including StorMax temperature cables (MDR2, CDR2, HDR2,) and MC:

To avoid damage, cables must be hanging free and away from sharp surfaces. Keep in mind that grain movement will cause cables to drift, even if cables have been "anchored." Cables should also be suspended out of the path of incoming grain to minimize wear. In bins with spreaders, adjust cable length according to where cables need to be installed to avoid mechanical interference and wear. Metal or heavy wall plastic tubing should also be placed over the cable along the zone of direct grain impact.

- **CABLE INSTALLATION USING AN "ANGLE BASE" SUSPENSION**

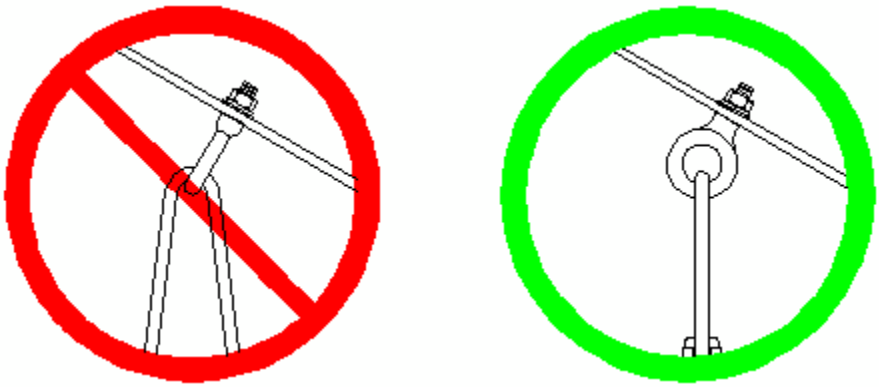
  1. Drill a 1-1/8" (29 mm) hole vertically at the point of suspension. If drilling through multiple layers, be sure to drill holes straight up and down to avoid damage caused by cables rubbing against sharp surfaces. If using Angle suspension, be sure to drill far enough away from vertical edge to allow for sufficient clearance and position the angle base with the raised printing pointing away from center. If the bin cap interferes with the angle base, the angle can be moved down the rib and secured to the flat surface.
  2. Install the cable by slowly uncoiling. **Never** drop the cable into the bin as this may result in damage to the cable.
  3. Secure the angle base by drilling self-tapping screws through the bottom section into the roof sheet.
  4. Use the supplied rubber gasket to seal off the hole. Use silicone to complete the seal if necessary.
  5. Be sure the top suspension is well "seated" into the angle base.



- **CABLE INSTALLATION USING A "HANGER" SUSPENSION**

1. For interior cable installation, make sure you have first read the "Roof Loading" section of this manual, as well as consulted your Bin Manufacturing Company to ensure the suspension structure is of sufficient strength.
2. Select a suspension method that provides complete 360° free movement of the Hanger suspension. Lack of free movement can result in Hanger suspension and/or cable failure.
3. Remove the "A-bolt" from the cable head (it may also be necessary to remove one of the "top" nuts from one side, depending on the size of the hole the "A-bolt" will be inserted through.)
4. Insert the "A-bolt" through a suspension hole on the rafter, or through an eyebolt.

   Note - When using eyebolts, be sure that the eyebolt is rated in excess of the cable breaking strength and installed with the eye parallel to the roof sheet rib, not on an angle, which may potentially cause eyebolt failure.



Eyebolt Perpendicular to Rafter (**BAD**) Eyebolt Parallel to Rafter (**GOOD**)

1. Remount the cable head onto the "A-bolt" (be certain to reinstall any "top" nut(s) that may have been removed previously.) Also, be sure to completely tighten and double-nut the bottom "A-bolt" nuts after installation.
2. Manually uncoil the cable. **Never** drop the cable into the bin as this may result in damage to the cable.

- **CABLE INSTALLATION USING A "PUCK" SUSPENSION (HDR2 CABLES)**

1. Be sure the suspension structure design exceeds the cable tensile strength.
2. Be sure the cable has free movement and is not rubbing against other surfaces.
3. Install the cable by manually uncoiling. **Never** drop the cable into the bin as this may result in damage to the cable.
4. Bolt the puck to the base to eliminate movement.
5. Properly ground the cable head to a proven earth ground.

LEAD ROUTING AND INSTALLATION

As part of the installation process, it will be necessary to route the lead wires from each cable back to a location where they can either be "read" manually via the StorMax handheld monitor or automatically via the automated Integris systems (cables are connected to the automated Integris systems via an electronic interface board known as an RTU, or in some cases an intermediary interface called a Line Expander.) In some cases, the lead may be directed to a "read" location. In other cases though, the leads will first be routed to a common interconnection point (or "Hub") where multiple cables will be joined together before continuing on to the "read" point. There are various options for interconnecting cables depending on the specific situation.

Note – lead wires must not be routed alongside power wires. Power running through a wire typically generates an electro-magnetic field around the wire that can induce a matching interference signal in nearby parallel wiring. This induced signal can interfere with data and signal transmission within the secondary wiring. The safe distance in which to run wires in parallel with one another varies with a wide variety of parameters. **If it is necessary to run lead wires parallel to power wires, a minimum separation of 12" to 18" should be maintained.** Lead wires may be routed to cross over power wires, but only if they cross at 90° of one another.

- **OPTIONS FOR LEAD ROUTING**

  1. **One, single cable lead-out** is the simplest application, whereby a single lead or interconnect cable for one single temperature cable is run to a StorMax handheld monitor connection point (it is possible to use this configuration with an Integris automated system as well, but is uncommon.)

  2. **Multi-cable with cable to cable to cable interconnection**, whereby multiple cables are joined together in parallel using one common line. This method is typically used with a row of single-cable bins, or in flat stores.

  3. **Multi-cable to a central "hub"** is the preferred method of routing, since it is easier to perform diagnostics and service from one central access point. From here, interconnects can either be run to the main interface, or to/from another bin. It should be noted that there are a number of different "hub" styles available with the current, the most common being based on spring-loaded terminal blocks, which may be mounted in their own enclosure, or in some automated systems, within the electronic interface enclosure.

     Note – it is important that any central "hub" be mounted externally to the bin (generally at roof top.) If it is located inside the bin, the advantages for troubleshooting, diagnostics and the ability to isolate "problem" cables is severely limited.

- **LEAD AND INTERCONNECT ROUTING – GENERAL INFORMATION**

  Sensing cables may be ordered with various lead lengths pre-attached and/or they can be extended using OPI-integris INT2-XXXX 2- Wire Interconnect extension leads. When connecting cables to one another, the cables are usually ordered with both a male and a female lead end (a male end has a male connector housing with female contacts inside and a female end has a female housing with male contacts inside.) In this case, it is important to make certain to run cables with the yellow tabbed "male" end pointing towards the next cable or interface device, whether using an INT2-XXLD Line Divider, an

INT3-XXLE Line Expander, RTU or StorMax monitor. All interface devices are equipped with female contacts to receive male contacts.

In all cases, make certain to route the interconnecting leads using the following guidelines:

1. Make sure to secure the connector off (using a tie-wrap or clip) to eliminate stress on the joint, allowing for swinging movement of the cable at the point of suspension.
2. Clip the lead wires to the bin approximately every 3' (1m.)
3. Avoid routing or securing lead wires between, around or across any structural components that may pinch, cut or stretch the wires if they shift during fill/empty procedures or during high winds/bad weather.
4. If running interconnect from one bin to another, be sure to secure the lead cable through conduit or to a steel cable, to avoid damage by wind etc.
5. Route the INT2 lead wires **away from** the grain distributor/flow.
6. If running through conduit or confined spaces, **DO NOT** apply extreme force while pulling on the lead wires, since stretching can cause damage that may show up down the road, often as an intermittent connection issue that is very hard to track down.
7. When installing cables inside a bin, be certain to bring all lead wires together at a common point and route them to the outside of the bin using either OPI-integris supplied flex conduit/fittings, or other suitable OPI-integris approved hardware.

- **LEAD ROUTING FOR SINGLE CABLE APPLICATIONS**

1. If the sensing cable comes equipped with both male and female connectors, the female connector will be unused. Simply plug the female contacts with silicone to prevent moisture from getting in.
2. Run the male end (yellow "tab") to the side of the bin.
3. Use clips and self-tapping screws (typically provided with the cables and lead wires) every 3' to 4' (1 m) to secure the lead.
4. Run the lead to a convenient location for plugging into the StorMax monitor or RTU.
5. For a StorMax monitoring system, an INT2-DOCK-SHORT "docking station" is required to protect the connector from weather and provide electrical protection to the cable assembly when not in use.

   Note - Cables must be plugged into docking station at all times when not in use to protect the cable/sensors from potential damage.

- **LEAD ROUTING FOR MULTI-CABLE WITH CABLE TO CABLE TO CABLE INTERCONNECTION**

1. Usually for this type of lead routing, all sensing cables will come equipped with both male and female connectors. At each cable, connections run from the male connector to the female connector of the next cable. The female connector on the initial cable (the cable farthest from the monitoring point) will be unused. Plug the unused female contacts with silicone to prevent moisture from getting in.

2. Use clips and self-tapping screws (typically provided with the cables and lead wires) every 3’ to 4’ (1 m) to secure the leads as you proceed.
3. Connect the male end of the final cable, with the monitoring lead positioned alongside the bin.
4. Run the lead to a convenient location for plugging into the monitor, or connecting to an automated Integris system.
5. For a StorMax monitoring system, an INT2-DOCK-SHORT “docking station” and an INT2-GRND lead are required to protect the connector from weather and provide electrical protection to the cable assembly when not in use.

   Note - Cables must be plugged into the ground lead and docking station at all times when not in use to protect the cable/sensors from potential damage.

- **LEAD/INTERCONNECT ROUTING FOR “MULTI” CABLES WITH INT2-XXLD “HUB” TERMINATION**

1. If the sensing cables come equipped with both male and female connectors, the female connectors will not be used. Simply plug the female contacts with silicone to prevent moisture from getting in.
2. Route the lead from the male connector of each cable back to the selected central location. Be sure to leave sufficient slack to avoid stress during cable movement, particularly in Hanger applications.
3. Use clips and self-tapping screws (typically provided with the cables and lead wires) every 3’ to 4’ (1 m) to secure the leads as you proceed.
4. Mount the termination “Hub(s)” in a location that is
   a. Central to all the cables being collected
   b. Accessible for future service
5. When connecting the individual cable leads to the “Hub,” it is best to connect the cables grouped in numerical order. Technically, it does not matter which cable goes into which 2-Wire input, however from a troubleshooting or service perspective, numerical order can be useful.
6. It is possible to connect more than one interconnecting “Hub” together on one 2-Wire Line. This may occur either when a bin has multiple hubs itself, or when joining from one bin to the next. It should be noted that there is an upper limit to how many cables may be connected to a single 2-Wire line, known as the CAP100 limit. The cap values for a system will normally be pre-determined when the system is designed. If the additions were not pre-determined ahead of time, it may be necessary to contact your authorized dealer, or OPI-integris directly, to determine if the desired addition falls within the CAP100 limit. In either case, INT2-XXXX Interconnect cables will be required to join together hubs.

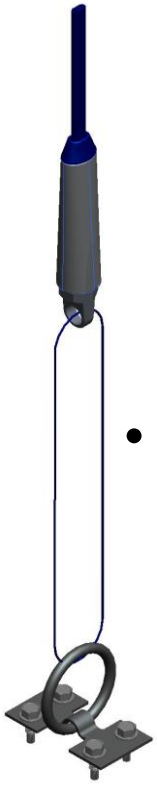
   Note - When joining multiple line dividers (a form of “hub” with multiple connectors molded into a single unit – sometimes also referred to as a “splitter” even though it is

technically a "joiner"), an extra female connector is required to receive the male tab from the previous divider.

- **INTERCONNECT ROUTING FROM "HUB" LOCATION**

1. As mentioned before, if running Interconnect from one bin to another, be sure to secure the lead cable through conduit or to a steel cable to avoid damage by wind, extreme weather, etc.
2. If running to ground for read-out using a StorMax monitor, use the clips and self-tapping screws every 3' to 4' (1 m) to secure the lead.
3. Run the lead to a convenient location for plugging into the monitor or connecting to the automated system.
4. For a StorMax monitoring system with multiple cables, both an INT2-GRND grounding cable and an INT2-DOCK-SHRT docking station are required.

SECURING THE CABLE BOTTOMS

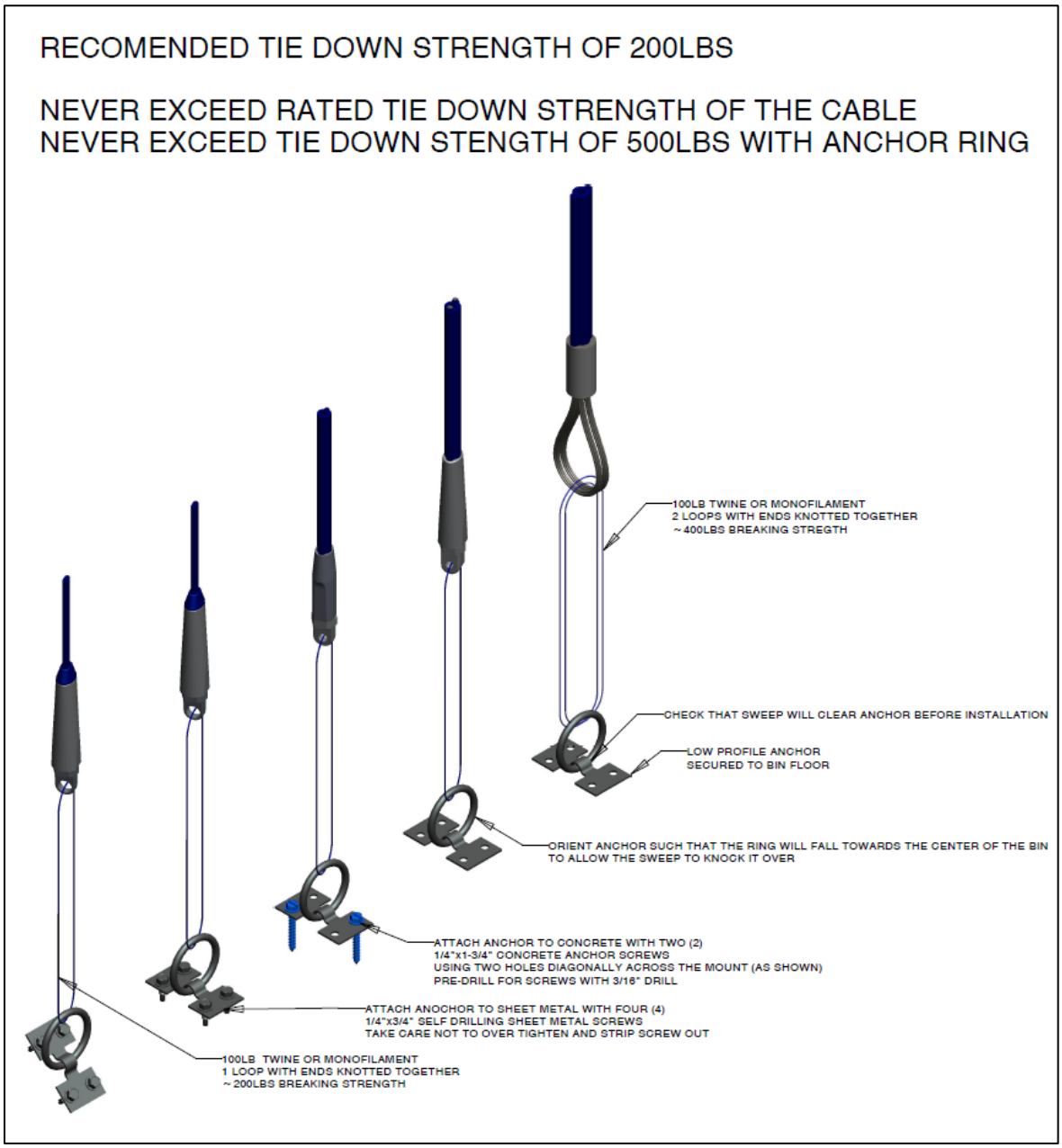


It is very important to secure the cable bottoms to minimize drift during loading and unloading, so that they remain in the desired position as the bin is filled or emptied. A cable that has not been secured may be pushed out of position and be unable to provide accurate data, as it won't be covering the desired area.
Cables bottoms are recommended to be secured with a tie down that will break with approximately 200lbs force. This will enable the bottom of the cable to break away under load thereby minimizing excess loads on the cable and/or roof support. In addition the tie down material must be suitable to allow the unload sweep to function correctly if the tie downs are not going to be manually removed before the bin sweep is utilized. The tie-down must be the weakest part of the system, providing a "break-point" for the system and protection for the cable and suspension structure.

- **Floor Tie Down**
  - The preferred method of securing cables bottoms is tying the cable to an anchor attached to the bin floor with a breakable material (ie., bailer twine, or fishing line).
  - The Stormax Tie-Down kit includes the items necessary to secure a cable to the floor: (1) Anchor Ring – 500lb safe load, (4) ¼"x¾" self-drilling sheet metal screws, (2) ¼"x1-¾" concrete anchor screws, 8ft of 100lb Twine.
  - Refer to Floor Tie Down Drawing for installation of floor tie downs.
  - A tie down with break strength of 200lbs is recommended to minimize the chance of bin damage in the case of adverse conditions. If tie downs are breaking and allowing cables to drift in high quality grain, increase the tie down strength with additional loops of twine. It is not recommended to exceed a tie down strength of 500lbs; **DO NOT** exceed the cable bottom eye break strength (see chart below) or rated safe loading for the

anchor (500lbs for supplied achor). Tie Down strength = (number of strands between anchor and cable) X (Rated strength of tie down material).

- Whenever possible, when cleaning out the bin, it is recommended that the tie downs be cut and removed before running the bin sweep auger. This will minimize foreign material mixed into the grain and prevent the tie down from getting wrapped around the sweep auger.
- After the bin is cleaned out tie downs should be inspected and replaced as necessary, to ready the bin for the next fill.



- **Weight (Consult your bin manufacturer)**
    - An OPI supplied weight may be used for securing the bottom of a cable in a tall narrow slip, where access to the cable bottom is not possible. Attach the weight to the eye in the cable bottom with the supplied shackle before lowering the cable into position.
    - Weights are not recommended in any structure with a height to diameter ratio of less than 2 or that requires more than 1 cable. The angle of repose of stored grain has a tendency to push cables with weights towards the bin wall.

	Unit	MDR2	CDR2	HDR2	MC	VM
Maximum Tie-Down Strength	**lb** **kg**	850 385	2100 950	2800 1270	400 * 180 *	1000 450

- * Design requirements for the MC only allow tie-down strength based on 1 of the 2 internal steel cables.
-
- **Note -** Due to the unloading characteristics of hopper bottom bins outer radius cables can generate extreme loads. It is recommended that outer radius cables **DO NOT** extend into the hopper on larger diameter bins (i.e., below the line where the sloped hopper bottom meets the side wall.) **In cases where the bottom of the cable does extend into the hopper section, it is very important that tie-downs are not secured absolutely tight, as would be done in a flat bottom bin. There must be some slack in the tie-down to allow for some lateral movement in the cable**. Otherwise, the additional load created by grain movement within the hopper can damage the roof structure.

COMMON INSTALLATION PITFALLS

While some mounting scenarios allow easier access for troubleshooting and repair, there are steps that can be taken to minimize access issues, as well as other steps that can be taken to minimize future failures. Following are some of the more common installation pitfalls…

- **Temperature and moisture cables are susceptible to sensor damage from contact with stray voltages** (such as a shock from static electricity during handling, or from the build-up of static charges that can occur during bin filling and unloading.) To protect the sensors, it is important to keep unused cables shorted and “in use” cables properly grounded. To that end, cables are shipped with the lead wires shorted to protect against stray voltages during shipping, handling, installation or storage. For cables with a connector, a set of shorting pins is inserted into the connector. For cables without connectors, the lead ends are stripped back slightly and twisted together.
- Installation in a StorMax handheld monitoring system typically includes “Dock Short” connectors, for mounting at the end of each lead run. The lead ends should be plugged into the “Dock Short” when not in use. Additionally, certain configurations also include a

grounding lead that grounds one side of the lead wires to the bin (of course this is only truly effective if the bin itself is properly grounded.) In an Integris automated system installation, one side of the leads are permanently connected to ground via the RTU interface modules (again, only truly effective if the RTU has been properly grounded.)

- **To help avoid sensor damage from stray voltages**
    - **Temperature and moisture cable leads must be kept shorted prior to being fully connected** to either an Integris automated system or to a permanently mounted "Dock Short" connector for a StorMax handheld system. Far too often, cables are left sitting for extended periods in storage, or partially installed with the short removed, resulting in sensor damage. Or they are installed for use in StorMax handheld systems without the dock short connector in place or in use.
    - **It is critical that grounding be correctly implemented.** Too often, equipment is simply grounded to a bin that is just sitting on a concrete pad and hasn't been properly grounded. True grounding typically involves the use of at least one extended grounding rod driven into the ground, which is then strapped to the bin using heavy gauge wire. Exactly how deep the rod must be driven into the ground depends on the area and soil conditions – check with local electricians.
- **Lead wires must not be routed alongside power wires.** Power running through a wire typically generates an electro-magnetic field around the wire that can induce a matching interference signal in nearby parallel wires. This induced signal can interfere with data and signal transmission within the secondary wiring. The safe distance to run wires parallel to one another varies with a wide variety of parameters. **If it is necessary to run lead wires parallel to power wires, a minimum separation of 12" to 18" should be maintained.** Lead wires may be routed to cross over power wires, but only if they cross at 90° of one another.
- **WHEN MOUNTING CABLES**
    - **The first cable in each ring should be mounted as close to due north as possible, with successive cables in the same ring mounted clockwise from that point.** This is not a physical requirement, but is extremely important as it is the convention used for all drawings, as well as within the software so that hotspots, level and fill shape are all properly reported.
    - **Mounting distances are typically parallel to the ground and from the dead center of the bin, rather than at an angle along the roof itself.** Occasionally installers will measure from the edge of the lid, or along the roof itself, resulting in incorrectly positioned cables that may not hang at the correct height.
    - **Cables should be installed into an empty bin whenever possible.** However, installing hanger cables into older bins is often done with a full bin for easy access to the rafters. When installing cables into a full bin:
        - ✓ **Cables should be laid out so that the cable won't tangle.** **DO NOT** leave the cable in a single coil.
        - ✓ **Cables should be laid in a single direction so they do not tangle with each other**

- ✓ **Position cables so that the flow of grain does not push them into other cables or other bin equipment.** As the bin is unloaded grain will flow toward the center, dragging the cable on top of the grain with it. The cable can potentially be damaged by anything fixed in its flow path
- ✓ **Push the cable bottom as far as possible into the grain.**
- ✓ **DO NOT operate the bin sweep before checking that it will not contact the cables.** When the bin is nearly empty it should also be verified that the correct length cables were ordered and will not be drawn into any unload equipment.
- ✓ **DO NOT add grain to the bin until after emptying the bin completely and securing the cable bottom.**

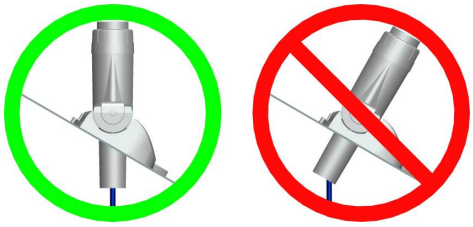
- **WHEN MOUNTING CABLES ON TOP OF THE ROOF**
  - **Cables must be mounted straight up and down.** It is not acceptable to have the cable mounted at a right angle to the roof slope. Cables mounted on the roof top typically sit in a cradle called an "angle mount". There are now 2 versions of this angle mount. Systems shipped prior to January 2013 will likely have the older style in which the angle was continuously variable from one end of its range to the other. In addition this older mount had only 2 bolt holes (top edge & bottom edge) to be used with supplied bolts and nutserts. The newer model (shipping almost exclusively from Jan 2013 forward) has only 2 fixed positions set to accommodate a flat bin top or an angled bin roof of approximately 30 – 35 degrees. This newer version has 4 bolt holes accommodating the use of 3 to 4 self tapping bolts. This new angle mount installs by simply drilling the center hole, inserting the cable, positioning the cable head straight up and down then installing the self tapping bolts. From there if a rib bracket is utilized the bracket can be set in place and it's associated position determined once the cable is mounted. Do not predrill the bracket nutsert holes as the exact position of the cable only needs to vary slightly to cause a poor fit. For the older continuously adjustable angle mounts the procedure is slightly more involved. This mount requires the drilling of a larger center hole for the body of the cable and 2 smaller holes for the "nutserts" in which the angle mount is bolted.

    For the older angle mount, installers often make the mistake of drilling the two nutsert holes evenly spaced above and below the center hole. This would be OK if the cable was meant to be installed at a right angle to the roof, but does not work well when trying to mount the cable straight up and down. In this scenario, once the cable head is moved towards the "straight up and down" position, the side of the cable on the downslope edge (the edge closest to the roof edge) will bump against the downslope edge of the center hole and will not be able to be fully positioned straight up and down. To avoid this problem, it is necessary to drill the nutsert holes with the top hole closer to the center hole and the bottom hole further from the center hole.

To determine exact spacing

- ✓ **Drill the center hole first**
- ✓ **Insert the cable**
- ✓ **Position it straight up and down**
- ✓ **Move it back and forth a bit to ensure it is centered in the hole, rather than up against one edge**
- ✓ **Mark the position of the two nutsert holes using the angle mount itself as the guide.**
- ✓ **Remove the cable.**
- ✓ **Drill the nutsert holes.**

From that, a template can be made or measurements taken for installation of the remaining cables, provided all bins have the same roof slope.



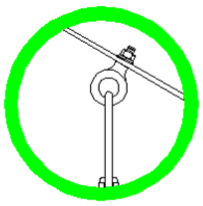
- **Mount any associated rib brackets *after* the cable has been properly mounted straight up and down.** Often installers will mount the first cable, measure the position of the rib brackets relative to the cable and then pre-drill the holes for subsequent rib brackets using those measurements. Unfortunately, slight variances in positioning can result in having the cable head pressed hard against the opening in the rib bracket that it fits in. It is important that the lead wire inside the rubber cover on the cable head is not pressed hard against the edge of this opening, as over time vibration and wear can cause damage. **It is always better to mark the rib bracket holes *after* mounting the cable** to ensure the rib bracket sits properly over the cable head.
- **Make certain the cable head lead wire is not pressed hard against the opening in any associated rib bracket.** See previous comment for details.

  Note – a quick and easy way to verify if the cable head is "straight up and down" is to hold a tool such as a wrench or screw driver suspended loosely alongside the cable head. If hanging "loosely" the tool should be oriented "straight up and down."

- **WHEN MOUNTING CABLES FROM THE INSIDE OF THE ROOF**
  - **Make sure to secure (tie-wrap) the connector to eliminate stress on the joint** (allowing for swinging movement of the cable at the point of suspension.)

- **If mounting cables suspended from rafters:**
  - ✓ **Clip each INT2 lead every 3' along the rafter, staying away from anything sharp or moving that can pinch, cut or stretch the lead.** In some cases, installers have wrapped cables around support or structural beams that are too close to roof or side wall sheeting. Subsequent flexing in the sheets, from grain fill or high winds, can then cause the sheets to bang up against these structural elements pinching and damaging the cables. In other cases, the wiring has been strapped too tight with no slack and shifting in the structure stretches the wire, causing damage over time.
  - ✓ **Route each INT2 away from the grain distributor/flow.**
  - ✓ **Bring all INT2's together up through the OPI-integris supplied flex conduit**.
- **If mounting using eyebolts:**
  - ✓ **DO NOT install eyebolts with the eye mounted perpendicular to the truss or rafter. Eyebolt may not support the cable load, causing eyebolt failure.**

Eyebolt Perpendicular to Rafter (BAD)



Eyebolt Parallel to Rafter (GOOD)

  - ✓ **DO:**
    - Use **welded** eyebolts
    - Use **shoulder** eyebolts
    - Mount **parallel** to truss or rafter (see diagram above)
    - Ensure the cable's U-bolt **moves freely** and **hangs straight down**
  - ✓ **DO NOT:**
    - Use **open-loop** (non-welded) eyebolts
    - Use eyebolts without a built-in "shoulder"
    - Mount **perpendicular** to truss or rafter (see diagram above)
    - Mount in any way that prevents the cable's U-bolt from hanging straight down
    - Leave thread showing on the cable side of the mount (the eyebolt must be mounted tight to the shoulder)

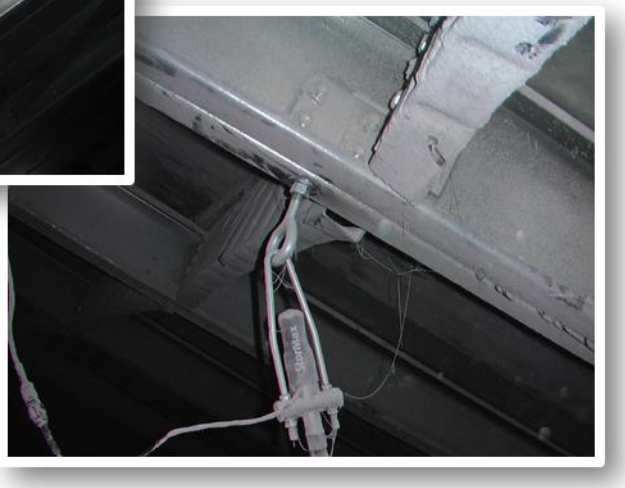
Advancing Grain Storage Management

The GOOD

Properly Mounted Eyebolt:
- Parallel to Truss/Rafter
- Shoulder Eyebolt
- No Threads showing

The BAD

Improperly Mounted Eyebolt:
- Perpendicular to Truss/Rafter
- **Not** a Shoulder Eyebolt
- Threads showing



The UGLY!

Improperly Mounted Eyebolt:
- Horizontal
- Bound into a Fixed position, unable to move freely

Result:
- Binding and Breaking

And The **WEAK!**

- **Consider adding access holes in the roof, so cable head and connector can be accessed even if the bin is not full.** Often, installations **DO NOT** include the addition of access holes, which allow for troubleshooting and repair at virtually any time regardless of the bin fill level. In cases where such access is not available, it is sometimes necessary to wait months for fill levels to be high enough to deal with problems. Access holes are typically about 6" (15 cm) in diameter and can be covered by a sealed removable plate. Two holes approximately 12" to 18" (30 – 45 cm) apart are ideal as these allow the use of two arms to reach and work on the cable, but one only would still work far better than none.
- **DO NOT under any circumstances connect multiple cable leads together to a common lead inside the bin.** At times installers have felt it expedient to connect multiple cables together inside the bin allowing them to route fewer cables outside the bin (or in some cases it was thought it would be better to mount the terminal blocks or splitters inside out of the weather.) This is a critical mistake! Under certain circumstances a bad sensor, damaged wiring or a faulty connector can cause a short, which will prevent that cable and any other connected cable from reporting. If each cable has an independent lead wire exiting the bin, and terminated where they can be accessed on top of the bin, then that one cable or wire can be readily disconnected thereby allowing the other connected cables to continue to function. If however, the common connecting point is inside the bin such a failure could remove multiple cables from service until such time as the bin can be adequately filled to access everything. As mentioned previously, this can sometimes be impractical for months at a time.

- **WHEN SECURING THE CABLE BOTTOMS**

    - It is very important to secure the cable bottoms to minimize drift during loading and unloading so that they remain in the desired position as the bin is filled or emptied**. A cable that has not been secured may be pushed out of position and be unable to provide accurate data as it won't be covering the desired area.**

    - Cables bottoms should be secured either by tie-down with a breakable material (i.e. bailer twine) no stronger than 25% of the cable breaking strength (see the chart below for the breaking strength of the various cable types). This will enable the bottom of the cable to break away under load so as not to impose excess loads on the cable and/or roof support. The tie-down must be the weakest part of the system, providing a "break-point" for the system and protection for the cable and suspension structure.

	Unit	MDR2	CDR2	HDR2	MC	VM
Maximum Tie-Down Strength	**lb** **kg**	850 385	2100 950	2800 1270	400 180	1000 450

- **Note 1 -** Outer radius cables in hopper-bottom bins can generate extreme loads, due to the unloading characteristics of hopper-bottomed bins. **It is recommended that outer radius cables <u>do not</u> extend into the hopper on larger diameter bins** (i.e. below the line where the sloped hopper bottom meets the side wall). **In cases where the bottom of the cable does extend into the hopper section it is very important that tie-downs are not secured absolutely tight as would be done in a flat bottom bin. There must be some slack in the tie down to allow some lateral movement in the cable** otherwise the additional load created by grain movement within the hopper can damage the roof structure.

- **Note 2 – Do not use a large weight suspended on the bottom of the cable**, as this will generate unnecessary loads on cables/roof suspension and has proven almost completely ineffective at keeping the cable bottoms in place.

SUMMARY OF COMMON PITFALLS

- **Temperature and moisture cables are susceptible to sensor damage from contact with stray voltages!**
- **To help avoid sensor damage from stray voltages**
    - Temperature and moisture cable leads must be kept shorted when not yet fully connected.
    - It is critical that grounding be correctly implemented.
- **Lead wiring must not be routed alongside power wiring.**
- **When mounting cables**
    - The first cable in each ring should be mounted as close to *due north* as possible with successive cables in the same ring mounted *clockwise* from there.
    - Mounting distances are typically given parallel to the ground and from the dead center of the bin, rather than at an angle along the roof itself.
- **When mounting cables on top of the roof**
    - Cables must be mounted straight up and down.
        - ✓ To determine exact spacing, simply drill the center hole first, insert the cable, position it straight up and down, move it back and forth to ensure it is centered in the hole rather than up against one edge, then mark the position of the two nutsert holes using the angle mount as the guide.
    - Mount any associated rib brackets after the cable has been properly mounted straight up and down.
        - ✓ It is always better to mark the rib bracket holes after mounting the cable.
    - Make certain the cable head lead wire is not pressed hard against the opening in any associated rib bracket.
- **When mounting cables from the inside of the roof**
    - Make sure to secure (tie-wrap) the connector to eliminate stress on the joint.
    - If mounting Cables suspended from rafters:
        - ✓ Clip each INT2 lead every 3’ along the rafter, staying out of the way of anything sharp or moving that can pinch, cut or stretch the lead.
        - ✓ Route each INT2 away from the grain distributor/flow.
        - ✓ Bring all INT2s together up through the OPI-integris supplied flex conduit.
    - If mounting using eyebolts:
        - ✓ **DO NOT install eyebolts with the eye mounted perpendicular to the truss or rafter. Eyebolt may not support the cable load, causing eyebolt failure.**
        - ✓ **DO:**
            - Use **welded** eyebolts
            - Use **shoulder** eyebolts

- Mount **parallel** to truss or rafter (see earlier diagram)
- Make certain the cable U-bolt **moves freely** and **hangs straight down**

✓ **DO NOT:**

- Use **open-loop** (non-welded) eyebolts
- Use eyebolts without a built in "shoulder"
- Mount **perpendicular** to truss or rafter (see earlier diagram)
- Mount in any way that prevents the cable's U-bolt from hanging straight down
- Leave thread showing on the cable side of the mount (the eyebolt must be mounted tight to the shoulder)

- **Consider adding access holes in the roof, so the cable head and connector can be accessed even if the bin is not full.**
- **DO NOT under any circumstances connect multiple cable leads together to a common lead inside the bin.**

- **When Securing the Cable Bottoms**
  - **A cable that has not been secured may be pushed out of position and be unable to provide accurate data, as it won't be covering the desired area.**
  - **Cable bottoms must not be secured with any material that has a breaking strength higher than 25% of the cable breaking strength.**
  - For hopper bottom bins where radius cables extend into the hopper section it is very important that tie-downs are not secured absolutely tight, as would be done in a flat bottom bin, and that some lateral movement in the cable is allowed.

✓ **DO NOT use a large weight suspended on the bottom of the cable,** as it creates unnecessary loading and has proven ineffective.