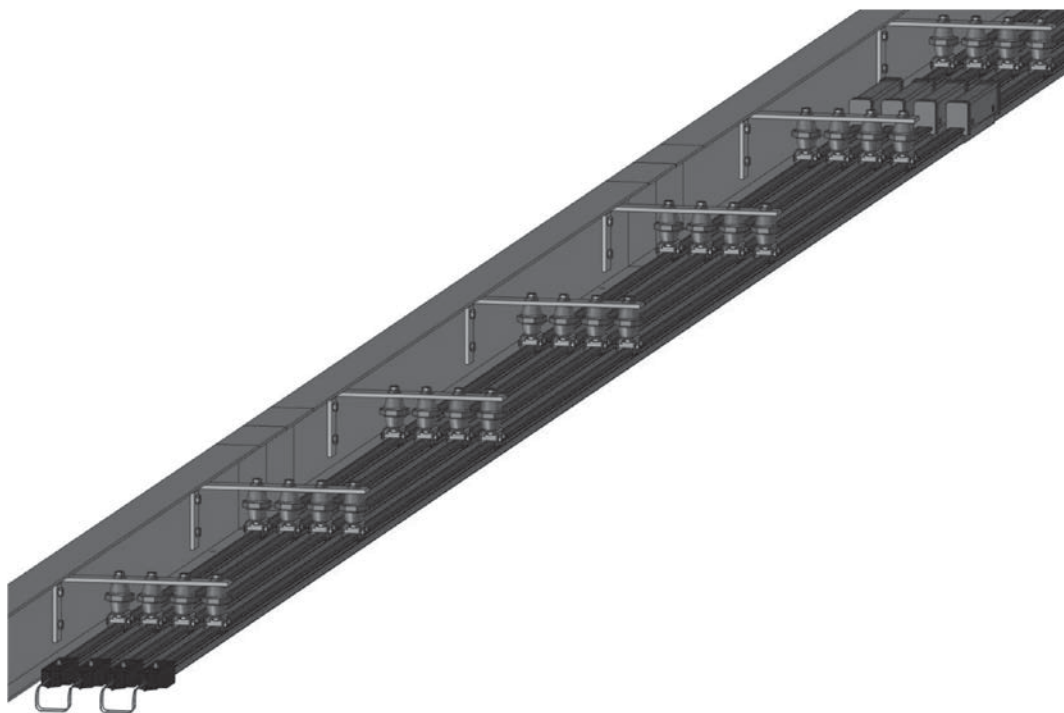


Conductor Bar Manual

Hevi-Bar II Heater Wire



CONDUCTIX INCORPORATED

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Seller is not responsible for incorrect choice of models or where products are used in excess of their rated and recommended capacities and design functions or under abnormal conditions. Seller assumes no liability for loss of time, damage or injuries to property or persons resulting from the use of Seller's products. Buyer shall hold Seller harmless from all liability, claims, suits and expenses in connection with loss or damage resulting from operation of products or utilization of services, respectively, of Seller and shall defend any suit or action which might arise there from in Buyer's name - provided that Seller shall have the right to elect to defend any such suit or action for the account of Buyer. The foregoing shall be the exclusive remedies of the Buyer and all persons and entities claiming through the Buyer.

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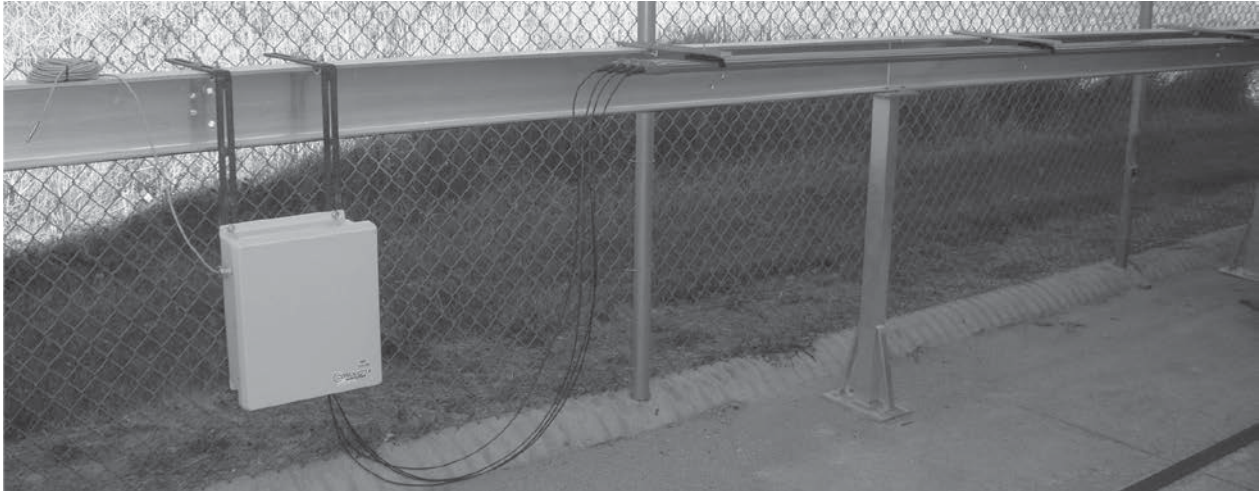
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1.0 ENVIRONMENTAL CONSIDERATIONS



1.1 Environmental Specifications

1.1.1 Medium Heat Cover (Polycarbonate) is suitable up to 250°F (121°C)

1.1.2 The following acidic or corrosive environments require the use of stainless steel hangers:

- Hydrochloric Acid
- Hydrofluoric Acid
- Sodium Hydrochloride
- Ammonium Chloride
- Chlorine Bleach
- Chloride Ions
- Fluoride Ions

1.2 Recommended Tools & Equipment

1. Man lift or platform lift for access to the installation location (if required)
2. Sharp knife – to cut power feed grommets.
3. Straight blade screwdriver – for replacing collector shoes.
4. Steel rule or tape measure – to position collectors during installation.
5. Wire/cable stripper.
6. Cable lug crimping tool
7. Cordless drill with socket adapter (1/4" or 3/8" drive).
8. Deep sockets for cordless drill ranging from 7/16" to 3/4"
9. Torque wrench for sockets listed above.
10. Open/box end wrenches (use ratcheting box end wrenches if you have them) ranging from 7/16" to 3/4".
11. Hacksaw
12. Flat file and/or rat tail file to remove burrs on field cut conductors.
13. Pliers.
14. Heat gun.
15. Scotch Brite Pads, or equivalent - to clean mating surfaces of bar.

2.0 SYSTEM OVERVIEW

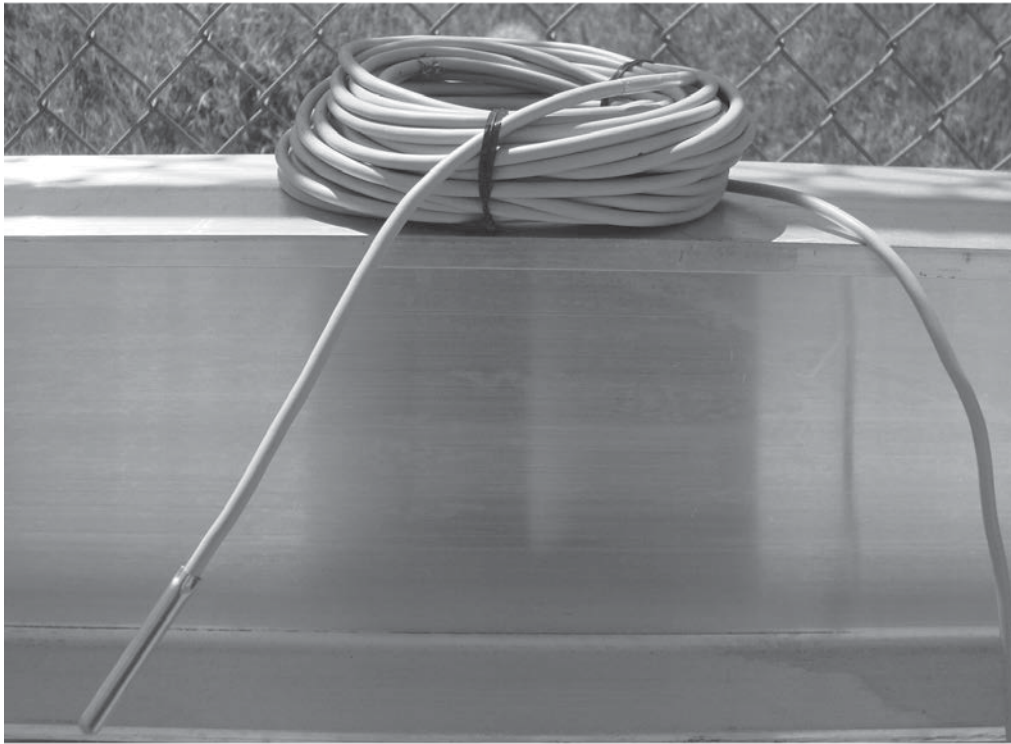
2.1 In applications where the conductor is outdoors in freezing weather, the customer may want heated conductor bar to keep ice from forming. Ice formation on conductors may force the collectors to disengage causing loss of current, damage to the collectors, the contact shoe, or to the running surface of the conductor. This either stops the crane or vehicle completely or may result in pitting or burn-through of the conductor and/or collector shoes. Heater wire systems are a cost-effective means of preventing frost or ice build-up to ensure reliable system operation in cold climates. The heater wire is factory installed in each section of the conductor. During installation, the heater wire ends are plugged together at each joint and a length of heat shrink is put in place to seal the connection. If a section of conductor is damaged and needs to be replaced, the damaged section can be removed and a new section installed and wired into the heater wire system.

2.2 How it works

2.2.1 The primary components to this heater wire system:

- a. A resistance wire factory installed in the cavity of the conductor bar.
- b. A thermostatically controlled power supply.

2.2.2 This heater system automatically supplies current to the resistant wire circuit when temperatures are at 35°F (2°C) or lower. It is designed to remain on until the ambient temperature rises above 35°F (2°C). The temperature sensor should be placed near the conductor bar, in free air. A 50' (15.25m) cable is supplied connecting the sensor to the control box.



2.2.3 **This is not intended as a high-output defroster.** If the system is left off during prolonged periods of snow and ice accumulation, it will likely take MANY HOURS of operation to thaw the system.

2.2.4 The conductors are covered with medium heat cover Lexan is good to 250°F (121°C) as a precaution against the unlikely event of the heater wire making contact with the inside of the conductor cover. The systems are designed to have an output of 4.5-7.6 Watts per Foot (15-25 Watts per Meter).

2.2.5 **NOTE:** The NEC does not allow the powering of the heater wire system from the conductor bar. It must be fed and protected by a separate circuit.

2.0 SYSTEM OVERVIEW



2.3 Thermostatic Control Box

2.3.1 The control box consists of a temperature and power module, transformer, contactor, and fuse blocks. There are three field connections to be made to install this:

1. Incoming power (either 120V or 220/480V)
2. Temperature sensor to ambient air
3. Power output wires running to the feed junction points (L1, L2, L3)

2.4 Cold Wire Connections

2.4.1 The cold wire connections are used to bring power from the control box to the heater wire. Additionally, there are cold wire connections (end loop connections) to jumper adjacent heater wire runs together to achieve the desired configuration.

2.4.2 **NOTE:** Heater wire feeds can be located with an end powerfeed in the system. However, heater wire feeds must have a dedicated feed point on all center fed systems.

2.5 Requirements for Determining System:

2.5.1 To determine a system you need to know:

1. Input Voltage
2. Number of Conductors
3. Length of System.

3.0 INSTALLATION & ASSEMBLY

3.1 General Assembly Instructions

WARNING: ALWAYS LOCK OUT/TAG OUT ALL ELECTRICAL POWER BEFORE STARTING WORK.

3.1.1 This manual provides detailed instructions in the general order of system installation.

3.1.2 System installation consists of 5 phases:

3.1.2.1. **Identifying and organizing the materials.** Check the pack list against the items received. Parts are labeled for your convenience. Review your specific installation layout drawing (if provided), the typical layout diagram provided at the back of this manual, or the Quick Quote layout to become familiar with component location on the system. Note where the anchors, expansions, power feeds, and other assemblies will be located along the runway. Read through these instructions before starting work.

Do not remove shipping support from expansion sections or power interrupting sections until they have been installed on the runway.

3.1.2.2. **Installation of brackets along the runway.** Keep them as level and evenly spaced as possible. You may install the hangers on the brackets before or after they are mounted along the runway.

3.1.2.3. **Pre-install assemblies on the ground.** It's faster, easier, safer and more convenient should you drop something.
a. Install splices on one end of conductors and expansions.

3.1.2.4. **Installation of hangers and conductors and final assembly along the runway.** This will most likely be accomplished from a lift or work platform.
a. **Ensure the power is locked out/tagged out!**
b. Install the hangers, per instructions on page 8. Ensure correct alignment and location of support brackets.
c. Roll conductors into the hangers.
d. Conductix recommends the first accessible conductor being the ground conductor (if applicable).
e. Move down the runway, install the next inboard conductor and join it to the corresponding conductor. Ensure all electrical joints are free from any contamination. Clean and apply Electrical Joint Compound (EJC) to mating surfaces of splice plates, powerfeed plates, and the conductor. Install the splice cover. Keep the splice assemblies at least 18" (457mm) from the hanger brackets to allow for conductor movement from expansion and contraction. Repeat for the remaining phases and ground conductors.
f. When you get to where the expansion assemblies are to be installed, refer to the instructions on page 16. Be sure to divide the total expansion gap distance (from chart) between the two air gap locations in the expansion assembly. (For example: If the total gap setting = 2.50" (63.5mm), there will be 0.25" (6.35mm) on either side of the 2.0" (50.8mm) slider). Ensure the expansion assembly body is at least 18" (457mm) from the nearest bracket.
g. Proceed with system installation ensuring anchors are positioned the correct distance from the expansions.
h. If a conductor must be cut to a specific length, ensure that the cut end is properly de-burred. The conductor cover is always shorter than the bar length. The proper cover length is 7.50" (190.5mm) shorter than the bar length (3.75" (95.25mm) on each end).
i. When running the feed cable to the power feed assembly, ensure the cables have sufficient free length and are flexible enough to enable movement of the conductor due to expansion and contraction. Locating the power feed as close as possible to the anchors minimizes this concern. DO NOT support the weight of the feed cables with the conductors.
j. Install power feeds on conductor bars per layout and the instructions beginning on page 16.
k. Ensure all armored cables are terminated into a suitable junction box and only flexible cables are installed into the power feed assemblies.

***NOTE: ALL HEATER WIRE WILL BE FED AT A SPlice, OR THROUGH AN END COVER. AT NO TIME WILL DRILLING A CENTER POWER FEED BE ALLOWED. THE HEATER WIRE SYSTEM WILL BE LABELED WITH A SPECIAL POWER FEED BAR ON THE SYSTEM LAYOUT.**

3.1.2.5 **Installation and alignment of collectors on the crane.** Collectors must be properly positioned and aligned to ensure safe, reliable operation. Collector arms should be parallel with the contact surface.

- The collector mounting post must be 5.50" (140mm) for 125/250 Amp collectors or 6.00" (152.5mm) for 200/400 Amp collectors below the contact surface of the conductor and the arms level from end to end.
- Slide the collectors on the mounting staff. Ensure the mounting base of each collector is centered below the corresponding conductor. Ensure the collectors are evenly spaced. Tighten hardware to specifications.

3.0 INSTALLATION & ASSEMBLY

3.1.3 REMEMBER

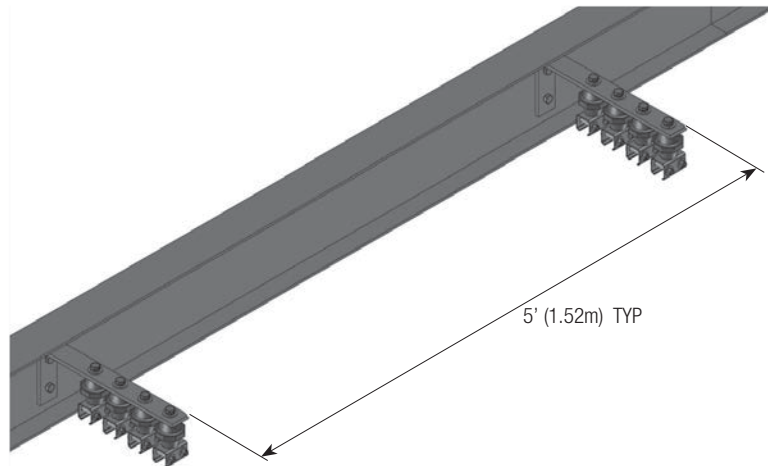
1. Follow lock out/tag out procedures.
2. Keep accessories at least 8" (203mm) from hanger brackets.
3. Follow all torque specifications.
4. Allow for movement of accessories due to expansion.
5. Connect only flexible power cables to power feed assemblies.
6. Keep collectors straight, level and aligned with conductors.

3.2 Support Bracket Installation

3.2.1 Locate and secure support brackets at the recommended spacing. (Note: Locate support brackets at a spacing that is divisible into the conductor bar lengths. This will always ensure that the joint positions do not interfere with the support brackets). Maximum bracket spacing to be 5' (1.52m). Flange Bracket Installation

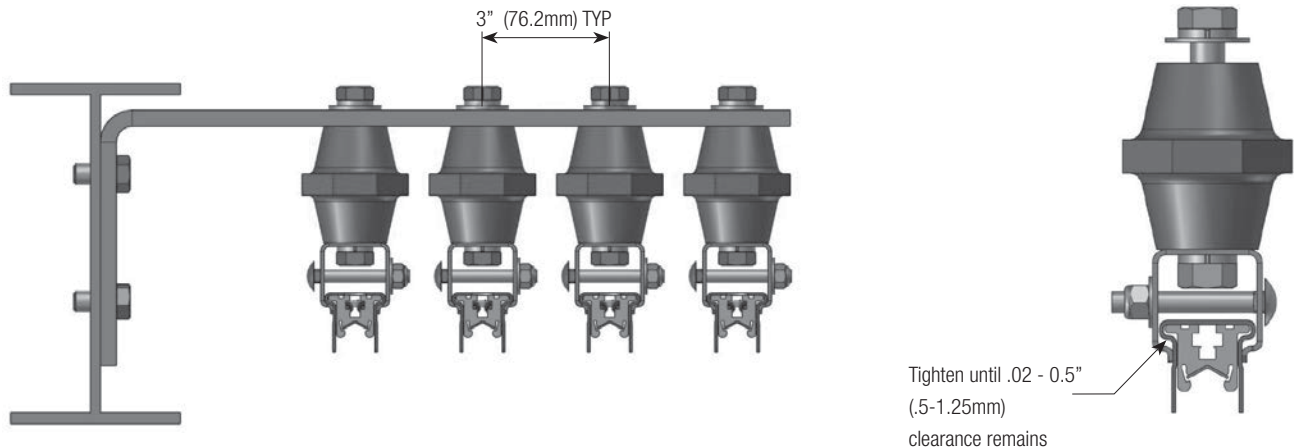
Note: Observe all alignment tolerances.

FOR CONDUCTIX BRACKETS: Hanger support brackets come complete with all necessary mounting holes for easy installation of hangers.



3.3 Installing Conductors into Hanger

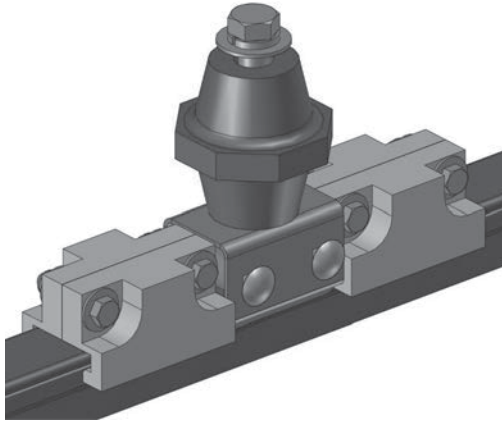
NOTE: Stainless steel hangers should be used with the appropriate insulators to avoid any shorting or ground.



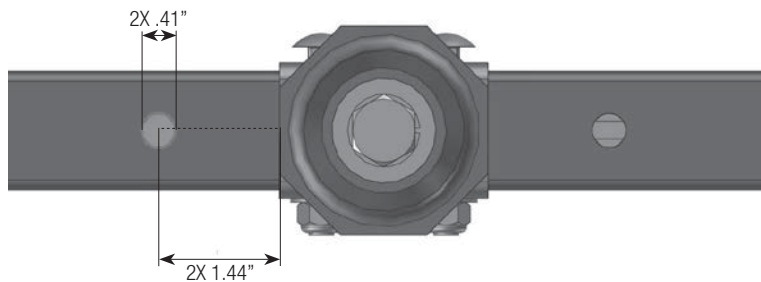
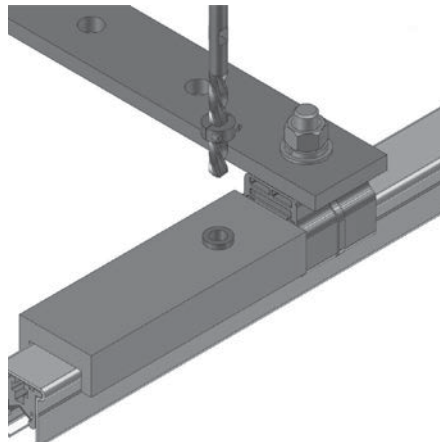
3.0 INSTALLATION & ASSEMBLY

3.4 Anchor Hanger Support Assembly

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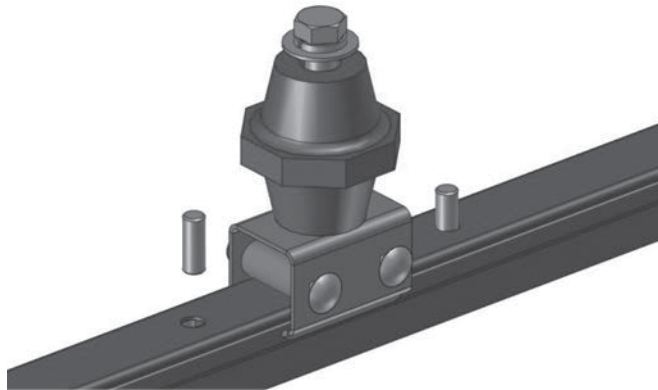
3.4.1 Using drill fixture XA-38561, drill (2) .41" holes through the top flange only of the conductor (verify correct depth by drilling scrap piece of conductor). Remove burrs and clean surface of cover from dirt and debris.



NOTE: Maximum width of bracket for anchor is 2.63" (66.8mm). If a wider bracket is used, order and install (2) hanger clamps on either side of the existing hanger clamp. The purpose of the (2) hanger clamps is to provide clearance for field drilling with the drill fixture.

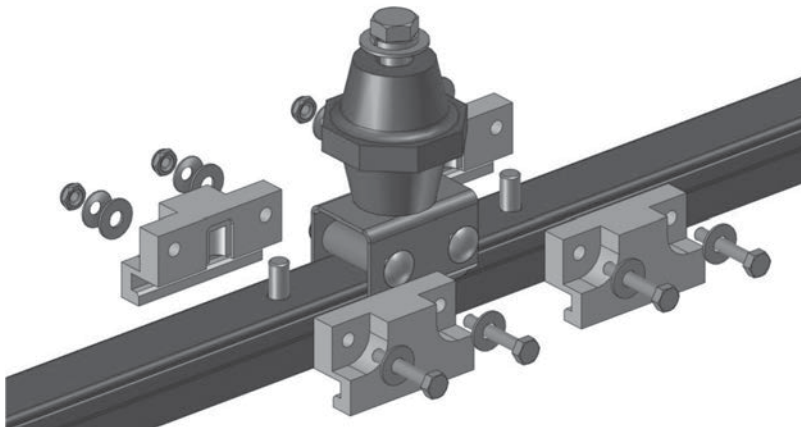
3.0 INSTALLATION & ASSEMBLY

3.4.2 Insert pins.



3.4.3 Fill cavity around pin of both clamps with RTV 5222 (by GE), or other adhesive compatible with Lexan 103 (RTV supplied by others).

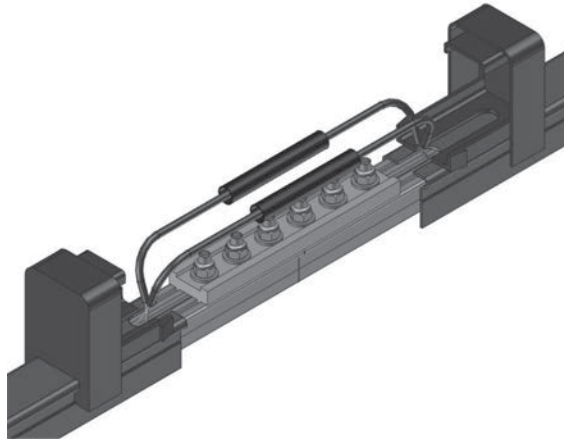
3.4.4 Insert clamp halves around the pins. Apply small amount of anti-seize (supplied by others) to the bolt threads and insert the hardware as shown. Torque to 4-5 Ft-Lb (5.4-6.7 Nm).



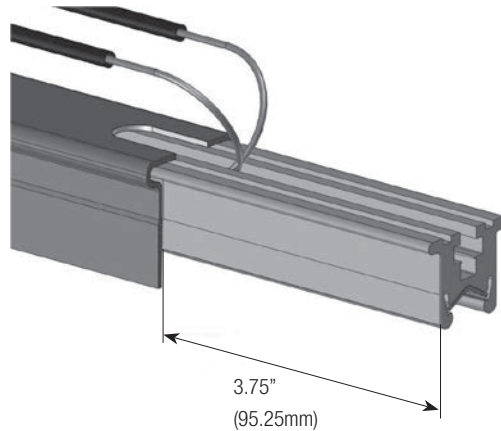
3.0 INSTALLATION & ASSEMBLY

3.5 Splice Assembly

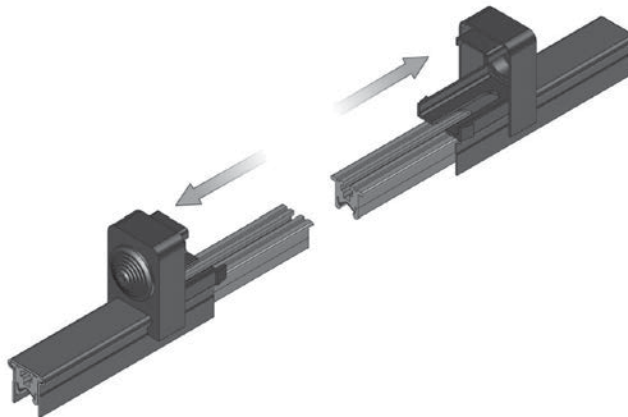
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3.5.1 Be sure the end of the conductor is cut square and free of any sharp edges. Deburr as required. Ensure the cover is cut back 3.75" (95.25mm).

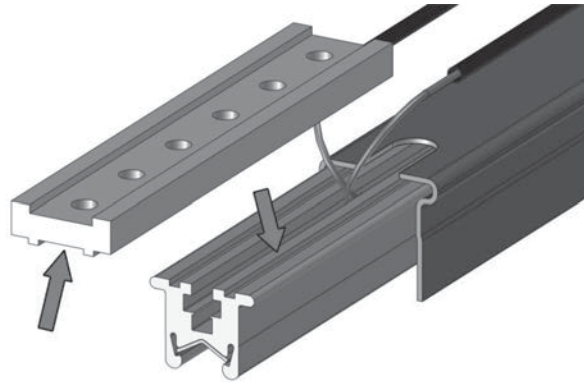


3.5.2 Slide end caps onto the conductor cover. Ensure heater wires are out of the way to prevent any damage. Note: The heater wire should not make contact with any cover and may need to be cut back to accommodate.

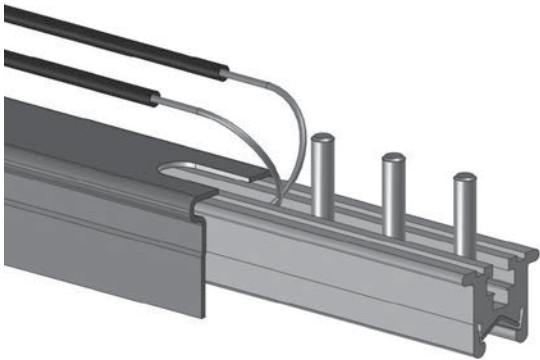


3.0 INSTALLATION & ASSEMBLY

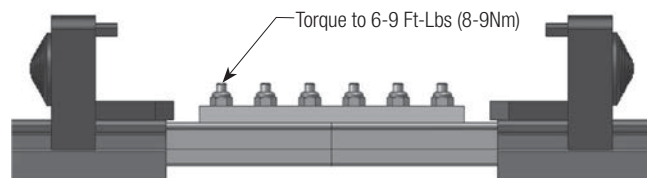
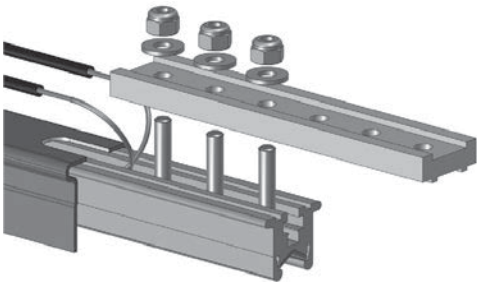
3.5.3 Clean mating surfaces with a Scotch Brite pad and apply EJC.



3.5.4 Slide (3) bolts in each conductor. Apply anti-seize to bolt threads.

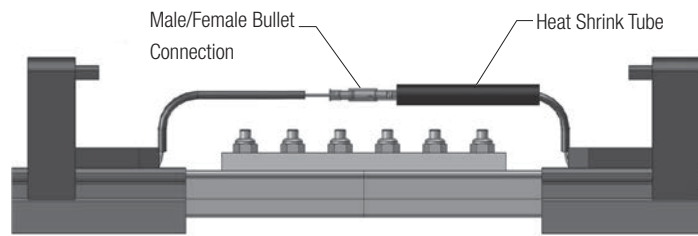


3.5.5 Place splice plate over bolts. Add washers and nuts. Torque to 6-9 Ft-Lbs (8-12Nm). **DO NOT OVER TORQUE.**



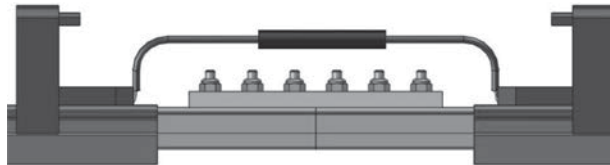
3.0 INSTALLATION & ASSEMBLY

3.5.6 Slide heat shrink tubing over the male or female end of the heater wire. Do not shrink.

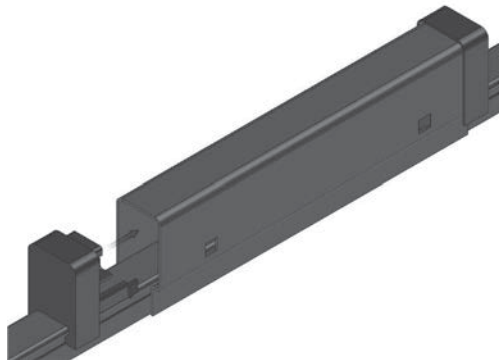


3.5.7 Connect the heater wires together using male/female bullet connectors.

3.5.8 Place heat shrink tubing over the bullet connection and shrink to secure connection.



3.5.9 Insert the overlap cover over the splice assembly and snap the end plugs into place on both sides.



3.0 INSTALLATION & ASSEMBLY

3.6 Expansion Section Assembly

3.6.1 **Locations:** The maximum allowable conductor system length without an expansion section is 390' (118M), assuming a maximum temperature range of 110°F (43°C).

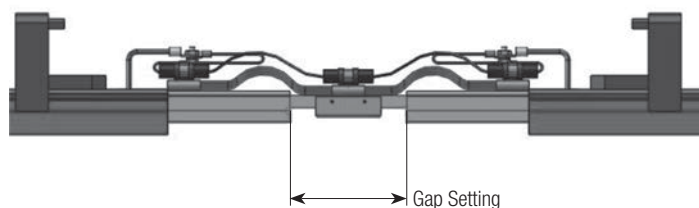
3.6.2 The maximum distance between anchor points with an expansion section at midpoint is: 230 Feet (70 Meters).

3.6.3 Set expansion gaps when installing assembly to appropriate gap setting for ambient temperature (see chart). The gap is adjusted by sliding the moving lengths of conductor in or out of the expansion assembly. Always allow sufficient time for the conductor bars to achieve ambient temperature before setting expansion gap. All expansion assemblies must be set on site; they are not pre-set before leaving the factory. Failure to set this part correctly could result in buckling of all conductors.

Table T-1

Gap Setting		Temperature Chart					
		Chart 1		Chart 2		Chart 3	
Inches	mm	°F	°C	°F	°C	°F	°C
2.00	50.8	120	48.9	110	43.3	100	37.8
2.16	54.9	115	46.1	105	40.6	95	35.0
2.33	59.2	110	43.3	100	37.8	90	32.2
2.50	63.5	105	40.6	95	35.0	85	29.4
2.66	67.6	100	37.8	90	32.2	80	26.7
2.83	71.9	95	35.0	85	29.4	75	23.9
3.00	76.2	90	32.2	80	26.7	70	21.1
3.16	80.3	85	29.4	75	23.9	65	18.3
3.33	84.6	80	26.7	70	21.1	60	15.6
3.50	88.9	75	23.9	65	18.3	55	12.8
3.66	93.0	70	21.1	60	15.6	50	10.0
3.83	97.3	65	18.3	55	12.8	45	7.2
4.00	101.6	60	15.6	50	10.0	40	4.4
4.16	105.7	55	12.8	45	7.2	35	1.7
4.33	110.0	50	10.0	40	4.4	30	-1.1
4.50	114.3	45	7.2	35	1.7	25	-3.9
4.66	118.4	40	4.4	30	-1.1	20	-6.7
4.83	122.7	35	1.7	25	-3.9	15	-9.4
5.00	127.0	30	-1.1	20	-6.7	10	-12.2
5.16	131.1	25	-3.9	15	-9.4	5	-15.0
5.33	135.4	20	-6.7	10	-12.2	0	-17.8
5.50	139.7	15	-9.4	5	-15.0	-5	-20.6
5.66	143.8	10	-12.2	0	-17.8	-10	-23.3
5.83	148.1	5	-15.0	-5	-20.6	-15	-26.1
6.00	152.4	0	-17.8	-10	-23.3	-20	-28.9

Expansion Air Gap Setting for Conductor Bars

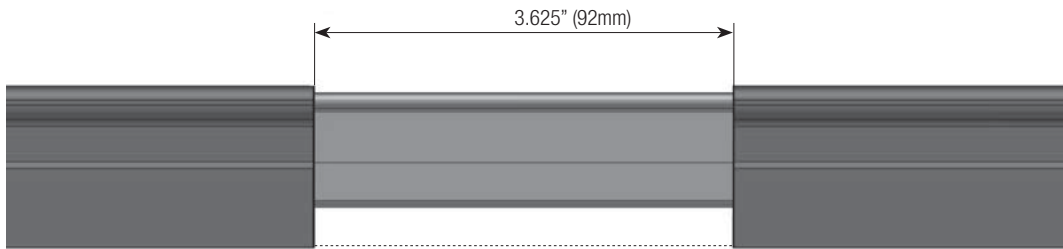


3.0 INSTALLATION & ASSEMBLY

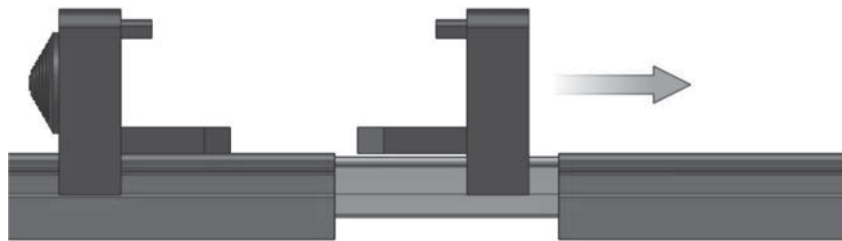
3.7 Powerfeed Assembly

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3.7.1 Cut 3.625" (92mm) section from top of cover where powerfeed is to be located.

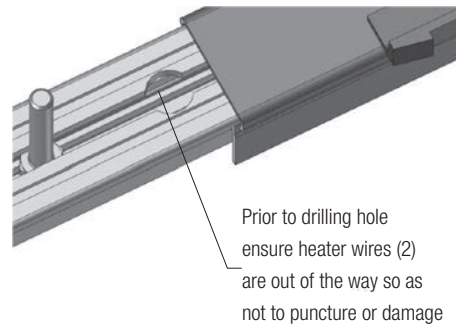
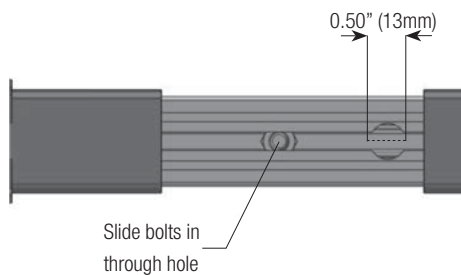


3.7.2 Attach end caps over the bare conductor and slide over top the conductor cover.



3.7.3 Ensure heater wires (2) are pushed toward the interior conductor walls. Drill 0.50" (13mm) hole in the center, just through the top of the conductor.

DO NOT DRILL INTO THE WIRE.

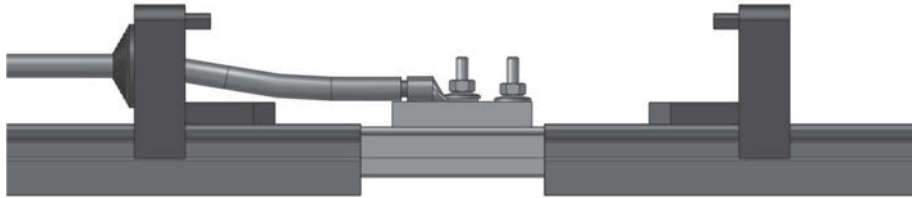


3.7.4 Clean mating surfaces with Scotch Brite pad and apply Electrical Joint Compound.

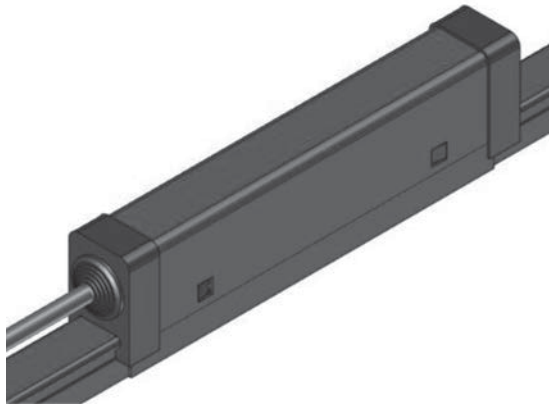
3.7.5 Insert bolt head through the hole and slide into position.

3.0 INSTALLATION & ASSEMBLY

3.7.6 Attach lug plate, lug and cable (by others), flat washer, Belleville washer, and nut. Torque to 6 Ft-Lb (8Nm).



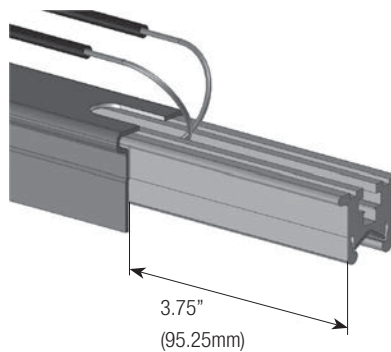
3.7.7 Install cover. Ensure end caps snap completely into position.



3.8 Center Feed Assembly

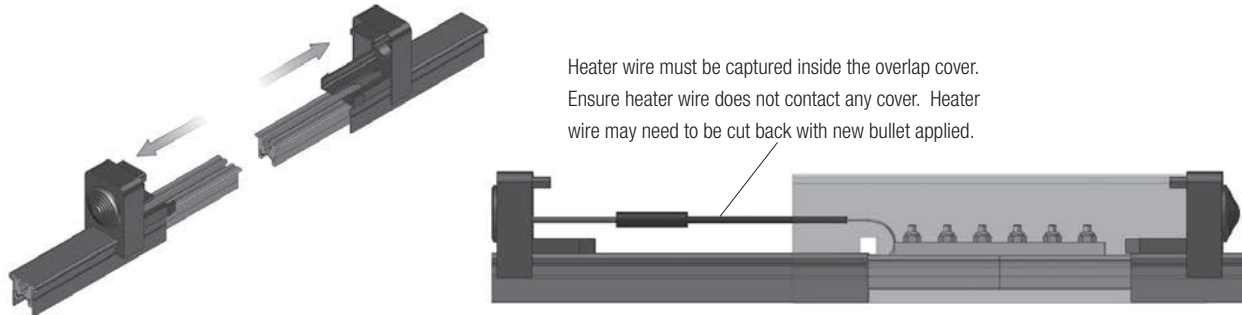
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3.8.1 Be sure the end of the conductor is cut square and free of any sharp edges. Deburr as required. Be sure the cover is cut back 3.75" (95.25mm).



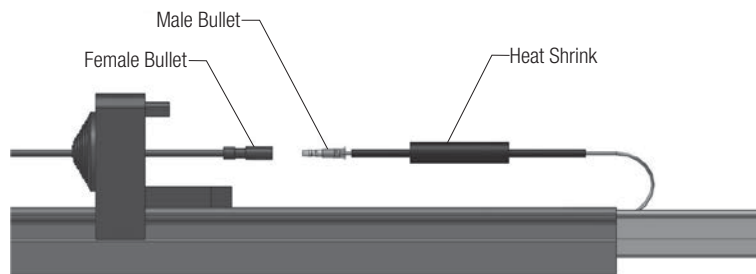
3.0 INSTALLATION & ASSEMBLY

3.8.2 Slide end caps with grommets onto the conductor cover. Ensure heater wires are out of the way to prevent any damage. Note: The heater wire will remain inside the overlap cover. The heater wire should not make contact with any cover and may need to be cut back to accommodate.



3.8.3 Cut a hole in the grommet to allow for the cold wire to connect to the heater wire.

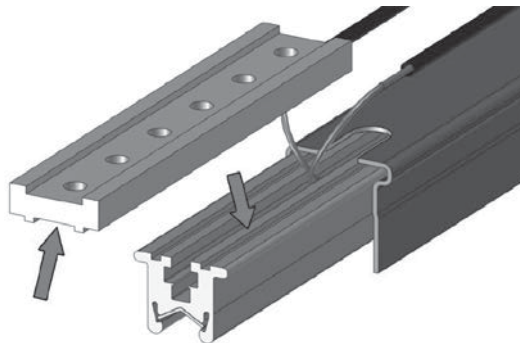
3.8.4 Slide heat shrink tubing over the heater wire. Do not shrink.



3.8.5 Connect the cold wire to the heater wire using male/female bullet connectors.

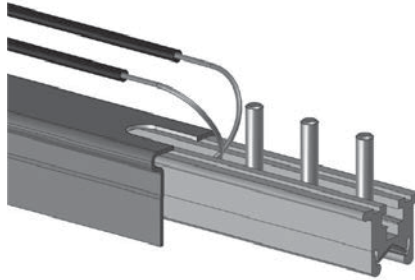
3.8.6 Place heat shrink tubing over the bullet connection and shrink to secure connection.

3.8.7 Clean mating surfaces with a Scotch Brite pad and apply EJC.

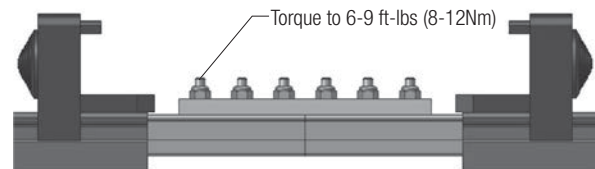
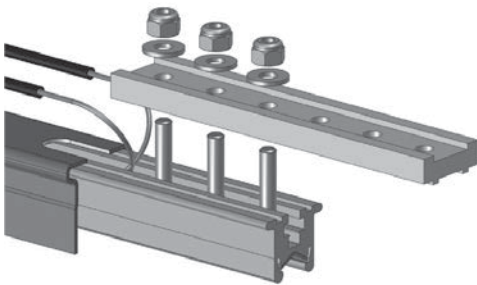


3.0 INSTALLATION & ASSEMBLY

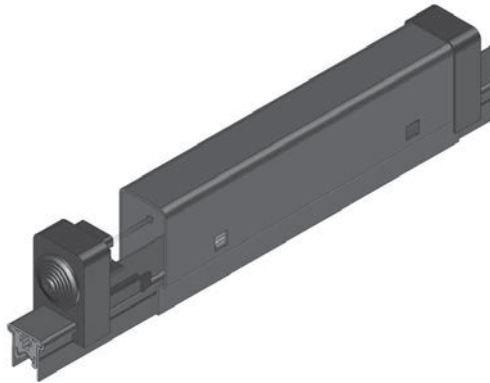
3.8.8 Slide (3) bolts in each conductor. Apply anti-seize to bolt threads.



3.8.9 Place splice plate over bolts. Add washers and nuts. Torque to 6-9 Ft-Lbs (8-12Nm). DO NOT OVER TORQUE.

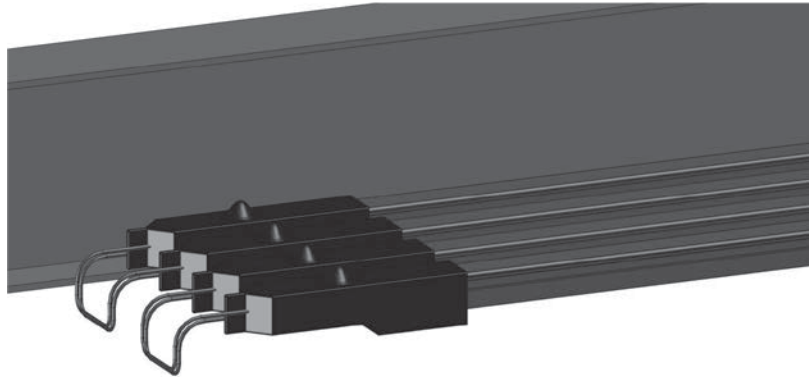


3.8.10 Insert the overlap cover over the splice assembly and snap the end plugs into place on both sides.



3.0 INSTALLATION & ASSEMBLY

3.9 End Loop Connection



Tools required: Heat gun, 3/8" wrench.

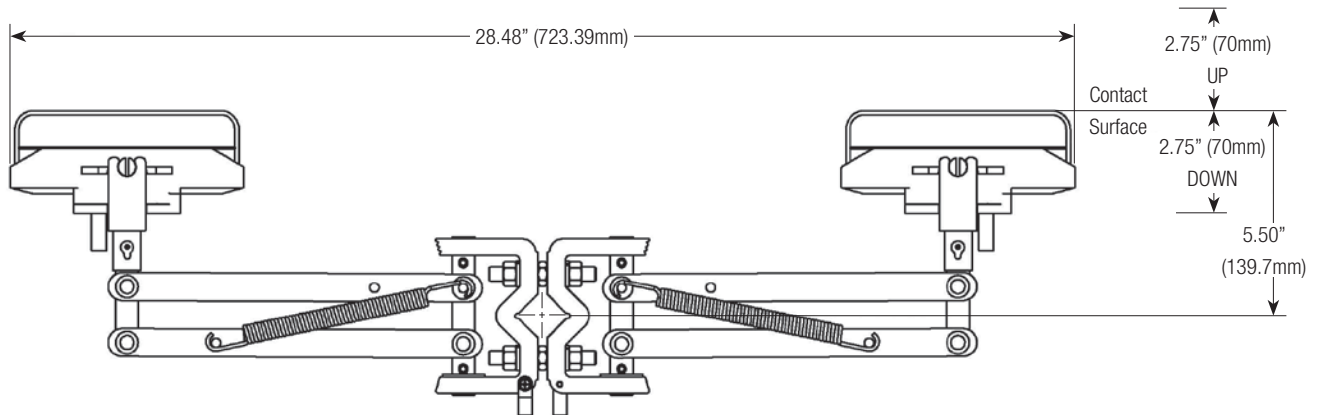
- 3.9.1 Position bolt and nut of end cover assembly 3.0" (76.2mm) in from the end of the conductor. Torque to 4-5 Ft-Lbs (5.5-7Nm).
- 3.9.2 Slide heat shrinkable tubing from end cover assembly over conductor bar. Do not shrink.
- 3.9.3 Slide heat shrinkable tubing over bullet on heater wire. Do not shrink.
- 3.9.4 Connect heater wire bullet to cold wire/end loop bullet ensuring that it snaps fully home.
- 3.9.5 Position heat shrinkable tubing centrally over bullet assembly and gently heat until it has encapsulated bullet assembly. Do not overheat tubing.
- 3.9.6 Repeat the above for each conductor bar (refer to the diagram selected for this system).
- 3.9.7 Place end cover heat shrinkable tubing over the ends of the conductor bar. Gently heat until it has encapsulated the conductor bar and cold wire/end loop per the dimensions shown on the end cover assembly drawing (sent with parts).

3.0 INSTALLATION & ASSEMBLY

3.11 Collector Mounting Details

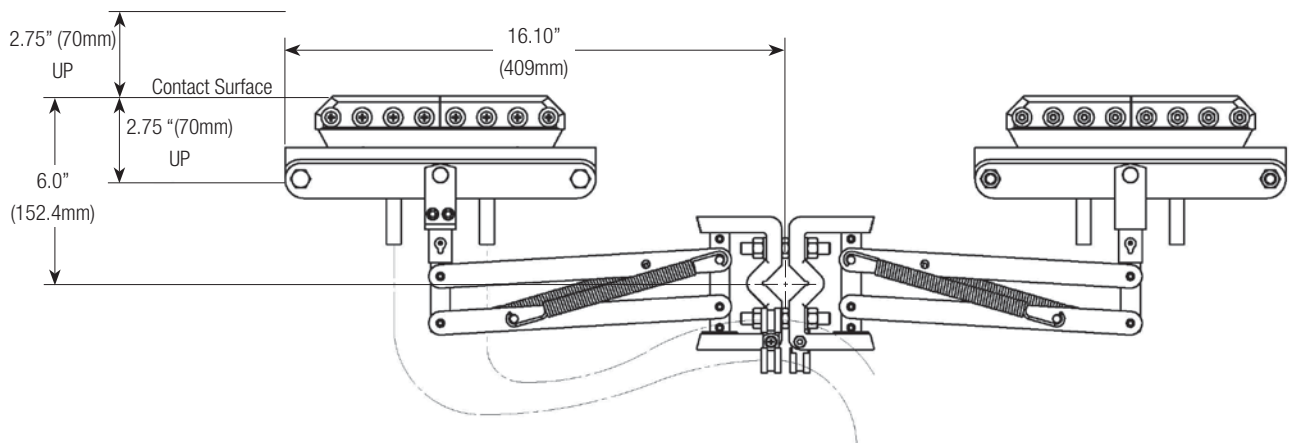
XA-30389

This tandem collector is rated for 250 Amps.



XA-24061

This tandem collector is rated for 400 Amps.



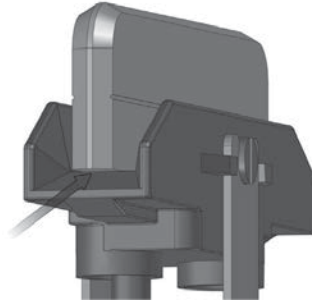
- 3.11.1 Fix collector mounting bracket to a suitable support at the correct setting height (see diagram).
- 3.11.2 Place collector on the mounting bracket. Ensure collector is aligned with its corresponding conductor.
- 3.11.3 Tighten nuts to Conductix recommended torque of 8-10 Ft-Lb (10-13.5Nm).

3.0 INSTALLATION & ASSEMBLY

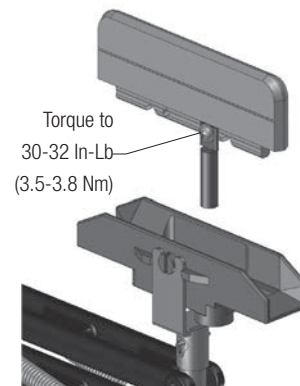
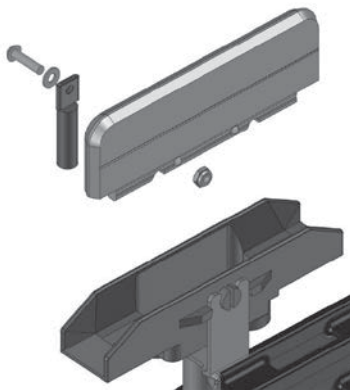
3.12 Shoe Replacement

XA-30516

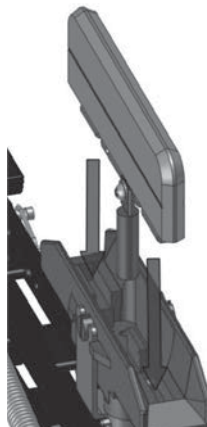
3.12.1.1 Lift shoe out of case with a flat head screw driver.



3.12.1.2 Remove screw, washer, and nut. Replace shoe. Re-attach hardware and torque to 30-32 In-Lb (3.5-3.8Nm).



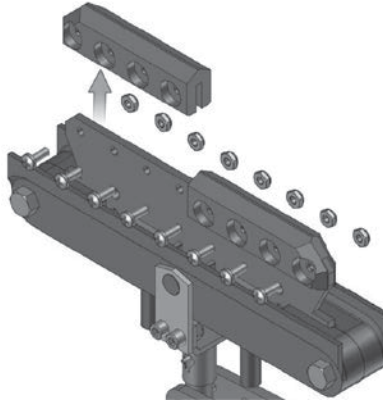
3.12.1.3 Ensure shoe snaps into case completely.



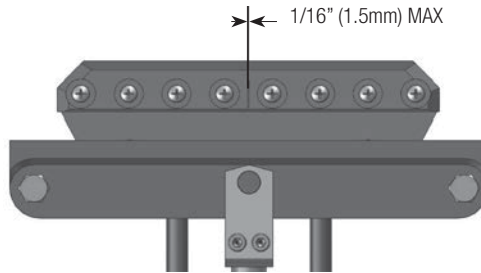
3.0 INSTALLATION & ASSEMBLY

XA-11417

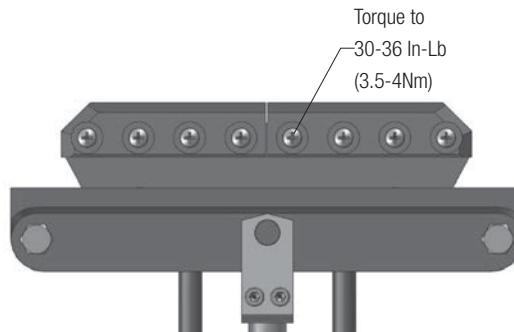
3.12.2.1 Remove screws and nuts from shoe holder assembly. Replace shoes and hardware.



3.12.2.2 Align shoe contact surfaces; sand halves to align, if required. Ensure the gap between the two shoe halves is 1/16" (1.5mm) or less. Torque to 30-36 In-Lb (3.5-4Nm).



3.12.2.3 Torque to 30-36 In-Lb (3.5-4Nm).



4.0 MAINTENANCE

4.1 Inspection & Maintenance Background

- 4.1.1 Proper system performance and reliability require thorough periodic system maintenance. Each component of the system must be inspected, as a minimum, annually. Many components require more frequent inspection and possibly maintenance. Bolt torque, cable connection integrity, insulating material integrity, and collector alignment and shoe wear among the primary areas of concern.
- 4.1.2 **WARNING: ALL POWER MUST BE DISCONNECTED FROM THE GUIDEWAY PRIOR TO PERFORMING ANY INSPECTION OR MAINTENANCE. PROPER LOCK OUT/TAG OUT PROCEDURES MUST BE FOLLOWED.**
- 4.1.3 Should questions or concerns arise regarding the condition of the system or its components, call Conductix Corporation at (800) 521-4888.

4.2 Inspection & Maintenance Frequency

Component	Frequency
Covers	Semi-Annually
Hanger Clamps	Semi-Annually
Conductor	Semi-Annually
Splice	Semi-Annually
Anchor	Semi-Annually
Expansion	Semi-Annually
Power Feed	Semi-Annually
End Cap	Semi-Annually
Collector Assemblies	Quarterly

4.3 Inspection & Maintenance of Covers

- 4.3.1 All covers (conductor and component overlap covers) shall be inspected semi-annually.
- 4.3.2 The integrity of the cover is critical. Damage to the cover in the form of cracks, splits, or holes requires replacement.
- 4.3.3 Inspect the visible outside surfaces of the conductor and overlap covers for signs of damage. Replace as necessary.

4.4 Inspection & Maintenance of Hanger Clamps

- 4.4.1 Check the hanger clamps to ensure there is no damage to the stainless steel hangers. Replace components as necessary.
- 4.4.2 Check bolt torque per drawing. This can be a random sampling of 2 hanger clamps between each set of anchors (distance between anchors is approximately 195' (59.4m) from the starting end and succeeding anchor points at 230' max (70.2m). If the hardware is loose contact conductix for torque specifications.

4.5 Inspection & Maintenance of Conductor

- 4.5.1 All conductors shall be inspected semi-annually.
- 4.5.2 Inspect the contact surfaces and open area inside the cover for any debris and abnormal wear in 150' (45.7m) intervals. This will give a good overall indication of the degree of debris accumulations throughout the system.

4.0 MAINTENANCE

4.6 Inspection & Maintenance of Splice

- 4.6.1 Remove covers and check bolt torque.
- 4.6.2 If bolts are loose, remove the splice plate and check for signs of burning or arcing between the conductor and splice plate. Replace damaged components as required following the installation instructions. Apply conductive grease when reinstalling splices.
- 4.6.3 Check overlap covers and end caps for signs of damage. Replace as required.

4.7 Inspection & Maintenance of Anchor Clamps

- 4.7.1 Check the anchor clamps to ensure there is no damage to the stainless steel hangers. Replace components as necessary.
- 4.7.2 Check bolt torque per drawing. This can be a random sampling. If the hardware is not at a minimum of 4-5 FT-LBS (5.5-6.8Nm), all the hardware must be checked and/or properly torqued.

4.8 Inspection & Maintenance of Expansion

- 4.8.1 All expansions shall be inspected semi-annually.
- 4.8.2 Inspect the contact surfaces and open area inside the cover for any debris and abnormal wear. Verify there are no obstructions in the slots that will inhibit movement. Grab the slider and determine if it is loose. Look for evidence of shoes hitting slider. This could indicate that the slider has come loose and will make shoes jump out of contact with conductor. The slider may have to be replaced.

4.9 Inspection & Maintenance of Power Feed

- 4.9.1 Remove covers and check bolt torque. If bolts are loose, remove the splice plate/lug plate and check for signs of burning or arcing between the conductor and splice plate/lug plate. Replace damaged components as required following the installation instructions. Apply conductive grease when reinstalling splices. **Check overlap covers and end caps for signs of damage. Replace as required. Check to ensure the grommets are located securely in the end plugs. Check cable for abrasion or damage to the jackets. Replace as required.**

4.10 Inspection & Maintenance of End Cap

- 4.10.1 Inspect the end cap for damage in the form of splits or holes. Replace as necessary.

4.11 Inspection & Maintenance of Collector

Inspect quarterly for signs of cracks, wear, damage, dirt accumulation, or anything that would indicate an item, or the assembly, needs to be replaced. At a minimum, the inspection should include:

4.11.1 Collector Arms

- 4.11.1.1 Inspect for cracks, deformation, or any other evidence of damage. Check the collector pivot points are free from any contamination. Collector arm should be replaced at least every 5 years.

4.11.2 Mounting Bracket & Bolts

- 4.11.1.2 Collector mounting base is square on the vehicle and it is aligned with the conductor.

4.0 MAINTENANCE

4.11.3 Tension spring

- 4.11.3.1 Spring is properly positioned on the pin in the base. Contact force and nominal distance between the mounting surface and contact surface. A “fish scale” may be used to verify contact force of 6-8 lbs (26.5-35.5N). Hook the scale on the collector arm as close to the shoe-end of the collector. Pull the scale. The contact force is the force at which the arm begins moving away from the conductor. Replace if spring tension is not correct.

4.11.4 Spring Pins

- 4.11.4.1 Inspect for cracks, deformation, or any other evidence of damage. Verify all are in place.

4.11.5 Cables

- 4.11.5.1 Cable length between lug on shoe and cable clamp on arm is per the drawing. Cable routing to vehicle must allow free movement of collector throughout its complete range of motion. Check that cables are properly terminated to the vehicle (specification by others).
- 4.11.5.2 Inspect the cables weekly for damage or abrasions. Ensure the electrical connections are solid and the bolted connections and the lugs are tight.

4.11.6 Shoe Holder

- 4.11.6.1 Inspect for cracks, deformation, or any other evidence of damage.
- 4.11.6.2 Inspect the shoes weekly for wear and damage. Replace the shoes when the height, measured at any location along the shoe, is 3/16" (4.75mm) or less.
- 4.11.6.3 If a broken shoe is found, inspect the system for the cause. Broken shoes usually result from:
- Insufficient contact force causing the shoe to bounce excessively. Replace the spring as required.
 - Gaps at a splice joint. Loosen splice hardware and butt conductors. Tighten fasteners and re-torque.
 - Misalignment between adjacent conductors. Realign as required.
 - Misalignment between the vehicle and guideway pulling the collector beyond its maximum horizontal and/or vertical envelope. This usually happens around curves in the guideway or in locations where hanger clamps and/or mounting brackets are not properly aligned. Realign as necessary. The base of the collector should be directly in line with its associated conductor.
 - Inspect the shoes for uneven wear on a monthly basis until a wear pattern can be established. Uneven wear can be an indication of insufficient contact force or bias on a shoe due to cable routing, incorrect location of the tension spring, or misalignment. Uneven shoe wear, if not corrected, can wear the side of the aluminum bar resulting in the stainless steel contact surface coming loose. Both ends of the shoe must be checked for uneven wear.

4.0 MAINTENANCE

4.11.7 Collector Shoe Replacement

4.11.7.1 Due to a wide variety of applications and environmental conditions, no time frame is given for shoe replacement. It is recommended, however, that the customer do periodic inspections of the collector heads to check for shoe wear. If the remaining shoe height is less than 3/16" (4.75mm), the shoe should be replaced immediately. The shoe should also be immediately replaced if the shoe shows signs of overheating, is pitted, cracked, or chipped. If the wear pattern on the shoe is more than 10 degrees off of even, the shoe should be replaced and the collector mounting position should be re-evaluated.

4.11.7.2 Several conditions may lead to accelerated shoe wear. The most common conditions are:

1. A loss of contact with the conductor surface creates an overheating situation which will cause pitting in the conductor surface. This pitting further reduces electrical contact, exacerbating the overheat condition and in turn, creates more pitting. Improper installation may prevent the collectors from maintaining adequate contact with the conductor contact surface along part or all of the complete length of the runway. This may be due to:
 - a. Poor alignment of the conductor mounting brackets in the vertical and horizontal places. In this case the collectors don't have enough travel to maintain good contact because the conductors don't stay within the optimal contact range of the collector.
 - b. Improper location of the collector mounting bracket relative to the conductor (too close or too far away). Too far away creates too little contact pressure and too close may cause the shoe to nose, or drag on one end.
 - c. Restricted movement of collector heads. It is essential that the collector pigtails (feed cables) to the shoes have adequate free loop to allow rotation of the collector head throughout the full range of motion. Too short pigtails can prevent good shoe contact and cause loss of contact.
 - d. Loosening of conductor joints. When too few expansion sections are used or when anchor clamps are loose, the conductor joints may separate. The gaps in the conductor contact surface caused by this separation can shave the shoes down and cause premature wear. If not detected in time, poor contact may result, creating overheating, pitting of the conductor, etc.
2. Contaminates in the environment may accumulate on the conductor contact surface contributing to overheating, pitting, etc. Some contaminants may be abrasive, increasing the rate of shoe wear. In environments that are subject to considerable buildup of dust, especially conductive dust, remove the dust at regular intervals by brushing.
3. Corrosive elements may create deposits on the collector shoe and/or the conductor contact surface that decrease conductivity at the sliding contact surface. Under severely corrosive conditions, the copper graphite shoes may be corroded to the point where less than half of the shoe is remaining, decreasing the available contact surface area and causing overheating and pitting.
4. Infrequent maintenance of the collectors can lead to prematurely worn shoes, poor contact, pitting, etc.

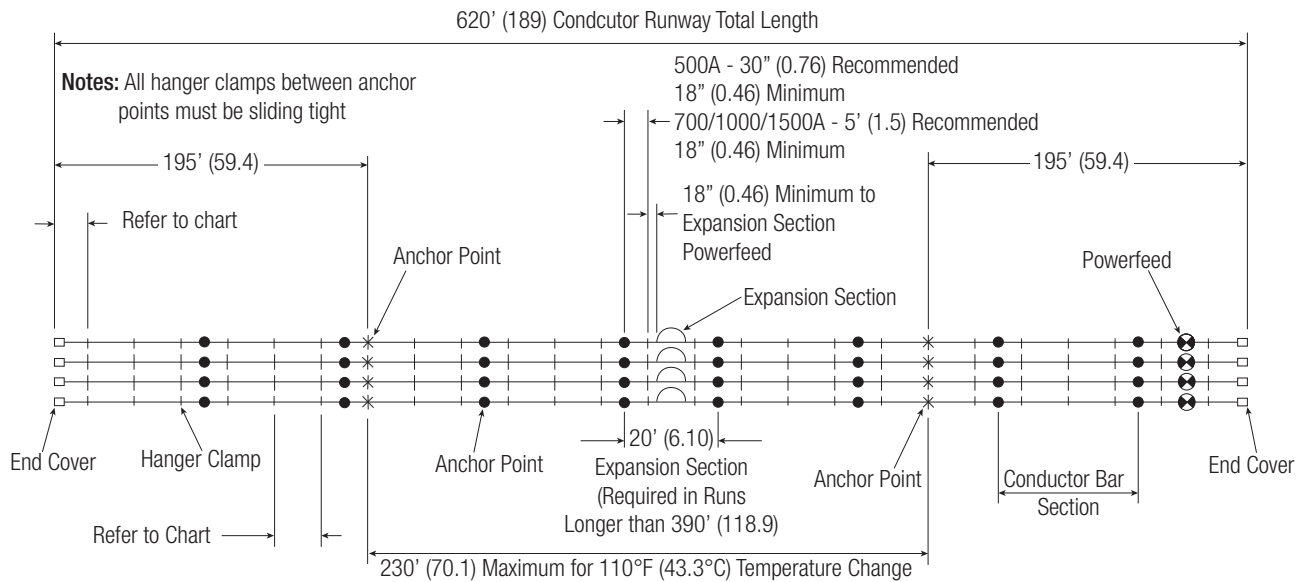
5.0 TROUBLESHOOTING

Problem	Possible Cause(s)	Possible Solution(s)
Overheating/Burning Conductor	Loose splice	Disassemble component, clean mating surfaces, apply EJC, and re-torque hardware replacing Belleville washers and nuts.
	Loose power feed and/or lug(s)	
	Overloading	Check electrical loading by doing a load survey. Rectify if not according to system parameters.
Arcing/pitting on the Stainless Steel Insert at a splice.	Loose splice	Disassemble component, clean mating surfaces, apply EJC, and re-torque hardware replacing Belleville washers and nuts.
	Misaligned conductors resulting in the copper shoe losing contact	Disassemble component, clean mating surfaces, apply EJC, realign conductors and re-torque hardware.
Arcing/pitting on the Stainless Steel Insert	Collector not making good contact with conductor	Check alignment of conductor with respect to vehicle. Adjust position of hanger clamp and/or hanger bracket. Verify contact force of collector is 6-7 lbs. Replace tension spring on collector arm.
		Investigate stainless steel insert for debris and/or misaligned splice joints causing collector to bounce. Remove debris and/or align conductor in splice.
		Check vehicle's running surface for anything causing sudden lurch of the vehicle or excessive vibration. Adjust as necessary.
Arcing/pitting on the Stainless Steel Insert at an Isolation.	Large voltage potential between both sides of the isolation.	Check for debris and/or misaligned isolation joint causing the collector to bounce. Remove debris and/or align conductors adjusting for a smooth transition of the collector shoe as required.
		Splice short pieces of conductor on either side of the isolation that can be easily replaced when worn out. Compare voltage drop from feed points on either side of the isolation.
		Adjust the location of the power feeds if possible
Conductor Binding/Snaking in between Hanger Clamps	Hanger clamp not "square" with the conductor	Loosen hardware on hanger clamp, make square with conductor and retorque. Check for debris and/or crack in cover impeding expansion and contraction of conductor. Remove debris with compressed air and/or water. Replace cover if necessary.
	Expansion gap set incorrectly	Measure expansion gap and adjust according to the gap setting chart.
	Anchor clamp not tight	Check torque of the hardware on the anchor. Retorque as required. Check anchor clamps and verify none are cracked or fractured. Replace as necessary.

5.0 TROUBLESHOOTING

Problem	Possible Cause(s)	Possible Solution(s)
Shoe Chipping on Leading Edge	Misaligned splice, power feed, and/or isolation	Check alignment of conductor joints at splice, power feed, and isolations by running a shoe across the joint by hand. Adjust alignment of conductors as required.
	Insufficient contact force of shoe on conductor resulting in the shoe "tipping" up on the bar and impacting the leading edge.	Verify correct position of collector base to contact surface then measure the contact force of the shoe on the conductor with a spring scale. Contact force should be 6-7 lbs (26.5-31N). Replace spring if necessary.
Excessive Shoe Wear	Misaligned splice, power feed, and/or isolation	Check alignment of conductor joints at splice, power feed, and isolations by running a shoe across the joint by hand. Adjust alignment of conductors as required.
	Arcing/pitting on the stainless steel creating a rough surface	See "Arcing/pitting on the Stainless Steel Insert" above.
Uneven Shoe Wear on Leading vs. Trailing Edge	Insufficient contact force of shoe on conductor resulting in the shoe "tipping" up on the bar and impacting the leading edge.	Verify correct position of collector base to contact surface then measure the contact force of the shoe on the conductor with a spring scale. Contact force should be 6-8 lbs (26.5-35.5N). Replace spring if necessary.
	Misaligned splice, power feed, and/or isolation impacting shoe in one direction	Check alignment of conductor joints at splice, power feed, and isolations by running a shoe across the joint by hand. Adjust alignment of conductors as required.

6.0 EXAMPLE OF SYSTEM



Legend

	Conductor Bar		End Cover
	Splice Joint		Hanger Clamp
	Expansion Section		Anchor Location
	Pickup Guide or Expansion Section		Powerfeed

Hanger Spacing Chart

System	First Hanger	Max. Hanger Spacing
500 Amp	2'-6" (0.76)	5.0' (1.5)
700 Amp	3'-9" (1.14)	7'-6" (2.29)
1000 Amp	5.0' (1.5)	10.0' (3.05)
1500 Amp	5.0' (1.5)	10.0' (3.05)

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